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BULLETINS
OF
AMERICAN
PALENOTOLOGY

VOL. LIII

1967

Paleontological Research Institution
Ithaca, New York 14850
U. S. A.

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BULLETINS
OF
AMERICAN
PALEONTOLOGY
(Founded 1895)

Vol. 53

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SOME LATE CENOZOIC BRYOZOA FROM CABO BLANCO, VENEZUELA

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Paleontological Research Institution
Ithaca, New York, U.S.A. 14850

PALEONTOLOGICAL RESEARCH INSTITUTION

1966 - 1967

BULLETINS OF AMERICAN PALEONTOLOGY
and
PALAEONTOGRAPHICA AMERICANA

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Library of Congress Catalog Card Number: GS 67-133

Printed in the United States of America

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SOME LATE CENOZOIC BRYOZOA FROM CABO BLANCO, VENEZUELA

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ABSTRACT

Twenty-eight species of Bryozoa in the order Cheilostomata are described, illustrated, and compared. Of this number, 14 are fossil and 14 are Recent. One is both fossil and Recent. Thirteen of the fossils are from the Playa Grande and Mare Formations (Lower Pliocene), and one is from the Abisinia Formation (Lower Pleistocene). Nine of the 28 species are described as new, and of those, three are Recent and six fossil. The new Recent species are *Setosella antilleana*, *"Schizoporella" mamoensis*, and *Rhynchozoon caribense;* the fossils are *Membranipora tacaguana*, *Cellaria catiana*, *Hippopodinella venezuelana*, *Rhynchozoon caboblanquense*, *Trematooecia cheethami*, and *Anoteropora ? triovicellata.*

A statistical tabulation of the fossils from the Cabo Blanco Group, arranged under the hierarchy of "Class", is presented to show the percentages of species in each formation that have survived to Recent time. It is suggested that similar tabulations or "mortality" tables based on all organisms within standard sections throughout the world would enable us to delimit more sensitively the chronologic divisions of the Cenozoic era—divisions first established by Lyell from the phylum Mollusca.

The citations in the Bibliography of this paper deal primarily with Cenozoic cheilostomatous Bryozoa (Ectoprocta), but other references are included that are considered germane to the present work.

INTRODUCTION

In 1955 and 1956, which were the last two of fourteen consecutive years of residence in Venezuela, I spent week-ends mapping the geology of, and collecting from, the Cabo Blanco area, a region situated along the coast between the towns of Maiquetía and Catia La Mar in the Distrito Federal, north of the capital city of Caracas. In this region there is an east-west chain of hills, here referred to as the Cabo Blanco hills, having a length of approximately 8 kilometers (5 miles), a maximum width of 2.4 kilometers, and a maximum elevation of about 135 meters (443 feet). The hills are deeply dissected but are modified at a number of levels by benches and terraces. On the north, the hills are immediately adjacent to the Caribbean Sea; on the south they are separated from the Coast Range by a narrow east-west valley east of the Río Tacagua, but in, and in places west of the Tacagua, the strata of the Cabo Blanco hills are in contact with the metamorphic rocks of the Coast Range foothills. The Cabo Blanco hills are made up of middle Tertiary, Pliocene, Pleistocene, and sub-Recent sediments, incorporated under the name of Cabo Blanco Group (Weisbord, 1957). The Pliocene and the marine Pleistocene strata of the group are fossiliferous, and

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since 1957, after having worked out the stratigraphy and structure of the Cabo Blanco area, I have been engaged in a taxonomic study of the invertebrate fossils, as well as of the Recent forms that were collected on the beach in front of the hills. The classes of invertebrates described thus far have been the gastropods (1962), the pelecypods (1964), the scaphopods and serpulid polychaetes (1964), and the cirripeds or barnacles (1966). The present paper deals with the fossil and Recent cheilostomatous Bryozoa which were recovered from the same material containing the other invertebrates noted above.

Though the literature on late Cenozoic Bryozoa is voluminous, only two papers dealing with Venezuela proper have been published, one by Osburn (1947) and the other by Lagaaij (1963b). Osburn's important monograph on the "Bryozoa of the Allan Hancock Atlantic Expedition" was concerned only with the living forms found in Venezuelan waters (Gulf of Venezuela, Cubagua, Tortuga, Coche, and Margarita), and in that work Osburn described 6 species of Venezuelan Entoprocta, one ctenostome, and 57 cheilostomes. Lagaaij's superb paper titled "*Cupuladria canariensis* (Busk) — portrait of a bryozoan", dealt with the fossil occurrence and ecology of that species in various localities of Venezuela, including Cabo Blanco, and so far as I am aware this is the first published account of a late Cenozoic (lower Miocene to Pliocene) bryozoan found in Venezuela. In this present work 28 species of Bryozoa are described, compared, and illustrated, and of that number 14 are fossil, 14 are Recent, and one is both fossil and Recent.

The synonymy of a particular species dealt with in this paper is, in effect, a list of references to that species, and rests on the authority of the taxonomist responsible for its identification. Under the heading Bibliography, most of the citations pertain to publications dealing with Cenozoic cheilostomatous Bryozoa throughout the world, though other listings are included that are considered related in one way or another to the subject at hand.

The types and specimens illustrated in the present work have been deposited with the Paleontological Research Institution, Ithaca, New York. The remaining duplicate material is stored in the Department of Geology, Florida State University, Tallahassee, Florida.

ACKNOWLEDGMENTS

In the writing of this paper I have been helped by, and am indebted to, Daniel E. Shier of Florida State University; Ernst Marcus of the Universidade de São Paulo; Robert Lagaaij of Koninklijke/Shell Exploratie en Produktie Laboratorium; Alan H. Cheetham of Louisiana State University; and Katherine V. W. Palmer of the Paleontological Research Institution. I am also grateful to the National Science Foundation for supporting this study through its Research Grant GB-1676.

Dr. Shier, on his own initiative, made a preliminary identification of a number of the Venezuelan species, and allowed me the use of his fine west Florida collection of Bryozoa which he has since donated to the Geological Department of Florida State University. Dr. Marcus has been most gracious and encouraging in his correspondence, and he has provided me with several of his publications which are out of print and difficult to obtain. Dr. Lagaaij, who is one of the few paleontologists with a field acquaintanceship of the Cabo Blanco area, has corresponded with me on some of the taxonomic problems, and was good enough to donate from his own collection two fine specimens of fossil Bryozoa from Cabo Blanco. Dr. Cheetham has carefully gone over my collection, and I am deeply obligated to him for his critical analysis of the taxonomy and for suggesting certain revisions which have been incorporated in the present work. I have also had the opportunity of comparing the Venezuelan material with his important collection of Pleistocene Bryozoa from the mudlumps of Louisiana. Needless to say this contribution of mine is the better for Cheetham's hand in it. Dr. Palmer has again found time, despite the enormous inroads on her energy in moving the Paleontological Research Institution to its recently acquired building, to attend to the details connected with the publication of this paper.

The pencil drawings were done by Judith Ann Schevo, a student at Florida State University. All of the photographs were taken and processed by Hal F. Riehle except the one on Plate 4 which was taken, in the nature of an experiment, through a binocular microscope, and enlarged some 90 times, by Ken Richards, photographer at Florida State University.

THE CABO BLANCO GROUP

STRATIGRAPHIC TABLE

The fossil Bryozoa described in this paper were found in the Playa Grande and Abisinia Formations of the Cabo Blanco group, the stratigraphy of which, as presented by Weisbord (1957), is summarized in the following table.

Formation	Member	Thickness (meters)	Description
		3 (max.)	Bench-forming beach rock, and reworked clays, sands, and gravels. Sub-Recent and Quaternary.
		Disconformity	
Abisinia		13 (max.)	Clays, silts, sands, and gravels. Locally with fossils. Lower Pleistocene.
		Disconformity	
Mare		19 (max.)	Friable coarse sandstones at base, soft siltstones above. Highly fossiliferous. Lower Pliocene.
		Angular unconformity to disconformity	
Playa Grande	Maiquetía	68+	Shales, siltstones, calcareous sandstones, and conglomerates. Bioherms of coralline algae. Invertebrate fossils moderately abundant. Lower Pliocene.
		Fault	
	Catia	156-233	Calcareous siltstones and sandstones, conglomerates, some shales and impure limestones, and occasional coquinas. Fossils, sometimes as molds and casts. Lower Pliocene.
		Angular unconformity	
Las Pailas		375+	Nonfossiliferous mudstones, siltstones, sandstones, and conglomerates. Middle Tertiary.

COLLECTING LOCALITIES

All of the stations in the Cabo Blanco area at which invertebrates were collected are listed below, and in this list is included the Bryozoa. The fauna from station "A" is Recent, but from all of the others it is fossil. The localities are shown on the geologic map accompanying the writer's paper (Weisbord, 1957), and on this map there are a number of field stations marked by the letter "W" to which the appropriate locality mentioned here refers. The letter preceding the stations given below is also used as a prefix for each species number in the collection. The formation and lithology pertaining to each locality are noted.

A. Beach at Playa Grande Yachting Club, Distrito Federal. Recent. Medium-grained, mostly noncalcareous sand and beach rock.

D. Eastern edge of Playa Grande village at W-30. Abisinia Formation. Granule to pebble gravel.

E. Approximately 215 meters [corrected distance] south-southwest of the crossing of Quebrada Mare Abajo and coast road, and 90 meters southwest of W-12. Mare Formation. Coarse unconsolidated sandstone grading upward to soft siltstone.

F. Hillside above west bank of Quebrada Mare Abajo at W-14. Upper Mare Formation. Soft, fine-grained sandstone.

G. Hillside above west bank of Quebrada Mare Abajo near W-14. Mare Formation. Soft, tan, fine-grained sandstone.

H. Fifteen meters south of axis of Punta Gorda anticline near W-25. Mare Formation. Highly fossiliferous wedge of unconsolidated calcareous sandstone.

I. Hillside above west bank of Quebrada Mare Abajo at W-13. Lower Mare Formation. Coarse sand or grit.

J. Small stream 100 meters west of Quebrada Mare Abajo. Lower Mare Formation. Coarse sand or grit.

K. Bluff 125 meters west of the intersection of the Playa Grande Yachting Club road and coast road, and about 95 meters due south of the shoreline. Playa Grande Formation (Catia Member). Tan, fine-grained calcareous sandstone.

L. South side of Playa Grande road about 220 meters west of W-15. Playa Grande Formation (Catia Member). Brown, fine-grained, calcareous sandstone.

M. South side of Playa Grande road at W-15, 40 meters southeast of the intersection with the Playa Grande Yachting Club road. Playa Grande Formation (Catia Member). Yellowish sandy limestone.

N. Near W-21 and to the south of that station, in stream flowing along the north flank of the Litoral anticline. Playa Grande Formation (Catia Member). Tan siltstones and sandstones with knobs of hard sandstone.

O. Dip slope 100 meters west of Costa fault and 130 meters south of shoreline at W-22. Playa Grande Formation (Catia Member). Dull gray pebbly sandstone.

P. North bank of Quebrada Las Pailas, 35 meters south of Mare Abajo fault and 150 meters southwest of the intersection of the Mare Abajo fault and Maiquetía anticline. Playa Grande Formation (Maiquetía Member). Brown siltstone.

Q. Quebrada Las Pailas at, and in the vicinity of W-4. Playa Grande Formation (Maiquetía Member). Soft blue-gray mudstone grading to tan siltstone.

R. Small waterfall in Quebrada Las Bruscas at W-26, 125 meters upstream from junction with Quebrada Las Pailas. Playa Grande Formation (Maiquetía Member). Soft massive siltstone with lentils and irregular knobs of hard calcareous sandstone, and a layer of blue-gray clay.

S. On and near the "*Lithothamnium*" reef at W-23, north flank of Punta Gorda anticline. Reef of calcareous algae with layer of cobbles at base. Maiquetía Member.

T. In stream 250 meters south-southwest of the mouth of Quebrada Las Pailas and 255 meters east-northeast of wireless station. Mare Formation. Soft silty sandstone.

U. South side of coast road at east end of the village of Catia La Mar. Playa Grande Formation. Tan massive siltstone with knobs of hard coarse calcareous sandstone.

V. Scarp at W-18, about 200 meters south of the intersection of the Costa fault with the shoreline. Playa Grande Formation (Catia Member). Fine-grained massive sandstone with knobs of hard calcareous sandstone.

X. In Quebrada Las Pailas at W-3, south side of Mare Abajo fault near its intersection with the Bruscas fault. Playa Grande Formation (Maiquetía Member). Tan siltstone, in places with nodular impure limestone.

Y. In Quebrada Las Pailas, north bank, 180 meters east of the intersection of the Bruscas and Mare Abajo faults. Soft brown silty sandstone. Maiquetía Member.

BRYOZOA COLLECTED IN THE CABO BLANCO AREA

The species of Bryozoa collected in the Cabo Blanco area, the formations in which they occur, the stratigraphic range of the known species, and the range of the known species which most closely resembles the new species are given below. Formational names are abbreviated thusly: Re = Recent; Ab = Abisinia Formation; Ma = Mare Formation; PGm = Playa Grande Formation (Maiquetía Member); and PGc = Playa Grande Formation (Catia Member).

The Bryozoa listed above are in the class Gymnolaemata and the order Cheilostomata. Pertaining to the Cheilostomata are 10 species in the suborder Anasca and 18 species in the suborder Ascophora. The zoaria of three species [*Cupuladria biporosa* Canu and Bassler, *Discoporella umbellata* (DeFrance), and *Anoteropora ? triovicellata* Weisbord, n. sp.] are unattached, but the rest are partially attached or wholly encrusting.

The Recent bryozoans are all encrusted on shells washed up to the beach from shallow depths near shore. The salinity of the surface water in this region of the Caribbean Sea is on the order of 36.5 parts per thousand from July to September. The temperature of the surface waters varies from about 87°F. in February to 83°F. in September. The present beach and the sea floor just off the beach are composed mostly of noncalcareous sand and calcareous beach rock. At and close to the beach are the hills of Cabo Blanco, and a short distance behind those is the towering Cordillera de la Costa.

Certain ecologic conditions in the Cabo Blanco area during the Pleistocene and Pliocene were not unlike those existing off the Cabo Blanco coast of today. The mountains of the Cordillera de la Costa were not far inland from the shoreline, and between the Cordillera and the shoreline there was probably a narrow belt of low hills made up of mid-Tertiary sedimentary rocks. The fossil bryozoans occur in strata which are arenaceous and calcareous in varying degree, and the evidence suggests that the sediments of the Playa Grande, Mare, and Abisinia Formations were laid down near shore in tropical waters of average salinity and rather shallow depths.

Species	Formation	Range of known species	Range of nearest related species
Aetea anguina (Linnaeus)	Re	Upper Eocene-Recent	
Aetea cf. A. ligulata Busk	Re	Recent	
Membranipora tacaguana Weisbord, n. sp.	PGc		Oligocene-Recent
Antropora typica Canu & Bassler	Re	Pliocene-Recent	
Cupuladria biporosa Canu & Bassler	Ma	Lower Miocene-Recent	
Discoporella umbellata (DeFrance)	PGm; Ma	Lower Miocene-Recent	
Steganoporella magnilabris (Busk)	PGm; Re	Miocene-Recent	
Biflustra cf. B. savartii (Audouin-Savigny)	Ma	Upper Cretaceous-Recent	
Setosella antilleana Weisbord, n. sp.	Re		Recent
Cellaria catiana Weisbord, n. sp.	PGc		Pliocene-Recent
Trypostega venusta (Norman)	Re	Upper Eocene-Recent	
Schizoporella floridana Osburn	PGm; Ma	Upper Eocene-Recent	
"Schizoporella" mamoensis Weisbord, n. sp.	Re		Upper Eocene-Recent
Cryptosula pallasiana (Moll)	Ma	Middle Miocene-Recent	
Dakaria subtorquata (d'Orbigny)	Re	Oligocene-Recent	
Microporella ciliata (Pallas), s. l.	Re	Oligocene-Recent	
Hippodiplosia pertusa (Esper)	Ab	Middle Miocene-Recent	
Smittipora abyssicola (Smitt)	Re	Recent	
Hippopodinella venezuelana Weisbord, n. sp.	Ma		Pliocene-Recent
Hippoporidra janthina (Smitt)	Ma	Upper Miocene-Recent	
Cleidochasma porcellanum (Busk)	Re	Middle Miocene-Recent	
Cleidochasma contractum (Waters)	Re	Upper Miocene?-Recent	
Rhynchozoon cf. R. verruculatum (Smitt)	Re	Middle Miocene-Recent	
Rhynchozoon caboblanquense Weisbord, n. sp.	Ma		Miocene-Recent
Rhynchozoon caribense Weisbord, n. sp.	Re		Recent
Harmerella dichotoma (Hincks)	Re	Pliocene-Recent	
Trematooecia cheethami Weisbord, n. sp.	PGM; Ma		Upper Tertiary-Recent
Anoteropora ? triovicellata Weisbord, n. sp.	Ma		Miocene-Recent

None of the Recent Bryozoa was collected alive, and only a few specimens, whether Recent or fossil, can be said to be well preserved. So far as the number of species is concerned, there is no doubt that assiduous collecting will reveal that in the Caribbean Sea near Cabo Blanco there are three to four times as many Recent species than are recorded in this work, and perhaps half again the number of fossil species. It is to be hoped that paleontologists will soon make an effort to collect more intensively from the Cabo Blanco hills as I fear that before long the hills will be completely modified by the works of man. I understand that even now many of the topographic features and fossil localities noted on my 1957 map of the Cabo Blanco area cannot be found because of alteration of the terrain by new roads, new buildings, and sundry other facilities.

ANALYSIS OF THE INVERTEBRATES OF THE CABO BLANCO GROUP

In the following tables all of the Cabo Blanco fossils thus far studied by me are enumerated by phylum or class to indicate the number and per cent of the fossil species in each formation that have survived to Recent time. As there is a judgment factor involved in determining whether a fossil species is identical to, or distinct from, its Recent analogue, the number of fossil species that have survived to the present is given as a minimum to maximum figure. Among the fossils collected and studied, the mollusks are by far the most abundant, and happily it was the mollusks that Lyell used to subdivide the Cenozoic era into epochs by the ratio of fossil to living species within the standard stratigraphic sections then established. On this percentage basis indicated by the Mollusca, and on the local stratigraphy, the Playa Grande and Mare Formations are judged to be early Pliocene in age and the Abisinia Formation to be early Pleistocene.

The purpose of determining the survival rate of species in phyla other than the Mollusca is to try to ascertain if the Lyellian principal can be applied to all groups of organisms in the Cenozoic era, and if so what percentage of the living to fossil invertebrates might be established for such nonmolluscan groups as, say, the polychaetes or barnacles or Bryozoa or Foraminiferida or corals or whatever. In the hierarchy of taxonomy what is the most appropriate biologic unit to be considered—the phylum ?, the class ?, the order ?—or should the entire biota of a depositional unit be the criterion? For example among the Mollusca in the Mare Formation of the Cabo Blanco area the survival ratio for the class Gastropoda is considerably smaller (16 to 34 per cent) than for the class Pelecypoda (39 to 46 per cent). However, for the phylum Mollusca which includes the classes Gastropoda, Pelecypoda, and Scaphopoda, the number of species that have survived to the present represents 25 to 39 per cent. Now, associated with the Mollusca at the type locality of the Mare Formation there are 71 species in the order Foraminiferida that have been identified by Bermúdez (1962), and every one of these species, or 100 per cent, is known to be living. On the other hand, according to Bermúdez, there are several species of Foraminiferida in the Mare and Playa Grande Formations that seem to be new to science (and will be described by him in a future work), and those might well lower the figure to 95 per cent or so in the Mare Formation. Obviously if we depend on the Foraminiferida alone we might consider the Mare Formation to be Pleistocene on the basis of Lyell's molluscan percentage, as indeed it was so considered by Bermúdez. But, if we are to employ Lyell's criterion in establishing the successive epochs of the Cenozoic Era we must also use his biologic key which was the Mollusca. On the other hand, having once established the age with the Mollusca in many regions of the world, could we not determine within the Cenozoic the percentage of living species of each biologic unit, and thus set up statistical standards whereby the percentages of nonmolluscan groups may be compared with those of the Mollusca? For example, the early Pliocene in the Cabo Blanco area of Venezuela contains a fauna whose species have survived to Recent time in the following percentages: Mollusca (phylum) 25 to 39 per cent; Polychaetia (class) 11 to 22 per cent; Cirripedia (class) 12 to 30 per cent; Bryozoa (phylum) 64 per cent; and Foraminiferida (order) approximately 95 per cent according to Bermúdez. If Cenozoic faunas all over the world were categorized by biologic unit and by the ratio of those species which are living to the total number present, a standard scale of percentages might be arrived at for each taxon or for all taxa within a given epoch. Thus for the Miocene we might have a median of 20 per cent of the molluscan species living and 55 per cent of the bryozoan species living; for the Pliocene it might be 45 per cent of the Mollusca, 70 per cent of the Bryozoa, and 95 per cent of the Foraminiferida; for the Pleistocene it might be 85 per cent of the Mollusca, 95 per cent of the Bryozoa, and 98 per cent of the Foraminiferida; and "In the Recent we may comprehend those deposits in which not only all the shells but all the fossil mammals are of living species . . ." (Lyell). Some groups of fossils will be more abundant than others, but once a standard is established for each biologic entity or for an entire fauna within a designated stratigraphic division, the statistical approach should still be valid. Lyell's Cenozoic calendar takes into consideration the evolution and extinction of species, and the longer the lapse of time the less chance is there for survival to the Recent; conversely, the shorter the lapse of time the greater the chance for survival. Longevity itself, however, varies considerably among organisms, and it is to illustrate this and the preceding comments that the following tables relating to the Cabo Blanco group of Venezuela are presented as a sort of pilot study.

Percentage of Recent species by class and formation
Abisinia Formation

Class		Total Number of species	Number of Recent species	Per cent of Recent species
Gastropoda	[Mollusca]	34	26-31	76-88
Pelecypoda		18	15-16	83-90
Scaphopoda		——	———	———
Polychaetia	[Annelida]	1	1	100
Cirripedia	[Crustacea]	1	1	100
Gymnolaemata	[Bryozoa]	1	1	100
	Total	55	44-50	80-91

Mare Formation

Class		Total number of species	Number of Recent species	Per cent of Recent species
Gastropoda		142	23-48	16-34
Pelecypoda		82	32-38	39-46
Scaphopoda		8	5	50
Polychaetia		2	1	50
Cirripedia		5	1- 2	20-40
Gymnolaemata		10	6	60
	Total	249	68-100	27-41

Playa Grande Formation (Maiquetía Member)

Class	Total number of species	Number of Recent species	Per cent of Recent species
Gastropoda	81	7-22	9-28
Pelecypoda	53	25-31	43-58
Scaphopoda	6	3	50
Polychaetia	1	0	———
Cirripedia	3	0- 1	0-33
Gymnolaemata	4	3	75
Total	148	38-60	26-40

Playa Grande Formation (Catia Member)

Class	Total number of species	Number of Recent species	Per cent of Recent species
Gastropoda	3	0- 1	0-33
Pelecypoda	26	8-10	31-40
Scaphopoda	2	1	50
Polychaetia	3	0- 1	0-33
Cirripedia	6	1	16
Gymnolaemata	2	0	0
Total	42	10-14	24-33

SYSTEMATIC DESCRIPTIONS
CHEILOSTOMATA
ANASCA

Aetea anguina (Linnaeus) Pl. 5, fig. 1

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1844. *Anguinaria spatulata* Lamarck, Couch, A Cornish Fauna. Pt. III, p. 103, pl. 19, fig. 2.
1847. *Anguinaria spatulata* Lamarck, Johnston, A History of the British Zoophytes, ed. 2, p. 290, pl. 50, figs. 7-8.
1847. *Aetea anguina* (Linnaeus), Nardo, Venezia e le sue Lagune, p. 135.
1848. *Aetea anguina* (Linnaeus), Gray, Centroniae or Radiated Animals, p. 133.
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1852. *Aetea anguina* (Linnaeus), Busk, Catalogue of the Marine Polyzoa in the Collection of the British Museum. Pt. I, p. 31, pl. 15, fig. 1. (*Anguinaria spatulate* is the name given on the plate).
1853. *Anguinaria spatulata* Lamarck, Gosse, A Naturalist's Rambles on the Devonshire Coast, p. 142, pl. 7, figs. 8-16.
1867. *Aetea anguina* (Linnaeus), Heller, K. - K. Zool.-Botan. Gesell. Wien, Verhandl., vol. 17, p. 88.
1867. *Aetea anguina* (Linnaeus) forma *spatulata* (Lamarck), Smitt, Kongl. Svenska Vetensk.-Akad. Förhandl., Öfvers., vol. 24, No. 5, p. 280, pl. 16, figs. 2-4.
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1877. *Aetea anguina* (Linnaeus), Gatty, Lit. Philos. Soc. Liverpool, Proc., vol. 31, p. 74.
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1880. *Aetea anguina* (Linnaeus), Hincks, A History of the British Marine Polyzoa, vol. 1, pp. 4-6; vol. 2, pl. 1, figs. 4-5.
1881. *Aetea anguina* (Linnaeus), Jullien, Soc. Zool. France, Bull., vol. 6, pp. 199, 204.
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1902. *Aetea anguina* (Linnaeus), Calvet, Inst. Zool. Univ. Montpellier, Trav., sér. 2, mém. No. 12, p. 8.
1903. *Aetea anguina* (Linnaeus), Calvet, [in] Jullien and Calvet, Résultats des Campagnes Scientifiques accomplies sur son Yacht par Albert Ier, Prince Souverain de Monaco, No. 23, p. 122.
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1909. *Aetea anguina* (Linnaeus), Norman, Linnean Soc. London, Jour., Zool., vol. 30, p. 283.
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1926. *Aetea anguina* (Linnaeus), Harmer, Siboga-Exped., vol. 14, Mon. 28a, pp. 194-195, p. 13, figs. 3-4.

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1932. *Aetea anguina* (Linnaeus), Hastings, Great Barrier Reef Exped., vol. 4, No. 12, p. 408.
1932. *Aetea anguina* (Linnaeus), Hasenbank, Wiss. Ergebn. Deutsch. Tiefsee-Exped., vol. 21, No. 2, p. 324.
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1937. *Aetea anguina* (Linnaeus), Stach, Roy. Soc. Victoria, Proc., n. s., vol. 49, p. 377.
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1940. *Aetea anguina* (Linnaeus), Osburn, New York Acad. Sci., Scientific Survey of Porto Rico and the Virgin Islands, vol. 16, pt. 3, pp. 345-346, pl. 1, fig. 8.
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1943. *Aetea anguina* (Linnaeus), Hastings, Discovery Repts., vol. 22, p. 471, figs. 57A-C.
1944. *Aetea anguina* (Linnaeus), Osburn, Chesapeake Biol. Lab., Publ. No. 63, pp. 28-29, fig. 17.
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1950. *Aetea anguina* (Linnaeus), Osburn, Allan Hancock Pacific Exped., Univ. Southern California Press, Publ., vol. 14, pt. 1, pp. 11-12, pl. 1, fig. 3.
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1953. *Aetea anguina* (Linnaeus), Bassler, Treatise on Invertebrate Paleontology, Pt. G, Bryozoa, p. G154, fig. 115,6.
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1957. *Aetea anguina* (Linnaeus), Harmer, Siboga-Exped., vol. 16, Mon. 28d, p. 651.
1957. *Aetea anguina* (Linnaeus), Maturo, Elisha Mitchell Sci. Soc., Jour., vol. 73, pp. 32-33, fig. 24.
1957. *Aetea anguina* (Linnaeus), Buge, Mus. Nat. Hist. nat. Paris, Mém., n.s., sér. C, vol. 6, p. 161.
1959. *Aetea anguina* (Linnaeus), Soule, Amer. Mus. Novitates, No. 1969, pp. 2-3.
1963. *Aetea anguina* (Linnaeus), Lagaaij, Inst. Marine Sci. Univ. Texas, Publ., vol. 9, pp. 164-165, pl. 8, fig. 1.
1964. *Aetea anguina* (Linnaeus), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, p. 606.

Scarcely visible, and nestled between other encrusting organisms, is an occasional single calcareous zoarium here referred to *Aetea anguina* (Linnaeus). The form in question is an attached irregular spindle- or sausage-shaped swelling (called a cystidium by Marcus) from which arises a short, free, nearly erect slender stalk or peristome. This stalk terminates distally into a spoon-shaped or semicylindrical hyaline orifice bent over the stalk at nearly a right angle. The length of the orifice is nearly double its width, and the membrane on the face of the orifice is missing. Below the orifice the stalk is corroded, but in certain light the stalk seems to be girdled by extremely fine annulations. The adnate cystidium is tumid but contracted here and there, and is minutely dotted.

Measurements.—Specimen A683aa: approximate length of cystidium 0.43 mm; maximum diameter of cystidium 0.12 mm; approximate length of stalk 0.24 mm, diameter 0.06 mm; length of orifice 0.191 mm, width 0.095 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. Attached to the pelecypod *Chama congregata* Conrad.

Remarks.—Of the several species of *Aetea* occurring in Western Atlantic waters, my specimen is closest to *A. anguina* by virtue of its bent-over orifice, by the nearly 2:1 ratio of the length of the orifice to its width, and by the faint annulations on the stalk below the orifice.

The species of *Aetea* are often difficult to distinguish, but thanks to the work of Marcus (1938a, p. 12) a useful key has been designed to facilitate determination. This key, translated from the Portuguese, appears below:

1 Below the area of the orifice there occur constrictions and swellings on the peristome .... *ligulata* Busk
Below the area of the orifice there is a uniformity in the diameter of the peristome or it expands gradually above 2

2 The erect tube is dotted in the area alluded to *truncata* (Landsborough)
The erect tube is annulated in the area alluded to 3

3 The distal region of the peristome is spatulate or has the form of a spoon; the ratio of its length to width is no more than 2:1, an average of 1.85:1 .... *anguina* (Linnaeus)
The distal region of the peristome is inconsiderable and gradually expanding; the ratio of its length to width is always more than 2:1, an average of 3:1 .... *sica* (Couch)

Range and distribution.—The earliest record of the occurrence of *Aetea anguina* (Linnaeus) is in the upper Eocene of Florida and Georgia in the United States of America, though the preservation is such that the identification is uncertain. As a fossil, the species has also been reported from the middle Miocene of France (étage Savignéen) and Egypt, from the Pliocene of Italy and South Carolina, United States, and from the Pleistocene of Italy. The living form is found in subpolar to tropical latitudes. It is generally a shallow-water dweller (low tide to 20 fathoms), but it has been dredged from a depth of 460 fathoms off Halmaheira in the East Indian Archipelago. In the Eastern Atlantic it occurs off the Scandinavian coast, Spain, France, the Azores, Madeira, St. Helena, and Tristan da Cunha. In the Western Atlantic the range is from Maine to Brazil, Argentina, Chile, and the Falkland Islands. In the Caribbean it is recorded from the Island of Cubagua (Venezuela), Jamaica, and Puerto Rico. In the Gulf of Mexico it occurs in west Florida and on Galveston Island, Texas. In the Eastern Pacific it ranges from Vancouver Island and vicinity southward to Peru and the Galapagos Islands. In the Western Pacific it is recorded from the Bonin Islands. In the East Indies it ranges eastward from Sumbawa to New Guinea and the Aru Islands. It occurs in Australia, Tasmania, and New Zealand. In India it occurs in the Gulf of Manaar. And off the east coast of Africa it is recorded from Natal and the Island of Zanzibar.

Details concerning the distribution of *Aetea anguina* (Linnaeus) in American waters are given by Lagaaij (1963a, pp. 164-165).

Aetea cf. **A. ligulata** Busk Pl. 5, figs. 2-4

1852. *Aetea ligulata* Busk, Catalogue of Marine Polyzoa, Pt. I, Cheilostomata, p. 30, pl. 42, 2 figs.
1888. *Aetea fueguensis* Jullien, Mission Scientifique du Cap Horn, vol. 6, p. 24, pl. 7, fig. 7 [*Fide* Osburn, 1940, p. 347].
1910. *Aetea Crosslandi* Waters, Linnean Soc. London, Jour., Zoology, vol. 31, pp. 232,253, pl. 24, fig. 8 [*Fide* Marcus, 1937, p. 30].
1937. *Aetea ligulata* Busk, Marcus, Faculdade Philos., Scienc. e Letras Univ. São Paulo, Bol., vol. 1, Zoologia No. 1, pp. 30-31, pl. 4, fig. 10.
1938. *Aetea ligulata* Busk, Marcus, Faculdade Philos., Scienc. e Letras Univ. São Paulo, Bol., vol. 4, Zoologia No. 2, p. 12.
1940. *Aetea ligulata* Busk, Osburn, New York Acad. Sci., Scientific Sur. of Porto Rico and the Virgin Islands, vol. 16, pt. 3, pp. 347-348, pl. 1, figs. 9-11.
1950. *Aetea ligulata* Busk, Osburn, Allan Hancock Pacific Exped., Univ. Southern California Press, Publ., vol. 14, pt. 1, p. 13, pl. 1, fig. 4.
1959. *Aetea ligulata* Busk, Soule, Amer. Mus. Novitates, No. 1969, p. 4.
1964. *? Aetea truncata* (Landsborough), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, pp. 606-607, figs. 1-2. [Probably not of Landsborough].

The calcareous zoarium consists of two sets of adnate tubules, primary and branching, with no "free" or nonadherent stalks that can be observed. The primary creeping tubule is long, serpentine, and more or less translucent, the middle section of small and rather uniform diameter. The primary tubule is bent up at one end into a short funnel-shaped process (kenozooecium?), and is inflated at the other end into an elongated sausage-like cystidium. The funnel-like process is cleaved vertically, with the truncated face adhering to the substrate, and the opening at the distal end of the funnel is large and semicircular; the outer surface of the translucent funnel is sculptured by a few vague concentric growth lines, and the stalk immediately below it marked by microscopic dots and faint, closely spaced annulations. The cystidium is also dotted, but annulations are wanting. The distal end of the cystidium is contracted into a short tube, suboval in section, and obliquely truncated. On the superior surface of the cystidium are two, separated, relatively large apertures of unequal size which may have been the site from which a free erect stalk or peristome arose. The secondary, branching tubules are of capillary diameter, gently crinkled by alternate constrictions and distensions, somewhat vermicular, and subtranslucent to translucent in texture. One of the secondary tubules branches off from the lip of the funnelel process mentioned above, but is broken off at the distal extremity so that the character of the orifice, assuming one was present, is not known; this tubule is both dotted and marked by extremely faint, closely spaced annulations. A second minor tubule branches off from the side of the cystidium, and this also is somewhat vaguely striated concentrically, with the distal end modified into a short spatulate "head" or orifice slightly larger in diameter than the tubule proper, with the truncated face of the head adherent to the substrate. A third branching tubule, rather like the primary one, branches off at a right angle from the under side of the cystidium and pursues a serpentine course; it too is translucent and minutely dotted, developing near the distal end a funnel-shaped or trumpet-like process, from the mouth of which emerges a relatively large tube, the latter bent into a tight "U" with an oval opening at the end. Lying to one side of the third branching tubule, but not now connected with it, is a ruptured globular glassy membranous vesicle with minute circular punctulations. Part of the upper surface of the adherent vesicle is gaping, and below the gape there is a smaller punctulate globule. The vesicle lies 0.16 mm from the third branching tubule, and this proximity, together with its character give rise to the speculation that the vesicle in question may be an expelled or remnantal ovicell from which the parent orifice has been removed. It is further presumed that the vesicle pertains to the species under discussion.

Measurements. — Specimen A683a: length of main creeping tube 1.37 mm; maximum diameter of cystidium 0.107 mm, length of cystidium 0.47 mm; diameter of middle section of primary tubule 0.035 mm; diameter of secondary tubule 0.028 mm; diameter of distal opening of the funnel-like process at end of main creeping tube 0.105 mm, length 0.12 mm; diameters of vesicle presumed to be the ovicell 0.19 mm × 0.14 mm.

Locality. — Recent, on beach at Playa Grande Yachting Club, Distrito Federal. One colony wholly attached to the bryozoan *Dakaria subtorquata* (d'Orbigny) which itself is encrusted on the pelecypod *Chama congregata* Conrad.

Remarks. — The classification of this form is uncertain but is referred to the genus *Aetea* because of the resemblance of the creeping tubes to those of such species as *A. ligulata* Busk, *A. anguina* (Linnaeus), *A. truncata* (Landsborough), and *A. sica* (Couch). However, unlike those species our single colony is encrusted throughout and no "free" and erect tubules can be observed as on the forms mentioned. On the other hand, the absence of such "free" stalks may well be fortuitous because of the small size and incomplete development of the zoarium, and indeed I would expect them to be present on more extensively developed colonies.

Except for the absence of "free" stalks, my specimen compares precisely with the form from west Florida referred to as *? Aetea truncata* (Landsborough) by Shier (1964). Because of certain additional structures not present on the typical *A. truncata,* Shier questioned his own identification of the Floridan form, and I think rightly so, as it seems to me that both his specimens from Florida and certainly my specimen from Venezuela are closer to, if not identical with, *A. ligulata* than to *A. truncata.* For example *A. ligulata* (and the synonymous *A. crosslandi* Waters, *fide* Marcus, 1937) bear funnel-shaped processes (spoken of as aberrant zooecia by Marcus and as öoecia by Shier), whereas they are not present on *A. truncata.* Furthermore the small branching tubules are alternately constricted and dilated along their length, and this character is diagnostic of *A. ligulata.*

Range and distribution.—The living *Aetea ligulata* Busk has been reported from the Western Atlantic in Santos Bay, Brazil (9 fathoms), along the Patagonian coast, in Tierra del Fuego, and in the Straits of Magellan. In the Caribbean it is found in Venezuela (this report) and off Guanica, Puerto Rico in 18-20 fathoms. In the Eastern Pacific it is found as far north as Queen Charlotte Island, Canada, and then to the south in Baja California, the Gulf of Panama, Colombia (7-40 fathoms), and the Galapagos Islands. Other localities may be west Florida (off Dog Island and Panama City in 5 fathoms) and Khor Dongonab in the Red Sea (as *A. crosslandi* Waters).

Membranipora tacaguana, new species Pl. 2, figs. 6, 7

Where not fragmented, the zoarium is seen as a flattened bilaminar expansion with a thick layer of zooecia, back to back, enveloped completely around it. The zooecia are generally elongated and more or less rectangular, but a few are broad and subpentagonal in outline. They are disposed in straight longitudinal rows which tend to divaricate and become irregular near the edge of the zoarium. Also, the alignment of a row may be interrupted by the occurence of a zooecium which is broader than the ones in the same row above and below it. The walls are thick, finely granular, a little elevated, and separated by a fine but distinct groove; at the distal end of the zooecium they form a gentle or slightly angular to ogival arch. The opesia are elongate oval to ovoid except on the broader zooecia where they are subovate to suborbicular, the narrowing directed toward the distal end of the zooecium. The opesial margin of the wall is finely and regularly crenulated, and from the cryptocyst, which is co-extensive with the wall, there project a few irregularly distributed calcareous spines. In the proximal corners of the opesia there may be a faint triangular depression representing the attachment area of the gymnocyst, but I have not seen any nodes in the proximal corners or elsewhere between the zooecia.

Measurements.—Holotype (M631a): zoarium fragment 4 mm long and 2.3 mm wide; zooecium length 0.52 mm, width 0.47 mm; opesium length 0.38 mm, width 0.31 mm. Paratype (M625a): zoarium fragment 3.6 mm in length, 2.8 mm in width; average zooecium length 0.45 mm, width 0.29 mm; opesium length 0.33 mm, width 0.18 mm.

Locality.—Playa Grande Formation (Catia Member) at W-15 on south side of Playa Grande road, 40 meters southwest of its intersection with the Playa Grande Yachting Club road. Nine fragments.

Remarks.—None of the fragments is especially well preserved, but as I have seen no species exactly like this, the Venezuelan form is thought to be new. The closest superficial resemblance is with the *Conopeum reticulum* of authors, and my first impression was that it was the same as that species. However, according to Bobin and Prenant (1962, pp. 383-386, figs. 4VII-XI) the *Conopeum reticulum* of Linnaeus is characterized by deep triangular interopesial spaces and by the pair of calcareous crenations (*"replis"*) projecting from the wall about at the level of the operculum (fig. 4IX). This pair of crenations is longer and more constant than the other crenations around the wall, and is best seen in basal view. Also, it would appear that the crenations of the inner wall of *Conopeum reticulum* (Linnaeus) are coarser and less numerous than on *Membranipora tacaguana*, n. sp.

The geologic range of *Conopeum reticulum* (Linnaeus) is given by Buge (1957, pp. 136,137) as Oligocene to Recent.

Antropora typica (Canu and Bassler) Pl. 5, fig. 5

1928. *Membrendoecium strictorostris* Canu and Bassler, U.S. Nat. Mus. Proc., vol. 72, art. 14, No. 2710, p. 23, pl. 2, fig. 7. (*Fide* Lagaaij, 1963a, p. 171).
1928. *Dacryonella typica* Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, art. 14, No. 2710, pp. 57-58, pl. 5, figs. 4-8; pl. 32, figs. 11-12; text fig. 8A.
1928. *Dacryonella typica* Canu and Bassler, Canu and Bassler, Soc. Sci. Seine-et-Oise, Bull., sér. 2, vol. 9, No. 5, pp. 65-66, pl. 1, fig. 10.
1940. *Canua typica* (Canu and Bassler), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, pp. 358-359.
1950. *Dacryonella* [*Antropora*] *typica* Canu and Bassler, Osburn, Allan Hancock Pacific Exped., Rept., vol. 14, pt. 1, p. 52.
1963. *Antropora typica* (Canu and Bassler), Lagaaij, Inst. Marine Sci. Univ. Texas, Bull., vol. 9, p. 171, pl. 1, fig. 3.
1964. *Antropora typica* (Canu and Bassler), Cheetham and Sandberg, Jour. Paleont., vol. 38, No. 6, pp. 1016-1017, text-fig. 3.
1964. *Antropora leucocypha* (Marcus), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, p. 613, fig. 4.

The zoarium is encrusting, one layer in thickness, pale yellow to whitish in color. The zooecia are pyriform to ovoid, generally somewhat narrower distally. The mural rim is thin, rounded at the crest, well defined, and minutely crenulate, with a restricted gymnocyst. The cryptocyst is granular and radially striate, generally wider proximally than at the sides or distal end where it is narrow. The opesia are elongated, pyriform to subovate, slightly narrower at the distal or opercular end. The frontal membrane covering the zooecium is delicate, transparent, sometimes light tan in color, and finely dotted. Occupying the interzooecial spaces are scattered avicularian chambers, broadly oval in outline, an occasional one with a membrane stretched across half of the opening. In some of the corners there are triangular nodes or triangular depressions. The ovicells are said to be small, endozooecial and smooth, but I have not seen them.

Measurements.—Specimen A672a: length of average zooecium 0.36 mm, width 0.24 mm; avicularium 0.06 mm × 0.05 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. Encrusted on the following dead mollusks:

Chlamys ornatus (Lamarck) (A672a); *Barbatia domingensis* (Lamarck) (A672b); *Arca imbricata* Bruguière (A672c); *Chama congregata* Conrad (A672d) 27531 PRI; *Cantharus auritulus* (Lamarck) (A672e); *Arca zebra* Swainson (A672f); *Trachycardium muricatum* (Linnaeus) (A672g).

Comparisons.—The identification of the Venezuelan species is confirmed by Cheetham, and, on comparing the Venezuelan specimens with Shier's "*Antropora leucocypha* (Marcus)" from west Florida, I find that they are identical. The west Florida specimens were collected by Shier in five fathoms off Dog Island and Panama City, and at half a fathom from Chokoloskee Bay near Everglades. The west Florida occurrences are the shallowest from which *A. typica* has been reported.

Range and distribution.—The range of *Antropora typica* is Pliocene to Recent. The Pliocene occurrence, according to Canu and Bassler, is in Minnitimmi Creek, Bocas Island, Almirante Bay, Panama. In the Pleistocene, the species occurs in the mudlumps off South Pass, Louisiana. The living form has been reported off the Braxilian coast, 100 kilometers east of Itabapoana, at 70 fathoms; on the coast of Venezuela at Cabo Blanco (this report) encrusted on dead mollusk shells; north of Cuba (130 to 167 fathoms); and off west Florida and at various stations in the Gulf of Mexico (see Lagaaij 1963a) from ½ to 117 fathoms.

Cupuladria biporosa Canu and Bassler Pl. 1, figs. 1-5

1859. *Cupularia canariensis* Busk (part), Quart. Jour. Microsc. Sci., vol. 7, pp. 66-67, pl. 23, figs. 7-8.
1859. *Cupularia canariensis* Busk, Palaeontogr. Soc. London, Mon. 11, p. 87, pl. 13, figs. 2a-e.
1873. *Membranipora canariensis* (Busk), Smitt, Kongl. Svenska Vetensk. Akad., Handl., vol. 11, No. 4, p. 10, pl. 2, figs. 69-71.
1888. *Membranipora canariensis* (Busk), Smitt (part ?), Mus. Comp. Zool., Bull., vol. 15, p. 79.
1899. *Cupularia canariensis* Busk ?, d'Angelis Ossat (part), Real Acad. Cienc. y Artes Barcelona, Bol., vol. 1, p. 33, pl. B, fig. 6 only.
1908. *Cupularia canariensis* Busk, Canu, Mus. Nac. Buenos Aires, An., ser. 3, vol. 10, p. 275, pl. 5, figs. 8-10.
1909. *Cupularia guineensis* Busk, Norman (part), Linnean Soc. London, Jour., Zool., vol. 30, p. 289, pl. 37, figs. 4,5. (figs. 3,6 = *C. canariensis* Busk).
1914. *Cupularia guineensis* Busk ?, Osburn (part), Carnegie Inst. Washington, Publ. No. 182, Papers from the Tortugas Laboratory, vol. 5, No. 11, p. 194.

1918. *Cupularia canariensis* Busk, Canu and Bassler, U.S. Nat. Mus., Bull. 103, pp. 119-120, pl. 53, figs. 5-7.
1919. *Cupuladria canariensis* (Busk), Canu and Bassler, Carnegie Inst. Washington, Publ. No. 291, p. 78, pl. 1, figs. 8-10.
1920. *Cupuladria canariensis* (Busk), Canu and Bassler, U.S. Nat. Mus., Bull. 106, p. 103, text fig. 24D.
1921. *Cupularia canariensis* Busk, Waters (part), Linnean Soc. London, Jour., Zool., vol. 34, pp. 410-412, pl. 29, fig. 5.
1923. *Cupuladria canariensis* (Busk), Canu and Bassler, U.S. Nat. Mus., Bull. 125, pp. 28-29, pl. 1, figs. 7-9.
1923. *Cupuladria biporosa* Canu and Bassler, U.S. Nat. Mus., Bull. 125, pp. 29-30, pl. 47, figs. 1,2.
1925. *Cupuladria canariensis* (Busk) ?, Mansfield, U.S. Nat. Mus., Proc., vol. 66, No. 2559, art. 22, pp. 5,8.
1928. *Cupuladria canariensis* (Busk), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, No. 2710, pp. 11,15-16, text fig. 2.
1929. *Cupuladria canariensis* (Busk), Hastings, Zool. Soc. London, Proc., pp. 714-715, pl. 8, figs. 38,40.
1929. *Cupuladria canariensis* (Busk), Canu and Bassler (part), U.S. Nat. Mus., Bull. 100, vol. 9, pp. 73-75, pl. 3, figs. 1,2.
1941. *Cupuladria canariensis* (Busk), McGuirt, Louisiana Geol. Sur., Bull. 21, pp. 46-47, pl. 1, figs. 1-3, 5, 6, 8.
1942. *Cupuladria canariensis* (Busk), Silén (part), Ark. f. Zool., vol. 34A, No. 2, pp. 13-15, text fig. 8. (text fig. 9 and pl. 4, figs. 15-16 = *C. pyriformis* Busk, *fide* Cook 1965, p. 168).
1950. *Cupuladria canariensis* (Busk), Osburn, Allan Hancock Pacific Exped., vol. 14, No. 1, pp. 33-34, pl. 3, figs. 2-3.
1953. *Cupuladria canariensis* (Busk), Bassler, Treat. Invert. Paleont., pt. G (Bryozoa), p. G156, fig. 118,2.
1959. *Cupuladria canariensis* (Busk), Soule, Amer. Mus. Novitates, No. 1969, pp. 8-9.
1961. *Cupuladria canariensis* (Busk), Galopim de Carvalho, Soc. Geol. Portugal, Bol., vol. 14, pp. 97-98, pl. 1, figs. 1-3.
1962. *Cupuladria canariensis* (Busk), Eveline and Ernst Marcus, Faculdade Filos., Cienc. e Letras Univ. São Paulo, Bol., No. 261, Zoologia No. 24, pp. 285-290, pl. 1, figs. 1-3.
1963. *Cupuladria canariensis* (Busk), Lagaaij (part), Palaeontology, vol. 6, No. 1, pp. 172-217, pl. 26, figs. 4-5; text fig. 16.
1964. *Cupuladria* sp. Cheetham and Sandberg, Jour. Paleont., vol. 38, No. 6, p. 1021.
1964. *Cupuladria canariensis* (Busk), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, pp. 610,611.
1965. *Cupuladria biporosa* Canu and Bassler, Cook, British Mus. (Nat. Hist.), Bull., Zoology, vol. 13, No. 5, p. 167.
1965. *Cupuladria biporosa* Canu and Bassler, Cook, British Mus. (Nat. Hist.), Bull., Zoology, vol. 13, No. 6, pp. 203-209, pl. 1, figs. 2A-6B, text figs. 1g-1j.

The few fossil fragments from Venezuela here referred to *Cupuladria biporosa* Canu and Bassler seem to indicate that the zoarium of a whole specimen is shallowly saucer-shaped. The zoarium consists of a single layer of deep zooecia lying on a basal mat which is about one-fifth the total thickness of the zoarium. The circumference of the zoarium is deeply scalloped or lobate, rendered so by the projection of the vibracular chamber on the peripheral zooecia. The basal surface is marked by fine radial and transverse grooves, dividing it into small subquadrate to subrectangular sectors, each sector bearing large subequal pores, the pores usually four in number but varying from one to five; where there are four pores they are located in the corners of the sector and are often large enough to fill up most of the sector. The zooecia are regularly arranged, rhomboidal to diamond-shaped, and each with a small interzooecial vibraculum at the distal end. The walls of the zooecia are nearly vertical, and the mural rim is high and sharply defined. The cryptocyst is narrow and minutely granular. The opesia are large and more or less ovoid. The normal vibracular opening is auricular or broadly semilunar, deeply channeled, and provided with a thickened tooth on the slightly high concave side. The character of the vicarious vibracula, which are said to occur near the center of the colony, has not been observed.

Measurements.—Specimen G624a: length of zoarium fragment 4 mm; length of average zooecium (including vibraculum) 0.43 mm; width of average zooecium 0.28 mm; thickness of zoarium 0.35 mm. Specimen G624b: length of zoarium fragment 2.6 mm; length of average zooecium (including vibraculum) 0.5 mm; width of average zooecium 0.25 mm; thickness of zoarium 0.42 mm.

Locality.—Mare Formation at W-14, on hillside above west bank of Quebrada Mare Abajo. Six fragments.

Remarks.—Applying the criteria established by Cook (1965b, p. 196) in her carefully prepared key, the Venezuelan form here described turns out to be *Cupuladria biporosa* Canu and Bassler rather than *Cupuladria canariensis* (Busk), though both of these species have much the same distribution and geologic range. On the basal surface, *C. biporosa* has 1-6 pores per sector whereas *C. canariensis* has 6-20 pores per sector. Another criterion for separating the two species is the relative length and width of the operculum; on *C. biporosa* it is longer than wide, on *C. canariensis* wider than long.

Cupuladria monotrema (Busk) (1884, p. 207, pl. 14, fig. 5) occurring off Bahia, Brazil, is a second species that has been regarded a synonym of *C. canariensis*, but on *C. monotrema* there is only a single perforation on each of the quadrate sectors of the dorsal surface. According to Cook (1965b, p. 210), *C. monotrema* is clearly distinct from *C. canariensis* but is similar to *C. biporosa* with which it may indeed be synonymous. However, until more material is available, *C. monotrema* "is distinguished by the opercular area, the more numerous vicarious vibracula, and the single layer of basal kenozooecial chambers."

A third species is the little-known *Cupularia calyxglandis* from the Manzanilla Formation (lower-middle Miocene) of Trinidad, described (but not figured) by R. J. Lechmere Guppy (1867, p. 175) as follows: "A crateriform species allied to *C. pyriforme* and *C. Owenii* but distinguished by its more completely cup-shaped form. The details of the cells are not very easily made out from my specimens, but they seem to resemble *C. pyriforme* in general arrangement." I have been unable to find additional information on *C. calyxglandis* Guppy, but it may turn out to be one of the lunulitiform species already known from Trinidad or Venezuela.

Range and distribution.—Cupuladria biporosa Canu and Bassler ranges from lower Miocene to Recent. The living form occurs generally in shallow water though there is one record of its having been found at 220 fathoms off Anguilla Island in the eastern Caribbean. In the Mediterranean *C. biporosa* has been reported from Algeria (Râs el-Amouch) at depths of four fathoms and deeper; in the Eastern Atlantic it is recorded from Tangier Bay (Morocco), Madeira, the Canary Islands, Cape Verde, and off the coast of west Africa; in the Western Atlantic it occurs off the Brazilian coast (Paraná and São Paulo, 60-70 fathoms; Cabo Frio, 0.5 fathoms; mouth of Amazon, 40 fathoms); in the Caribbean the localities are Barbados (40 fathoms), Anguilla (25-220 fathoms), and off Yucatan; in the Gulf of Mexico it is known from the Tortugas (10 fathoms) and west Florida (14 fathoms); and in the Eastern Pacific it has been reported from the coast of California, Baja California and Mexico, Colombia, Ecuador, and the Galapagos Islands. In the Pleistocene *C. biporosa* occurs in Italy, Argentina, and Louisiana. In the Pliocene it occurs in Italy, Portugal, Spain, England, Argentina, Venezuela, Panama, Florida, and Louisiana. Younger Miocene localities are in Italy, Austria and Hungary, Trinidad, Venezuela, Jamaica, Santo Domingo, Costa Rica, Florida, and Louisiana. Older Miocene localities are Trinidad, Venezuela, Costa Rica, Alabama, Mississippi, and Louisiana.

Most of the citations in my synonymy are taken from Cook (1965b, p. 203), though I am responsible for the others. I have re-examined the fragments referred to *C. canariensis* (Busk) by Shier (1964, pp. 610-611) and believe that they fit the diagnosis of *C. biporosa* Canu and Bassler.

Discoporella umbellata (DeFrance) Pl. 1, figs. 6-13

1823. *Lunulites umbellata* DeFrance, Dictionnaire des Sciences Naturelles, vol. 27, p. 361, pl. 47, figs. 1-1b.
1834. *Lunulites urceolata* Blainville, Manuel d'Actinologie ou de Zoophytologie, p. 449, pl. 72, fig. 1. [*Fide* Waters 1921, p. 414].
1853. *Discoporella umbellata* (DeFrance), d'Orbigny, Paléontologie Française. Terrains Crétacés, vol. 5, p. 473, pl. 717, figs. 1-3, 5 (*non* 4). [*Fide* Buge 1957, p. 177].
1853. *Discoporella berardana* d'Orbigny, Paléontologie Française. Terrains Crétacés, vol. 5, p. 474. [*Fide* Cook 1965a, p. 177].
1854. *Cupularia Lowei* Busk, Catalogue of the Marine Polyzoa in the British Museum. Pt. II, p. 99, pl. 116, figs. 1-6. [*Fide* Cook 1965a, p. 177].
1862. *Discoporella denticulata* Gabb and Horn, Acad. Nat. Sci. Philadelphia, Jour., ser. 2, vol. 5, pp. 142-143, pl. 20, fig. 25. Not *Lunulites denticulata* Conrad 1841, p. 348.
1869. *Cupularia umbellata* (Defrance), Manzoni, K. Akad. Wiss. Wien, Sitzungsber., vol. 59, pt. 1, p. 26, pl. 2, fig. 16.
1873. *Cupularia umbellata* (DeFrance), Smitt, Kongl. Svenska Vetensk. Akad., Handl., vol. 11, No. 4, Pt. II, pp. 14-15, pl. 3, figs. 75-80.
1875. *Cupularia umbellata* (DeFrance), Manzoni, I Briozoi Fossili antico di Castrocaro, p. 39, pl. 5, fig. 67.
1879. *Cupularia umbellata* (DeFrance), Seguenza, R. Accad. Lincei Roma, Mem., Cl. Sci. Fis., Mat. e Nat., ser. 3, vol. 6, pp. 131, 296, 371.
1889. *Cupularia umbellata* (DeFrance), Jelly, A Synonymic Catalogue of Marine Bryozoa, pp. 79-80.
1890. *Cupularia umbellata* (DeFrance), Pantanelli, Soc. Toscana Sci. Nat. Pisa, Atti, vol. 7, pp. 25-28.
1895. *Cupularia umbellata* (DeFrance), Neviani, Soc. Romana Studi Zool., Boll., vol. 4, pt. II, pp. 237, 243.
1895. *Cupularia umbellata* (DeFrance), Neviani, Palaeontogr. Italica, vol. 1, pp. 101-102.
1898. *Cupularia umbellata* (DeFrance), Neviani, Soc. Romana Studi Zool., Boll., pt. 4, vol. 7, No. 12, pp. 35, 38; pt. 5, vol. 8, No. 13, pp. 98, 100, 106.
1900. *Cupularia umbellata* (DeFrance), Neviani, Soc. Romana Studi Zool., Boll., pt. 6, ser. 2, vol. 1, p. 60.
1900. *Cupularia umbellata* (DeFrance), Neviani, Soc. Geol. Italiana, Boll., vol. 19, p. 362.
1900. *Cupularia umbellata* (DeFrance), Neviani, Palaeontogr. Italica, vol. 6, pp. 168-169.
1904. *Cupularia umbellata* (DeFrance), Ulrich and Bassler, Maryland Geol. Sur., Miocene, p. 415.
1907. *Cupularia umbellata* (DeFrance), Calvet, Expéditions scientifiques du "Travailleur" et du "Talisman" pendant les années 1880-1883, p. 393.

1908. *Cupularia umbellata* (DeFrance), Canu, Mus. Nac. Buenos Aires, An., vol. 17, p. 274, pl. 5, figs. 4-5.
1908. *Cupularia canariensis* Robertson, Univ. California Publ. Zool., vol. 4, No. 5, pp. 314-315, pl. 24, figs. 90-91. [Not of Busk 1859, p. 66].
1909. *Cupularia umbellata* (DeFrance), Canu, Soc. Géol. France, Bull., sér. 4, vol. 9, pp. 448, 454, pl. 16, figs. 16-17.
1909. *Cupularia Lowei* Gray [*sic*], Norman, Linnean Soc. London, Jour., Zool., vol. 30, p. 290, pl. 37, figs. 7-12.
1912. *Cupularia umbellata* (DeFrance), Canu, Inst. Égyptien, Mém., vol. 6, No. 3, p. 205.
1913. *Cupularia umbellata* (DeFrance), Canu, Soc. Géol. France, Bull., sér. 4, vol. 13, pp. 125, 126, 130.
1914. *Cupularia lowei* Osburn, Carnegie Inst. Washington, Publ. No. 182, Papers Tortugas Lab., vol. 4, pt. 11, pp. 194-195. [Not of Busk 1854 *fide* E. and E. Marcus 1962, p. 293].
1915. *Cupularia umbellata* (DeFrance), Canu, Soc. Géol. France, Bull., sér. 4, vol. 16, p. 322.
1916. *Cupularia umbellata* (DeFrance), Canu, Soc. Géol. France, Bull., sér. 4, vol. 16, p. 137.
1918. *Cupularia umbellata* (DeFrance), Canu and Bassler, U.S. Nat. Mus., Bull. 103, pt. 6, pp. 118-119.
1919. *Cupularia umbellata* (DeFrance), Canu and Bassler, Carnegie Inst. Washington. Publ. No. 291, pp. 76,85, pl. 1, figs. 5-7; pl. 2, figs. 17-21.
1920. *Cupularia umbellata* (DeFrance), Duvergier, Soc. Linn. Bordeaux, Actes, vol. 72, p. 150.
1921. *Cupularia Lowei* Busk, Waters, Linnean Soc. London, Jour., Zool., vol. 34, pp. 412-413, pl. 30, figs. 1-6, 26-29.
1921. *Cupularia umbellata* (DeFrance), Waters, Linnean Soc. London, Jour., Zool., vol. 34, pp. 414-415.
1921. *Cupularia umbellata* (DeFrance), Cipolla, Soc. Sci. Nat. ed Econ. Palermo, Giorn., vol. 32, p. 55, pl. 2, figs. 19-21.
1922. *Cupularia peyroti* Duvergier, Soc. Linn. Bordeaux, Proc. Verb., vol. 73, p. 124. [*Fide* Cook 1965a, p. 177].
1923. *Cupularia robertsonae* Canu and Bassler, U.S. Nat. Mus., Bull. 125, p. 82, pl. 34, figs. 5-7.
1923. *Cupularia umbellata* (DeFrance), Canu and Bassler, U.S. Nat. Mus., Bull. 125 pp. 9,68,75,76,80-82, text figs. 10G, 13A-F, pl. 2, figs. 15-19.
1923. *Cupularia umbellata* (DeFrance), Duvergier, Soc. Linn. Bordeaux, Actes, vol. 75, p. 150.
1924. *Cupularia peyroti* Duvergier, Soc. Linn. Bordeaux, Actes, vol. 75, p. 19, pl. 1, figs. 6-10.
1924. *Cupularia umbellata* (DeFrance), O'Donoghue, Union South Africa Fish. and Marine Biol. Sur., Rept. No. 3, p. 39.
1925. *Cupularia umbellata* (DeFrance), Mansfield, U.S. Nat. Mus., Proc., vol. 66, art. 22, No. 2559, pp. 5, 8.
1927. *Cupularia umbellata* (DeFrance), Canu and Lecointre, Soc. Géol. France, Mém., n. s., vol. 3, No. 4, p. 39, pl. 4, figs. 8-10.
1928. *Cupularia umbellata* (DeFrance), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, art. 14, No. 2710, p. 64, pl. 7, figs. 1-3.
1929. *Discoporella umbellata* (DeFrance), Hastings (part), Zool. Soc. London, Proc., No. 47, pp. 718-719.
1929. *Cupularia umbellata* (DeFrance), Canu and Bassler, U.S. Nat. Mus., Bull. 100, vol. 9, pp. 129, 142-144, text figs. 31G-H, pl. 15, figs. 5-11.
1930. *Cupularia umbellata* (DeFrance), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 76, art. 13, No. 2810, pp. 2, 11-12.

1940. *Discoporella umbellata* (DeFrance), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, p. 374.
1941. *Discoporella umbellata* (DeFrance), McGuirt, Louisiana Geol. Sur., Geol. Bull. No. 21, p. 65, pl. 1, figs. 4,7,9-11.
1942. *Discoporella umbellata* (DeFrance), Silén, Ark. f. Zool., vol. 34A, pp. 15-17, figs. 10-12.
1946. *Discoporella umbellata* (DeFrance), Roger and Buge, Soc. Géol. France, Bull., sér. 5, vol. 16, p. 226.
1947. *Discoporella umbellata* (DeFrance), Osburn, Allan Hancock Atlantic Exped., Rept., No. 5, p. 18.
1949. *Cupularia umbellata* (DeFrance), Vigneaux, Soc. Géol. France, Mém., n. s., vol. 28, No. 60, pp. 51-52, pl. 4, figs. 14-15.
1950. *Discoporella umbellata* (DeFrance), Osburn, Allan Hancock Pacific Exped., Rept., vol. 14, pt. 1, pp. 113-114, pl. 11, figs. 7-10.
1952. *Discoporella umbellata* (DeFrance), Bassler, Treat. Invert. Paleont., pt. G, Bryozoa, p. G171, fig. 131,9.
1953. *Discoporella umbellata* (DeFrance), Lagaaij, Nederl. Geol. Sticht., Meded., n.s., No. 7, pp. 13,16-17, pl. 1, fig. 3.
1956. *Discoporella umbellata* (DeFrance), Parker, Amer. Assoc. Petrol. Geol., Bull., vol. 40, No. 2, p. 335.
1957. *Discoporella umbellata* (DeFrance), Buge, Mus. Nat. Hist. nat. Paris, Mém., sér. C, vol. 6, pp. 139,177, pl. 9, fig. 5; pl. 10, fig. 3.
1957. *Discoporella umbellata* (DeFrance), Soule and Duff, California Acad. Sci., Proc., ser. 4, vol. 29, No. 4, pp. 99-100.
1957. *Discoporella umbellata* (DeFrance), Maturo, Elisha Mitchell Sci. Soc., Jour., vol. 73, p. 41.
1959. *Discoporella umbellata* (DeFrance), Soule, Amer. Mus. Novitates, No. 1969, pp. 34-35.
1959. *Discoporella umbellata* (DeFrance), Abrard and Gorodiski, Acad. Sci. Paris, C. R., vol. 248, pt. 2, p. 3459.
1959. *Discoporella umbellata* (DeFrance), Kanakoff and Emerson, Los Angeles County Mus., Contrib. Sci., No. 31, p. 18.
1962. *Discoporella umbellata* (DeFrance), Eveline and Ernst Marcus, Faculdade Filos., Ciênc. e Letras Univ. São Paulo, Bol., No. 261, Zoologia No. 24, pp. 291-304, pl. 1, fig. 4; pls. 2-5.
1963 *Discoporella umbellata* (DeFrance), Hertlein, California Acad. Sci., Proc., ser. 4, vol. 32, No. 8, p. 233.
1963. *Discoporella umbellata* (DeFrance), Lagaaij, Palaeontology, vol. 6, pt. 1, pp. 173, 198, 215, text fig. 1b.
1963. *Discoporella umbellata* (DeFrance), Cook, Cahiers Biol. Marine, vol. 4, pp. 408-411, pl. 1, text figs. 1a,1c.
1964. *Discoporella umbellata* (DeFrance), Cheetham and Sandberg, Jour. Paleont., vol. 38, No. 6, p. 1022, text fig. 14.
1964. *Discoporella umbellata* (DeFrance), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, p. 621.
1964. *Discoporella umbellata* (DeFrance), D. F. Soule and J. D. Soule, Amer. Mus. Novitates, No. 2199, pp. 10-11.
1965. *Discoporella umbellata* (DeFrance), Cook, British Mus. (Nat. Hist.), Bull., Zoology, vol. 13, No. 5, pp. 177-180, pl. 1, fig. 7; pl. 3, figs. 1,3,5-6; text fig. 4.
1965. *Discoporella umbellata* (DeFrance), Cook, British Mus. (Nat. Hist.), Bull., Zoology, vol. 13, No. 6, pp. 221-223; pl. 3, fig. 3; text fig. 2h.

The zoarium of the Venezuelan fossil specimens is free, and discoidal, saucer-shaped, or broadly conical, with the periphery of the cup orbicular to suborbicular in outline. The periphery of the young zoarium is strongly scalloped or stellate by reason of the projecting zooecia, but the periphery of adult specimens is relatively smooth. The underside or interior surface of the zoarium is divided into numerous narrow sectors by faintly impressed radii diverging from the off-centered apex. The sectors bear small, closely spaced, solid tubercles which, with growth of the zoarium, may develop a crater at the top. The zooecia are regularly arranged in radial rows and are more or less diamond-shaped, with a relatively large interzooecial vibraculum at the distal end. The opercular orifice is large, semicircular to subbtrigonal, and closed off from the opesium by a lamella nearly as high as the mural wall. The mural walls are thin, with a rather steeply sloping and minutely granular cryptocyst. The vibracular chamber is deep, semilunate to oval in outline, and generally slightly smaller than the orifice. The opesium is moderately depressed, microporine, and perforated around the border with large opesiular pores, the pores averaging seven or eight in number, but varying from six to eleven.

Measurements.—Specimen S617a (adult): diameter of zoarium 6.9 mm, height 2.6 mm, thickness at periphery 1.2 mm; length of average zooecium including vibraculum 0.47 mm, width 0.29 mm; opercular orifice 0.16 mm × 0.12 mm; vibracular chamber 0.12 mm × 0.095 mm. Specimen G619a (adolescent): diameter of zoarium 3.4 mm, height 0.85 mm, thickness at periphery 0.45 mm; length of average zooecium including vibraculum 0.42 mm, width 0.33 mm. Specimen F619a (young): diameter of zoarium 1.77 mm, height 0.50 mm, thickness at periphery 0.45 mm, length of average zooecium including vibraculum 0.57 mm, width 0.24 mm.

Localities.—Playa Grande Formation (Maiquetía Member) in Quebrada Las Bruscas at W-26, approximately 125 meters upstream from junction with Quebrada Las Pailas (rare); in Quebrada Las Pailas at W-3, south side of Mare Abajo fault near its intersection with the Bruscas fault (rare); north flank of Punta Gorda anticline (abundant). Lower Mare Formation at W-13, on hillside above west bank of Quebrada Mare Abajo (fairly common); in small stream 100 meters west of Quebrada Mare Abajo (common). Mare Formation near W-14, on hillside above west bank of Quebrada Mare Abajo (abundant); south flank of Punta Gorda anticline (abundant). Upper Mare Formation, in stream 250 meters south-southwest of the mouth of Quebrada Las Pailas (fairly common).

Remarks.—This species has much the same geographic distribution and geologic range as *Cupuladria canariensis* (Busk) and *Cupuladria biporosa* Canu and Bassler with which it is often associated. *D. umbellata* is much more abundant and widespread than *Cupuladria biporosa* in the Cabo Blanco area, but the two species do occur together in the Mare Formation on the hillside above the west bank of Quebrada Mare Abajo.

Range and distribution.—Lower Miocene to Recent. In the older Miocene, *D. umbellata* has been reported from Italy, France, Germany, and the state of Louisiana, United States (in deep wells); in the middle to upper Miocene, from Senegal, Egypt, Italy, France, The Netherlands, Trinidad, the Dominican Republic, Jamaica, and Costa Rica; in younger Miocene, from the states of North Carolina and South Carolina, United States; in the Pliocene, from Italy, France, England, Venezuela, Florida, and South Carolina; in the Pleistocene, from Italy and Argentina as well as from the mudlumps off South Pass, Louisiana. The living *D. umbellata* is found near shore to a depth of as much as 960 fathoms, though it is most abundant between 30 and 40 fathoms. In the Eastern Atlantic the species occurs in Madeira, the Canary and Cape Verde Islands, west Africa, and South Africa; in the Mediterranean it has been reported from Algeria; in the Western Atlantic the range is from North Carolina to Brazil; in the Caribbean, from Brazil westward to Colombia; in the Gulf of Mexico from Yucatan, the Tortugas, west Florida, and Louisiana; and in the Eastern Pacific from Baja California to Ecuador and the Galapagos Islands.

Steganoporella magnilabris (Busk) Pl. 2, figs. 1-3; Pl. 6, fig. 1

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Two specimens were collected, one a dead, partially incrusted Recent form, the other a corroded fossil fragment from the Playa Grande Formation.

The zoarium of the Recent specimen is decumbent, discoidal, undulatory, irregularly ovate in outline, and made up of two cellular layers that are easily separated. The basal surface of the lower layer is thin, subnacreous, and marked by faintly impressed lines dividing it into fairly regular columnar sectors, the sectors further divided into segments by transverse, slightly curved, or chevron-like incisions. The basal surface of the upper layer is membranous, glassy, and transparent, and similarly segmented. In edge view, the layers are seen to be made up of squarish cells. The zooecia are oblong, horseshoe-shaped above, straight-walled below, with a toothlike projection on each side of the mural rim at about the middle. Half of the frontal area is occupied by a depressed, hyaline, minutely punctulate cryptocyst, upturned at the distal end near the middle of the zooecium into a sharp laminar and slightly overturned tongue, the tongue horizontally truncated at the tip, and with a U- or flask-shaped re-entrant cut on either side into the cryptocyst proper. The *a*-zooecia far outnumber the *B*-zooecia. The opercula, some of which are preserved on individual zooecia, are chitinous, and are suborbicular in outline but with a straight lower border conforming to the outline of the upper type fitting over the *a*-zooecia, in which the sclerite forms a narrow chamber of the zooecium. There are two types of opercula: the type fitting over the *a-zooecia,* in which the sclerite forms a narrow continuous bow conforming to the arch of the zooecium; and the type fitting over the *B*-zooecium which consists of a pair of divergent wings, separated slightly just below the apex of the sclerite, and having straight inner borders. The sclerite, or outer margin, of both types of operculum is furnished on the posterior aspect with a row of acute, conical, flexible spicules, but these are obliterated on our specimen.

The zoarium of the fossil fragment appears to have been frondose rather than decumbent as is the Recent form described above. The fossil specimen is badly worn but sufficient of it has been preserved to suggest its identity as *Steganoporella magnilabris.*

Measurements.—Specimen A632a: Length of zoarium 21.5 mm; width 14 mm; thickness 1.43 mm. Length of *a*-zooecium (including both chambers) 0.93 mm; width 0.43 mm. Length of *B*-zooecium 1.0 mm; width 0.57 mm. Operculum of *a*-zooecium 0.36 mm × 0.33 mm; of *B*-zooecium 0.5 mm × 0.48 mm.

Localities.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. One specimen. Playa Grande Formation (Maiquetía Member) at W-23, north flank of Punta Gorda anticline. One specimen (S629a).

Remarks.—The Recent zoarium of *Steganoporella magnilabris* is itself encrusted by the serpulid polychaete *Hydroides* aff. *bispinosa* Bush (see Weisbord, 1964, pp. 156-158, pl. 21, figs. 1-3).

Range and distribution.—*Steganoporella magnilabris* (Busk) ranges from Miocene to Recent. The living form is widespread, occurring in east Africa, South Africa, West Africa, along the coast of South America from Brazil to Venezuela and Colombia, in the Caribbean Sea (St. Vincent, Puerto Rico, Jamaica), the Yucatan Peninsula, the Bermuda Islands, Tortugas and Florida; in the Western Pacific (Korea, Japan, China, the Philippines, and Borneo); in the Malay and Indonesian Archipelago as far east as the Admiralty Islands and Queensland, Australia; in the Indian Ocean (Ceylon, Burma, India); and in the North Pacific (the Hawaiian Islands). The maximum depth recorded is 242 fathoms in the Sulu Archipelago, but optimum depths are 15 to 40 fathoms. In Venezuela, the Recent *S. magnilabris* has been previously recorded from Coche, Margarita, Tortuga, and the Gulf of Venezuela. As a fossil, *S. magnilabris* has been found in the Pliocene of Florida (Caloosahatchee Marl) and the Republic of Panama. In the Miocene it has been reported from Australia, and in the upper Miocene it occurs in the richly fossiliferous deposit at Jackson Bluff, in Leon County, Florida.

Biflustra cf. B. **savartii** (Audouin-Savigny)

Pl. 2, figs. 4,5,9-11; Pl. 4, fig. 1; Pl. 6, fig. 2; Pl. 7, fig. 1

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1964. *Acanthodesia savartii* (Audouin), Eveline and Ernst Marcus, Acad. Brasileira Ciênc., An., vol. 36, No. 3, p. 359.
1964. *Membranipora savartii* (Audouin), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, pp. 607-608.

The zoarium is encrusted on divers shells and rock fragments. The zooecia are subrectangular to elongate hexagonal, generally disposed in straight longitudinal rows, gently arched at the distal end, truncate to angulate at the proximal end, and sometimes a little contracted at the proximal half. The walls are moderately thin and slightly elevated to low and moderately thick, and are separated by a fine groove; the mural rim is faintly to conspicuously beaded by narrow, transverse crenations. Laterally and distally the minutely granulate cryptocyst is narrow, but proximally it widens into an apron occupying one-fifth to two-fifths the length of the opesium. The opesial margin of the cryptocyst is finely denticulate around the distal half of the zooecium, with occasional discrete spinules projecting laterally into the field of the opesium. The opesial margin of the apron is generally serrated in varying degree, but the "denticulate process" is reduced to a blunt projection or a trigonal spine; more often the opesial edge of the apron is subtruncate or concave, and from it there protrude small spinules on one side and a larger spine or two away from the middle toward the other side. The opesia are semioval to suborbicular, and are slightly depressed. The frontal membrance is thin, transparent, and microscopically dotted. Small rounded tubercles may be present in the proximal corners of some of the opesia, but on a number of specimens the tubercles are wanting. The endozooecial ovicell is globular and affixed to the base of the zooecium; the upper surface of the ovicell is often modified by the appearance of small rounded mammilate processes.

Measurements. — Specimen I623a: zoarium length 3.1 mm, width 2.5 mm; one of the larger zooecia is 0.52 mm in length, 0.26 mm in width; average opesium length 0.24 mm, width 0.18 mm. Specimen I628a: zoarium length 6.6 mm, width 6.0 mm; average zooecium length 0.47 mm, width 0.33 mm; opesium length 0.25 mm, width 0.21 mm. Specimen I640a: (27530 PRI) zoarium length 10.1 mm, width 7.5 mm; average zooecium length 0.47 mm, width 0.34 mm; opesium length 0.36 mm, width 0.26 mm; length of cryptocyst at proximal end 0.10 mm; diameter of large ovicell 0.19 mm. Specimen T620a: zoarium length 7 mm, width 6 mm; average zooecium length 0.45 mm, width 0.29 mm; opesium length 0.43 mm, width 0.27 mm. Specimen T620b: average zooecium length 0.48 mm, width 0.29 mm; opesium length 0.43 mm, width 0.27 mm; average length of cryptocyst at proximal end 0.095 mm.

Localities.—Lower Mare Formation at W-13, on hillside above west bank of Quebrada Mare Abajo. Eleven fragments, five of them, probably from the same colony, encrusted on an echinoid. Upper Mare Formation, in stream 250 meters west-southwest of the mouth of Quebrada Las Pailas. Four fragments, one of them, specimen T620a, with the present species *Biflustra savartii* joined to the side of *Trematooecia cheethami* Weisbord, n. sp.

Remarks.—The Venezuelan specimens, all of them fossil, exhibit variation in the thickness and crenation of the walls, in the character of the proximal cryptocyst, and in the presence or absence of opesial tubercles. Most of the variants are similar to one form or another of *B. savartii,* though some approach the *B. tenuis* of authors, particularly that of Maturo (1957, pp. 35-36, fig. 28) from Beaufort, North Carolina. As there is some question, according to Cheetham, about the true identity of *B. tenuis* (Desor), and as *B. savartii* has priority, it seems advisable to relate the Venezuelan forms to *B. savartii*. It must be noted, however, that Audouin's original figure of *Flustra savartii* is stylized, and also does not show the apron-like development of the cryptocyst in the proximal end of the zooecium. On the other hand, the Venezuelan fossils here described do resemble the *B. savartii* of Smitt, Marcus (1937), Canu and Bassler (1928,1929), and Osburn (1950), and it is for this reason that the forms in question are compared with that species.

Range and distribution.—Biflustra savartii is said to be a cosmopolitan and long-lived species, extending as far back as the late Cretaceous, in which period it was reported by Waters (1885) from the Senonian Stage of France. In the middle Eocene it has been recorded from France, and in the upper Eocene from Spain and the states of Alabama and Mississippi, United States. In the Oligocene, *B. savartii* has been recorded from the Vicksburg Formation of Alabama and Mississippi, the Marianna Limestone of Florida, and from the Rupelian Stage of Germany. Lower Miocene occurrences are in Egypt, Italy, and France; later Miocene occurrences are in Austria, France, Portugal, Jamaica, Trinidad, the states of Virginia and Maryland in the United States, and Australia. In the Pliocene, the species is found in Tunis, Algeria, Italy, Belgium, England, Venezuela (this report), and Australia. Pleistocene localities are in Sicily, Argentina, Florida, Maryland, and California. The Recent form lives in temperate to tropical waters at shallow depths to about 40 fathoms. In East Africa, it occurs off Zanzibar; in North Africa it occurs in the Red Sea, Egypt, and Morocco; in the Western Atlantic it is reported from North Carolina to Brazil and Argentina; in the Caribbean it occurs in a number of islands off the coast of Venezuela, in the Gulf of Venezuela, and in Puerto Rico; in the Gulf of Mexico it occurs in the Tortugas, west Florida, Louisiana, and Texas; in the Eastern Pacific it ranges from southern California to Panama and the Galapagos Islands; in the Western Pacific it occurs from Japan to the Philippine Islands, to the Malay Peninsula, to Java, to New Guinea, and to north and south Australia; and, in the Indian Ocean, it occurs in southwest India and Ceylon.

Setosella antilleana, new species Pl. 8, fig. 1

The zoarium is expansive, encrusting, and one layer in thickness. The zooecia are whitish and subhyaline, broadly rhomboidal to angularly oval in outline, moderately distinct, and separated by low walls which are finely and closely beaded along the rim. The cryptocyst is densely granulated, generally a little depressed near the lateral margins, and slightly convex below the orifice. The opesium and orifice are practically co-extensive. The orifice is relatively large, more or less oval transversely, and sometimes contracted below the middle to form a shallowly concave or gently subangular sinus, the inner rim of which is normally minutely denticulate; the distal rim of the orifice is flush against the wall of the zooecium and immersed, and it too may be microscopically beaded. On some zooecia the orifice seems to be provided with a minute pair of condyles or contracted a little below the middle. There are two slightly unequal, narrowly elliptical, and completely closed opesiules, each one situated near, but usually separated from, its respective lateral margin; the long axis of the opesiules is parallel with the long axis of the zooecium, and the inner border of both opesiules is provided with tiny denticles. In the intermural angles of adjacent zooecia there is often present an oval opening or chamber with a relatively thick wall, or a completely calcified node instead. The avicularia arise from zooecia which replace the autozooecia of the colony. The avicularian-bearing zooecia are smaller than the normal zooecia and are hexagonal to pentagonal in outline. The opesium of the avicularian zooecia is more or less oval or diamond-shaped or spatulate, but the mandible itself has not been seen. Nor has the ovicell been observed.

Measurements.—Holotype (A684a): average zooecium length 0.35 mm, width 0.26 mm; maximum diameter of orifice 0.083 mm, least diameter 0.71 mm; length of opesiule 0.047 mm, maximum width 0.024 mm; avicularian zooecium length 0.26 mm, width 0.16 mm; intermural (vibracular) chamber, length 0.036 mm, width 0.032 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. Encrusted on the gastropod *Cantharus* (*Pollia*) *auritulus* (Lamarck).

Comparisons.—The distinguishing characters of *Setosella antilleana* are the intermural cells or nodes lying in some of the corners between adjoining zooecia, the evenly elliptical and completely closed opesiules, the relatively broad zooecia, and the densely granulated cryptocyst. The closest resemblance is with *Andreella uncifera* (Busk) described and illustrated by Canu and Bassler (1928b, pp. 67-68, pl. 2, figs. 6-9) from a specimen dredged in 1877 by the "Norseman" in mid-Atlantic approximately 600 nautical miles east of southern Brazil, at a depth of 70 fathoms. The description of *A. uncifera* by Canu and Bassler is brief, and there is no indication in either the description or the illustrations, of the cells or nodes between the zooecia. These vibracular chambers are common on *S. antilleana,* though, to be sure, they are not always present. Compared with the original *Micropora uncifera* as illustrated by Busk (1884, p. 71, pl. 15, figs. 7-7a), the Venezuelan *S. antilleana* lacks the articulate spine on each side of the summit of *M. uncifera,* and the orifice of *S. antilleana* has a shallowly concave sinus rather than the straight, truncated proximal rim of *M. uncifera.*

As pointed out to me by Dr. Cheetham, another rather closely related species is *Setosella vulnerata* (Busk), first described from Shetland Island but now known also from the Caribbean Sea and Gulf of Mexico. Both *S. vulnerata* (Busk) and *S. antilleana,* n. sp. are variable forms, but in general it seems that the zooecia of *S. antilleana* are broader and much more granular than those of *S. vulnerata;* that the opesiules of *S. antilleana* are elliptical and somewhat broader than on *S. vulnerata* where they are often crescentic and slitlike; and that the proximal lip on the orifice of *S. antilleana* is gently concave or has a slight subangular sinus whereas that of *S. vulnerata* is straight and sharply defined.

In reviewing the literature on *Setosella vulnerata* (Busk), the following references have been noted:

1860. *Membranipora vulnerata* Busk, Quart. Jour. Microsc. Sci., vol. 8, p. 124, pl. 25, fig. 3.
1868. *Membranipora vulnerata* Busk, Norman, British Assoc. Advance. Sci., Rept. 38th Meeting, p. 305.
1877. *Setosella vulnerata* (Busk), Hincks, Ann. Mag. Nat. Hist., ser. 4, vol. 20, p. 529.
1880. *Setosella vulnerata* (Busk), Hincks, History of the Marine British Polyzoa, pp. 181-182, pl. 21, fig. 7.

1880. *Setosella vulnerata* (Busk), Hincks, Ann. Mag. Nat. Hist., ser. 5, vol. 6, pp. 73-74, pl. 9, fig. 5.
1882. *Setosella vulnerata* (Busk), Jullien, Soc. Zool. France, Bull., vol. 7, p. 524, pl. 17, fig. 66.
1899. *Setosella vulnerata* (Busk), Jelly, A Synonymic Catalogue of the Recent Bryozoa, p. 246.
1907. *Setosella vulnerata* (Busk), Calvet, Expéditions scientifiques du "Travailleur" et du "Talisman" pendant les années 1880-1883, vol. 8, p. 394.
1909. *Setosella vulnerata* (Busk), Levinsen, Morphological and Systematic Studies on the Cheilostomatous Bryozoa, p. 196.
1925. *Setosella vulnerata* (Busk), Waters, Ann. Mag. Nat. Hist., ser. 9, vol. 15, p. 349, pl. 21, fig. 2.
1929. *Setosella vulnerata* (Busk), Canu and Bassler, U.S. Nat. Mus., Bull. 100, vol. 9, p. 161, figs. 42A-C.
1939. *Setosella vulnerata* (Busk), Neviani, R. Ist. Veneto Sci., Lett. ed Arti, Mem., vol. 30, No. 4, p. 113.
1940. *Setosella vulnerata* (Busk), Marcus, Danmarks Fauna, vol. 46, p. 155, fig. 83.
1942 *Setosella vulnerata* (Busk), Silén, Ark. f. Zool., vol. 34A, pp. 5, 6-7, fig. 4; pl. 2, figs. 8-9.
1953. *Setosella vulnerata* (Busk), Bassler, Treat. on Invert. Paleont., Part G, Bryozoa, p. G174, fig. 134,4.
1963. *Setosella vulnerata* (Busk), Lagaaij, Inst. Marine Sci. Univ. Texas, Publ., vol. 9, pp. 178-179, pl. 2, fig. 7.
1963. *Setosella vulnerata* (Busk), Ryland, Sarsia, vol. 14, pp. 4,10,41.
1965. *Setosella vulnerata* (Busk), Lagaaij and Gautier, Micropaleontology, vol. 11, No. 1, Chart 1.

Setosella vulnerata (Busk) is a Recent species with a distribution as follows:

Northern and Eastern Atlantic: Shetland Island (80-110 fathoms), Norway (Bergen, North Brattholen reef, 30 fathoms +), Skagger Rack (111 fathoms), Iberian coast, Gulf of Gascogne, Bay of Biscay (218-600 fathoms), Josephine Bank (280-360 fathoms), Azores, Madeira (Funchal Bay, 30 fathoms), Canary Islands (2,055 fathoms), Cape Verde Islands (255 fathoms).

Western Atlantic and Caribbean: Bermuda, San Bartholomew (16-25 fathoms), north of Anguilla (170 fathoms), Florida Straits (120-122 fathoms).

Gulf of Aden: (16 fathoms).

Mediterranean: Rhone Delta (64 fathoms), Marseilles, Nice, Capri; Tunisia, Algiers, northwest of Morocco (350 fathoms).

Gulf of Mexico: about 80 miles southeast of Galveston, Texas (30 fathoms).

Cellaria catiana, new species Pl. 2, fig. 8; Pl. 5, fig. 6

The internode is slender and cylindrical, slightly contracted in girth at the proximal end. The zooecia are elongate, rhombic to subrhombic, with moderately high and fairly thick walls. The zooecia are regularly arranged in nine alternating columns, the face of each column more or less flattened, and the lateral angles of one column joined to the terminal angles of the adjacent column. The cryptocyst is depressed, hardly concave, and finely granular. The orifice, which is situated in the distal half of the zooecium, is transversely semilunar, and bears a thin, scarcely elevated peristome. The distal rim of the orifice is gently and regularly arched; the proximal lip is provided with a small sinus in each corner, and with generally two, but occasionally three or more sharp denticles projecting from the tongue. Thus the tongue is serrated in varying degree, though occasionally it is relatively smooth. The ovicells are situated above the orifice, and are small, roughly orbicular, and entotoichal. The proximal rim of the ovicell also has two or more denticles but these are rarely seen on our single imperfect specimen. One of the ovicells is partially closed by a hemispheric membrane and another completely closed by a thin domal membrane below the rim of the opening. The disposition and character of the avicularia cannot be ascertained.

Measurements.—Holotype (M638a): length of internode 2.3 mm, maximum diameter 0.64 mm; average zooecium length 0.47 mm, width 0.17 mm, transverse diameter of orifice 0.1 mm, height 0.06 mm; diameter of ovicell 0.07 mm.

Locality.—Playa Grande Formation (Catia Member), south side of Playa Grande road, 40 meters southeast of its intersection with the Playa Grande Yachting Club road. One specimen, the holotype.

Comparisons.—This species is characterized by the rounded ovicells, by the small but prominent sinus on each corner of the poster, and by the presence, between the sinuses, of two or more denticles on the tongue of the proximal lip, thereby rendering it serrate in greater or lesser degree. These characters, though the configuration of the orifice and ovicellular opening are by no means constant on any species of this genus, serve to differentiate *Cellaria* *catiana, n. sp.* from such similar forms as *C. salicornis* (Pallas) (1766), *C. fistulosa* (Linnaeus) (1758), and *C. sinuosa* (Hassall) (1840). One of those species—*C. salicornis*—has been cited by Guppy (1867, p. 165) as occurring in the Recent and in the Pliocene (Matura Formation) of Trinidad. Some Matura fossils have been found in the formations of the Cabo Blanco Group of Venezuela, and it is just possible that *C. catiana* is the *C. salicornis* of Guppy, though without comparative material from Trinidad this is merely a conjecture.

ASCOPHORA

Trypostega venusta (Norman) Pl. 11, fig. 1

1851. *Mollia tuberculata* d'Orbigny, Paléontologie Française, Terrains Crétacés, vol. 5, p. 388 [*Fide* Waters, 1905, p. 6].

1864. *Lepralia venusta* Norman, Ann. Mag. Nat. Hist., ser. 3, vol. 13, pp. 84-85, pl. 10, figs. 2-3.

1873. *Gemellipora glabra* forma *striatula* Smitt, Kongl. Svenska Vetensk.-Akad., Handl., vol. 11, No. 4, pt. II, pp. 37-40, pl. 11, fig. 207. [*Fide* Waters, 1913, p. 507].

1873. *Lepralia inornata* (Gabb and Horn), Smitt, Kongl. Svenska Vetensk.-Akad., Handl., vol. 11, No. 4, pt. II, pp. 61-62, pl. 11, figs. 215-216. [Not of Gabb and Horn, *fide* Harmer, 1957, p. 953].

1880. *Schizoporella venusta* (Norman), Hincks, British Marine Polyzoa, p. 276, pl. 30, figs. 6-7.

1882. *Lepralia striatula* (Smitt), MacGillivray, Roy. Soc. Victoria, vol. 19, pt. II, p. 134, pl. 3, figs. 17-17a.

1885. *Schizoporella striatula* (Smitt), Waters, Geol. Soc. London, Quart. Jour., vol. 41, pp. 285,301.

1887. *Gemellipora striatula* Smitt, MacGillivray, [*in*] McCoy, Prodromus of the Zoology of Victoria, vol. 2, p. 150, pl. 138, fig. 10.

1888. *Schizoporella venusta* (Norman), Kirkpatrick, Ann. Mag. Nat. Hist., ser. 6, vol. 1, p. 76.

1889. *Schizoporella striatula* (Smitt), *S. venusta* (Norman), and *S. inornata* (Gabb and Horn), Jelly, A Synonymic Catalogue of the Recent Marine Bryozoa, pp. 233,237,128.

1890. *Schizoporella venusta* Norman, Kirkpatrick, Roy. Soc. Dublin, Proc., n. s., vol. 6, p. 612.

1890. *Schizoporella venusta* (Norman), Kirkpatrick, Ann. Mag. Nat. Hist., ser. 6, vol. 5, p. 17.

1899. *Schizoporella venusta* (Norman), Roy. Microsc. Soc. London, Jour., pp. 7, 16, pl. 3, fig. 23.

1900. *Schizoporella striatula* (MacGillivray), Philipps, Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands, and Elsewhere collected during 1895-1897, pt. 4, No. 22, p. 440.

1902. *Trypostega venusta* (Norman), Levinsen, Vidensk, Medd. Naturhist. Foren. Kjøbenhavn, p. 23.

1905. *Gemellipora glabra* forma *striatula* Smitt, Thornely, Ceylon Pearl Oyster Fisheries, Rept. to Colonial Govt., pt. 4, Suppl. Rept. No. 26, p. 118.

1907. *Schizoporella venusta* (Norman), Calvet, Expéditions Scientifiques du "Travailleur" et du "Talisman" pendant les années 1880-1883, vol. 8, p. 416.

1907. *Gemellipora glabra* forma *striatula* Smitt, Thornely, Indian Mus. Calcutta, Rec., vol. 1, p. 190.

1909. *Trypostega venusta* (Norman), Levinsen, Morphological and Systematic Studies on Cheilostomatous Bryozoa, p. 281, pl. 19, figs. 1a-1d; pl. 22, figs. 13a-13d.

1909. *Trypostega venusta* (Norman), Linnean Soc. London, Jour., Zool., vol. 30, p. 299.

1912. *Gemellipora glabra* forma *striatula* (Macgillivray), Thornely, Linnean Soc. London, Trans., vol. 15, p. 149.

1913. *Trypostega venusta* (Norman), Waters, Zool. Soc. London, Proc., pp. 506-507.

1914. *Trypostega venusta* (Norman), Osburn, Carnegie Inst. Washington, Publ. No. 182, Papers Tortugas Lab., vol. 5, No. 11, pp. 198-199.

1918. *Trypostega venusta* (Norman), Waters, Linnean Soc. London, Jour., Zool., vol. 34, p. 4.

1920. *Trypostega venusta* (Norman), Canu and Bassler, U.S. Nat. Mus., Bull. 106, pp. 53, 328,330-332, pl. 85. figs. 15-16, text fig. 9E.

1923. *Trypostega venusta* (Norman), Canu and Bassler, U.S. Nat. Mus., Bull. 125, p. 95, pl. 16, fig. 1.

1927. *Trypostega venusta* (Norman), Livingstone, Australian Mus. Sydney, Rec., vol. 16, p. 58.

1928. *Trypostega venusta* (Norman), Canu and Bassler, Soc. Sci. Seine-et-Oise, Bull., sér. 2, vol. 9, No. 5, p. 76.

1928. *Trypostega venusta* (Norman), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, No. 2710, art. 14, pp. 77-78, pl. 8, figs. 5-6, text fig. 11E.

1929. *Trypostega venusta* (Norman), Canu and Bassler, U.S. Nat. Mus., Bull. 100, vol. 9, pp. 248-249, pl. 22, figs. 9-11.

1929. *Trypostega venusta* (Norman), Hastings, Zool. Soc. London, Proc., p. 270.

1929. *Trypostega pusilla* Canu and Bassler, U.S. Nat. Mus., Bull. 100, vol. 9, p. 248, pl. 22, fig. 8, text fig. 44B.

1930. *Trypostega venusta* (Norman), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 76, art. 13, No. 2810, pp. 14-15.

1931. *Tryptostega* [*sic*] *venusta* (Norman), Calvet, Résultats des Campagnes . . . Prince Souverain de Monaco, vol. 83, p. 77.

1932. *Trypostega venusta* (Norman), Hastings, Great Barrier Exped., Rept., vol. 4, p. 426.

1938. *Trypostega venusta* (Norman), Marcus, Faculdade Filos., Ciênc. e Letras Univ. São Paulo, Bol., vol. 4, Zoologia No. 2, pp. 35-36, pl. 8, fig. 19; pl. 20, fig. 53

1938. *Trypostega venusta* (Norman), Marcus, Vidensk. Medd. Dansk. Naturhist. Foren., vol. 101, p. 23, text fig. 16.

1939. *Trypostega venusta* (Norman, Marcus, Faculdade Filos., Ciênc. e Letras Univ. São Paulo, Bol., vol. 13, Zoologia No. 3, p. 172.

1940. *Trypostega venusta* (Norman), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, p. 409.

1941. *Trypostega venusta* (Norman), McGuirt, Louisiana Geol. Sur., Geol. Bull. No. 21, pp. 69,142, pl. 18, figs. 5,8.

1947. *Trypostega venusta* (Norman), Osburn, Allan Hancock Atlantic Exped., Rept., No. 5, p. 28.

1949. *Trypostega venusta* (Norman), Marcus, Mus. Hist. Nat. Montevideo, Comunic. Zool., vol. 3, No. 53, p. 1.

1952. *Trypostega venusta* (Norman), Osburn, Allan Hancock Pacific Exped., Rept., vol. 14, pt. 2, pp. 280-281, pl. 30, fig. 10.
1953. *Trypostega venusta* (Norman), Bassler, Treat. Invert. Paleont., (G) Bryozoa, p. G196, fig. 146.2.
1956. *Trypostega venusta* (Norman), Buge, Ann. Mines Geol. Tunis, No. 17, pp. 43-45, pl. 7, fig. 5.
1957. *Trypostega venusta* (Norman), Harmer, Siboga-Exped., vol. 16, Mon. 28d, pp. 939,952, 953-955, pl. 73, figs. 22-24,26.
1961. *Trypostega venusta* (Norman), Soule, Amer. Mus. Novitates, No. 2053, p. 5.
1963. *Trypostega venusta* (Norman), Hertlein, California Acad. Sci., Proc., ser. 4, vil. 32, No. 8, p. 233.
1964. *Trypostega venusta* (Norman), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, p. 627.

The zoarium is encrusting, white, hyaline, and unilaminar. The zooecia are distinct, regularly arranged, lanceolate to subrhomboidal, generally narrowed distally, and separated by a narrow shallow groove. The frontal is a slightly to moderately convex tremocyst, punctated by small raised equidistant pores. Dwarf zooecia or zooeciules (Marcus prefers the term heterozooecia) are present on the distal side of each zooecium, or sometimes compressed between two zooecia. The zooeciules are obtusely hexagonal to oblong in outline, are provided with a minute circular to oval orifice which is somewhat elevated, and are perforated like the zooecia. The orifice of the autozooecia is small and keyhole-shaped, bearing an angulate pair of condyles below the middle. The porta of the orifice is circular, and there is a deep V-shaped or U-shaped sinus in the proximal lip. There is no peristome. Generally present, however, is a low rounded umbo situated in the midline just proximal to the sinus. The operculum is yellowish and chitinous, slightly concave upward as it covers the orifice, and microscopically dotted on the external surface.

Measurements.—Specimen A678a: length of a zooecium and superjacent zooeciule 0.52 mm; average zooecium length 0.41 mm, width 0.26 mm; length of an average zooeciule 0.12 mm, width 0.083 mm; average diameter of orifice 0.095 × 0.0714 mm; diameter of zooeciule orifice 0.023 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. Encrusted on the pelecypod *Chama congregata* Conrad.

Range and distribution.—This species is reported as far back as the upper Eocene, occurring, according to McGuirt, in the Jackson Group of Louisiana, United States, McGuirt and Canu and Bassler have also recorded *Trypostega venusta* from the lower Oligocene (Vicksburg Formation) of Louisiana and Mississippi, and Canu and Bassler listed it from the Marianna Limestone of the upper Oligocene in Alabama. Late Miocene occurrences are in the states of North Carolina and Virginia, United States. In the Pliocene it occurs in Tunisia, Sicily, and Italy. I have seen no notice of its occurrence in the Pleistocene though there is every reason to believe it will be found in deposits of that epoch. The living form of *Trypostega venusta* is cosmopolitan, living in temperate to tropical waters at depths ranging from 2 to 230 fathoms. In the Eastern Atlantic it has been found in Guernsey (9 fathoms), in the English Channel off the Calvados coast of France, and southward to Madeira, the Cape Verde Islands (100 fathoms), and St. Helena. In the Western Atlantic it ranges from the coast of South Carolina to Santos, Brazil; in the Caribbean it occurs in Aruba, Colombia, Panama, Puerto Rico, and Cuba, at depths of 10 to 24 fathoms; in the Gulf of Mexico it occurs in the Tortugas and west Florida (5 to 68 fathoms); in the Eastern Pacific it is recorded from Baja California to Cocos Island, Panama, Colombia, and the Galapagos Islands in low water to 100 fathoms; in the Western Pacific it has been noted in Japan, the China Sea (27 fathoms), and the Philippines (19-230 fathoms); in the Indian Ocean it is recorded at depths of 22 to 125 fathoms off Burma in the Bay of Bengal, and on the Island of Mauritius; and in Australian waters it occurs in Torres Strait (13-18 fathoms), off Queensland, at Port Philipp (Victoria), and on the Great Barrier Reef.

Schizoporella floridana Osburn Pl. 3, figs. 4-6; Pl. 7, fig. 2

1914. *Schizoporella floridana* Osburn, Carnegie Inst. Washington, Publ., No. 182, Papers Tortugas Lab., vol. 11, pp. 205-206, figs. 17-18.
1923. *Schizopodrella floridina* [*sic*] (Osburn), Canu and Bassler, U.S. Nat. Mus., Bull. 125, p. 106, pl. 16, figs. 11-15.
1927. *Schizoporella floridana* Osburn, K. Zool. Genootsch., Natura Artis Magistra Amsterdam, vol. 25, pp. 126-127.
1928. *Schizopodrella floridana* (Osburn), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, art. 14, No. 2710, pp. 93-95, pl. 10, figs. 4-6. text-figs. 15D,E.
1940. *Schizoporella floridana* Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, p. 422.
1947. *Schizoporella floridana* Osburn, Allan Hancock Atlantic Exped., Rept., No. 5, p. 29.

1951. *Schizoporella floridana* Osburn, Pearse and Williams, Elisha Mitchell Sci. Soc., Jour., vol. 67, p. 137.
1957. *Schizoporella floridana* Osburn, Maturo, Elisha Mitchell Sci. Soc., Jour., vol. 73, p. 51.
1964. *Schizoporella unicornis* var. *floridana* Osburn, Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, p. 630.
1965. *Schizoporella floridana* Osburn, Cheetham and Sandberg, Jour. Paleont., vol. 38, No. 6, p. 1030, text-fig. 32.

The fossil zoarium is encrusting and several layers in thickness. The basal surface of the primary layer is smooth, and the zooecia are elongate-rectangular or squarish to rhomboidal in outline, and are arranged in longitudinal, slightly curved rows. The zooecia of the upper layers are crowded, the distal end of one zooecium often encroaching on the proximal end of its neighbor. The frontal is convex, consisting of a thick granular coarsely perforate tremocyst. The lateral margins of the frontal are faintly costulate, and between the costules, as well as around the ends, there are large areolae. In the medial line of the frontal just below the orifice there maybe a small umbo, but the umbo is wanting on some of the zooecia. The orifice, situated near the distal end of the zooecium, is semicircular and generally placed asymmetrically; the proximal third of the orifice is straight but is emarginated by a well-developed U-shaped sinus. A low moderately thin peristome surrounds the orifice. Many zooecia are provided with a single elevated acuminate avicularium immediately adjacent to the orifice, directed obliquely forward and with the rounded proximal end more or less even with the proximal lip of the orifice. On the same zoarium, a few zooecia may be provided with two avicularia, one on each side of the orifice, but on still others there are no avicularia whatsoever. The cross bar on which the operculum is mounted is imperfectly seen on only a few of the avicularia, but as the zoaria are weathered and many of the characters are obliterated, it is inferred that the cross bar is normally present. Neither the ovicell nor the "large vicarious avicularia mounted on large swollen cells" (Osburn, 1914, p. 206, fig. 18) were observed.

Measurements.—Specimen S627a: zoarium fragment length 6.7 mm, width 5.9 mm; length of an average rectangular zooecium on the encrusting surface of the basal layer 0.64 mm, width 0.41 mm; average zooecium length on upper layer 0.66 mm, width 0.52 mm;

average diameters of orifice 0.17 mm × 0.13 mm; suboral avicularium length 0.19 mm, width 0.12 mm.

Locality.—Playa Grande Formation (Maiquetía Member), north flank of Punta Gorda anticline. Four fragments.

Remarks.—Although the Venezuelan fossils do not display such diagnostic characters as the ovicell and the vicarious avicularia which are present on the fully developed *Schizoporella floridana* Osburn, they are otherwise identical with, or close to the Recent *S. floridana* from west Florida in the Shier collection at Florida State University, and to the Pleistocene *S. floridana* from the mudlumps of Louisiana in the Cheetham collection at Louisiana State University. It should be mentioned, however, that the Venezuelan forms also resemble markedly a number of fossil and living species without ovicells from the Americas that have been identified as *Schizoporella unicornis* (Johnston), so that without certain critical features to go on, there is a judgment factor involved in the determination. In the present instance I have been guided by the opinion of Dr. Cheetham, who examined my specimens, and by the statement of Cheetham and Sandberg (1964, p. 103) that *S. unicornis* and *S. floridana* "have been confused in the literature, and many of the American records of *S. unicornis*, especially from the tropics and subtropics, are probably *S. floridana*." With the ovicell present, *S. unicornis* is readily distinguished from *S. floridana*: the ovicell of *S. unicornis* is marked by grooves radiating away from the center of the hood; the ovicell of *S. floridana*, on the other hand, is small, short, high, smooth, and imperforate.

Range and distribution.—The range of *Schizoporella floridana* Osburn is given as upper Miocene to Recent. In the upper Miocene it is recorded from Florida and North Carolina, United States; in the Pliocene from Venezuela (this report); and in the Pleistocene from the mudlumps off South Pass, Louisiana. The living form is found in the Caribbean Sea, the Western Atlantic, and the Gulf of Mexico. In the Caribbean *S. floridana* occurs east of Yucatan, Puerto Rico (6-19 fathoms), Curaçao (6-41 fathoms), Isla Tortuga (Venezuela, 41 fathoms), and Colombia (21-22 fathoms). In the Western Atlantic it occurs in North Carolina. And in the Gulf of Mexico it occurs in the Tortugas (15-18 fathoms) and along the west Florida coast (5 fathoms).

Addendum.—As some of the citations referring to *Schizoporella unicornis* (Johnston) may include the species *S. floridana* Osburn, and as the possibility exists that a synonym of *S. unicornis* may turn out to be a prior name for *S. floridana,* there is listed below as many references to, and synonyms of, *S. unicornis* that I have been able to find:

1839,1846. ? *Escharina Isabelleana* d'Orbigny, Voyage dans l'Amérique Méridionale, vol. 5, pt. 4, p. 12, pl. 4, figs. 13-16. [*Fide* Marcus, 1937, pp. 83,85].

1844. *Lepralia unicornis* Wood, *ex* Johnston MS, p. 19.

1847. *Lepralia ansata* Johnston, A History of the British Zoophytes, ed. 2, p. 307, pl. 54, fig. 12.

1847. *Lepralia unicornis* Johnston, A History of the British Zoophytes, ed. 2, p. 320, pl. 57, fig. 1.

1847. *Cellepora tetragona* Reuss [*in*] Haidinger, Naturwiss. Abhandl., vol. 2, p. 78, pl. 9, fig. 19. [*Fide* Busk, 1859b, p. 45].

1848. *Escharina unicornis* (Johnston), Gray, List of the Specimens of British Animals in the Collection of the British Museum, Pt. I, p. 124.

1848. *Lepralia variolosa* Desor, Boston Soc. Nat. Hist., Proc., vol. 5, p. 66.

1851. *Reptoporina rugosa* d'Orbigny, Paléontologie Française. Terrains Crétacés, vol. 5, p. 443. [*Fide* Waters 1905b, p. 8].

1852. *Lepralia unicornis* Johnston, Landsborough, A Popular History of British Zoophytes or Corallines, p. 322.

1854. *Lepralia spinifera* Johnston, Busk, Catalogue of Marine Bryozoa, pp. 69-70, pl. 80, fig 7. [*Fide* Lagaaij, 1952, p. 65].

1855. *Escharina variabilis* Leidy, Acad. Nat. Sci. Philadelphia, Jour., ser. 2, vol. 3, p. 10.

1857. *Lepralia unicornis* Johnston, Alder, Tyneside Naturalists' Field Club, Trans., vol. 3, p. 49.

1859. *Lepralia unicornis* Johnston, Busk, Palaeontogr. Soc. London, Mon., vol. 11, p. 45, pl. 5, fig. 4.

1867. *Lepralia spinifera* var. *unicornis* and var. *serialis* Heller, K.-K. Zool.-Botan. Gesell. Wien, Verhandl., vol. 17, p. 104. [*Fide* Calvet [*in*] Jullien and Calvet, 1903, p. 138].

1870. *Mollia unicornis* (Johnston), Fischer, Soc. Linn. Bordeaux, Actes, vol. 27, p. 22.

1870. *Mollia spinifera* d'Orbigny, Fischer, Soc. Linn. Bordeaux, Actes, vol. 27, p. 22.

1873. *Hippothoa Isabelleana* (d'Orbigny), Smitt, Kongl. Svenska Vetensk.-Akad., Handl., vol. 11, No. 4, pt. II, pp. 44-45, pl. 8, figs. 166-168.

1873. *Hippothoa isabelleana* (d'Orbigny), Verrill and Smith, U.S. Fish Comm., Rept. for 1871-72, p. 713.

1875. *Escharella variabilis* (Leidy), Verrill, Amer. Jour. Sci. and Arts, ser. 3, vol. 10, No. 55, art. 10, p. 41.

1875. *Hippothoa reversa* Verrill, Amer. Jour. Sci. Arts, ser. 3, vol. 10, No. 55, art. 10, p. 41, pl. 3, fig. 1.

1876. *Lepralia spinifera* Heller, Stossich, Soc. Adriat. Sci. Nat., Boll., vol. 2, No. 3, p. 358.

1877. *Lepralia unicornis* Johnston, Barrois, Recherches sur l'Embryologie des Bryozoaires, p. 152, pl. 8, figs. 30,33,35,37.

1878. *Hippothoa variabilis* (Leidy), Verrill, [*in*] Coues and Yarrow, Acad. Nat. Sci. Philadelphia, Proc., vol. 30, p. 305.
1879. *Escharina variabilis* Leidy, Verrill, U.S. Nat. Mus., Proc., vol. 2, p. 193.
1879. *Lepralia ansata* var. *porosa* Waters, Ann. Mag. Nat. Hist., ser. 5, vol. 3, p. 32. [*Fide* Calvet, [*in*] Jullien and Calvet, 1903, p. 138].
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1884. *Lepralia unicornis* Johnston, De Stefani, R. Accad. Lincei Roma, Mem., Cl. Sci. Fis., Mat. e Nat., vol. 18, pp. 213,227.
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1889. *Schizoporella unicornis* (Johnston), Jelly, A Synonymic Catalogue of Recent Marine Bryozoa, pp. 236-237.
1889. *Schizoporella unicornis* (Johnston), Pergens, Zool. Anzeig., vol. 12, Nos. 317-318, p. 12.
1890. *Schizoporella unicornis* (Johnston), Ortmann, Arch. f Naturgesch. Berlin, vol. 1, p. 49, pl. 3, fig. 35.
1890. *Schizoporella unicornis* (Johnston), Kirkpatrick, Ann. Mag. Nat. Hist., ser. 6, vol. 5, p. 16.
1891. *Schizoporella unicornis* (Johnston), Waters, Geol. Soc. London, Quart. Jour., vol. 47, pp. 4,27.
1895. *Schizoporella unicornis* (Johnston), Neviani, Soc. Romana Studi Zool., Boll., vol. 4, pt. I, No. 1, p. 113; No. 3, p. 118; pt. II, No. 5, p. 230; No. 7, p. 238.
1895. *Schizoporella unicornis* (Johnston), Neviani, Palaeontogr. Italica, vol. 1, pp. 83,114, pl. 6, figs. 8-11.
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1896. *Schizoporella unicornis* (Johnston), Neviani, Soc. Geol. Italiana, Boll., vol. 15, No. 4, pp. 558-589.
1898. *Schizoporella unicornis* (Johnston), Neviani, Soc. Romana Studi Zool., Boll., vol. 7, pt. IV, No. 12, pp. 35,44; No. 14, p. 101; No. 15, p. 107.
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The range and distribution of *Schizoporella unicornis* (Johnston) as given in the preceding citations is upper Eocene to Recent. It has been reported from the upper Eocene of Italy and the upper Oligocene (Stampian Stage) of France. It occurs in the lower Miocene of Italy; in the Miocene of Poland; in the middle to upper Miocene of Italy, Austria, France, Jamaica, the states of Maryland, Virginia, North Carolina, and South Carolina in the United States; and in the upper Miocene of Suffolk, England. In the Pliocene, *S. unicornis* is recorded from Italy, The Netherlands, Belgium, Great Britain, Panama, and Florida. In the Pleistocene it is found in Louisiana, Florida, South Carolina, Maryland, and Italy. The living *S. unicornis* is widely distributed, and can tolerate extremes in temperature. It is found in both the North Atlantic and South Atlantic Oceans, from Norway to South Africa, and from Greenland to Brazil. In the Caribbean Sea it occurs off Margarita Island (Venezuela), Curaçao, Columbia, Puerto Rico, and the Virgin Islands. In the Gulf of Mexico it is reported from the Tortugas and west Florida. In the Eastern Pacific it ranges from California to the Galapagos Islands. In the Western Pacific it is reported from off Japan and in the China Sea. It is also found in the Mediterranean Sea, the Red Sea, the Indian Ocean, and off Queensland, Australia.

Schizoporella unicornis (Johnston) ranges in depth from near shore to 90 fathoms, the latter recorded in the Gulf of Gascogne.

Schizoporella floridana ? Osborn Pl. 3, figs. 7-9; Pl. 7, fig. 3

The zoarium is encrusting, multi-layered, and somewhat convex in cross section. The zooecia of the basal layer are subhexagonal to subrectangular, and, as seen on the under surface, are separated by moderately thick walls. The frontal of the basal zooecia is finely granular in the interior, and the perforations are fairly large. The zooecia of the outer layer are crowded, rhomboidal, and poorly defined. The frontal is expansive, smooth to coarsely granulose, convex to a little swollen, faintly costulate at the lateral margins, and perforated by rather widely separated pores, and somewhat larger areolae encircling the margin. The orifice is low, semicircular distally, and with a moderately deep, evenly rounded U- or V-shaped sinus in the center of the proximal lip. The peristome is hardly developed. On one zooecium the lateral wall is seen to be perforated by about seven rounded communication pores aligned in a horizontal row a little below the upper surface. No ovicells or avicularia have been discerned.

Measurements.—Specimen I621aa: zoarium fragment length 3.3 mm, width 2.6 mm; thickness 0.95 mm; average zooecium length 0.62 mm, width 0.41 mm; orifice length 0.13 mm, width 0.12 mm.

Locality.—Lower Mare Formation, on hillside above west bank of Quebrada Mare Abajo at W-13. One worn fragment.

Remarks.—The only colony is badly corroded and without avicularia or ovicells. The identity is in doubt though there is a close resemblance to those specimens of *Schizoporella floridana* Osburn in which the zooecia lack avicularia, ovicells, and an umbo below the orifice.

"Schizoporella" mamoensis, new species Pl. 8, fig. 2

The zoarium is encrusting, subhyaline, and one layer in thickness. The zooecia are subhexagonal, somewhat rounded at the distal end, and separated by a shallow linear furrow. The frontal is depressed well below the peristome, and is perforated by numerous small pores which are produced into short ciliar tubules. In profile the central area of the frontal surface is plane to slightly concave. The orifice is a little longer than wide, nearly circular distally, and straight proximally, with a well-developed and regularly outlined U-shaped sinus. The peristome is moderately thick and somewhat raised. It is not possible to determine whether or not there are distal or lateral spines on the peristome, but there is a faint suggestion that they are indeed present and that there are about six of them. On each side of the orifice a little above the midline there is a raised ovate-acuminate avicularium imbedded next to the peristome; these avicularia are relatively small and seem to be provided with a cross bar. The hyperstomial ovicell is a thickly and smoothly calcified globular hood bearing a few scarcely visible perforations and having a large semilunar aperture normal to the surface of the frontal.

Measurements.—Holotype (A687a): length of zooecium plus ovicell 0.55 mm, width 0.29 mm; ovicell of same zooecium, width 0.18 mm, depth 0.14 mm, approximate height 0.07 mm; average diameters of zooecial orifice 0.09 mm × 0.07 mm; avicularium length 0.14 mm, width 0.095 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. One zoarium encrusted on the pelecypod *Barbatia domingensis* (Lamarck).

Comparison.—The principal difference between this species and the upper Eocene to Recent *Schizoporella unicornis* (Johnston) lies in the ovicell which is smooth on the Venezuelan form but has radial grooves diverging from the center of the hood on *S. unicornis.* The Venezuelan form also lacks the medial suboral umbo which is often present on *S. unicornis.*

Cryptosula pallasiana (Moll) Pl. 2, fig. 14; Pl. 6, figs. 3,4

1803. *Eschara Pallasiana* Moll, Eschara ex Zoophytorum seu Phytozoorum, p. 57, pl. 3, figs. 13A-13B.
1816. *Cellepora Pallasiana* (Moll), Lamouroux, Histoire des Polypiers Coralligènes flexibles, vulgairement nommés Zoophytes, p. 95, No. 190.
1824. *Cellepora Pallasiana* (Moll), Lamouroux, Corallina; or a classical arrangement of flexible coralline Polypidoms, p. 24.
1824. *Cellepora Pallasiana* (Moll), Lamouroux, [*in*] Encyclopédie Méthodique, Vers, vol. 2, pt. 1, p. 184, No. 22.
1840. *Flustra Hibernica* Hassall, Ann. Mag. [Nat.] Hist., ser. 1, vol. 6, No. 36, art. 21, p. 172, pl. 7, fig. 1. [*Fide* Busk, 1854, p. 81].
1841. *Lepralia pedilostoma* Hassall, Ann. Mag. [Nat.] Hist., ser. 1, vol. 7, No. 45, art. 39, p. 368, pl. 9, fig. 4. [*Fide* Busk, 1854, p. 81].
1842. *Lepralia pediostoma* Hassall, Ann. Mag. [Nat.] Hist., ser. 1, vol. 9, No. 59, art. 44, pp. 407,408,411. [*Fide* Busk, 1854, p. 81].
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1855. *Escharina pediostoma* (Hassall), Leidy, Acad. Nat. Sci. Philadelphia, Jour., ser. 2, vol. 3, p. 9, fig. 23. [*Fide* Osburn, 1912a, p. 240].
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1863. *Lepralia Pallasiana* (Moll), Smitt, Uppsala Univ., Aarsskr., p. 24.

1864. *Lepralia Pallasiana* (Moll), Grube, Die Insel Lussin und ihre Meeresfauna, p. 67.

1865. *Lepralia Pallasiana* (Moll), Smitt, Kongl. Vetensk. Akad. Förhandl., Öfvers., vol. 22, No. 1, pp. 7,18,28, pl. 1, figs. 11-12; pl. 2, fig. 1; pl. 3, figs. 12-17.

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1870. *Lepralia Pallasiana* (Moll), Fischer, Soc. Linn. Bordeaux, Actes, sér. 3, vol. 7, No. 4, p. 351.

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1877. *Lepralia Pallasiana* (Busk), Joliet, Arch. Zool. Expér. et Génér., vol. 6, p. 291.

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1909. *Smittina Pallasiana* (Moll) Levinsen, Morphologic and Systematic Studies on the Cheilostomatous Bryozoa, p. 340.
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1927. *Hippoporina pallasiana* (Moll), Neviani, Accad. Nuovi Lincei, Mem., vol. 10, p. 178.
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1935. *Lepralia pallasiana* (Moll), Sílen, Ark. f. Zool., vol. 28A, No. 16, p. 3.
1935. *Cryptosula pallasiana* (Moll), Stach, Victorian Natural., vol. 52, p. 83.
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1965. *Cryptosula pallasiana* (Moll), Lagaaij and Gautier, Micropaleontology, vol. 11, No. 1, Chart 1.

The Venezuelan fossil bryozoan referred to this species is encrusting and one layer in thickness. The zooecia are deep, relatively large, variably elongate-hexagonal, rhomboidal or subquadrangular in outline, disposed in alternating, somewhat irregular rows, and separated by a thin wall hardly rising above the level of the frontal. The frontal is a slightly convex tremocyst sloping upward toward the orifice; it is perforated completely through by a reticulate network of large polygonal pores whose diameter is twice that of the walls between them; the pores occupy the whole of the frontal, with a single row around the distal end of the orifice, with generally two rows on each side of the orifice, the outer of the two the larger, and with five to eight rows from the proximal lip of the orifice to the proximal end of the zooecium. On some zooecia there is a small umbonate process near the middle of the proximal lip, the process bearing a subcircular opening facing the orifice; the opening is thought to be the chamber of the avicularium. The orifice is large, suboval, contracted slightly and gracefully below the middle, and longer than wide, having a length about two-fifths that of the zooecium. The sides of the orifice are subparallel and there is a small pair of blunt condyles below the middle, the condyles separating the much taller, regularly arched porta from the narrow, gently concave, and slightly wider vanna. The peristome is slightly elevated, somewhat thickened, forming a conspicuous border around the primary orifice, and sometimes rising on each side into a blunt angle. The distal end of the peristome is separated from the distal wall of the zooecium by a single row of pores. There are a dozen or so dietellae at the base of the vertical walls of the zooecium, and the side of each wall is provided with two to four multiporous septula of oval outline. Attached to about the middle of the lateral wall at the proximal end of a broken zooecium are two inflated, doughnut-shaped, perforate, membranous globules, with a more or less central semilunar orifice on the superior surface. One of the globules lies at the extreme proximal end of the zooecium, straddling the wall between that and the adjacent zooecium; the other lies next and distally to the first but does not quite touch it. These inflated membranous structures are taken to be internal ovisacs.

Measurements.—Specimen T633a: zoarial fragment 4.5 mm long, 2.3 mm wide, 0.52 mm thick; average zooecium 0.61 mm in length, 0.32 mm in width; orifice (measured at outer edge of peristome) 0.26 mm long, 0.19 mm wide. Specimen T633b: multiporous septulum 0.05 mm × 0.03; diameter of ovisac 0.13 mm.

Locality.—Upper Mare Formation, in stream 250 meters south-southwest of the mouth of Quebrada Las Pailas. Two fragments.

Comparisons.—*Exechonella brasiliensis* Canu and Bassler (1928b, p. 72, pl. 3, fig. 5), a Recent species from Bahia Bay, Brazil, is superficially close to the Venezuelan fossil specimen of *Cryptosula pallasiana* (Moll). As *C. pallasiana* is also found living in Brazil (near Rio de Janeiro), one wonders if *E. brasiliensis* might not be the same as the prior-named *C. pallasiana.* The principal difference noted by Marcus (1942, p. 61) was the considerably larger size of the zooecia of *E. braziliensis,* and as Canu and Bassler's description of *E. brasiliensis* was brief and lacking in detail, Marcus thought it advisable to consider the two as distinct species.

Range and distribution.—The known fossil occurrences of this species are rare. A form compared with *C. pallasiana* from the middle Miocene (Burdigalian) of the Rhone Basin in France has been reported by Canu (1913b, p. 128). *C. pallasiana* has also been reported from the Pliocene of England, Sicily, and Italy, as well as the post-Pliocene of Italy. The age of the upper Mare Formation (in which my specimens were collected) is also Pliocene—probably early Pliocene. The living form is of shallow-water habitat. In the Eastern Atlantic it is found from western Norway and the North Sea to England and Ireland, in northern Spain, and off Madeira, at depths from the littoral to less than 28 fathoms. In the Adriatic it has been dredged from the Island of Lošinj (7-10 fathoms), and in the Mediterranean it occurs on both the north and south shores. In the Western Atlantic, the species ranges from Nova Scotia to Brazil. In the Eastern Pacific, it ranges from southern Alaska to Baja California, Mexico. And, in the far Pacific, it occurs in Japan (Mutsu Bay), the Yellow Sea, Australia, and New Zealand.

Dakaria subtorquata (d'Orbigny) Pl. 10, fig. 1

1826,1828. *Cellepora ? ovoidea* Audouin-Savigny, Description del Egypte. Hist. Nat., vol. 1, pt. 4, p. 238, pl. 8, figs. 1.1-1.2 Not *Cellepora ovoidea* Lamouroux. 1816.

1839,1846. *Escharina torquata* Edwards, d'Orbigny, Voyage dans l'Amérique Meridionale, vol. 5, pt. 4, pl. 4, figs. 1-4. Not *Flustra torquata* Lamoroux, 1824.

1845. *Escharina tumidula* Lonsdale, Geol. Soc. London, Quart. Jour., vol. 1, pp. 502-503, fig. p. 502. [*Fide* Canu and Bassler, 1923].

1852. *Cellepora subtorquata* d'Orbigny, Paléontologie Française. Terrains Crétacés, vol. 5, p. 399. For *Escharina torquata* d'Orbigny, 1839,1846.

1852. *Cellepora subovoidea* d'Orbigny, Paléontologie Française. Terrains Crétacés, vol. 5, p. 402. For *Cellepora ovoidea* Audouin-Savigny, 1826,1828.

1854. *Lepralia cucullata* Busk, Catalogue of Marine Bryozoa in the Collection of the British Museum, Pt. II, Cheilostomata, p. 81, pl. 96, figs. 4-5. [*Fide* Harmer, 1957].

1855. *Lepralia atrofusca* Busk, [*in*] Carpenter, Catalogue of the Collection of Mazatlan Shells in the British Museum Collected by Frederick Reigen, p. 3.

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The zoarium is encrusting and unilaminar. The zooecia are large, elongated, subrhomboidal, well defined, separated by a fine purplish lamina, and generally light tan in color though occasionally iridescent and pale black. The frontal is a moderately convex, slightly granular tremocyst, perforated by numerous, large, evenly spaced, rounded tremopores. The orifice is large, transversely oval, situated at the extreme distal end of the zooecium; the porta is broadly arcuate; the condyles are strong and conspicuous, and are situated well below the middle of the orifice; below the condyles is a broad, evenly and deeply concave sinus with a wide proximal lip. The peristome is somewhat raised, a little thickened, and smooth. Rising vertically upward from the rim of the peristome, and lying just distal to each of the condyles, there may be a short blunt thickened projection. The operculum is chitinous and is stained a purplish black in the central area. No avicularia or ovicells have been noted.

Measurements.—Specimen A681a: a typical zooecium is 0.81 mm in length and has a maximum width of 0.51 mm; on the same zooecium the transverse diameter of the orifice is 0.22 mm, the shorter diameter 0.19 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. Encrusted on the pelecypod *Chama congregata* Conrad.

Remarks.—This Venezuelan bryozoan is identical with the description and illustration of D'Orbigny's *Escharina torquata* Edwards from Brazil. In 1892 D'Orbigny noted that his *Escharina torquata* was not the *Flustra torquata* of Lamouroux (with which *E. torquata* Edwards was placed in synonymy), and changed the name to *Cellepora subtorquata*. The genus of *subtorquata* has since been changed to *Dakaria,* and in view of the close similarity between the Venezuelan form and that of D'Orbigny's original species from Brazil, I refer it to D'Orbigny's species as *Dakaria subtorquata.* Harmer (1957) on the other hand preferred the name *Dakaria subovoidea* (d'Orbigny) (for *Cellepora ovoidea* Audouin-Savigny 1826,1828), but I hesitate to use that name for two reasons: one is that there is some doubt in my mind that *D. subovoidea* is the same as *D. subtorquata,* for Savigny's illustration of *Cellepora ovoidea* shows no condyles in the orifice; secondly, if they are the same, should not *D. subtorquata* (d'Orbigny, 1852, p. 399) have priority over *D. subovoidea* (d'Orbigny, 1852, p. 402)? Complicating the nomenclatural problem is the referral by authors of *Watersipora cucullata* (Busk) to this species, and as shown by Hastings (1929) and Marcus (1937), there is no doubt that some of them are the same; however, for those that are the same, the name *D. subtorquata* still has priority. Additional synonyms may be *Escharina tumidula* Lonsdale, *Lepralia atrofusca* (Busk), *Schizoporella aterrima* Ortmann, and *Dakaria chevreuxi* Jullien. All of these and their sources are given in my "synonymy" which more accurately should be termed a list of references to the species in question.

Range and distribution.—This species has been reported from the Miocene (Burdigalian) of France by Vigneaux, from the Miocene of Italy by Neviani, and doubtfully from the Miocene of Virginia, United States (as *Escharina tumidula* Lonsdale) by Canu and Bassler, 1932. In the Pliocene and post-Pliocene, *Dakaria subtorquata* is recorded from Italy. The Recent form is cosmopolitan, living at depths ranging from near shore to 122 fathoms. Off Europe and Africa it occurs in the Aegean Sea, the Adriatic Sea, the Bay of Naples, the Mediterranean Sea, the Red Sea, off Morocco, the Azores, the Cape Verde Islands, and South Africa. In the Western Atlantic it is recorded from Brazil; in the Caribbean Sea from Puerto Rico; and in the Gulf of Mexico from the Tortugas. In the Eastern Pacific it ranges from Baja California to the Galapagos Islands. In the Western Pacific it is found in Japan; in the southern Pacific in New Caledonia; and in the Indian Ocean in Ceylon and Burma.

Microporella ciliata (Pallas) *s.l.* Pl. 10, fig. 2

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1938. *Microporella ciliata* (Pallas), Marcus, Faculdade Philos., Scienc. e Letras Univ. São Paulo, Bol., vol. 4, Zoologia No. 2, p. 73, pl. 19, fig. 50.

1939. *Microporella ciliata* (Pallas), Neviani, R. Ist. Veneto Sci., Lett. ed Arti, Mem., vol. 30, No. 4, pp. 36-37.

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1940. *Microporella ciliata* (Pallas), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, pp. 432-433.
1944. *Microporella ciliata* (Pallas), Osburn, Chesapeake Biol. Lab., Publ. No. 63, pp. 45-46, fig. 28.
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1947. *Microporella ciliata* (Pallas), Osburn, Allan Hancock Atlantic Exped., Rept. No. 5, p. 35.
1948. *Microporella ciliata* (Pallas), Balavoine, Soc. Géol. France, Bull., sér. 5, vol. 18, p. 436.
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1951. *Microporella ciliata* (Pallas), Pearse and Williams, Elisha Mitchell Sci. Soc., Jour., vol. 67, p. 137.
1952. *Microporella ciliata* (Pallas), Osburn, Allan Hancock Pacific Exped., Rept., vol. 14, pt. 2, p. 377, pl. 44, fig. 1.
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1952. *Microporella ciliata* (Pallas), Brown, The Tertiary Cheilostomatous Polyzoa of New Zealand, pp. 250-252, fig. 184.
1954. *Microporella ciliata* (Pallas), Light, Intertidal Invertebrates of the Central California Coast, p. 282.
1956. *Microporella ciliata* (Pallas), Buge, Ann. Mines Geol. Tunis, No. 17, pp. 51-52, pl. 8, fig. 2.
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1957. *Microporella ciliata* (Pallas), Soule and Duff, California Acad. Sci., Proc., ser. 4, vol. 29, No. 4, pp. 114-115.
1957. *Microporella ciliata* (Pallas), Harmer, Siboga-Exped., vol. 16, Mon. 28d, pp. 1960-1961,1962,1963.
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1960. *Microporella ciliata* (Pallas), Noorthorn and Lagaaij, Geol. en Mijnbouw, Jaarg 39, No. 11, p. 720.
1961. *Microporella ciliata* (Pallas), Soule, Amer. Mus. Novitates, No. 2053, pp. 23-24.
1963. *Microporella ciliata* (Pallas), Hertlein, California Acad. Sci., Proc., ser. 4, vol. 32, No. 8, p. 233.
1963. *Microporella ciliata* (Pallas), Galopim de Carvalho, Soc. Geol. Portugal, Bol., vol. 15, No. 1, p. 110.
1964. *Microporella ciliata* (Pallas), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, p. 636.
1965. *Microporella ciliata* (Pallas), Lagaaij and Gautier, Micropaleontology, vol. 11, No. 1, Chart.

The zoarium is encrusting, one layer in thickness, and light tan in color. The zooecia are subhexagonal to rhombic, arranged alternately in longitudinal rows, separated externally by a narrow groove. The frontal is a slightly convex tremocyst with minute perforations, the perforations often obscured by numerous coarse rounded granulations. The orifice is semilunar to suboval, situated near the distal extremity of the zooecium, with a relatively straight proximal lip. The peristome is thin to moderately thick, and raised but little; on one or two zooecia with a thickened peristome there is the suggestion, from minute projections, that the peristome may bear small oral spines, perhaps five or six in number. A short distance below the proximal lip of the orifice, and in the midline of the zooecium, there is a small slightly raised ascopore, lunate to oval in outline, and occasionally bearing a few minute spicules on the inner margin. A single avicularium may be developed lateral to the orifice or below and to one side of the ascopore. The avicularium, where present, is higher and larger than the ascopore, and is ovate in outline. In the area between the ascopore and the proximal lip of the orifice there are two rows of tremopores. The ovicell has not been observed.

Measurements.—Specimen A677a: average zooecium length 0.47 mm, width 0.32 mm; length of orifice on same zooecium 0.102 mm, width 0.071 mm; ascopore 0.036 mm × 0.024 mm; avicularium length 0.07 mm, width 0.05 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. Encrusted on the pelecypod *Pseudochama radians* (Lamarck).

Remarks.—Without the ovicell it is not possible to place this species with assurance, though the specimen in question seems in all other respects to fit *Microporella ciliata* (Pallas), particularly as keyed, described, and illustrated by Osburn (1952, pp. 376,377, pl. 44, fig. 1). However, and again in the absence of the ovicell, the Venezuelan form also resembles the Pleistocene and Recent *M. pontifica* Osburn (1952, pp. 376,383-384, pl. 44, fig. 5), particularly the Pleistocene species from the mudlumps off South Pass, Louisiana, described by Cheetham and Sandberg (1964, p. 1035, text-figs. 40-41). On the other hand, the Recent nonovicelled Venezuelan specimen compares so closely with the nonovicelled area of an ovicell-bearing zoarium of a living *M. ciliata* from west Florida that I am constrained to refer the Venezuelan form in a broad sense to *Microporella ciliata*.

Range and distribution.—Microporella ciliata (Pallas) is reported to range from Oligocene to Recent. The Oligocene occurrence is said to be in Germany. Middle to upper Miocene localities are in Senegal, Tunisia, Italy, Austria, Hungary, France, Portugal, the states of Florida and Maryland, United States, and Australia. In the Pliocene, *M. ciliata* is reported from Tunisia, Sicily, Rhodes, Italy, The Netherlands, Belgium, England, and New Zealand. In the Pleistocene it is recorded from Italy, England, California, and New Zealand. The living *M. ciliata* is able to thrive in boreal to tropical waters at depths ranging from shore to 360 fathoms and in divers oceanic provinces. North Atlantic: Greenland. Eastern Atlantic: The Netherlands, Cape Verde Islands. Mediterranean: Spain, France, Monaco, Corsica, Sicily, Italy, Tunisia. Western Atlantic: Labrador to Brazil. Caribbean: Venezuela (Cubagua and Coche), Curaçao, Puerto Rico. Gulf of Mexico: Tortugas, west Florida. Eastern Pacific: Canada to Panama, Cocos Island, and the Galapagos. Western Pacific: The Philippines, China Sea, Japan (Mutsu Bay). Southern Pacific: Australia and New Zealand. And the Red Sea.

Hippodiplosia pertusa (Esper) Pl. 9, fig. 4

1796. *Cellepora pertusa* Esper, Forsetzungen der Pflanzenthiere in Abbildungen der Natur mit Farben erleuchtet nebst Beschreibungen, vol. 1, pt. 6, p. 149, pl. 10, figs .1-2 .

1822-29. *Cellepora perlacea* Delle Chiaje, Memoria sulla Storia e Notomia degli Animali senza Vertebre del Regno di Napoli, vol. 3, p. 37, pl. 34, figs. 4,6; vol. 5, p. 148, pl. 158, figs. 1-6. [*Fide* Smitt 1873, p. 55].

1836. *Escharina pertusa* (Esper), Milne-Edwards, [*in*] Lamarck, Histoire Naturelle des Animaux sans Vertèbres, ed. 2, vol. 2, p. 232.

1836. *Escharina perlacea* Delle Chiaje, Milne Edwards, [*in*] Lamarck, Histoire Naturelle des Animaux sans Vertebres, p. 234. [*Fide* Busk, 1854, p. 80].

1842. *Cellepora perlacea* Delle Chiaje, Thompson, Ann. Mag. Nat. Hist., ser. 1, vol. 10, p. 20. [*Fide* Busk, 1854, p. 80].

1847. *Lepralia pertusa* (Esper), Johnston, A History of the British Zoophytes, ed. 2, p. 311, pl. 54, fig. 10.

1848. *Lepralia pertusa* (Esper), Gray, List of the Specimens of British Animals in the Collection of the British Museum, Pt. I, p. 119.

1850-53. *Cellepora perlacea* Delle Chiaje, d'Orbigny, Paléontologie Française. Terrains Crétacés, vol. 5, p. 400. [*Fide* Smitt, 1873, p. 55].

1850-53. *Cellepora pertusa* Esper, d'Orbigny, Paléontologie Française. Terrains Crétacés, vol. 5, p. 401. [*Fide* Smitt, 1873, p. 55].

1854. *Lepralia pertusa* (Esper), Busk, Catalogue of the Marine Polyzoa in the British Museum, Pt. II, Cheilostomata, p. 80, pl. 78, fig. 3 (*non* figs. 1-2, *fide* Brown, 1952, p. 267); pl. 79, figs. 1-2.

1859. *Lepralia pertusa* (Esper), Dawson, Geol. Sur. Canada, Rept. Progress 1858, p. 256.
1867. *Lepralia pertusa* (Esper), Heller, K.-K. Zool.-Botan. Gesell. Wien, Verhandl., vol. 17, p. 35.
1868. *Lepralia pertusa* (Esper), Norman, Quart. Jour. Microsc. Sci., n. s., vol. 8, p. 222.
1873. *Escharella pertusa* (Esper), Smitt, Kongl. Svenska Vetensk.-Akad., Handl., vol. 11, No. 4, Pt. II, pp. 55-56.
1873. *? Lepralia pertusa* (Esper), Hutton, [*in*] Catalogue of the Marine Mollusca of New Zealand, p. 98.
1879. *Lepralia pertusa* (Esper) var. *rotundata, armata* Waters, Ann. Mag. Nat. Hist., ser. 5, vol. 3, p. 31. [Not var. *sinuata* Waters, p. 31, pl. 8, fig. 5, *fide* Marcus, 1938, p. 39].
1879. *Escharina porosa* Verrill, U.S. Nat. Mus., Proc., vol. 2, pp. 193-194. [*Fide* Osburn, 1912, pp. 241,242].
1880. *Lepralia pertusa* (Esper), Hincks, A History of the British Marine Polyzoa, vol. 1, pp. 305-307; vol. 2, pl. 43, figs. 4-5.
1881. *Lepralia pertusa* (Esper), Jullien, Soc. Zool. France, Bull., vol. 6, pp. 201,209.
1883. *Lepralia pertusa* (Esper), Waters, Geol. Soc. London, Quart. Jour., vol. 39, p. 437.
1884. *Lepralia pertusa* (Esper), Busk, Voyage H.M.S. Challenger, Rept. Sci. Results, Zoology, vol. 10, pt. 30, p. 146.
1887. *? Lepralia pertusa* (Esper), Waters, Geol. Soc. London, Quart. Jour., vol. 43, pp. 44,61.
1892. *Lepralia pertusa* (Esper), Hincks, Ann. Mag. Nat. Hist., ser. 6, vol. 9, p. 154.
1895. *Lepralia pertusa* (Esper), MacGillivray, Roy. Soc. Victoria, Trans., n. s., vol. 4, p. 72, pl. 10, fig. 8.
1895. *Hippoporina pertusa* (Esper), Neviani, Soc. Romana Studi Zool., Boll., vol. 4, p. 109.
1896. *Hippoporina pertusa* (Esper), Neviani, [*in*] Ossat and Neviani, Soc. Geol. Italiana, Boll., vol. 15, p. 15.
1896. *Lepralia pertusa* (Esper), Henning, Kongl. Vetensk. Akad. Förhandl., Ofversigt, vl. 53, p. 358.
1898. *Hippoporina pertusa* (Esper), Neviani, Soc. Romana Studi Zool., Boll., vol. 7, pt. 5, No. 14, p. 101.
1898. *Lepralia pertusa* (Esper), Hamilton, New Zealand Inst., Trans. and Proc., vol. 30, p. 198.
1901. *Lepralia pertusa* (Esper), Whiteaves, Geol. Sur. Canada, Rept., p. 101.
1902. *Lepralia pertusa* (Esper), Calvet, Inst. Zool. Univ. Montpellier, Trav., sér. 2, Mém. No. 11, p. 51.
1902. *Lepralia pertusa* (Esper), Calvet, Inst. Zool. Univ. Montpellier, Trav., sér. 2, Mém. No. 12, p. 26.
1903. *Lepralia pertusa* (Esper), Jullien, [*in*] Jullien and Calvet, Résultats des Campagnes Scientifiques accomplies sur son Yacht par Albert Ier, Prince Souverain de Monaco, No. 20, pp. 69-70.
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1905. *Eschara nordlandica* Nordgaard, Bergens Mus., Meeresfauna von Bergen, pt. II, p. 167, pl. 4, figs. 32-35. [*Fide* Marcus 1938, p. 39].
1906. *Eschara nordlandica* Nordgaard, Second Norwegian Arctic Exped. From 1898-1902, Rept., No. 8, p. 22.
1907. *Lepralia pertusa* (Esper), Cornish, Marine Fish. Rept. Canada, Sessional Paper No. 22, p. 77.

1912. *Lepralia pertusa* (Esper), Osburn, Bur. Fish., Bull., vol. 30 for 1910, pp. 241-242, pl. 26, figs. 56-56c.
1913. *Lepralia pertusa* (Esper), Sumner, Osburn and Cole, Bur. Fish., Bull., vol. 31 for 1911, Pt. I, pp. 108,109, chart 43.
1913. *Lepralia pertusa* (Esper), Sumner, Osburn and Cole, Bur. Fish., Bull., vol. 31 for 1911, Pt. II, p. 604.
1914. *Lepralia pertusa ?* (Esper), Levinsen, Medd. Grønland, vol. 23, p. 602.
1918. *Hippoporina pertusa* (Esper), Nordgaard, Tromso Mus., Aarsh., vol. 40 (1917), No. 1, p. 59.
1919. *Hippoporina pertusa* (Esper), Osburn, Amer. Mus. Nat. Hist., Bull., vol. 16, art. 19, pp. 611,616.
1924. *Lepralia pertusa* (Esper), Prenant and Teissier Stat. Biol. Roscoff, Trav., vol. 2, p. 14.
1928. *Hippodiplosia pertusa* (Esper), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 42, No. 2710, art. 14, pp. 106-107, pl. 9, fig. 6; pl. 32, fig. 10; text fig. 19B.
1929. *Hippodiplosia pertusa* (Esper), Hastings, Zool. Soc. London, Proc., No. 47, pp. 724-725, pl. 17, fig. 118.
1930. *Lepralia pertusa* (Esper), Visscher, U.S. Bur. Fish., Bull., vol. 43 for 1927, pt. II, p. 212.
1933. *Hippodiplosia pertusa* (Esper), Osburn, [*in*] Procter, Biol. Sur. Mount Desert Region, pt. 5, p. 329, pl. 14, fig. 8.
1935. *? Hippodiplosia pertusa* (Esper), Sakakura, Fac. Sci. Tokyo Imp. Univ., Jour., Sect. 2, Geol., vol. 4, No. 1, pp. 23-24, pl. 4, fig. 4.
1938. *Hippodiplosia pertusa* (Esper), Marcus, Faculdade Philos., Scienc. e Letras Univ. São Paulo, Bol., vol. 4, Zoologia No. 2, pp. 39-41, pl. 10, figs. 23A-C.
1940. *Hippodiplosia pertusa* (Esper), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol 16, pt. 3, p. 430.
1940 *Hippodiplosia pertusa* (Esper) Marcus, Danmarks Fauna, vol. 46, pp. 251-252, fig. 129.
1945. *Hippodiplosia pertusa* (Esper), Hutchins, Connecticut Acad. Arts and Sci., Trans., vol. 36, p. 543.
1952. *Hippodiplosia pertusa* (Esper), Osburn, Allan Hancock Pacific Exped., Rept., vol. 14, pt. 2, p. 340, pl. 40, figs. 5-8.
1952. *Hippoporina pertusa* (Esper), Brown, The Tertiary Cheilostomatous Polyzoa of New Zealand, pp. 267-269, fig. 199.
1957. *Hippoporina pertusa* (Esper), Harmer, Siboga-Exped., vol. 16, Mon. 28c, p. 977.
1964. *Hippodiplosia pertusa* (Esper), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, p. 632.
1964. *Hippoporina pertusa* (Esper), Cheetham and Sandberg, Jour. Paleont., vol. 38, No. 6, p. 1043, text fig. 54.
1964. *Hippoporina pertusa* (Esper), Cook, British Mus. (Nat. Hist.), Bull., Zoology, vol. 12, No. 1, pp. 5-6, fig. 1A.

The zoarium is encrusting and one layer in thickness. The zooecia are oblong-hexagonal to asymmetrically rhomboidal and disposed in a regular serial alignment. The walls are relatively thin, sometimes separating the zooecia as a low salient lamina, and sometimes completely submerged, the separation then of the zooecia hardly discernible. The frontal is slightly convex, smooth to granular depending on the degree of calcification, and perforated by large pores with the distances between the pores a little greater than their diameter. The primary orifice is rounded, displaying a semicircular porta and a shallowly concave vanna separated by a small pair of condyles well below the middle of the orifice. The peristome is more or less encircling, moderately high proximally, and somewhat nodular, surrounding the narrow shelf-like olocyst of the primary orifice, and thickened at the proximal lip where it may be drawn up into a mucro at the middle. Neither avicularia nor ovicells have been observed.

Measurements.—Specimen D685a: average zooecium, length 0.45 mm, width 0.29 mm; orifice 0.095 mm × 0.083 mm.

Locality.—Abisinia Formation, eastern edge of Playa Grande village at W-30. Encrusted on the pelecypod *Pseudochama radians* (Lamarck).

Comparisons.—Species resembling *Hippodiplosia pertusa* (Esper) are *H. americana* (Verrill) (see Osburn, 1912a, p. 241, pl. 25, figs. 55-55a), *Cryptosula pallasiana* (Moll) (see Osburn, 1912a, p. 240, pl. 25, fig. 54; pl. 30, fig. 89), and *Dakaria sertata* Marcus (1937, pp. 95-96, pl. 19, figs. 50A-B). The frontal of *H. americana* is coarser, and the perforations fewer and larger than on *H. pertusa*. On *Cryptosula pallasiana* the proximal lip of the orifice is straight, on *H. pertusa* it is shallowly concave. According to Marcus, his *Dakaria sertata* is distinguished from *H. pertusa* by its much stronger condyles, by its open rather than encircling peristome, and by differences in the operculum (not present on the Venezuelan example).

Range and distribution.—The age of the Venezuelan specimen here referred to *Hippodiplosia pertusa* (Esper) is Pleistocene. The range of the species is middle Miocene to Recent. It has been recorded from the middle Miocene of Australia and New Zealand by Brown (1952) and questionbly from the Pliocene of New Zealand by the same author. Canu and Bassler (1928c) reported the species from the Pliocene of Bocas Island, Panama, but Hastings (1929) doubted that fossil form was the same as *H. pertusa* (Esper). Neviani recorded *H. pertusa* from the Pliocene and Pleistocene (?) of Italy, and Sakakura from the Pleistocene of Japan. A sub-Recent occurrence is in the mudlumps in the mouth of the Mississippi River off South Pass, Louisiana. The Recent form lives in arctic, temperate, and tropical waters at depths between shore and 100 fathoms. In the Eastern Atlantic it has been found from Greenland to Great Britain to the north coast of France (Etretat). Farther south it has been dredged from the Adriatic Sea and Mediterranean Sea, and west Africa. In the Western Atlantic it occurs as far north as Labrador and as far south as Santos Bay, Brazil. In the Caribbean Sea it occurs off Puerto Rico, and in the Gulf of Mexico it occurs east of Yucatan (25 fathoms), in the Tortugas (53 fathoms), and off west Florida (5 fathoms). In the Eastern Pacific it ranges from southern California to Mexico to Panama to Colombia, and to the Galapagos Islands at depths of 4 to 23 fathoms. In the southern Pacific it is said to occur in Australia, New Zealand (?), and in the Fiji and Samoan Islands.

Smittipora abyssicola (Smitt) Pl. 8, fig. 3

1873. *Vincularia abyssicola* Smitt, Kongl. Svenska Vetensk.-Akad., Handl., vol. 11, No. 4, Pt. II, pp. 6-7, pl. 1, figs. 60-61.
1881. *Smittipora abyssicola* (Smitt), Hincks, Ann. Mag. Nat. Hist., ser. 5, vol. 7, pp. 155-156, pl. 10, fig. 4.
1881. *Smittipora abyssicola* (Smitt), Jullien, Soc. Zool. France, Bull., vol. 6, p. 284.
1882. *Vincularia abyssicola* Smitt, Hincks, Ann. Mag. Nat. Hist., ser. 5, vol. 9, p. 85.
1884. *Smittipora abyssicola* (Smitt), Hincks, Ann. Mag. Nat. Hist., ser. 5, vol. 13, p. 358.
1887. *Smittipora abyssicola* (Smitt), Hincks, Ann. Mag. Nat. Hist., ser. 5, vol. 19, pp. 161,164.
1889. *Smittipora abyssicola* (Smitt), Jelly, A Synonymic Catalogue of the Recent Marine Bryozoa, p. 253.
1893. *Onychocella abyssicola* (Smitt), Hincks, Ann. Mag. Nat. Hist., ser. 6, vol. 11, p. 181.
1914. *Smittipora abyssicola* (Smitt), Osburn, Carnegie Inst. Washington, Publ. No. 182, Papers Tortugas Lab., vol. 5, No. 11, pp. 195-196.
1920. *Smittipora abyssicola* (Smitt), Canu and Bassler, U.S. Nat. Mus., Bull. 106, pp. 204,224, figs. 56E,59A-C.
1927. *Smittipora abyssicola* (Smitt), Osburn, K. Zool. Genootsch., Natura Artis Magistra Amsterdam, vol. 25, pp. 125-126.
1928. *Rectonychocella abyssicola* (Smitt), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, No. 2710, pp. 53-54, pl. 5, figs. 1-3.
1937. *Smittipora abyssicola* (Smitt), Marcus, Faculdade Philos., Scienc. e Letras Univ. São Paulo, Bol., vol. 1, Zoologia No. 1, p. 52.
1940. *Rectonychocella abyssicola* (Smitt), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, p. 371.
1941. *Smittipora abyssicola* (Smitt), Marcus, Faculdade Filos., Cienc. e Letras Univ. São Paulo, Bol., vol. 22, Zoologia No. 5, pp. 18,21,22,23.

1949. *Smittipora abyssicola* (Smitt), Marcus, Mus. Hist. Nat. Montevideo, Comunic. Zool., vol. 3, No. 53, pp. 8,9.
1953. *Smittipora abyssicola* (Smitt), Bassler, Treat. Invert. Paleont., Pt. G, Bryozoa, p. G169, fig. 128.7.
1955. *Smittipora abyssicola* (Smitt), Marcus, Mus. Nac. Rio de Janeiro, Arq., vol. 42, pt. I, p. 283.

This species is represented by two encrusting zoaria, one with the ectocyst and onychocellarium intact, the other with these processes removed and the colony somewhat weathered. The ectocyst is an extremely thin transparent film covering the whole of the zooecium. The zoaria are tabulate and one layer in thickness. The zooecia are distinct, elongated, irregularly rhomboidal, generally rounded at the distal end, and narrowing somewhat toward the proximal end. The walls of the zooecia are moderately thick, somewhat elevated, finely beaded around the mural rim, and separated from the adjacent walls by a narrow groove between them. Piercing each of the walls near the base of the zooecium is a rounded opening representing the communication passage between the zooecia. The inner slope of the lateral walls from the mural rim to the surface of the cryptocyst averages about 50° or so. The cryptocyst is minutely tuberculate, depressed below the level of the mural rim. On the well-preserved though dried specimen (A675a) the cryptocyst is generally even and plane-surfaced, and horizontally truncate at the proximal edge of the opercular aperture. However, on some of the opesia of that zoarium there is a faint longitudinal depression on the cryptocyst near each lateral wall, and the cryptocyst rises gently to form a low lip at the proximal border of the opercular aperture. Though the opesium is straight along the proximal border of the aperture there is a tendency to develop an incipient notch or opesiule at each corner, and these opesiules are even somewhat more evident on the more weathered specimen (B675a) though not to the extent that they are on typical examples of *Smittipora levinseni* [= *S. americana*] (Canu and Bassler). The opercular aperture is horseshoe-shaped, with a semicircular distal rim and a sharply truncate proximal rim. The operculum itself, which has the same outline as the aperture it covers, is amber-colored, chitinous, thickened around the periphery, and microscopically tuberculate on the outer surface. The avicularian-bearing zooecia are nearly as long, but somewhat narrower than, the normal zooids and are rhombic to pentagonal in outline. Projecting from the avicularian zooid, with its spacious opesium, is the onychocellarium which is provided with a large bimembranous mandible. The mandible consists of a rhachis in the middle and two large symmetrical membranous wings, one on each side of the axial rhachis. These aliform expansions are delicate, ovate-triangular in outline, and extend for a distance of perhaps three-fourths the length of the rhachis which it joins near the distal end at an acute angle. The base of the rhachis is small and sharply triangular, and continues from that as a thick hair-like process which curves upward near the distal end and is acuminate at the extremity. No teeth can be observed on the distal portion of the rhachis in our material.

Measurements.—Specimen A675a: zooarium length 2.7 mm, width 2.2 mm, thickness 0.29 mm; average zooecium length 0.53 mm, maximum width 0.38 mm; opercular aperture length 0.17 mm, width 0.15 mm; avicularian-bearing zooecium length 0.52 mm, width 0.23 mm; length of rhachis 0.41 mm.

Localities.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal, encrusted on the pelecypod *Arca zebra* Swainson. Recent, on beach southeast of Higuerote, State of Miranda, encrusted on the pelecypod *Trachycardium muricatum* (Linnaeus).

Comparisons.—The distinction between *Smittipora abyssicola* (Smitt) with which my specimens are identified, and the later-named *S. levinseni* [= *S. americana*] (Canu and Bassler), lies in the greater convexity of the lip area of the cryptocyst just below the operculum, and the more pronounced development, in *S. levinseni,* of the opesiules or notches in the corners of the cryptocyst at the proximal rim of the opercular aperture. However, as suggested by Marcus (1941, pp. 71-23; 1955, pp. 282-283) in his detailed analyses of *S. levinseni,* the two species might be identical, and the characters mentioned above could represent extremes in th normal variation of the same species. An example of this is the *S. americana* (Canu and Bassler) of Shier (1964, p. 618) from west Florida which seems to me to lie between the typical *S. abyssicola* and the typical *S. levinseni.* Nevertheless, for want of more material, Marcus decided to maintain the separateness of the two species, and that suggestion is followed here. References to the *S. levinseni* group are cited below.

1909. *Onychocella* sp. Levinsen, Morphological and Systematic Studies on the Cheilostomatous Bryozoa, p. 22, figs. 3a-3d.
1917. *Velumella (Onychocella) levinseni* Canu and Bassler, U.S. Nat. Mus., Bull. 96, p. 26.
1920. *Velumella (Onychocella) levinseni,* Canu and Bassler, Canu and Bassler, U.S. Nat. Mus., Bull. 106, p. 213, figs. 58A-D; p. 214.
1926. *Smittipora abyssicola* (Smitt), Harmer, Siboga-Exped., vol. 14, Mon. 28b, pp. 259-260, pl. 16, figs. 10-13. [Not of Smitt, *fide* Canu and Bassler, and re-named *Smittipora harmeriana* Canu and Bassler, 1928, p. 54].
1928. *Velumella americana* Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, No. 2710, pp. 54-60, pl. 6, figs. 9-10, text fig. 7.
1929. *Velumella americana* Canu and Bassler, U.S. Nat. Mus., Bull. 100, vol. 9, p. 128.
1940. *Velumella americana* Canu and Bassler, Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, pp. 371-372.
1941. *Smittipora levinseni* (Canu and Bassler), Marcus, Faculdade Filos., Ciênc. e Letras Univ. São Paulo, Bol., vol. 22, Zoologia No. 5, pp. 17-23, figs. 1A-1B.
1947. *Velumella americana* Canu and Bassler, Osburn, Allan Hancock Atlantic Exped., Rept., No. 5, p. 17.
1949. *Smittipora harmeriana* Canu and Bassler, Marcus, Mus. Hist. Nat. Montevideo, Comunic. Zool., vol. 3, No. 53, p. 9.
1950. *Velumella americana* Canu and Bassler, Osburn, Allan Hancock Pacific Exped., Rept., vol. 14, pt. 1, p. 103, pl. 12, figs. 7-8.
1953. *Smittipora levinseni* (Canu and Bassler), Bassler, Treat. Paleont., Pt. G, Bryozoa, p. G148, fig. 107.1d.
1955. *Smittipora levinseni* (Canu and Bassler), Marcus, Mus. Nac. Rio de Janeiro, Arq., pp. 282-283, fig. 24.
1959. *Velumella americana* Canu and Bassler, Soule, Amer. Mus. Novitates, No. 1969, pp. 28-29.
1964. *Smittipora americana* (Canu and Bassler), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, p. 618.
1964. *Smittipora levinseni* (Canu and Bassler), Cook, Inst. Océanogr., Ann., vol. 41, No. 6, pp. 71-73, text fig. 13.

Range and distribution—Smittipora abyssicola (Smitt) has been reported from Florida (68 fathoms), the Tortugas (low water to 15 fathoms), north of Cuba (387,450 fathoms), and off the Island of Curaçao, in shallow water. *Smittipora levinseni* (Canu and Bassler) has been reported from west Florida (5 fathoms), 15 miles south of Miami, Florida, in the Gulf of Mexico (30 fathoms), off the north coast of Cuba (115 and 143 fathoms), Puerto Rico (6-11 fathoms), Curaçao, Colombia, Gulf of Venezuela (21-22 fathoms), Margarita (Venezuela), the island of São Sebastião (100 kilometers east of Santos, Brazil, encrusted on a beach shell), West Africa (20-28 fathoms), and the Cape Verde Islands (2-40 fathoms). In the Eastern Pacific, it is recorded from the Gulf of California (14-30 fathoms), from the Gulf of Panama, and from Chatham

Island in the Galapagos (17-32 fathoms). *Smittipora harmeriana* (Canu and Bassler) is recorded from Ceylon, in the East Indian Archipelago from Singapore to New Guinea (5-25 fathoms), and from Holborn Island off Queensland, Australia in shallow water to 146 fathoms. It has also been recorded from the Antillean island of St. Vincent.

Hippopodinella venezuelana, new species Pl. 3, figs. 1-3; Pl. 10, fig. 3

The zoarium is encrusting and slightly convex, conforming thereby with the surface of the shell to which it was attached. The under side of the zoarium is relatively smooth, and the outlines of the irregularly polygonal zooecia lightly defined by fine grooves. The zooecia of the superior surface are more or less rhomboidal, and are arranged alternately in longitudinal radiating rows. The orifice is hippoporine, with a pair of small lateral condyles below the middle. The porta is regularly and deeply arched; the vanna is generally shallowly concave, is about the same width as the porta, and forms a small re-entrant at the condyles. The peristome is narrow, smooth, and hardly raised. The peristome, or space between the inner and outer orifices, is fairly broad. The frontal is convex, heavily calcified, granular to verrucose, and at an early stage minutely punctate. The vibracula are paired and symmetrical, each one situated on a sturdy and often rugose elevated node or boss lying just below and to one side of the proximal lip. A single row of prominent areolae completely encircles the margin of the frontal, and some of the areolae, particularly the lateral ones, are set in interareolar costules. There are approximately 23 such areolae on a zooecium of average size including those between the distal rim of the orifice and the wall of the zooecium. The character of the ovicell is not known.

Measurements. — Holotype (I621a): Zoarium 2.7 mm long and 1.3 mm wide; average zooecium length 0.45 mm, width 0.31 mm; orifice length 0.15 mm, width 0.09 mm.

Locality.—Lower Mare Formation, on hillside above west bank of Quebrada Mare Abajo at W-13. Four fragments. Specimen I621a was encrusted on and pried off of the gastropod *Pyrene (Eurypyrene) venezuelanum* Weisbord (Bull. Amer. Paleont., vol. 42, No. 193, pp. 332-334, pl. 29, figs. 19-20, 1962).

Comparisons.—The species described above is similar to the Pliocene to Recent *Hippopodinella lata* (Busk) (1856a, p. 309, pl. 10, figs. 1-2), differing, however, in the position and configuration of the orifice. On *H. lata* the distal rim of the orifice is confluent with the distal border of the zooecium, but on *H. venezuelana* there is a narrow space between them revealing the marginal areolae. The porta of the orifice of *H. venezuelana* is deeply and regularly arched, whereas that of *H. lata* is typically ogival. The vanna of the Venezuelan specimens is shallowly concave at the proximal lip, whereas the proximal lip or poster of *H. lata* is straight or truncated.

Hippopodinella lata (Busk) ranges from Pliocene to Recent. In the Pliocene it has been recorded from Italy and from the subsurface of the Netherlands (Scaldisian Stage) in borings at Haamstede, Vlissingen, and Wilmarsdonck. The living form of *H. lata* occurs off the island of Guernsey, along the north coast of Spain and France, at Madeira, in the Rhone delta, in the Mediterranean and Adriatic Sea, and on the north coast of Africa.

Hippoporidra janthina (Smitt) Pl. 3, figs. 10,11; Pl. 7, fig. 4

1873. *Lepralia edax* forma *janthina* Smitt, Kongl. Svenska Vetensk.-Akad., Handl., vol. 11, No. 4, pt. II, pp. 63-65, pl. 11, figs. 224-225.
1880. *Lepralia edax* (Busk), Hincks (part), A History of the British Marine Polyzoa, pp. 311-315, pl. 24, figs. 7-7a.
1904. *Lepralia maculata* Ulrich and Bassler, Maryland Geol. Sur., Miocene, pp. 423-424, pl. 115, figs. 8-9; pl. 118, fig. 7. [*Fide* Cook, 1964b, p. 27].
1914. *Lepralia janthina* (Smitt), Osburn, Carnegie Inst. Washington, Publ. No. 182, Papers Tortugas Lab., vol. 11, p. 213.
1920. *Cellepora janthina* (Smitt), Canu and Bassler, U.S. Nat. Mus., Bull. 106. p. 615, figs. 185A-C.
1923. *Cellepora minuta* Canu and Bassler, U.S. Nat. Mus., Bull. 125, p. 182, pl. 25, figs. 10-13. [*Fide* Cook, 1964b, p. 27].
1928. *Hippotrema janthina* Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, art. 14, No. 2710, pp. 141-142. [not *Cellepora janthina* Waters = *Cleidochasma rotundorum* (Norman), *fide* Cook, 1964b, p. 27].
1929. *Hippotrema (Lepralia) janthina* (Smitt), Canu and Bassler, U.S. Nat. Mus., Bull. 100, vol. 9, pp. 418,419.
1940. *Hippotrema janthina* (Smitt), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 6, pt. 3, p. 454.
1947. *Hippotrema janthina* (Smitt), Osburn, Allan Hancock Atlantic Exped., Rept., No. 5, p. 43.
1952. *Hippoporidra janthina* (Smitt), Osburn, Allan Hancock Pacific Exped., Rept., vol. 14, No. 3, p. 355, pl. 45, figs. 13-15.
1953. *Hippoporidra janthina* (Smitt), Bassler, Treat. Invert. Paleont., pt. G, Bryozoa, p. G204, fig. 154,2.

1957. *Hippoporidra edax* (Busk), Soule and Duff, California Acad. Sci., Proc., ser. 4, vol. 29, No. 4, p. 113. [= *Hippoporidra janthina* (Smitt), *fide* Cook, 1964b, p. 27].
1957. *Hippoporidra janthina* (Smitt), Maturo, Elisha Mitchell Sci. Soc., Jour., vol. 73, pp. 53-54, fig. 59.
1964. *Hippoporidra janthina* (Smitt), Cook, British Mus. (Nat. Hist.), Bull., Zoology, vol. 12, No. 1, pp. 27-28.
1964. *Hippoporidra janthina* (Smitt), Cheetham and Sandberg, Jour. Paleont., vol. 38, No. 6, p. 1033, text-fig. 36.

The zoarium forms a thick botryoidal crust completely coating spheroidal bodies of uncertain identity. One of the spheroids (1582a) has a rounded opening resembling the aperture of a gastropod. The encrustation of another spheroid (I582b), donated by Dr. Robert Lagaiij) also has a botryoidal appearance, but the spheroid has no opening. The zooecia are crowded, subhexagonal, unoriented, thickly calcified, and coarsely granular, some of them salient, others immersed. The orifice is suborbicular, slightly longer than wide, bearing a pair of prominent condyles well below the middle; the porta is nearly circular, the vanna transversely crescentic with a shallowly and evenly concave proximal lip nearly as wide, to as wide as the porta. Where the zooecia are not too tightly crowded they are distinctly separated by a lamina though this is not often seen. The frontal of the salient zooecia is more or less convex, steeply sloping, verrucose to occasionally radially costulate. The margin of the frontal is provided with one, or occasionally two rows of generally large, widely separated areolae, and piercing the frontal proper are a number of rather large perforations. The peristome is subdued, and rising above it from the midline a short distance below the proximal lip, there is a sturdy irregularly calcified and puckered boss or umbone. A frontal avicularium is situated below and to one side of the apex of the umbone, near the peristome, and occasionally there is another one on a tapering rostrum elsewhere near the peristome. These avicularia are ovate-acuminate, and possess a cross bar nearer the rounded end. Scattered throughout the zoarium are large and relatively broad interzooecial avicularia, rounded at one end and attenuated at the other, bearing a cross bar near the rounded end. The minute details of the cross bar are not clear due to corrosion, but in an occasional interzooecial avicularium the bar is seen to be scalloped into three lobes along the edge facing the attenuated end of the avicularium. The opening behind the straight edge of the cross bar is shallowly crescentic. The character of the ovicell cannot be clearly discerned.

Measurements.—Specimen I582a: diameters of specimen 17.5 mm × 13 mm; average zooecium length 0.405 mm, width 0.286 mm; long diameter of orifice 0.095 mm; diameters of porta 0.0714 mm; width of vanna 0.0714, length 0.0238 mm; interzooecial avicularium length 0.14 mm, maximum width 0.087 mm. Specimen I582b: diameters of specimen 17 mm × 13.2 mm; average zooecium length 0.405 mm, width 0.298 mm; long diameter of orifice 0.107 mm; width of porta 0.083 mm; width of vanna 0.081 mm; interzooecial avicularium length 0.214 mm, width 0.202 mm.

Locality.—Lower Mare Formation at W-13, on hillside above west bank of Quebrada Mare Abajo. Two specimens.

Comparisons.—According to Cook, "*H. janthina* is obviously very closely related to *H. edax,* being distinguished by the wider shallower sinus and the greater frequency of frontal pores." The Venezuelan fossil specimens meet Cook's criteria, and also differ in the character of the interzooecial avicularia which are broadly trigonal in outline, as contrasted with those of *H. edax* which are broad-shaped (see Vigneaux, 1949b, p. 81, fig. 32), having a large oval head and a longish nail-like mandibular prolongation. On the other hand the trilobate or doubly indented cross bar of the interzooecial avicularium seems identical with that of *H. edax.* Neither Smitt nor later authors have clearly described or illustrated the interzooecial avicularia of *H. janthina,* but if they are broadly trigonal as shown on Plate 7, figure 4, the Venezuelan form should probably be referred to *H. janthina* for it agrees well in other respects. Cook has tentatively grouped all Western Atlantic records of the *H. edax-H. janthina* complex under *H. janthina* (Smitt), but this leaves unresolved the correct placement of Smitt's *H. edax* forma *typica* and *H. edax* forma *calcarea* from off the east coast of Florida. Both of these are similar in many respects, including the shape of the interzooecial avicularium, to *H. edax* (Busk). Some authors (*ie.* Osburn 1914, pp. 212-213) combined *H. calcarea* with *H. edax* (Busk), but others (Canu and Bassler, 1928c, pp. 139-142) regarded Smitt's *H. edax* forma *typica,* Smitt's *H. edax* forma *calcarea,* and Smitt's *H. janthina* as separate species.

Range and distribution.—*Hippoporidra janthina* (Smitt) is reported as ranging from upper Miocene to Recent. In the upper Miocene it occurs in the Calvert Formation of Maryland (as *Lepralia maculata* Ulrich and Bassler). In the Pleistocene it occurs in the mudlumps off South Pass, Louisiana, and is recorded at Newport, California, by Soule and Duff as *Hippoporidra edax*. The Recent form is found in the Western Atlantic in North Carolina, off the east coast of Florida (13 fathoms), and possibly in Bermuda. In the Gulf of Mexico it occurs in the Tortugas at six fathoms. In the Caribbean it is reported from north of Cuba (130 fathoms), Colombia, the Venezuelan islands of Cubagua and Margarita, and Aruba, from shore to 71 fathoms. In the Eastern Pacific it is said to occur in the Gulf of California and Baja California (2-60 fathoms), as well as off Mazatlan, Mexico.

The following references to *Hippoporidra edax* (Busk) have come to my attention. Those marked with an asterisk occur in the Western Atlantic or are reported as fossils in eastern United States.

1847. *? Cellepora parasitica* Michelin, Iconographie Zoophytologique, p. 326, pl. 7, fig. 3. [*Fide* Lagaaij, 1952, pp. 147-148].

1859. *Cellepora edax* Busk, Palaeontogr. Soc. London, Mon., vol. 11, pp. 59-60, pl. 9, figs. 6, a-c; pl. 22, figs. 3, a-c.

1861. *Cellepora edax* Busk, Quart. Jour. Microsc. Sci., n.s., vol. 1, p. 154, pl. 34, figs. 3-3a.

1862. *Cellepora edax* Busk, Hincks, Ann. Mag. Nat. Hist., ser. 3, vol. 9, p. 304.

1872. *Cellepora edax* Busk, Wood, Palaeontogr. Soc. London, Mon., vol. 25, pp. 54-55, pl. 5, figs. 25a-b.

*1873. *Lepralia edax* (Busk) forma *typica*, forma *calcarea*, Smitt, Kgl. Svenska Vetensk.-Akad., Handl., vol. 11, No. 4, pt. 2, pp. 63-65, pl. 11, figs. 220-223.

1874. *Cellepora edax* Busk, Houzeau de Lehaie, [*in*] van den Broeck, Soc. Roy. Malac. Belgique, Ann., vol. 9, p. 204.

1879. *Celleporaria edax* (Busk), Seguenza, R. Accad. Lincei Roma, Mem., Cl. Sci. Fis., Mat. e Nat., ser. 3, vol. 6, pp. 129,207,371.

1879. *Lepralia edax* (Busk), Hincks, Ann. Mag. Nat. Hist., ser. 5, vol. 3, No. 14, pt. 17, p. 159.

1880. *Lepralia edax* (Busk), Hincks, A History of the British Marine Polyzoa, p. 311, pl. 24, figs. 7-7a.

1882. *Lepralia edax* (Busk), Waters, Geol. Soc. London, Quart. Jour., vol. 38, p. 270.

1885. *Lepralia edax* (Busk), Waters, Geol. Soc. London, Quart. Jour., vol. 41, art. 28, pp. 284,297-298.

1889. *Lepralia edax* (Busk), Jelly, A Synonymic Catalogue of Recent Marine Bryozoa, p. 126.

1901. *Hippoporina edax* (Busk), Neviani, Palaeontogr. Italica, vol. 6, pp. 136,186.

*1901. *Lepralia edax* (Busk), Verrill, Connecticut Acad. Arts and Sci., Trans., vol. 11, pt. 1, art. 2, p. 54.

1904. *Hippoporina edax* (Busk), Neviani, Soc. Geol. Italiana, Boll., vol. 23, No. 3, pp. 511,529.

1912. *Cellepora edax* Busk, Leriche, Soc. Géol. France, Bull., sér. 4, vol. 12, p. 805, text figs. 41-42a.

*1914. *Lepralia edax* (Busk), Osburn, Carnegie Inst. Washington, Publ. No. 182, Papers Tortugas Lab., vol. 11, pp. 212-213.

1915. *Cellepora parasitica* Michelin, Couffon, Contribution á l'étude des faluns de l'Anjou. IV., Angers, p. 7. [*Fide* Buge, 1957, p. 320].

*1923. *Cellepora minuta* Canu and Bassler, U.S. Nat. Mus., Bull. 125, p. 182, pl. 25, figs. 10-13. [*Fide* Canu and Bassler, 1928].

1923. *Cellepora edax* Busk, Duvergier, Soc. Linn. Bordeaux, Actes, vol. 75, p. 186, pl. 6, figs. 5-10.

1926. *Lepralia edax* (Busk), Marcus, Die Tierwelt der Nord-und Ostsee, Lief. 4, Teil 7c-1, p. 92, fig. 124.

*1928. *Hippoporidra edax* (Busk), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, No. 2710, art. 14, pp. 4,5,139-140, pl. 22, figs. 1-4.

1929. *Cellepora parasitica* Michelin, Lecointre, Soc. Géol. France, Bull., sér. 4, vol. 29, p. 403, pl. 35, figs. 1-5. [*Fide* Buge 1957, p. 320].

*1929. *Hippoporidra edax* (Busk), Canu and Bassler, U.S. Nat. Mus., Bull. 100, vol. 9, p. 418.

1930. *Hippoporidra edax* (Busk), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 76, No. 2810, art. 13, p. 43.

1931. *Cellepora parasitica* Michelin, Douville, Soc. Géol. France, Bull., sér. 5, vol. 1, p. 391, pl. 19, figs. 1-3.

1931. *Hippoporidra edax* (Busk), Prenant, Mus. Roy. Hist. Nat. Belgique, vol. 7, No. 17, pp. 1-6.

1933. *Cellepora parasitica* Michelin, Lecointre, Soc. Géol. France, Bull., sér. 5, vol. 3, p. 485, pl. 24, figs. 1-2. [*Fide* Buge, 1957, p. 320].

1937. *Lepralia edax* (Busk), Moore, Liverpool Biol. Soc., Proc., vol. 50, p. 202.

*1940. *Hippoporidra edax* (Busk), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, p. 454.

1946. *Cellepora parasitica* Michelin, Roger and Buge, Soc. Géol. France, Bull., sér. 5, vol. 16, p. 227. [*Fide* Buge, 1957, p. 320].

1947. *Hippoporidra calcarea* (Smitt), Osburn, Allan Hancock Atlantic Exped., Rept., No. 5, pp. 42-43.

1947. *Cellepora parasitica* Michelin, Roger and Buge, Soc. Géol. France, Bull., sér. 5, vol. 17, pp. 461-470, pl. 17, figs. 4-7, 10-15. [*Fide* Lagaaij, 1952, p. 148].

1947. *Hippoporidra edax* (Busk), Roger and Buge, Soc. Géol. France, Bull., sér. 5, vol. 17, pp. 465,466,469, pl. 17, figs. 8-9.

1949. *Hippoporidra edax* (Busk), Vigneaux, Soc. Géol. France, Mém., n. s., vol. 28, No. 60, p. 81, text fig. 32.

*1951. *Hippoporidra edax* (Busk), Pearse and Williams, Elisha Mitchell Sci. Soc., Jour., vol. 67, p. 138.

1952. *Hippoporidra edax* (Busk), Lagaaij, Nederl. Geol. Sticht., Meded., ser. C, vol. 5, No. 5, pp. 147-149, pl. 15, fig. 13; pl. 16, fig. 6.

1952. *Hippoporidra edax* (Busk), Osburn, Allan Hancock Pacific Exped., Rept., vol. 14, pt. 2, p. 354.

1953. *Hippoporidra edax* (Busk), Lagaaij, Nederl. Geol. Sticht., Meded., n. s., No. 7, chart.

*1953. *Hippoporida edax* (Busk), Blake, Smithsonian Misc. Collec., vol. 121, No. 12, Publ. 4129, pp. 20,24, pl. 1, fig. 1.

1957. *Hippoporidra edax* (Busk), Soule and Duff, California Acad. Sci., Proc., ser. 4, vol. 29, No. 4, p. 113. [= *Hippoporidra janthina* (Smitt) *fide* Cook, 1964, pp. 27,28].
1957. *Hippoporidra edax* (Busk), Buge, Mus. Nat. Hist. nat. Paris, Mém., n. s., sér. C, vol. 6, pp. 320-323, pl. 11, fig. 2, pl. 12, figs. 3-6.
1959. *Hippoporidra edax* (Busk), Kanakoff and Emerson, Los Angeles County Mus., Contrib. Sci., No. 31, p. 19.
1964. *Hippoporidra edax* (Busk), Cook, British Mus. (Nat. Hist.), Bull., Zoology, vol. 12, No. 1, pp. 26-27, pl. 3, figs. 5-7.

Range and distribution.–Hippoporidra edax (Busk) is said to range from upper Oligocene to Recent. According to Waters (1882, p. 270), the upper Oligocene *Cumulipora angulata* v. Münst., Reuss, from Söllingen, Germany is synonymous with *Hippoporidra edax* (Busk). In the Miocene, *H. edax* has been reported from France (Helvetian), Italy, the states of North Carolina and South Carolina, United States, and south Australia. Pliocene localities are Italy, Belgium, The Netherlands (Scaldisian), England (Gedgravian), and South Carolina. In the Pleistocene, it is recorded by Blake at Wailes Bluff, St. Marys Co., Maryland, by Soule and Duff at Newport, California, and by Neviani at Reggio, Italy. However, the California species may be *Hippoporidra janthina* (Smitt), according to Cook (1964). The living *H. edax* has been recorded from the North Sea, England, and France; from New Jersey to the Carolinas and the Bermuda Islands in the Western Atlantic; from the Tortugas and west Florida (18-79 fathoms) in the Gulf of Mexico; from Venezuela (Margarita, Cubagua), Aruba, Colombia, and Yucatan (2-23 fathoms) in the Caribbean Sea; and from south Australia.

Cleidochasma porcellanum (Busk) Pl. 11, fig. 3

1860. *Lepralia porcellana* Busk, Quart. Jour. Microsc. Sci., vol. 8, p. 283, pl. 31, fig. 3.
1873. *Lepralia cleidostoma* Smitt, Kongl. Svenska Vetensk.-Akad., Handl., vol. 11, No. 4, pp. 62-63, pl. 11, figs. 217-219.
1884. *Lepralia cleidostoma* Smitt, var. Hincks, Ann. Mag. Nat. Hist., ser. 5, vol. 13, p. 212.
1884. *Lepralia cleidostoma* Smitt, var. Hincks, Geol. and Nat. Hist. Sur. Canada, p. 41.
1890. *Lepralia cleidostoma* Smitt, Kirkpatrick, Ann. Mag. Nat. Hist., ser. 6, vol. 5, p. 16.
1890. *Lepralia cleidostoma* Smitt, Kirkpatrick, [*in*] Ridley, Linnean Soc. London, Jour., Zool., vol. 20, p. 504.
1905. *Lepralia cleidostoma* Smitt, Thornely, Ceylon Pearl Oyster Fisheries, Rept. to Colonial Govt., pt. 4, Suppl. Rept. No. 26, p. 121.

1909. *Lepralia porcellana* Busk, Norman, Linnean Soc. London, Jour., Zool., vol. 30, p. 305, pl. 40, figs. 1-2.
1914. *Lepralia porcellana* Busk, Osburn, Carnegie Inst. Washington, Publ. No. 182, Papers Tortugas Lab., vol. 5, No. 11, p. 209.
1920. *Hippoporina porcellana* (Busk), Canu and Bassler, U.S. Nat. Mus., Bull. 106, p. 373, fig. 113A; p. 374, fig. 114B-E.
1920. *Hippoporina porcellana* (Busk), Duvergier, Soc. Linn. Bordeaux, Actes, vol. 72, No. 2, p. 152.
1928. *Hippoporina cleidostoma* (Smitt), Canu and Bassler, Soc. Sci. Seine-et-Oise, Bull., sér. 2, vol. 9, No. 5, pp. 80-81.
1928. *Hippoporina cleidostoma* (Smitt), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, No. 2710, art. 14, pp. 104-105, pl. 9, fig. 7; pl. 32, fig. 5; text fig. 18A-E.
1929. *Hippoporina porcellana* (Busk), Canu and Bassler, U.S. Nat. Mus., Bull. 100, vol. 9, p. 320, fig. 132F-H.
1929. *Hippoporina porcellana* (Busk), Hastings, Zool. Soc. London, Proc., No. 47, pp. 721-722.
1930. *Hippoporina cleidostoma* (Smitt), Canu and Bassler, U.S. Nat. Mus., vol. 76, No. 2810, art. 13, pp. 18-19.
1930. *Hippoporina simplex* Canu and Bassler, Stat. Océanogr. Salammbô, Ann., No. 5, p. 49, pl. 6, figs. 3-6. [*Fide* Marcus, 1937, p. 97].
1935. *Hippoporina porcellana* (Busk), Sakakura, Fac. Sci. Tokyo Imp. Univ., Jour., sect. 2, vol. 4, No. 1, p. 23, pl. 4, fig. 6.
1937. *Hippoporina procellana* (Busk), Marcus, Faculdade Philos., Scienc. e Letras Univ. São Paulo, Bol., vol. 1, Zoologia No. 1, pp. 96-97, pl. 19, fig. 51.
1940. *Hippoporina porcellana* (Busk), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, p. 428.
1947. *Hippoporina porcellana* (Busk), Osburn, Allan Hancock Atlantic Exped., Rept., No. 5, p. 32.
1949. *Hippoporina porcellana* (Busk), Vigneaux, Soc. Géol. France, Mém., n. s., vol. 28, p. 60, pl. 5, fig. 7.
1952. *Hippoporina porcellana* (Busk), Osburn, Allan Hancock Pacific Exped., Rept., vol. 14, pt. 2, pp. 344-345,346, pl. 41, figs. 1-3.
1955. *Hippoporina porcellana* (Busk), Marcus, Mus. Nac. Rio de Janeiro, Arq., vol. 42, pt. 1, p. 298.
1957. *Cleidochasma porcellana* (Busk), Harmer, Siboga-Exped., vol. 16, Mon. 28d, p. 1038.
1961. *Cleidochasma porcellana* (Busk), Soule, Amer. Mus. Novitates, No. 2053, pp. 18-19.
1964. *Cleidochasma porcellanum* (Busk), Cheetham and Sandberg, Jour. Paleont., vol. 38, No. 6, pp. 1015,1032-1033, text fig. 35.
1964. *Hippoporina porcellana* (Busk), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, pp. 633-634.
1964. *Cleidochasma porcellanum* (Busk), Cook, British Mus. (Nat. Hist.), Bull., Zoology, vol. 12, No. 1, pp. 11-14, pl. 1, fig. 4; pl. 2, figs. 1-2; text figs. 4A-E.

The zoarium is more or less hyaline, encrusting, and both unilaminar and multi-layered. The zooecia are convex, hexagonal to rhomboidal in outline, disposed in alternating longitudinal rows, and separated by straight shallow grooves. According to Marcus (1937, p. 96), young zooecia are marked by zigzag lines contiguous to the walls, but due to advanced calcification they are not visible on my specimens; furthermore, where the colonies are cumulate all zooecial boundaries are ill-defined. The frontal of the adult zooecium is a thick and finely beaded but smoothish olocyst bearing occasionally a few areolar pores near the margin. The orifice is near the distal margin of the zooecium and is sunken, with a nearly circular porta and a concave vanna which is a little narrower than the porta. There is a well-developed vestibular arch which may be finely beaded. Separating the porta from the vanna is a pair of strong condyles situated well below the middle of the orifice. The peristome is raised and thickened, often bearing a coarse nodule just below the proximal lip as well as a pair of nodules on the rim of the peristome on either side of the lip. On the distal margin of the peristome there are also a few small protuberances that may be the vestiges of spines. On one zooecium of specimen A674a, there is an ovate avicularium on the frontal wall well below and to one side of the proximal lip, with the acuminate end pointing obliquely toward the orifice. No ovicells are discernible.

Measurements.—Specimen A674a: average zooecium, length 0.31 mm, width 0.24 mm; orifice length 0.12 mm, width 0.095 mm; avicularium length 0.05 mm, width 0.03 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. Encrusted on the pelecypod *Chama congregata* Conrad.

Range and distribution.—The range of *Cleidochasma porcellanum* (Busk) is middle Miocene to Recent. In the middle Miocene (Burdigalian) it occurs in Cestas, France; in the Pliocene it occurs in Bocas Island, Almirante Bay, Panama; in the Pleistocene it is reported by Sakakura in the Bôsô Peninsula, Japan; and by Cheetham and Sandberg in Louisiana, United States, where it occurs in mudlumps off South Pass at the mouth of the delta of the Mississippi River. The Recent form of *C. porcellanum* is temperate to tropical in habitat, living generally at depths of 8 to 40 fathoms, with a maximum recorded depth of 204 fathoms. Eastern Atlantic localities are Madeira, St. Helena and West Africa. In the Western Atlantic the species ranges from Cape Cod, Massachusetts to Santos Bay, Brazil, and occurs in the Bermuda Islands. In the Mediterranean it has been reported from off Tunisia. In the Eastern Pacific the species ranges from British Columbia to Peru and the Galapagos Islands. In the Caribbean it occurs off Margarita (Venezuela) in 18 fathoms, at Cabo La Vela, Colombia (18-24 fathoms), Cuba, Puerto Rico, and in the Yucatan Channel. In the Western Pacific it is recorded from Japan, south China, and the Philippines. And in the Indian Ocean it is recorded from Ceylon in the east and the Almirante Islands in the west.

Cleidochasma contractum (Waters) Pl. 11, fig. 2

1899. *Lepralia contracta* Waters, Roy. Microsc. Soc. London, Jour., p. 11, pl. 3, figs. 4-6.
1909. *Lepralia contracta* Waters, Norman, Linnean Soc. London, Jour., Zool., vol. 30, p. 306, pl. 41, figs. 5-6.
1912. *Lepralia serrata* Osburn, Bur. Fish., Bull., vol. 30 for 1910, pp. 206,242, pl. 26, figs. 57-57c.
1914. *Lepralia contracta* Waters var. *serrata* Osburn, Carnegie Inst. Washington, Publ. No. 182, Papers Tortugas Lab., vol. 5, No. 11, pp. 211-212.
1920. *Perigastrella (Lepralia) contracta* (Waters), U.S. Nat. Mus., Bull. 106, p. 576, fig. 174A-E.
1923. *Gemellipora asper* Canu and Bassler, U.S. Nat. Mus., Bull. 125, pp. 110-111, pl. 18, figs. 5-6. [*Fide* Lagaaij, 1963, p. 189].
1928. *Gemellipora asper* Canu and Bassler, Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, No. 2710, art. 14, p. 90, pl. 10, fig. 1. [*Fide* Lagaaij 1963, p. 189].
1929. *Perigastrella contracta* (Waters), Canu and Bassler, U.S. Nat. Mus., Bull. 100, vol. 6, p. 403, fig. 156A-E.
1929. *Perigastrella contracta* (Waters), Hastings, Zool. Soc. London, Proc., p. 722, pl. 11, fig. 60.
1937. *Perigastrella contracta* (Waters), Marcus, Faculdade Philos., Scienc. e Letras Univ. São Paulo, Bol., vol. 1, Zoologia No. 1, pp. 98-99, pl. 20, figs. 52A-B.
1938. *Perigastrella contracta* (Waters), Marcus, Faculdade Philos., Scienc. e Letras Univ. São Paulo, Bol., vol. 4, Zoologia No. 2, p. 85.
1939. *Perigastrella contracta* (Waters), Marcus, Faculdade Filos., Ciênc. e Letras Univ. São Paulo, Bol., vol. 13, Zoologia No. 3, p. 205.
1940. *Hippoporina contracta* (Waters), Osburn, New York Acad. Sci., Sci. Sur. Porto Rico and the Virgin Islands, vol. 16, pt. 3, pp. 428-430.
1945. *Hippoporina contracta* (Waters), Hutchins, Connecticut Acad. Arts and Sci., Trans., vol. 36, p. 543.
1947. *Hippoporina contracta* (Waters), Osburn, Allan Hancock Atlantic Exped., Repts., No. 5, p. 33.
1949. *Hippoporina contracta* (Waters), Rogick and Croasdale, Biol. Bull. Woods Hole, vol. 96, No. 1, p. 57, figs. 34-41.
1951. *Hippoporina contracta* (Waters), Pearse and Williams, Elisha Mitchell Sci. Soc., Jour., vol. 67, No. 1, p. 137.
1952. *Hippoporina contracta* (Waters), Osburn, Allan Hancock Pacific Exped., Repts., vol. 14, pt. 2, pp. 346-347, pl. 41, figs. 4-5.

1955. *Hippoporina contracta* (Waters), Marcus, Mus. Nac. Rio de Janeiro, Arq., vol. 42, p. 1, p. 298.
1956. *Hippoporina contracta* (Waters), Menzel, Oceanogr. Inst. Florida State Univ., Contrib. No. 61, p. 13.
1957. *Lepralia (Perigastrella) contracta* (Waters), Harmer, Siboga-Exped., vol. 16, Mon. 28d, pp. 823,1025.
1957. *Hippoporina contracta* (Waters), Maturo, Elisha Mitchell Sci. Soc., Jour., vol. 73, No. 1, p. 52, fig. 57.
1961. *Cleidochasma contracta* (Waters), Soule, Amer. Mus. Novitates, No. 2053; pp. 19-20.
1963. *Cleidochasma contracta* (Waters), Lagaaij, Inst. Marine Sci. Univ. Texas, Publ., vol. 9, pp. 189-191, pl. 5, fig. 2.
1963. *Cleidochasma contracta* (Waters), Hertlein, California Acad. Sci., Proc., ser. 4, vol. 32, No. 8, pp. 232-233.
1964. *Hippoporina contracta* (Waters), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, pp. 632-633.
1964. *Cleidochasma contractum* (Waters), Cheetham and Sandberg, Jour. Paleont., vol. 38, No. 6, p. 1032, text fig. 38.
1964. *Cleidochasma contractum* (Waters), Cook, British Mus. (Nat. Hist.), Bull., Zoology, vol. 12, No. 1, pp. 14-17, fig. 5A.
1964. *Cleidochasma contracta* (Waters), Soule and Soule, Amer. Mus. Novitates, No. 2199, pp. 18-19.

The zoarium is encrusting and one layer in thickness. The zooecia are tubular, nearly flat-lying, hexagonal in outline, well defined in the youngest portion of the colony, where they are separated by a sharp groove, but less so in the center of the colony. The frontal is convex, smoothly granular, and imperforate, but with extremely faint areolae at the margin. The primary orifice is key-hole shaped, with a circular porta much larger than the vanna, and a small regular U-shaped sinus in the proximal border. Separating the porta from the vanna is a pair of condyles but it cannot be determined whether they are bifid as they are in *Cleidochasma contractum*. The vestibular arch is regularly beaded with about 16 minute evenly spaced denticles projecting from it. The peristome around the orifice is raised and a little thickened, often bearing a somewhat irregular mucro in front of the sinus; laterally and distally the rim of the peristome is studded by perhaps five to seven slender projections probably representing the sites of oral spines. The avicularia are not particularly abundant, and there are three types: the most prominent are those with small suboval chambers mounted on slender mamillate processes which arise near the base of the frontal and extend upward at varying angles; another type is ovate-acuminate in outline (with part of the aperture serrated) immersed in the peristome on one side or the other of the mucro;

the third type is uncommon and spatulate, lying lengthwise along the side of the frontal; on some of the zooecia, avicularia are absent. The ovicell is hyperstomial, imperforate, globular-hemispherical, smooth to rather coarsely calcified, wider than deep, the front side vertically truncated and lying normal to the zooecial orifice. The front of the ovicell is closed by a semilunate thin calcareous plug bounded at the base by a horizontal bar.

Measurements.—Specimen A686a: zoarium 2.2 mm × 1.4 mm; zooecium 0.31 mm × 0.21 mm; orifice 0.083 mm × 0.071 mm; ovicell 0.155 mm. in width, 0.095 mm in depth, 0.12 mm in height.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. One zoarium encrusted on the pelecypod *Barbatia* (*Barbatia*) *candida* (Helbling).

Remarks.—Except for the hardly discernible marginal areolae which are generally prominent on *Cleidochasma contractum,* and for the uncertainty (because they cannot be seen) that the condyles are bifid, the Venezuelan specimen is identical in other diagnostic characters—particularly the orifice and ovicell—to *C. contractum.* The species is a variable one, and it is possible that the lack of development of marginal areolae on the single Venezuelan specimen constitutes an individual rather than specific variation.

Range and distribution.—The range of *C. contractum* is Pleistocene to Recent, but if *Gemellipora asper* Canu and Bassler is the same as *C. contractum,* then it is known from the upper Miocene of Florida and the Pliocene of South Carolina as well. The Pleistocene occurrence is in the mudlumps off South Pass, Louisiana. The living *C. contractum* has been reported from the island of Madeira; off the coast of West Africa; from the Western Atlantic between Cape Cod, Massachusetts, and Santos Bay, Brazil, in 5 to 15 fathoms; from the Caribbean off Margarita Island (Venezuela), and Cabo La Vela (Colombia) in 11 to 41 fathoms, and off Puerto Rico in 6 fathoms; from the Gulf of Mexico in the Tortugas (5-18 fathoms), west Florida (5-33 fathoms), Louisiana (7-70 fathoms), and Texas (6-50 fathoms); and from the Eastern Pacific in Baja, California (.5 to 40 fathoms) to Ecuador, including Cocos Island, the Galapagos (12-15 fathoms), and Gorgona Island, Colombia (30 fathoms).

Rhynchozoon cf. R. verruculatum (Smitt) Pl. 7, fig. 5

1873. *Cellepora verruculata* Smitt, Kongl. Svenska Vetensk.-Akad., Handl., vol. 11, No. 4, pt. II, pp. 50-51, pl. 8, figs. 170-172.
1879. *Cellepora verruculata* Smitt, Waters, Ann. Mag. Nat. Hist., ser. 5, vol. 3, p. 193, pl. 14, figs. 1,7.
1884. Not *Escharoides verruculata* (Smitt), Busk, Voyage H.M.S. Challenger, Rept. Sci. Results, Zoology, vol. 10, pt. 30, p. 150. [= *Rhynchozoon longirostris* (Hincks), *fide* Waters, 1900, p. 49; Hastings, 1929, p. 729].
1885. *Cellepora verruculata* Smitt, Waters, Roy. Microsc. Soc., Jour., ser. 2, vol. 5, No. 17, p. 5, pl. 14, fig. 7.
1889. *Cellepora verruculata* Smitt, Jelly, A Synonymic Catalogue of the Recent Marine Bryozoa, p. 60.
1902. *Cellepora verruculata* Smitt, Calvet, Inst. Zool. Univ. Montpellier, Trav., mém. No. 11, p. 66, pl. 2, figs. 6-9.
1902. *Cellepora verruculata* Smitt, Calvet, Inst. Zool. Univ. Montpellier, Trav., mém. No. 12, p. 37.
1905. *Rhynchozoon verruculatum* (Smitt) ,Thornely, Ceylon Pearl Oyster Fisheries, Rept. to Colonial Govt., pt. 4, Suppl. Rept. No. 26, p. 22.
1907. *Cellepora verruculata* Smitt, Calvet, Expéditions scientifiques du "Travailleur" et du "Talisman", vol. 8, p. 444.
1914. *Cellepora verruculata* Smitt, Osburn, Carnegie Inst. Washington, Publ. No. 182, Papers Tortugas Lab., vol. 11, p. 214.
1919. *Rhynchozoon verruculatum* (Smitt), Barroso, Real Soc. Española Hist. Nat., Bol., vol. 19, p. 342, figs. 6-11a.
1923. *Rhynchozoon verruculatum* (Smitt), Canu and Bassler, U.S. Nat. Mus., Bull. 125, p. 157, pl. 3, figs. 11-13.
1928. *Rhynchozoon verruculatum* (Smitt), Canu and Bassler, Soc. Sci. Seine-et-Oise, Bull., vol. 9, No. 5, pp. 88-89, pl. 7, figs. 2-3.
1928. *Rhynchozoon verruculatum* (Smitt), Canu and Bassler, U.S. Nat. Mus., Proc., vol. 72, art. 14, No. 2710, p. 6.
1929. *Rhynchozoon verruculatum* (Smitt), Hastings, Zool. Soc. London, Proc., pp. 728,729.
1939. *Rhynchozoon verruculatum* (Smitt), Marcus, Faculdade Filos., Ciênc. e Letras Univ. São Paulo, Bol., vol. 13, Zoologia No. 3, pp. 153-155, pl. 11, figs. 20A-C.
1940. *Rhynchozoon verruculatum* (Smitt), Osburn, New York Acad. Sci., Scientific Survey of Porto Rico and the Virgin Islands, vol. 16, pt. 3, p. 444.
1952. *Rhynchozoon rostratum* (Busk) and *Rhynchozoon verruculatum* (Smitt), Osburn, Allan Hancock Pacific Expedition, Rept., vol. 14, pt. 2, pp. 456-458, pl. 54, figs. 1-3.
1955. *Rhynchozoon verruculatum* (Smitt), Marcus, Mus. Nac. Rio de Janeiro, Arq., vol. 42, pt. 1, pp. 303-304.
1957. *Rhynchozoon rostratum* (Busk), Maturo, Elisha Mitchell Sci. Soc., Jour., vol. 73, pp. 57-58, fig. 63.
1964. *Rhynchozoon rostratum* (Busk), Shier, Bull. Marine Sci. Gulf and Caribbean, vol. 14, No. 4, pp. 640-641.

The zoarium is encrusting, one layer in thickness, vitreous white, and roughened on the surface in varying degree. The zooecia are hexagonal to more or less ovate, well oriented at the margin of the zoarium but crowded and somewhat irregular toward the center. Around the margin of the frontal is a row of areolae separated by short costules, the areolae often obscured by encroachment of adjacent zooecia and by calcification. The surface of the mature zoarium is characterized by ridges, corrugations, and tuberosities. The frontal is moderately convex, heavily calcified, and granular to verrucose in texture. The primary orifice has a nearly circular porta and a moderately deep U-shaped sinus on the proximal lip of the vanna. The vestibular arch is rather prominently beaded. The upper surface of the operculum is marked by exceedingly minute dots. Lying on one side of the orifice is a small clathridiate to semilunar avicularium, and rarely, on the frontal of a lightly calcified zooecium, there may be present a diamond-shaped avicularium resembling that of Smitt's figure 170. Here and there are large subspatulate avicularia lying parallel with the surface of the zoarium and situated athwart the peristome at the proximal end of the orifice. Generally, however, the avicularia are supported on bosses, in which case the frontal avicularium is arcuate, oval or ovate acuminate. With increasing calcification the primary orifice becomes sunken, and is surrounded by the peristome which is thick, rugose, and subcircular to suboval in outline. On or around the peristome there are sundry projections and occasional pustules. Two ovicells have been noted, one an inflated oval, the other also inflated but more discoidal. Both are peristomial and project somewhat over the immersed primary orifice. The ovicell is hyaline, imperforate, and minutely but smoothly granulose. The ovicell opens above the aperture through a slit at the base of the labellum. In thickly calcified areas, the peristome is irregular and bears an elevated mucro with an asymmetric notch next to it on the proximal edge.

Measurements.—Specimen A676a: average zooecium near center of colony, length 0.43 mm, maximum width 0.31 mm; primary orifice, length 0.10 mm, width 0.09 mm; suboral avicularium on same zooecium, length 0.048 mm, width 0.035 mm; frontal avicularium (diamond-shaped), length 0.095 mm; frontal avicularium (ovate) on boss, length 0.10 mm, width 0.07 mm; spatulate avicularium, length 0.36 mm, width 0.11 mm, oval ovicell 0.19 mm in diameter, 0.24 mm in depth; discoidal ovicell 0.23 mm in diameter, 0.19 mm in depth.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. Encrusted on *Pseudochama radians* (Lamarck) and *Chama congregata* Conrad.

Remarks.—Where thickly calcified, the Venezuelan specimen agrees fairly well with adult specimens of *R. verruculatum* from Florida except for the notches in the proximal rim of the peristome which are not nearly so pronounced as they are in the examples from Florida or in the illustrations by Marcus of *R. verruculatum* from Brazil. However, these notches occur on the side of calcified growths on the peristome of adult zooecia, and our single zoarium from Venezuela had not yet attained its full maturity and maximum calcification.

In 1952, the Western Atlantic *R. verruculatum* (Smitt) was placed in synonymy with the Eastern Pacific *R. rostratum* (Busk) by Osburn, and in this he has been followed by Maturo and Shier. The similarities between *R. rostratum* and *R. verruculatum* were noted as early as 1929 by Hastings but she separated the two on the character of the ovicell. Marcus (1939,1955) also noted the resemblance between *R. rostratum* and *R. verruculatum* but preferred the name *R. verruculatum* for the Brazilian form. As the Venezuelan specimen here described was found between Florida and Brazil, it too is referred to the Western Atlantic *R. verruculatum*.

Range and distribution.—*R. verruculatum* (Smitt) is reported as ranging from middle Miocene to Recent. In the middle Miocene it is recorded from Jamaica; in the upper Miocene and Pliocene from Florida; and in the Pleistocene from South Carolina. The species is living from Massachusetts to Brazil (including North Carolina, Florida, the Tortugas, Puerto Rico, and near Santos, Brazil) at depths of 6 to 42 fathoms. In Europe *R. verruculatum*, or variants thereof, is reported from Algeciras (Spain), Corsica, and the Bay of Naples.

R. rostratum (Busk) is found from southern California to Colombia (including Mexico, Costa Rica, and Panama) and the Galapagos Islands, at depths ranging from shore to 100 fathoms.

Rhynchozoon caboblanquense, new species Pl. 11, fig. 4

The zoarium is encrusting, one layer in thickness, and heavily calcified. The zooecia are hexagonal and fairly distinct. The frontal is inflated, finely granulose but smooth, bearing a marginal row of areolae of which there are 15 on one zooecium having a length of 0.38 mm and a width of 0.33 mm. The orifice is relatively large, sunken, a little longer than wide, provided with a pair of condyles a little below the middle, and marked by a minutely beaded vestibular arch. The porta is nearly circular, the vanna shallowly and regularly concave and about as wide as the porta though less in height. Except on the proximal rim the peristome is low, thickened, and hardly differentiated, marked occasionally by five or six small circular openings, possibly marking the site of spinose projections. Rising from the proximal side of the peristome, and often elevated well above the orifice is an avicularian-bearing rostrum or mucro, the tip of the mucro usually erose. On another colony there is no mucro on the zooecia though there may be a swelling at the proximal lip of the orifice. Typically there is a large oval frontal avicularium below and a little to one side of the mucro, and yet another avicularium near the side of the peristome. This peristomial avicularium is ovate-acuminate, and is intermediate in size between the rostral and frontal avicularia. In addition, small frontal avicularia are present randomly. The ovicell has not been seen.

Measurements.—Holotype (J660b): length of zoarium 1.8 mm; average zooecium, length 0.35 mm, width 0.26 mm; rostral avicularium, length 0.03 mm, width 0.02 mm; frontal avicularium, length 0.08 mm, width 0.05 mm; peristomial avicularium, length 0.05 mm, width 0.03 mm.

Locality.—Lower Mare Formation, in small stream 100 meters west of Quebrada Mare Abajo. Encrusted on the right valve of a juvenile oyster, possibly *Ostrea* (*Alectryonia* ?) *caboblanquensis* Weisbord (Bull. Amer. Paleont., vol. 45, pp. 190-192, pl. 25, figs. 1-6, 1964).

Comparisons.—Though not dissimilar, this species is at once distinguished from the Miocene to Recent *R. verruculatum* (Smitt) by its much smoother frontal even though it is also thickly calcified. There is some resemblance to the Pliocene *R. corniger* Canu and Bassler from the Panama Canal Zone but the orifice of *R. corniger* is elliptical-transverse whereas that of *R. caboblanquense,* n. sp. is more or less orbicular and a little longer than wide.

Rhynchozoon caribense, new species Pl. 12, fig. 1

The zoarium is encrusting, hyaline, and one layer in thickness. The zooecia radiate outward in alternating longitudinal rows, are well defined, recumbent, generally hexagonal though occasionally pentagonal with the proximal end truncate, and are separated by depressed narrow grooves. Where the base of the zooecium is revealed, it is seen that each distal wall of the hexagon is provided with about three transversely oval dietellae. The frontal is glassy, convex, and microscopically granulate, with no marginal pores or areolae that can be discerned. The primary orifice is small, sunken, and circular, bearing a short and rather narrow U-shaped sinus, with the sides of the sinus vertical and parallel. The vestibular arch is minutely, regularly, and rather closely serrate. The peristome is thick, raised, roughened by projections, and more or less circular. On the peristome there may be a stubby growth or erose mucro just below the sinus, and there may be four to six smaller projections around the rim of the peristome. The operculum covering the primary orifice is membranous, transparent, and microscopically spotted. Frontal avicularia are present on about half the zooecia. These avicularia are placed on a raised, relatively large ovate-acuminate boss occupying the lower half of the frontal and a little to one side of the midline; the rounded or shorter end of the boss is more elevated than the acuminate end; the acuminate end of the boss is directed proximally, and nearly reaches the lowest side or the lowest angle of the zooecium. The chamber of the avicularium is located on the distal end of the boss about half way down the frontal; the chamber is small, ovate, and provided with a cross bar. The ovicell has not been seen.

Measurements.—Holotype (A673a): zoarium, length 2.14 mm, width 2.00 mm; average zooecium, length 0.33 mm, maximum width 0.23 mm; length of avicularian boss 0.12 mm, maximum width 0.17 mm, diameter of primary orifice 0.084 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. One specimen encrusted on the pelecypod *Trachycardium muricatum* (Linnaeus).

Comparisons.—The distinguishing characters of *Rhynchozoon caribense,* n. sp. are the large proximally directed avicularian boss on the frontal, and the absence of marginal pores or areolae on the frontal. There is some similarity to *R. angulatum* Levinsen (1909, p. 225, pl. 3, fig. 4), but *R. angulatum* has a relatively larger orifice, is provided with a few marginal pores on some of the zooecia, and may have, in addition to the frontal avicularium (which is similar to that of the Venezuelan species here described) a bulbous suboral avicularian eminence on the proximal side of the peristome. *R. caribense,* n. sp. is differentiated from the fossil *R. caboblanquense,* n. sp. described in this paper, in being less heavily calcified, in lacking the marginal areolae, and in having a U-shaped sinus rather than the evenly concave vanna of *R. caboblanquense.*

Harmerella dichotoma (Hincks) Pl. 12, fig. 2

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The zoarium is encrusting and flat-lying. The zooecia are white to translucent, crowded against each other, and cumulate. In form the zooecia are subhexagonal at the base, but rise therefrom as erect, mammillate-conical cells, most of them elevated but others sunken. The frontal is smooth and vitreous, rarely surrounded by a ring of circular pores a short distance below the peristome, or with a few areolae near the margin. The primary orifice is subcentral, large, suborbicular, generally deeply immersed, and slightly contracted below the middle so that the porta is semicircular and the proximal lip embayed into a rounded V-shaped or shallow U-shaped sinus. The peristome of the young zooecium is elevated, and has a thin rim which descends to form a notch or spiramen adjacent to the rounded end of the avicularium if that is present. The peristome of heavily calcified zooecia is hardly raised above the primary orifice, and has a thickened suborbicular rim, sometimes bearing small irregular nodulations. Present on some of the zooecia is a comparatively large suboral avicularium situated on a large hollow boss which raises the avicularium to the side of, and often above, the peristome. The avicularium is bluntly acuminate, the acuminate end directed away from the proximal rim, and complete with cross bar. The ovicell has not been observed.

Measurements.—Specimen A682a: average zooecium, length 0.40 mm, width 0.33 mm; primary orifice, length 0.123 mm, width 0.105 mm; peristome 0.201 mm × 0.175 mm; suboral avicularium, length 0.087 mm, width 0.044 mm.

Locality.—Recent, on beach at Playa Grande Yachting Club, Distrito Federal. Encrusted on the pelecypod *Chama congregata* Conrad.

Remarks.—Lagaaij (1952) introduced the generic name *Harmerella* for taxa having a "lateral spiramen or pseudospiramen in the proximal lip of the peristome, flanked by a suboral avicularium in the opposite side of the lip." As the spiramen is not well developed, and as there are no ovicells (which are said to be irregularly and coarsely perforate) with which to make a comparison, the identification of my specimen as *H. dichotoma* is tentative.

Range and distribution.—Harmerella dichotoma (Hincks) is able to live in cold, temperate, and warm waters at depths ranging from near shore to 1,208 fathoms. It has been found in the North Atlantic off the Faroes and Norway, and ranges therefrom to Great Britain, Spain (Santander), and northern France. In the Mediterranean it is recorded from Monaco on the north and North Africa on the south. Eastern Atlantic localities are the Azores, Madeira, and the Canary Islands. In the Western Atlantic *H. dichotoma* ranges from North Carolina to Santos Bay, Brazil, and in the Gulf of Mexico the species occurs on the Tortugas Islands. Venezuelan localities other than Playa Grande are Margarita Island and the Gulf of Venezuela. As a fossil, *H. dichotoma* occurs in the Pliocene on Bocas Island, Panama, according to Canu and Bassler (1928). It also occurs in the sub-Recent mudlumps off South Pass, Louisiana, United States.

Trematooecia cheethami, new species Pl. 2, figs. 12,13; Pl. 9, figs. 1-3

The zoarium is encrusting, and multi-layered or unilaminar. With the basal surface facing the observer, it is seen that the zooecia are rhomboidal to hexagonal in outline, that they are disposed in fairly regular alternating rows, that the walls are moderately thick, that the interior of the frontal is deep and minutely granulose, and that each of the condyles of the orifice is extended to the side of the interior surface as a raised ledge or lappet. The zooecia of multi-layered colonies are irregularly cumulate and unoriented, those of the upper layer either immersed, obliquely projecting, or erect and salient, the latter conical in shape and sloping upward to a more or less central orifice. The frontal of the projecting zooecia is heavily calcified, and densely granular to smooth in the adult stage, hyaline to finely granulose in the young. The margin of the frontal is perforated by a single row of large areolae, of which there are 18 or so on one zooecium with a length of 0.45 mm, but with a greater or lesser number around the margin of other zooecia of approximately the same size. The primary orifice is orbicular and generally deeply sunken, bearing near or a little below the middle, a pair of sturdy condyles; the porta is semicircular, the vanna shallowly concave. The peristome is raised and thickened, and rising from it, immediately in front of the proximal rim of the orifice, is a sturdy mucro elevated above the peristome and attenuated into a blunt spine at the upper extremity; the interior of the mucro is hollow. The frontal avicularia are ovate-acuminate, with a cross bar lying a little nearer the rounded end of the chamber, and with the pointed end generally directed away from the orifice. Some of the avicularia are situated in the peristome to one side of the mucro, but more often, where they are present, they are situated below and to one side of the mucro on a slightly elevated boss of the frontal. In addition there are occasional interzooecial avicularia lying parallel with the zoarial surface, and these are large and generally elongate-spatulate. On or around the peristome there may be several rounded openings that are interpreted as having been the site of moderately prominent oral spines; the spines are not preserved on most zooecia, but five or six of them have been noted on an occasional peristome. The ovicell is hyperstomial and globular, rising as a rounded inflated imperforate hood above the distal margin of the orifice, with the opening of the ovicell lying normal to the horizontal plane of the zooecial orifice; the aperture of the ovicell is orbicular to transversely oval, and is as large or larger than the zooecial orifice; the membrane closing off the opening of the ovicell is rather thickly calcified and smooth; and a small but prominent pustule or node is present atop the central area of the hood.

This species is named in honor of Alan H. Cheetham, formerly of Louisiana State University.

Measurements.—Holotype (T620c, a unilaminar colony): zoarium length 4.3 mm, width 2.5 mm, average zooecium length 0.40 mm, width 0.23 mm; primary orifice 0.10 mm × 0.10 mm; frontal avicularium length 0.07 mm, width 0.05 mm; ovicell width 0.19 mm, depth 0.14 mm, diameter of aperture 0.13 mm. Paratype (J641a, a colony with cumulate zooecia): zoarium length 12 mm, width 8 mm; average zooecium length 0.35 mm, width 0.29 mm; diameter of orifice 0.12 mm; avicularium below mucro, length 0.095 mm, width 0.047 mm. Paratype (JJ641): interzooecial avicularium length 0.22 mm, maximum width 0.083 mm.

Localities.—Playa Grande Formation (Maiquetía member) at W-23, north flank of Punta Gorda anticline. Two fragments. Lower Mare Formation, in small stream 100 meters west of Quebrada Mare Abajo. Two fragments. Lower Mare Formation at W-13, on hillside above west bank of Quebrada Mare Abajo. One fragment. Mare Formation (JJ641a), 300 meters west-northwest of W-13 (unfigured paratype, 27504a PRI). Two specimens, donated by Dr. Robert Lagaaij. Upper Mare Formation, in stream 250 meters south-southwest of the mouth of Quebrada Las Pailas. One fragment.

Remarks.—The prominent, bluntly pointed and hollow mucro or rostrum rising above the proximal side of the orifice, the five or six oral spines around the distal end and sides of the peristome, the strong condyles in the orifice, and the calcified growth or pustule on the hood of the ovicell serve to differentiate *Trematooecia cheethami* from other Recent or fossil species. Superficially there is a close resemblance between *T. cheethami* and the lower Miocene to Recent *Celleporaria albirostris* (Smitt) (1873, pp. 70-72, pl. 12, figs. 233-239), but *C. albirostris* is distinguished by its asymmetrical notch in the secondary orifice to one side of the mucro, and by the absence of strong condyles in the lower third of the orifice.

Anoteropora ? triovicellata, new species Pl. 3, figs. 12-14; Pl. 12, fig. 3

Zoarium oval in outline, thickly calcified, unilaminar, gently cupuliform, the frontal surface convex, the basal surface concave. The basal surface is finely granular and porose, divided faintly into small polygons which are perforated by tiny rounded pores of unequal size. Situated a little off center of the base is a relatively large opening but whether this is due simply to corrosion or is in fact a part of the ancestrula (which itself is indiscernible) cannot be determined. The zooecia of the upper surface are deep, hexagonal, a little longer than wide, and disposed in regular alternate rows around the zoarium, with the lateral walls of adjacent zooecia in contact. The upper surface is coarsely granular, and the walls are thick, with low irregular nodulations on the mural rim. The frontal of the zooecia is worn away so that the character of the orifice and avicularia is unknown, but from the remaining fringe of the frontal on one or two of the zooecia, it is seen to be coarse, thickly calcified, and perforate. In edge view the zooecia are elongated and deep. The two or three ovicells that are present occur near the margin of the zoarium on both the superior and inferior faces. The ovicells are hyperstomial, large, bulbous, closely perforate, and more or less trigonal in outline. When fully developed, the ovicell is divided into three somewhat unequal segments by two arcuate grooves running across the chamber more or less parallel with the broader margin. The perforations of the ovicell are rather regular, with roughly five columns in the upper or broadest segment, about six columns in the middle segment, and seven to perhaps ten columns in the narrowest and longest segment. The ovicell occupies a zooecium, and when fully developed may spread over a portion of the immediately surrounding zooecia.

Measurements.—Holotype (1626a): zoarium, 2.6 mm long, 1.7 mm wide, and 0.6 mm in thickness; average zooecium 0.35 mm × 0.26 mm; ovicell on superior edge of zoarium 0.38 mm × 0.31 mm; ovicell on inferior edge 0.37 mm × 0.31 mm.

Locality.—Lower Mare Formation, in stream 100 meters west of Quebrada Mare Abajo. One specimen.

Remarks.—Because of the imperfect preservation of the specimen, the generic designation is uncertain. The most notable character is the tripartite ovicell, the like of which I have not seen on any other species. The worn frontal surface of the Venezuelan specimen resembles that of the Miocene to Recent *Mamillopora cupulata* Smitt as illustrated by Canu and Bassler (1928c) in their figure 13 of plate 26, but the tripartite ovicell of the new species is entirely different. The worn dorsal surface of *A ? triovicellata* n. sp. is reminiscent of that of the Recent Philippine *A. magnicapitata* Canu and Bassler (see Canu and Bassler, 1929b, pl. 65, fig. 2), but the frontal surface and ovicell of the two species are dissimilar.

The range of the genus *Anoteropora* is Pliocene to Recent.

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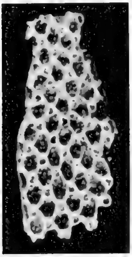

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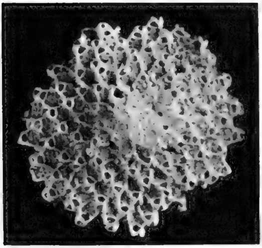

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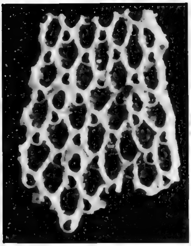

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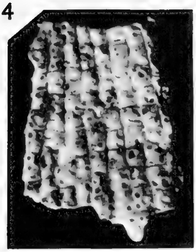

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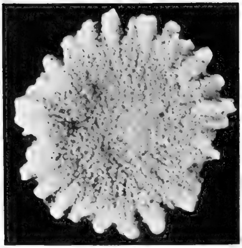

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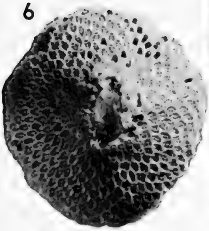

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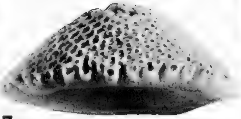

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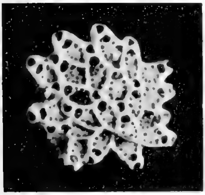

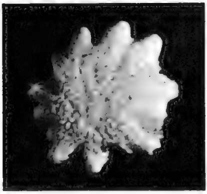

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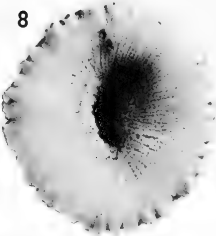

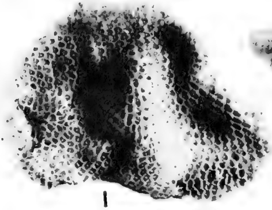
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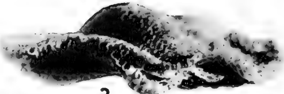
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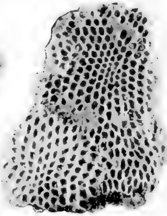
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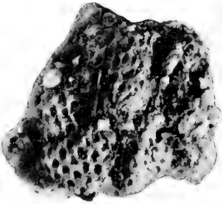
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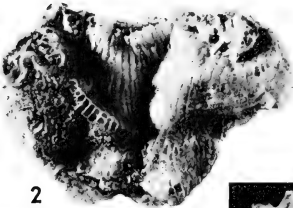
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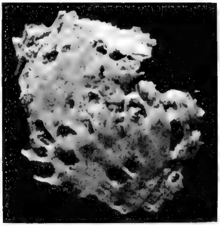
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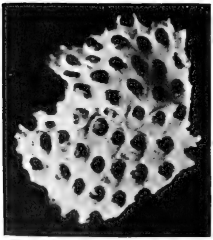
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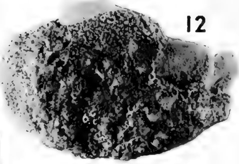
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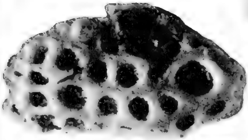
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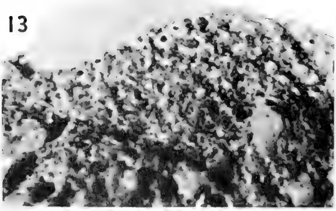
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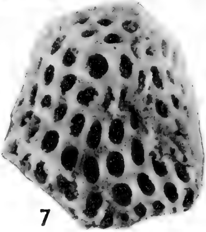
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EXPLANATION OF PLATE 2

Figure Page

1-3. **Steganoporella magnilabris** (Busk) 35

Specimen A632a, PRI 27497. Frontal, basal, and lateral views of zoarium. Length 21.5 mm., thickness 1.43 mm. Enlarged about 3X. Recent. See Plate 6, fig. 1 for greatly enlarged drawing of zooecia.

4,5. **Biflustra** cf. **B. savartii** (Audouin-Savigny) 39

Specimen T620a, PRI 27498. Frontal and basal surfaces of zoarium. Fragment length 7 mm., width 6 mm. Enlarged 5X. Mare Formation. See Plate 6, fig. 2 for enlarged drawing of zooecia.

6. **Membranipora tacaguana,** n. sp. 24

Holotype (M631a), PRI 27499. Frontal surface. Zoarium length 4 mm., width 2.3 mm. Enlarged 10X. Playa Grande Formation (Catia Member).

7. **Membranipora tacaguana,** n. sp. 24

Paratype (M625a), PRI 27500. Frontal surface. Zoarium length 3.6 mm., width 2.8 mm. Enlarged about 10X. Playa Grande Formation (Catia Member).

8. **Cellaria catiana,** n. sp. 48

Holotype (M638a), PRI 27501. Internode length 2.3 mm., maximum diameter 0.64 mm. Enlarged 18X. Playa Grande formation (Catia Member). See Plate 5, fig. 6 for greatly enlarged drawing of two zooecia of this same internode.

9. **Biflustra** cf. **B. savartii** (Audouin-Savigny) 39

Specimen 1628a, PRI 27502. Frontal surface. Length of zoarium 6.6 mm., width 6 mm. Enlarged nearly 5X. Lower Mare Formation.

10,11. **Biflustra** cf. **B. savartii** (Audouin-Savigny) 39

Specimen I623a, PRI 27503. Frontal and basal surfaces. Zoarium length 3.1 mm., width 2.5 mm. Enlarged 16X. Lower Mare Formation. See Plate 4, fig. 1 for a greater enlargement of this specimen.

12,13. **Trematooecia cheethami, n. sp.** 106

Paratype (J641a), PRI 27504. Frontal surface. Zoarium length 12 mm., width 8 mm. Fig. 12, zoarium enlarged nearly 4X; fig. 13, portion of zoarium enlarged about 10X. Lower Mare Formation. See Plate 9, fig. 3 for greatly enlarged drawing of zooecia.

14. **Cryptosula pallasiana** (Moll) 62

Specimen T633a, PRI 27505. Frontal surface. Zoarium length 4.5 mm., width 2.3 mm. Enlarged 9X. See Plate 6, figs. 3,4 for greater enlargement of zooecia. Mare Formation.

EXPLANATION OF PLATE 3

Figure		Page
1-3.	**Hippopodinella venezuelana,** n. sp. Holotype (I621a), PRI 27506. Frontal and basal surfaces. Zoarium length 2.7 mm., width 1.3 mm. Figs. 1 and 3 enlarged about 14X; fig. 2, a portion of the zoarium, enlarged about 23X. Lower Mare Formation. See Plate 10, fig. 3 for greatly enlarged drawing of zooecia.	86
4-6.	**Schizoporella floridana** Osburn Specimen S627a, PRI 27507. Frontal, basal, and lateral views of zoarium. Length 6.7 mm., width 5.9 mm. Enlarged nearly 6X. Playa Grande Formation (Mariquetía Member). See NPlate 7, fig. 2 for a greatly enlarged drawing of a zooecium.	52
7-9.	**Schizoporella floridana** ? Osburn Specimen I621aa, PRI 27508. Frontal and basal surfaces. Zoarium length 3.3 mm., width 2.6 mm. Figs. 7 and 9 enlarged about 12X; fig. 8, a portion of the zoarium, enlarged 24X. Lower Mare Formaton. See Plate 7, fig. 3 for details of zooecia.	60
10,11.	**Hippoporidra janthina** (Smitt) Specimen I582a, PRI 27509. Zoarium developed on a gastropod. Length of gastropod 17.5 mm., width 13 mm. Enlarged a little over 2X. Lower Mare Formation. See Plate 7, fig. 4 for enlarged drawing of zooecia.	87
12-14.	**Anoteropora ? triovicellata,** n. sp. Holotype (I626a), PRI 27510. Frontal, basal, and lateral views of zoarium. Length 2.6 mm., width 1.7 mm., thickness 0.6 mm. Enlarged about 15X. Lower Mare Formation. See Plate 12, fig. 3 for greatly enlarged drawing of ovicell on lower right side of zoarium in Plate 3, fig. 12.	108

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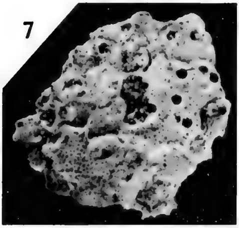

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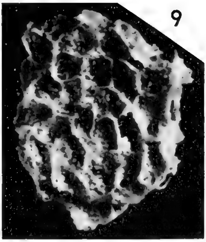

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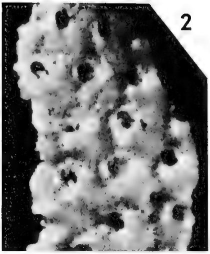

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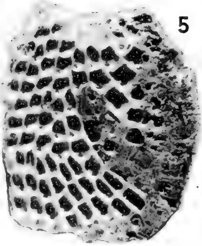

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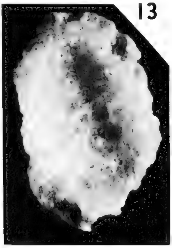

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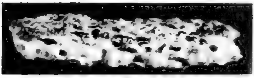

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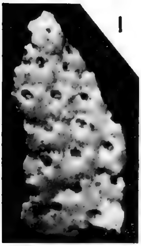

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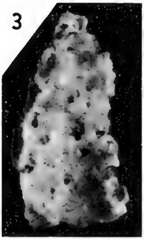

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Explanation of Plate 4

Figure		Page
1.	**Biflustra cf. B. savartii** (Audouin-Savigny)	39

Specimen G619a, PRI 27495. Apical, basal, and lateral views of 3.1 mm., width 2.5 mm. Enlarged 90X. Lower Mare Formation. See Plate 2, figs. 10,11 for other views of this same specimen.

ERRATUM

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Explanation of Plate 4, figure 1

For explanation line 1, "Specimen G619a, PRI 27495. Apical, basal, and lateral views of" *read* "Specimen 1623a, PRI 27503. Frontal surface. Zoarium length"

EXPLANATION OF PLATE 5

Figure Page

1. **Aetea anguina** (Linnaeus) 16
Specimen A683aa, PRI 27511. View showing cystidium, peristome, and bent-over orifice. Maximum diameter of cystidium 0.12 mm.; width of orifice 0.095 mm. Enlarged about 85X. Recent.

2-4. **Aetea** cf. **A. ligulata** Busk 22
Specimen A683a (detached into three parts), PRI 27512. Fig. 2, view of the cystidium, main creeping tube, and three secondary tubules. Length of cystidium 0.47 mm. Fig. 3, separated prolongation of uppermost tubule of fig. 2, showing trumpet-like process at distal end. Fig. 4, vesicle lying to one side and detached from the lowermost tubule of fig. 2. Diameters of vesicle 0.19 mm. X 0.14 mm. All drawings enlarged about 92X. Recent.

5. **Antropora typica** (Canu and Bassler) 26
Specimen A672a, PRI 27513. Frontal surface of four zooecia showing kenozooecia and avicularian chambers in corners. Average zooecium length 0.36 mm., width 0.24 mm. Enlarged about 84X. Recent.

6. **Cellaria catiana,** n. sp. 48
Holotype (M638a), PRI 27501. Note serrations on proximal lip of the distal zooecium. Average zooecium length 0.47 mm., width 0.17 mm. Enlarged about 140X. Playa Grande Formation (Catia Member). See Plate 2, fig. 8 for photograph of internode bearing these same zooecia.


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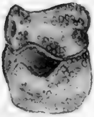
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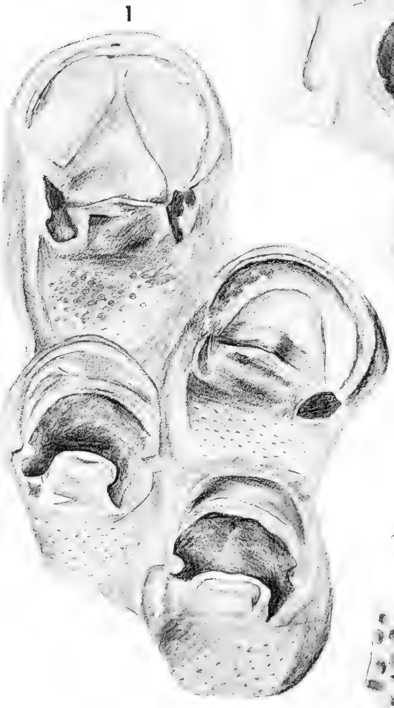
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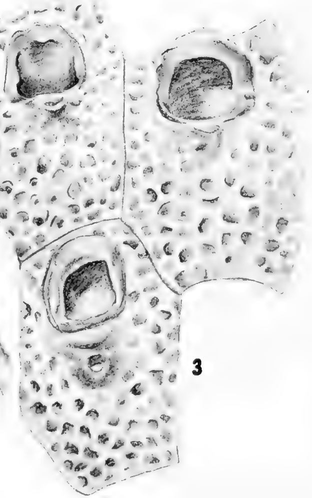
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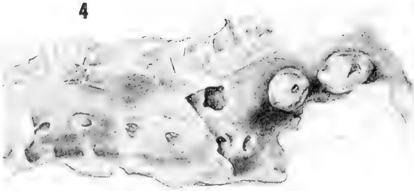
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EXPLANATION OF PLATE 6

Figure		Page
1.	**Steganoporella magnilabris** (Busk) .... Specimen A632a, PRI 27497. Frontal surface of four zooecia showing *B*-zooecium upper left and *a*-zooecium upper right. Average length of *B*-zooecium 1.00 mm., of *a*-zooecium 0.93 mm. Enlarged about 60X. Recent. See Plate 2, figs. 1-3 for photographs of zoarium of this same specimen.	35
2.	**Biflustra** cf. **B. savartii** (Audouin-Savigny) .... Specimen T620a, PRI 27498. Average zooecium length 0.45 mm., width 0.29 mm. Enlarged about 70X. Upper Mare Formation. See Plate 2, figs. 4,5 for photographs of zoarium of this same specimen.	39
3,4.	**Cryptosula pallasiana** (Moll) .... Fig. 3, specimen T633a, PRI 27505. Frontal surface. Average zooecium length 0.61 mm., width 0.32 mm. Enlarged about 75X. Fig. 4, specimen T633b, PRI 27505a. Side view showing multiporous septulae and ovisacs (at right). Enlarged about 75X. See Plate 2, for view of zoarium of specimen T633a. Both specimens T633a and T633b are from the upper Mare Formation.	62

EXPLANATION OF PLATE 7

Figure Page

1. **Biflustra cf. B. savartii** (Audouin-Savigny) 39
Specimen T620b, PRI 27514. Average zooecium length 0.48 mm., width 0.29 mm. Enlarged about 60X. Upper Mare Formation.

2. **Schizoporella floridana** Osburn 52
Specimen S627a, PRI 27507. Approximate length of figured zooecium 0.66 mm., width 0.52 mm. Enlarged about 53X. Playa Grande Formation (Maiquetía Member). See Plate 3, figs. 4-6 for photographs of zoarium which bears this zooecium.

3. **Schizoporella floridana** ? Osburn 60
Specimen I621aa, PRI 27508. Frontal surface of three zooecia. Average zooecium length 0.62 mm., width 0.41 mm. Enlarged about 60X. Lower Mare Formation. See Plate 3, figs. 7-9 for photographs of zoarium of this same specimen.

4. **Hippoporidra janthina** (Smitt) 87
Specimen I582b, PRI 27515. Portion of frontal surface showing a large interzooecial avicularium with a trilobate bar. Length of interzooecial avicularium 0.21 mm., width 0.20 mm. Surface enlarged about 60X. See Plate 3, figs. 10,11 (specimen I582a) for photographs of a complete zoarium developed on a gastropod shell. Lower Mare Formation.

5. **Rhynchozoon cf. R. verruculatum** (Smitt) 98
Specimen A676a, PRI 27516. Frontal surface showing verrucose character of the zooecia, the frontal avicularia, and the large subspatulate avicularia lying parallel with the surface. Average zooecium near center of colony, length 0.43 mm., width 0.31 mm. Enlarged about 65X. Recent.

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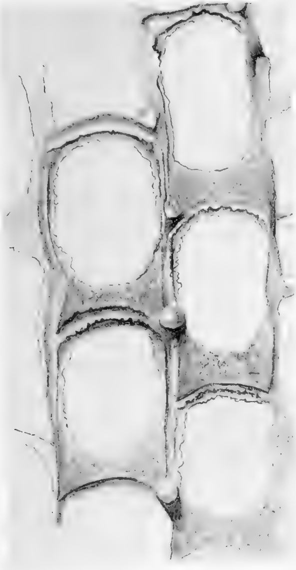

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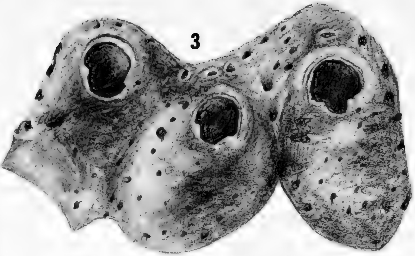

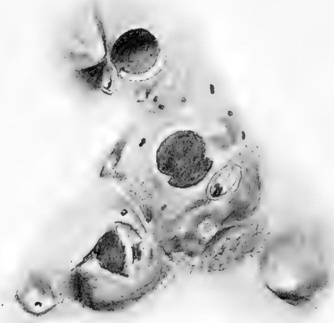

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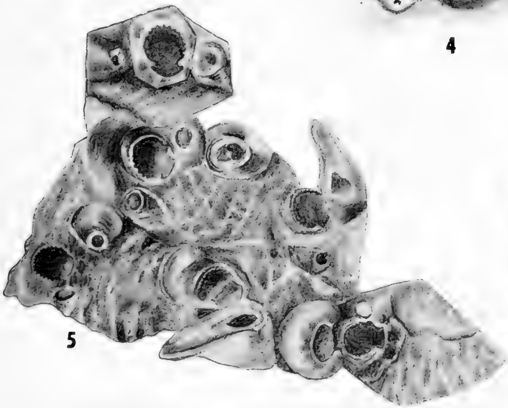

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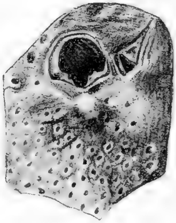

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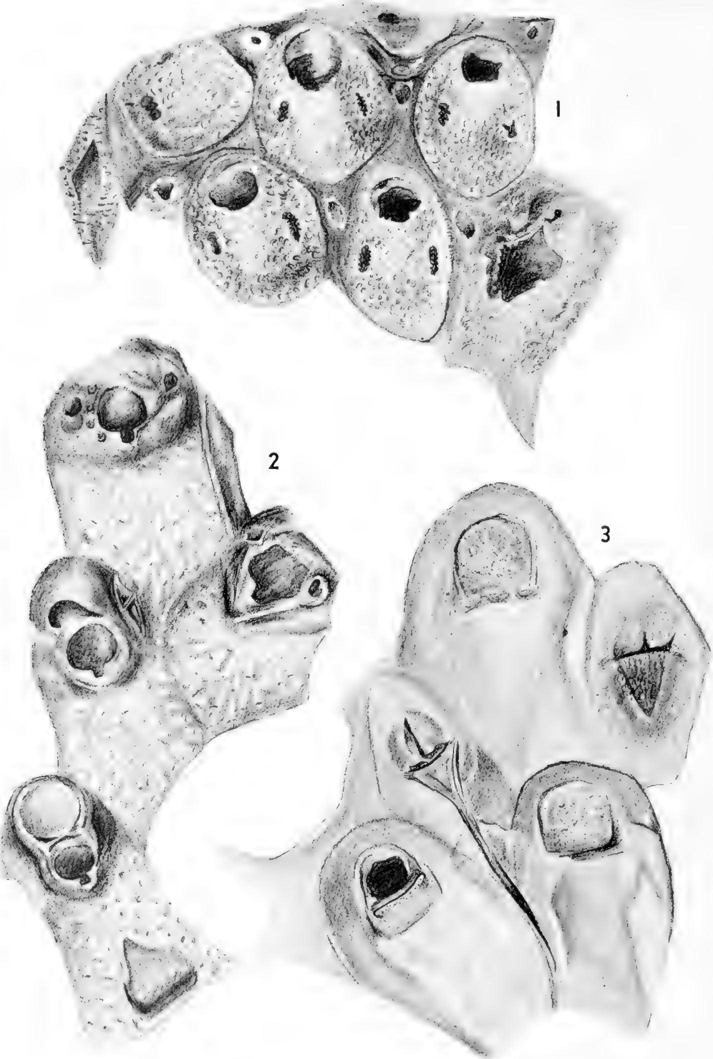
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EXPLANATION OF PLATE 8

Figure		Page
1.	**Setosella antilleana,** n. sp. ...... Holotype (A684a), PRI 27517. Frontal view. Average zooecium length 0.35 mm., width 0.26 mm. Enlarged about 85X. Recent.	45
2.	**"Schizoporella" mamoensis,** n. sp. ...... Holotype (A687a), PRI 27518. Frontal view. Length of zooecium plus ovicell 0.59 mm.; width of zooecium 0.29 mm. Enlarged about 85X. Recent.	61
3.	**Smittipora abyssicola** (Smitt) ...... Specimen A675a, PRI 27519. Frontal view showing avicularian-bearing zooecium and rhachis. Average autozooecium length 0.53 mm., width 0.38 mm. Enlarged about 90X. Recent.	82

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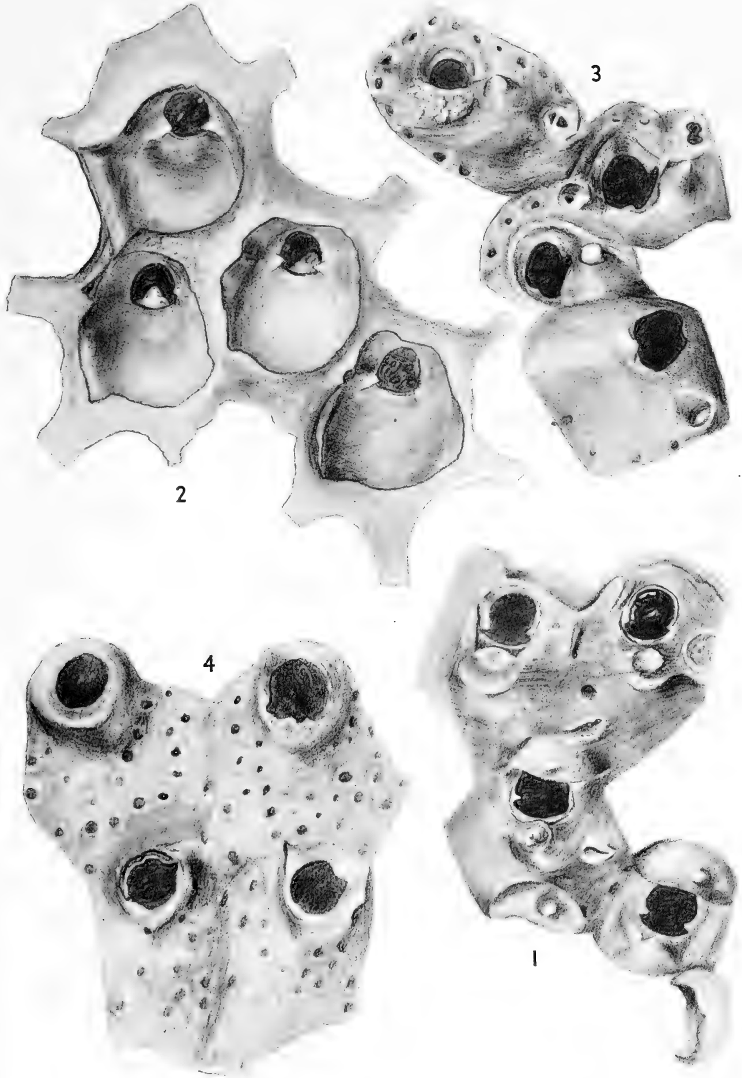
Figure		Page
1-3.	**Trematooecia cheethami,** n. sp. .... Figs. 1,2, holotype (T620c), PRI 27520. Frontal and basal views of same specimen. Fig. 1 shows four ovicells, three with a nodule on top. Average zooecium length 0.40 mm., width 0.23 mm. Enlarged about 100X. Upper Mare Formation. Fig. 3, paratype (J641a), PRI 27504. Frontal view. Average zooecium length 0.33 mm., width 0.29 mm. Enlarged about 100X. Lower Mare Formation. See Plate 2, figs. 12,13 for photographs of zoarium of J641a.	106
4.	**Hippodiplosia pertusa** (Esper) .... Specimen D685a, PRI 27521. Frontal view. Average zooecium length 0.45 mm., width 0.29 mm. Enlarged about 100X. Abisinia Formation.	78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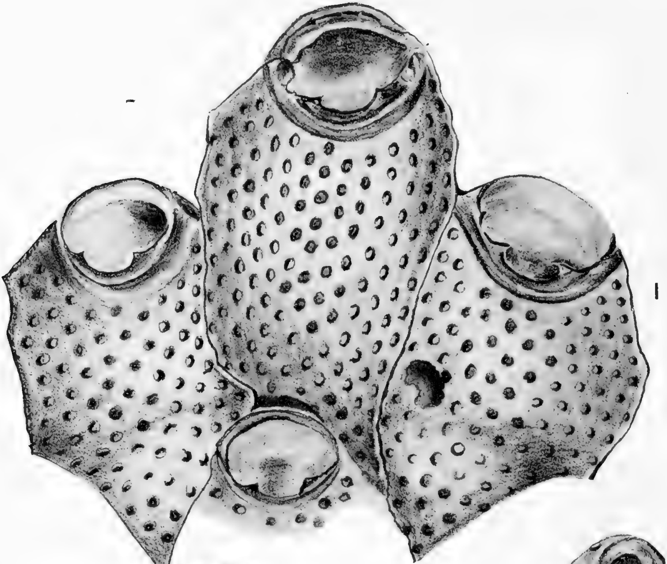

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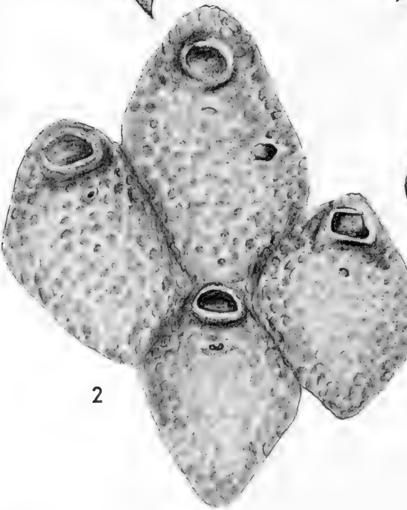

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EXPLANATION OF PLATE 10

Figure Page

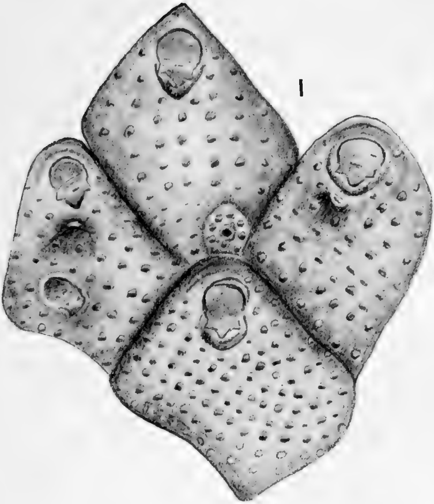
1. **Dakaria subtorquata** (d'Orbigny) 68
Specimen A681a, PRI 27522. Average zooecium length 0.81 mm., width 0.32 mm. Enlarged about 94X. Recent.

2. **Microporella ciliata** (Pallas) *s. l.* 72
Specimen A677a, PRI 27523. Average zooecium length 0.47 mm., width 0.32 mm. Enlarged about 94X. Recent.

3. **Hippopodinella venezuelana,** n. sp. 86
Holotype (I621a), PRI 27506. Frontal view showing vibracular nodes. Average zooecium length 0.45 mm., width 0.31 mm. Enlarged about 94X. Lower Mare Formation. See Plate 3, figs. 1-3 for photographs of the zoarium of this species.

EXPLANATION OF PLATE 11

Figure		Page
1.	**Trypostega venusta** (Norman) Specimen A678a, PRI 26524. Frontal view showing four zooecia and one zooeciule. Average zooecium length 0.41 mm., width 0.26 mm. Enlarged about 100X. Recent.	49
2.	**Cleidochasma contractum** (Waters) Specimen A686a, PRI 27525. Average zooecium length (excluding ovicell) 0.31 mm., width 0.21 mm. Enlarged about 90X. Recent.	95
3.	**Cleidochasma porcellanum** (Busk) Specimen A674a, PRI 27526. Average zooecium length 0.31 mm., width 0.24 mm. Enlarged about 100X. Recent.	92
4.	**Rhynchozoon caboblanquense,** n. sp. Holotype (J660b), PRI 27527. Average zooecium length 0.35 mm., width 0.26 mm. Enlarged about 87X. Lower Mare Formation.	100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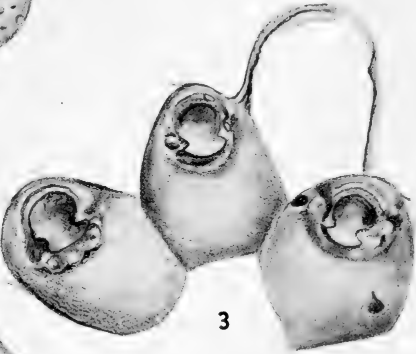
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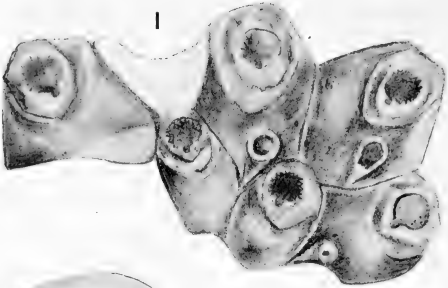

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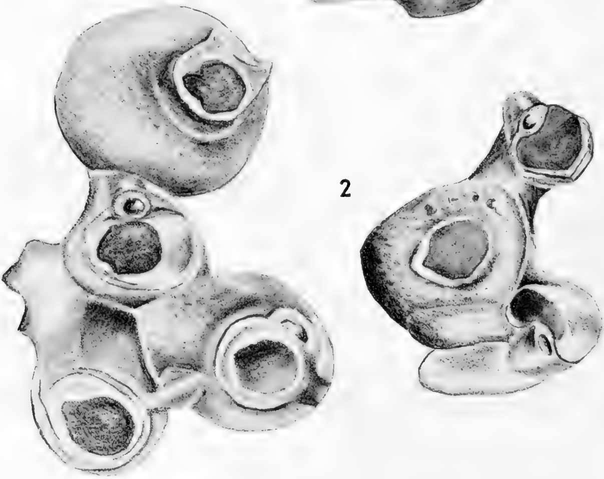

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EXPLANATION OF PLATE 12

Figure		Page
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BULLETINS
OF
AMERICAN
PALEONTOLOGY

(Founded 1895)

Vol. 53

No. 238

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By

JOHN LYMAN CARTER

1967

Paleontological Research Institution
Ithaca, New York, U.S.A. 14850

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AMERICAN PALEONTOLOGY

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Ithaca, N. Y., 14850 U. S. A.

Library of Congress Catalog Card Number: GS 67-137

Printed in the United States of America

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MISSISSIPPIAN BRACHIOPODS FROM THE CHAPPEL LIMESTONE OF CENTRAL TEXAS

John Lyman Carter

ABSTRACT

The Chappel Limestone of late Kinderhookian and possibly early Osagian age is a thin discontinuous crinoidal limestone that crops out along the western, northern, and eastern edges of the Llano Uplift of central Texas.

A well-preserved fauna has been collected from these beds. The microfossils have been described in some detail by Roundy (1926) and Hass (1959). Except for the unusual collection of juveniles, mainly brachiopods, described by Girty (1926), the macrofauna, with few exceptions, has never been described. The present report consists of the systematic description of the diverse brachiopod fauna, with a reassessment of Girty's taxa and the application, when possible, of those names to large collections that include mature specimens. Fifty-one genera and sixty-five species are recognized. Three new genera, *Cyphotalosia, Amesopleura,* and *Crassumbo,* and 25 new species are proposed. Wherein possible, simple statistical techniques are used to characterize growth patterns of both individuals and sample populations.

Correlation of the Chappel Limestone with the upper Chouteau Group of the Mississippi Valley is reaffirmed by this study of the brachiopod fauna.

INTRODUCTION

The Chappel Limestone of central Texas is a thin bioclastic unit of early Mississippian age that crops out at many places along the eastern, northern, and western margins of the Llano region of Texas. It is stratigraphically delimited above by the Barnett Formation of late Mississippian age, and below by various older strata ranging in age from Ordovician (Ellenburger Group) to late Devonian or early Mississippian (Houy Formation).

Along the eastern edge of the uplifted region it consists of several thin beds of gray, fine to medium-grained, crinoidal limestone, ranging in thickness from a feather edge to a few feet. Macrofossils are rare, and if present, are usually minute juveniles. In the northern and western portions of the region the texture is similar, but the color is often reddish or pink, although gray beds predominate at some outcrops and sparry calcite is often mixed with the fine-grained matrix. The thickness is erratic but the greatest thickness known, about 40 feet, is attained here in small structural sinks. A large well-preserved macrofauna, consisting mostly of brachiopods, has been collected from several localities in this part of the uplifted region, usually from the previously mentioned structural sinks. Several species of trilobites have been described by Hessler (1963, 1965) and Grant (1965) described three species of stenoscismatacean brachiopods. Except for the minute forms, mostly juvenile brachiopods, described by Girty (1926), the macrofauna has not been described in detail.

The main purpose of this study is to systematically describe the brachiopod fauna of the Chappel Limestone. Secondary objectives are the recognition and establishment of Girty's taxa from his so-called "Boone-age fauna" and the correlation of this fauna with similar shelly facies in the mid-continent.

ACKNOWLEDGMENTS

The study was undertaken at the U.S. National Museum. The author is grateful to R. S. Boardman, Curator of Invertebrate Paleontology, for making available the facilities of the museum. G. A. Cooper, Chairman of the Department of Paleobiology, suggested this study as a doctoral dissertation and made available the great comparative brachiopod collections in his care. The author extends his warmest thanks to G. A. Cooper and K. E. Caster of the University of Cincinnati for jointly supervising the study and providing advice and encouragement throughout. In addition, thanks are due P. E. Cloud, Jr., and V. E. Barnes, who kindly consented to the use of their collections, now in the National Museum, for the purposes of this study. R. E. Grant made helpful suggestions and provided stimulating discussions concerning brachiopod systematics. Jesse E. Merida assisted the author in developing preparation techniques. Peter U. Rodda loaned specimens of the Texas Bureau of Economic Geology. Finally, this study would not have been possible without the infinite patience and constant encouragement of the author's wife, Ruth, who also typed all drafts of the manuscript.

The cost of the engraving of the illustrations has been met by a grant from the Graduate School of the University of Cincinnati.

BIOSTRATIGRAPHY AND CORRELATION

The Chappel Limestone was named by Sellards (1932, p. 91, 92) for the so-called "Boone or Osage age" deposits described by Roundy, Girty, and Goldman (1926). Cloud and Barnes (1946, 1948), in their studies of the Ellenburger Group, also mapped the younger formations, including the Chappel Limestone but considered it to be of late Kinderhookian (Chouteau equivalent) or perhaps early Osagian age. F. B. Plummer investigated the Chappel Limestone and redefined it to include four members ranging in age from early Kinderhookian through mid-Osagian. Hass (1959) accepted only one of Plummer's members (Espey Creek Limestone) as being Chappel Limestone and also considered the age to be late Kinderhookian and early Osagian. Plummer's youngest member, the Whites Crossing Coquina, was considered by Hass (1959) and Cloud and Barnes (1948) to be a facies of the Barnett Formation. This correlation was because of its stratigraphic position above the Chappel Limestone and because a Keokuk-age macrofauna was found in both the coquina and more typical Barnett lithologies. The present writer agrees with this interpretation. Plummer's oldest members, the Ives Conglomerate and King Creek Marl, were placed by Hass in the Houy Formation as defined by Cloud, Barnes, and Hass (1957).

The Chappel Limestone is used in this report as defined by Hass (1959), who presented a number of accurately measured sections and designated three faunal zones based on the conodont fauna that was collected from those and other carefully measured sections. These zones are from bottom to top the *Siphonodella cooperi* Zone, *Gnathodus punctatus* Zone, and the *Bactrognathus communis* Zone. According to Hass (p. 368-370) the lower two zones are late Kinderhookian (Chouteau) in age, and the uppermost zone is early Osagian.

The distribution of the macrofossil localities is unusual and perhaps worthy of consideration. Several of the largest collections (USNM localities 9045, 9042-3, and 9044) were taken from beds consisting mainly of winnowed piles of brachiopod shells, crinoidal debris, and minor amounts of both sparry and micritic matrix. These beds occur in the so-called structural sinks as described by Cloud and Barnes (1948, p. 51). Other collections were obtained from smaller isolated outcrops that could also be remnants of structural sinks (*e.g.* USNM localities 9047 and 9048). Only the collections from USGS localities 2623 and 9367 were clearly taken from flat-bedded strata typical of the eastern portion of the outcrop area.

Because the Chappel beds arch over the sink wall in the manner of folded beds, and from lithic character and the distribution of these beds, Cloud and Barnes concluded that the Chappel beds were either let down from an original subhorizontal position concomitantly with solution or that they fell into solution-formed caves prior to Barnett time. This writer considers the latter alternative unlikely because it does not explain the presence of winnowed piles of brachiopod shells found in beds at several of these structural sinks. It seems more likely that the shells accumulated in depressions formed by gradually collapsing sinks. The greater proportion of sparry to micritic calcite matrix in some beds of these sinks suggests that there were stronger bottom currents in this portion of the Llano region than to the east where sparry calcite is rare and concentrations of macrofossils are lacking.

Unfortunately, unbiased sample populations were not obtained for this study. This is due to several factors: the difficulties involved in collecting a macrofauna from a hard limestone matrix; the uncertain time span represented by slowly accumulated death assemblages; and the fact that many of the finest and most useful specimens were not collected by the writer. As a result no serious effort was made to statistically analyze the collections from a population viewpoint. The graphs and scatter diagrams in this study are presented solely to illustrate variation in mode of growth during ontogeny.

AGE OF THE MACROFAUNA

Of the 65 species described in the systematic portion of this study less than half prove to be useful for stratigraphic correlations at the present time. It is probable that detailed studies of other faunas of similar age will eventually facilitate the use of a larger proportion of the Chappel fauna for these purposes. In general, the species excluded from consideration are either geographically limited to the Chappel Limestone, as far as is known, or are too poorly preserved or represented by too few specimens for accurate identification. Furthermore, forms such as *Ectochoristites inflatus,* n. sp., *Acanthoplecta inopinata,* n. sp., and *Tornquistia*? *transversalis,* n. sp. represent lineages that have not previously been reported from this continent. Species such as *Merista maccullochensis,* n. sp. and *Rotaia* sp. are anachronisms, being most closely related to Siluro-Devonian and late Osagian species, respectively, and lack correlation value at this time. It must also be kept in mind that the macrofauna was not collected from every bed, and it is unlikely that the evidence for correlation presented here is as complete as can be obtained with micropaleontological collecting techniques.

DISCUSSION

Only two of the chonetid species appear to have value in correlation. These are *Rugosochonetes burlingtonensis* (Weller) and *Plicochonetes* aff. *P. ornatus* (Shumard). The former is common in USNM collections from the Caballero Formation of New Mexico and was described by Weller from Kinderhook bed #6 in Iowa. *Plicochonetes* aff. *P. ornatus* is closely related to *Chonetes "glenparkensis"* of Weller (1914) and Branson (1938). Both of these species indicate a late Kinderhookian or early Osagian age.

Of the productid species *Rhytiophora calhounensis* (Moore), and *Rhytiophora* aff. *R. blairi* (Miller) indicate a Chouteau-Caballero-Chappel correlation. *Productina sampsoni* (Weller) has been identified by many authors from both late Kinderhook and early Osage strata in Missouri and New Mexico. *Geniculifera brevicula,* n. sp. and *Avonia* cf. *A. pustulifera* Moore indicate only approximate Kinderhook-Osage affinities.

Most of the rhynchonellids are not useful in correlation, especially the stenoscismataceans. In general, the Chappel species of that superfamily, at least as currently understood, indicate little more than a Mississippian age although *Coledium evexum* Grant appears to be related to *C. bisinuata* (Rowley), an early Osagian species in the Mississippi Valley region. *Shumardella obsolescens* Weller and *Cupularostrum*? sp. are Chouteau-Caballero-Chappel species and neither ranges into the Osagian as far as is known. The unusual large form described as *Rotaia* sp. probably represents an early development of this genus but does not seem to indicate a correlation with Osagian strata. *Rhynchopora sansabensis,* n. sp. is probably related to *R. persinuta* (Winchell) and *R. cooperensis* (Shumard) but is not useful for Kinderhook-Osage differentiation.

The retziid species, *Plectospira problematica* (Girty), was initially identified by the writer as *P. sexplicata* (White and Whitfield) a commonly identified species in both late Kinderhookian and early Osagian faunas. However, the Chappel species is clearly distinct and of limited value in correlation.

Except for the species of *Cleiothyridina* the Chappel athyrid species are also of little use in correlation. *Merista maccullochensis,* n. sp. is most closely related to Silurian and Devonian species and is hence an anachronism. *Cleiothyridina tenuilineata* (Rowley) has been widely identified in both late Kinderhook and early Osagian strata, and *Cleiothyridina* cf. *C. prouti* (Swallow) is similar to an undescribed species in the Caballero Formation. These species have close affinities with the Fern Glen-Pierson-Lake Valley species, *Cleiothyridina prouti* (Swallow), but occur stratigraphically below that species. *Camarophorella dorsata,* n. sp. is most similar to *C. mutabilis* Hyde, from the upper Waverly Group of Ohio.

Most of the spiriferid species have been identified by various authors in both late Kinderhook and early Osagian strata in Missouri and New Mexico, *e.g. Cyrtina burlingtonensis* Rowley, *Spirifer gregeri* Weller, *Brachythyris chouteauensis* (Weller), and *Reticularia cooperensis* (Swallow). Only *Eomartiniopsis girtyi* (Branson) and *Tylothyris* cf. *T. missouriensis* (Weller) indicate an exclusively Kinderhookian age.

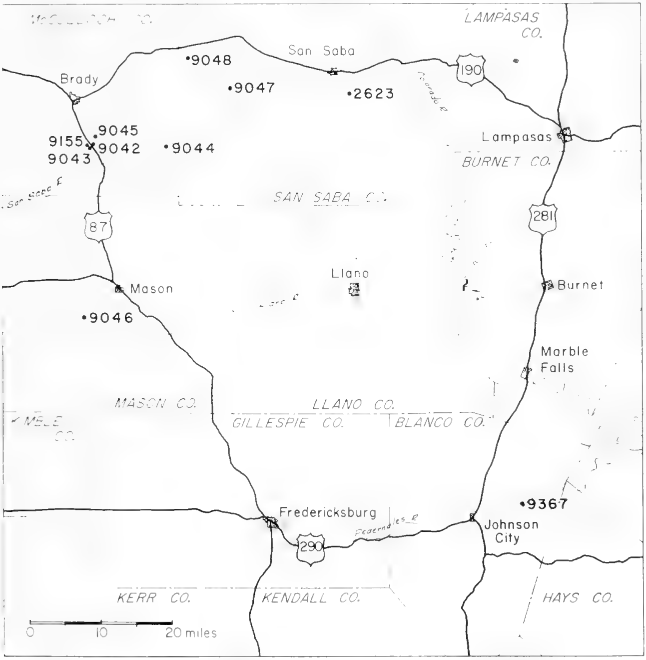
Because Mississippian terebratulids are so difficult to identify accurately, they are not ordinarily useful in correlation. However, the distinctive species *Beecheria chouteauensis* (Weller) has been positively identified in late Kinderhookian and early Osagian formations in New Mexico by Armstrong (1958, 1962) as well as from similar age strata in Missouri by Weller (1914) and Branson (1938). *Girtyella cedarensis* Weller is a Northview-Sedalia species in Missouri and probably indicates a late Kinderhookian age in the Chappel Limestone.

SUMMARY

Of the 19 species useful for correlation at the present state of knowledge only four would seem to indicate an exclusively late Kinderhookian age. The other 15 species have been identified in both Kinderhookian and Osagian formations in the Mississippi Valley and New Mexico. None of the latter species are known only from Osagian strata.

The Chappel brachiopod fauna is most similar to and correlative with that of the Caballero Formation of New Mexico. The Sedalia-Northview formations of the Chouteau Group of the Mississippi Valley, as delimited by Beveridge and Clark (1952), contain many similar or conspecific brachiopod species although there are also many similarities with the lower Pierson Formation fauna of Spreng (1952). The latter formation is considered to be basal Osagian by the above mentioned authors.

The lack of exclusively Osagian species in the Chappel macrofauna is considered significant, and the author deems it unlikely that at least the beds from which the macro-fossils were recovered are Osagian. The preponderance of evidence from the brachiopod fauna indicates a late Kinderhookian age, essentially agreeing with the conodont correlations as established by Hass (1959).



Text-fig. 1 — Map showing localities at which brachiopods were collected from the Chappel Limestone.

COLLECTING LOCALITIES AND FOSSIL LISTS

Collections were made by the author from all the localities listed below except for the type locality near Chappel, San Saba County, which has been covered by road fill. Attempts to collect a macrofauna from nearby exposures were unsuccessful. USNM locality 9046 and Cloud-Barnes locality 16T-2-27A which produced such excellent specimens for Cloud, Barnes, and Cooper failed to yield more than fragmentary material to this writer.

USNM locality 9042 — Margin of a caliche pit on the east side of U.S. Highway 87, about 6.7 miles SSE of the courthouse at Brady, McCulloch County, Texas. Equivalent to Cloud locality TF-385 and USGS locality 15533.

Cyphotalosia masonensis Carter
Quadratia egregia Carter
Acanthoplecta inopinata Carter
Productina sampsoni (Weller)
Geniculifera brevicula Carter
Ovatia sp.
Shumardella obsolescens Weller
Coledium evexum Grant
Tylothyris brevaurita Carter
Fusella llanoensis Carter
Brachythyris chouteauensis (Weller)
Reticularia cooperensis (Swallow)
Crassumbo turgidus Carter
Eomartiniopsis girtyi (Branson)
Cranaena texana Carter
Hamburgia chappelensis Carter
Dielasmella larga Carter

USNM locality 9043 — Pasture on the west side of U.S. Highway 87, across the road from a caliche pit, about 6.7 miles SSE of the courthouse at Brady, McCulloch County, Texas. Equivalent to Cloud locality TF-389, Plummer locality 153-T-110 and USGS locality 15534.

Schizophoria sp.
Leptagonia sp.
Tornquistia? sp.
Retichonetes? gibberulus Carter
Rugosochonetes burlingtonensis (Weller)
Plicochonetes aff. *P. ornatus* (Shumard)
Productina sampsoni (Weller)
Geniculifera brevicula Carter
Rhytiophora calhounensis (Moore)
Rhytiophora cf. *R. blairi* (Miller)

Cupularostrum? sp.
Shumardella obsolescens Weller
Sedenticellula sacra Grant
Coledium undulatum Grant
Rhynchopora sansabensis Carter
Plectospira problematica (Girty)
Athyris bradyensis Carter
Merista maccullochensis Carter
Crurithyris parva (Weller)
Tylothyris brevaurita Carter
Tylothyris cf. *T. missouriensis* (Weller)
Amesopleura texana Carter
Spirifer chappelensis Carter
Spirifer cf. *S. gregeri* Weller
Brachythyris chouteauensis (Weller)
Crassumbo inornatus Carter
Crassumbo turgidus Carter
Eomartiniopsis girtyi (Branson)
Cranaena texana Carter
Cranaena cf. *C. hannibalensis* Moore
Hamburgia chappelensis Carter

USNM locality 9044 — From a structural sink on the east side of a North-South fence, 1000 to 1500 feet ENE of the mouth of Joe Davis Hollow, about 1.76 miles N 60 E of the mouth of Lost Creek, McCulloch County, Texas. Equivalent to Cloud locality TF-392 and USGS locality 9353.

Schizophoria sp.
Plicochonetes aff. *P. ornatus* (Shumard)
Acanthoplecta inopinata Carter
Geniculifera brevicula Carter
Ovatia sp.
Sedenticellula sacra Grant
Coledium evexum Grant
Coledium undulatum Grant
Rhynchopora sansabensis Carter
Athyris bradyensis Carter
Camarophorella dorsata Carter
Amesopleura texana Carter
Fusella llanoensis Carter
Brachythyris chouteauensis (Weller)
Reticularia cooperensis (Swallow)
Crassumbo inornatus Carter
Eomartiniopsis girtyi (Branson)

USNM locality 9045 — From the SE corner of a structural sink on the May Brook Kothman ranch, about 2900 feet N 39 W of the peak of Bald Ridge and High Lonesome windmill and about 6.2 air-miles S 33 E of the courthouse at Brady, McCulloch County, Texas. Equivalent to Cloud locality TF-406 and USGS locality 9360.

Philhedra sp.
Schizophoria sp.

Rhipidomella perminuta Girty
Leptagonia sp.
Schuchertella? sp.
Tornquistia? transversalis Carter
Retichonetes? gibberulus Carter
Rugosochonetes burlingtonensis (Weller)
Plicochonetes aff. *P. ornatus* (Shumard)
Cyphotalosia masonensis Carter
Quadratia egregia Carter
Acanthoplecta inopinata Carter
Productina sampsoni (Weller)
Avonia honeycreekensis Carter
Geniculifera brevicula Carter
Rhytiophora calhounensis (Moore)
Rhytiophora sp.
Marginatia sp.
Ovatia sp.
Shumardella obsolescens Weller
Rotaia sp.
Sedenticellula sacra Grant
Coledium evexum Grant
Coledium undulatum Grant
Coledium vadosulcatum Carter
Rhynchopora sansabensis Carter
Plectospira problematica (Girty)
Hustedia? texana Girty
Cyrtina burlingtonensis Rowley
Athyris bradyensis Carter
Cleiothyridina tenuilineata (Rowley)
Cleiothyridina cf. *C. prouti* (Swallow)
Actinoconchus sp.
Merista maccullochensis Carter
Camarophorella dorsata Carter
Crurithyris parva (Weller)
Tylothyris brevaurita Carter
Amesopleura texana Carter
Spirifer chappelensis Carter
Spirifer cf. *S. gregeri* Weller
Fusella llanoensis Carter
Brachythyris chouteauensis (Weller)
Ectochoristites inflatus Carter
Punctospirifer sp.
Reticularia cooperensis (Swallow)
Crassumbo inornatus Carter
Eomartiniopsis girtyi (Branson)
Cranaena texana Carter
Cranaena cf. *C. hannibalensis* Moore
Hamburgia chappelensis Carter
Girtyella aff. *G. cedarensis* Weller
Dielasma sp.
Beecheria chouteauensis (Weller)

USNM locality 9046 — North side of a draw, 0.6 to 0.7 mile up Honey Creek from Texas Ranch Road 1871, about 8 miles SW of Mason, Mason County, Texas. Equivalent to Cloud locality TF-417c.

Schizophoria sp.
Rugosochonetes burlingtonensis (Weller)
Plicochonetes aff. *P. ornatus* (Shumard)
Cyphotalosia masonensis Carter
Productina sampsoni (Weller)
Avonia honeycreekensis Carter
Rhytiophora calhounensis (Moore)
Rotaia sp.
Coledium undulatum Grant
Rhynchopora sansabensis Carter
Athyris bradyensis Carter
Merista maccullochensis Carter
Crurithyris parva (Weller)
Tylothyris brevaurita Carter
Amesopleura texana Carter
Fusella llanoensis Carter
Brachythyris chouteauensis (Weller)
Ectochoristites inflatus Carter
Reticularia cooperensis (Swallow)
Crassumbo inornatus Carter
Crassumbo turgidus Carter
Eomartiniopsis girtyi (Branson)
Cranaena texana Carter
Hamburgia chappelensis Carter
Beecheria chouteauensis (Weller)

USNM locality 9047 — 800 to 900 feet SSE of an abandoned well and just SE of a stock pen on the Jack Sloan ranch. The pen and abandoned well are on a seldom used rancher's road that is about 1.0 mile south and 0.5 mile east from the 7th cattle guard south from U.S. Highway 190 on the Richland Springs-Maxwell Crossing county road or about 7.5 airmiles S 10 W from Richland Springs, San Saba County, Texas. Equivalent to Plummer locality 205-T-77.

Philhedra sp.
Schizophoria sp.
Tornquistia? transversalis Carter
Retichonetes? gibberulus Carter
Cyphotalosia masonensis Carter
Acanthoplecta inopinata Carter
Productina sampsoni (Weller)
Geniculifera brevicula Carter
Ovatia sp.
Shumardella obsolescens Weller
Sedenticellula sacra Grant
Coledium evexum Grant
Coledium undulatum Grant
Coledium vadosulcatum Carter
Rhynchopora sansabansis Carter
Plectospira problematica (Girty)
Cyrtina burlingtonensis Rowley
Cleiothyridina tenuilineata (Rowley)

Camarophorella dorsata Carter
Crurithyris parva (Weller)
Tylothyris brevaurita Carter
Amesopleura texana Carter
Fusella llanoensis Carter
Brachythyris chouteauensis (Weller)
Reticularia cooperensis (Swallow)
Crassumbo inornatus Carter
Eomartiniopsis girtyi (Branson)
Cranaena texana Carter
Cranaena? dorsisulcata Carter
Hamburgia chappelensis Carter
Girtyella aff. *G. cedarensis* Weller
Dielasma sp.
Dielasmella larga Carter

USNM locality 9048 — Just NW of Antelope Pond on the J. W. Gibbons-Oakdale-Miller ranch. The pond is about 0.5 mile NNE of the abandoned Gibbons-Oakdale ranch house and is about 8.3 airmiles S 58 W of Richland Springs, San Saba County, Texas.

Philhedra sp.
Rhipidomella perminuta Girty
Cyphotalosia masonensis Carter
Acanthoplecta inopinata Carter
Avonia cf. *A. pustulifera* Moore
Geniculifera brevicula Carter
Shumardella obsolescens Weller
Sedenticellula sacra Grant
Coledium altisulcatum Carter
Coledium evexum Grant
Coledium vadosulcatum Carter
Rhynchopora sansabensis Carter
Plectospira problematica (Girty)
Hustedia? texana Girty
Cyrtina burlingtonensis Rowley
Cleiothyridina tenuilineata (Rowley)
Cleiothyridina cf. *C. prouti* (Swallow)
Merista maccullochensis Carter
Camarophorella dorsata Carter
Crurithyris parva (Weller)
Tylothyris brevaurita Carter
Tylothyris cf. *T missouriensis* (Weller)
Amesopleura texana Carter
Spirifer chappelensis Carter
Fusella llanoensis Carter
Brachythyris chouteauensis (Weller)
Punctospirifer sp.
Crassumbo inornatus Carter
Eomartiniopsis girtyi (Branson)
Cranaena texana Carter
Cranaena cf. *C. hannibalensis* Moore
Hamburgia chappelensis Carter
Girtyella aff. *G. cedarensis* Weller
Dielasma sp.
Dielasmella larga Carter

USNM locality 9155 — Small inlier 500 feet SW of U.S. Highway 87, about 6.5 speedometer miles SSE of the courthouse at Brady, McCulloch County, Texas. Equivalent to Cloud locality TF-408.

Retichonetes? gibberulus Carter
Rugosochonetes burlingtonensis (Weller)
Plicochonetes aff. *P. ornatus* (Shumard)
Sedenticellula sacra Grant
Coledium evexum Grant
Coledium? costatulum Carter
Rhynchopora sansabensis Carter
Plectospira problematica (Girty)
Hustedia? texana Girty
Crurithyris parva (Weller)
Tylothyris brevaurita Carter
Tylothyris cf. *T. missouriensis* (Weller)
Fusella llanoensis Carter
Brachythyris chouteauensis (Weller)
Reticularia cooperensis (Swallow)
Eomartiniopsis girtyi (Branson)
Hamburgia chappelensis Carter

USGS locality 2623 — Type section for the Chappel Limestone but now covered by road fill, 2.4 miles SE from courthouse at San Saba, San Saba County, Texas, on the old San Saba to Chappel road, downhill from sharp turn in the road, and high on the side of a hill. The following species list consists of those species recognized by the present writer.

Rhipidomella perminuta Girty
Anopliopsis subcarinata (Girty)
Plectospira problematica (Girty)
Hustedia? texana Girty

USGS locality 9367 — Elm Pool, Johnson City area, about 5.2 miles SSW of Cypress Mill, 4000 feet North of the mouth of Miller Creek, and about 3 miles NE of Honeycut Bend on the Pedernales River, Blanco County, Texas. Equivalent to Cloud and Barnes locality 16T-2-27A.

Sedenticellula sacra Grant
Coledium undulatum Grant
Brachythyris chouteauensis (Weller)
Hamburgia chappelensis Carter

PREPARATION TECHNIQUES

Preparation of the exteriors of specimens was done with various kinds of grinding apparatus and by the use of chisel-edged needles. Natural interiors were ordinarily lacking. Interior data were obtained indirectly from serial transverse sections and directly by calcining specimens. Internal details were sometimes satisfactorily revealed by this latter method if the matrix was of a different contrast than the shell substance in reflected light, either dry or immersed in water. The transverse serial sections were obtained by means of a Croft Parallel Grinder and were preserved as cellulose peels made in the manner described by Boardman and Utgaard (1964, p. 768). This technique has the advantages of forming an accurate replica of the shell structure as well as leaving a near permanent record of the sections. Furthermore, the peels can be projected in an ordinary small-format photographic enlarger, producing excellent study photographs of ten or more diameters magnification. The text-figures illustrating the serial sections in this study were made from tracings taken directly from such enlargements.

Many of the specimens were partially spalled and uneven in color. In order to make the overall tone of the figured specimens even, they were coated with a washable opaquing ink. All the figured specimens were coated lightly with ammonium chloride before they were photographed.

MATERIAL STUDIED

Many of the U.S. National Museum collections from the Chappel Limestone were made by Cloud and Barnes during the course of their study of the Ellenburger Group of central Texas. G. A. Cooper subsequently added substantially to these collections as did the writer. Although the USNM collections form the largest part of the material studied, part of the F. B. Plummer collection in the Texas Bureau of Economic Geology collections was also examined, some of it in detail.

All primary types are deposited in the U.S. National Museum.

SYSTEMATICS

The brachiopods of the Chappel Limestone have never been studied in detail, except for the small fauna described by Girty (1926) from the type locality of the formation near San Saba, San Saba County. Girty's collection was made by P. V. Roundy and

K. C. Heald in 1919 and consisted of numerous small individuals, most of which are immature, with a few adult representatives of smaller species. Some of Girty's specimens have been lost or misplaced, although all the type specimens are available for study. This writer has attempted to assess Girty's taxa in terms of their probably being early ontogenetic stages of the species found to the west of the type locality. Because the collections from the western and northern portions of the Chappel outcrop area often yield excellent growth series, it has been possible in some cases to apply Girty's species names to taxa in which the early ontogenetic stages are easily recognized. In other cases, Girty's minute specimens are not identifiable, at least by this student of brachiopods, and are considered by him to be *nomina dubia*. Should some other student of this fauna successfully recognize Girty's specimens as being growth stages of any of the species described herein, then Girty's names must be applied to those taxa.

The author's disposition of the 23 brachiopod species and varieties recognized by Girty is as follows:

Lingulidiscina aff. *L. minuta* Mather.—This specimen is unique and poorly preserved. Not recognized.

Crania pertenuis Girty, 1926 — Based on six minute highly variable individuals. Species characters are not adequately established. Not recognized.

Rhipidomella perminuta Girty, 1926 — The types are juveniles of a species described in detail below.

R. perminuta var. Girty, 1926 — These specimens are possibly juveniles of the large undescribed species of *Schizophoria* considered below.

Schuchertella morsei Foerste? — Original specimens apparently lost. Not recognized.

Schuchertella? sp. — This specimen may be lost. Not recognized.

Chonetina subcarinata Girty, 1926 — Represented in this fauna only by the syntypes from the Chappel Limestone, although the description was based on specimens from the Ridgetop Shale of Tennessee. These specimens are possibly not conspecific with the Chappel Limestone specimens.

Pustula inconspicua Girty, 1926 — Girty's collection of productid juveniles is sizable. The specimens described as *P. inconspicua* are probably spat of some larger productid species. Not recognized.

Pustula moorefieldana var. *pusilla* Girty? — Specimens apparently lost. Not recognized.

Pustula aff. *P. indianensis* Hall — Specimens apparently lost. Not recognized.

Camarophoria? aff. *C. bisinuata* Rowley—This specimen is definitely a juvenile of the genus *Coledium* Grant. However, it is not specifically identifiable.

Dielasma? sp. — Four of these specimens are unidentifiable terebratulids and two are probably small rhynchonellids or meristoids. Not recognized.

Selenella? *subcircularis* Girty, 1926 — These specimens are probably juveniles of one or more of the terebratulid species described below but unfortunately cannot be assigned generically. Judging from their shape and general configuration they are probably juveniles of *Hamburgia, Cranaena,* or *Girtyella.* It is unlikely that these specimens are sufficiently advanced ontogenetically to show generic characters even if sectioned. Not recognized.

Ambocoelia laevicula Rowley? — Girty's specimens are representatives of the species described by the writer as *Crurithyris parva.*

Spirifer sp. — The specimens described by Girty are juveniles and not identifiable specifically. In all probability they are representatives of several delthyrid and spiriferid species described below.

Spirifer sp. var. — One of these specimens possesses a ventral septum and is probably a juvenile *Tylothyris* or *Cyrtina.* Not recognized.

Reticularia sp. — Probably a juvenile of *R. cooperensis,* a possibility recognized by Girty.

Brachythyris? *simulans* Girty, 1926 — This specimen is possibly a juvenile individual of *B. chouteauensis.* Not recognized.

Hustedia? *texana* Girty, 1926 — These specimens are small adults or large juveniles, the species is thoroughly described below. Generic assignment remains in doubt.

Hustedia? *problematica* Girty, 1926 — Assigned to the genus

Plectospira Cooper and described in detail below. The type specimens are small adults or large juveniles but easily recognized.

Hustedia? *subaequalis* Girty, 1926—The holotype is most probably an aberrant *Plectospira problematica*. The other specimen is a juvenile of some spiriferid species. Not recognized.

Hustedia? *parvicostata* Girty, 1926 — This specimen is probably a juvenile of one of the spiriferid species described below. Not recognized.

Cleiothyridina? sp. — Most of these specimens are not generically identifiable. One specimen appears to be a juvenile of *Camarophorella*. Not recognized.

Much of this paper was written before the publication of the Brachiopoda volumes (Part H) of the *Treatise on Invertebrate Paleontology*. The writer has attempted, where possible, to apply the morphological terminology and higher classification used in the Treatise. Some exceptions are noted below.

The compilers of the Treatise indicate a preference for the nondescriptive terms *primary layer* and *secondary layer* for the various shell tissues. Because our understanding of the nature of shell deposition in brachiopods is still rudimentary, the writer prefers to use the established descriptive terms *lamellar layer, fibrous layer,* and *columnar layer* as used by Dunlop (1962).

The use of the term *crural plate* in the Treatise for assorted structures that "extend from the inner edge of outer hinge plate or crural base to floor of brachial valve. . . ." is inadvisable because it is usually neither descriptive nor genetic. If the crural bases actually extend to the floor of the valve it seems unnecessary to use two terms for the same structure. If structures unrelated to the crural bases (histologically) extend to the floor of the valve, then the term *crural plate* is a misnomer. The writer prefers to use descriptive terms for the latter such as buttressing, basal, or supporting plates.

The abbreviations USNM and USGS indicate localities or specimen numbers of the United States National Museum and United States Geological Survey respectively.

SYSTEMATICS

Phylum BRACHIOPODA Duméril, 1806
Class INARTICULATA Huxley, 1869
Order ACROTRETIDA Kuhn, 1949
Suborder CRANIIDINA Waagen, 1885

Superfamily **CRANIACEA** Menke, 1828

Family **CRANIIDAE** Menke, 1828

Genus **PHILHEDRA** Koken, 1889

Philhedra sp. Pl. 15, figs. 18a-19b

Six craniid brachial valves constitute the entire collection of inarticulate brachiopods from the Chappel Limestone. Only one of these specimens possesses shell material. A fragment of this shell substance is covered with fine sinuous costellae, this being the main evidence for the generic assignment.

Occurrence. — USNM localities 9045, 9047, and 9048.

Class ARTICULATA Huxley, 1869
Order ORTHIDA Schuchert and Cooper, 1932
Suborder ORTHIDINA Schuchert and Cooper, 1932

Superfamily **ENTELETACEA** Waagen, 1884

Family **ENTELETIDAE** Waagen, 1884

Subfamily **SCHIZOPHORIINAE** Schuchert and LeVene, 1929

Genus **SCHIZOPHORIA** King, 1850

Schizophoria sp. Pl. 13, figs. 1a-3e

Medium size for the genus, biconvex, subelliptical in outline, wider than long, greatest width at about midlength; lateral profile lenticular, brachial valve more convex than the pedicle valve; beaks moderate in size, slightly curved; hinge line straight, narrow, cardinal extremities evenly rounded; ventral interarea apsacline, dorsal interarea orthocline to slightly apsacline; anterior commissure rectimarginate; both valves evenly convex or one or both valves with a slight sulcus; surface multicostellate, shell substance punctate.

Pedicle valve interior unknown.

Brachial valve interior with small bilobed cardinal process, divergent brachiophore bases that bound the adductor muscle field;

adductor muscle field of moderate size divided by a short thick median ridge, obscurely divided into two parts, an outer posterior and an inner anterior pair.

Remarks. — Because many of the Mississippian species of this genus are highly variable in shape and size, no attempt is made here to assign the few Chappel Limestone specimens specifically. It is worth noting that some of these specimens are similar to *Schizophoria sulcata* Sanders, 1958, from the Represso Limestone of Sonora, Mexico, *Schizophoria sedaliensis* Weller, 1914, from the Sedalia Limestone of Missouri, and *Schizophoria subelliptica* (White and Whitfield), 1862, from Kinderhook bed No. 6 of Iowa. All of these species are about the same age as the Chappel Limestone. However, a careful study of large population samples of these species is necesary to assess their validity as species.

Table 1. — Measurements in millimeters of *Schizophoria* sp. from USNM locality 9045.

USNM No.	Length	Width	Thickness
154526	25.2	30.6	14.2
154527	17.4	20.9	10.2
154528	10.1	12.6	5.5

Illustrated specimens. — USNM Nos. 154526, 154527, 154528.

Occurrence and abundance. — Five nearly complete and several dozen fragmentary specimens from USNM locality 9045, and several fragments each from localities 9047, 9046, 9048, and 9044 make up the collection of this species.

Family **RHIPIDOMELLIDAE** Schuchert, 1913

Genus **RHIPIDOMELLA** Oehlert, 1890

Rhipidomella perminuta Girty Pl. 13, figs. 4a-7e

1926. *Rhipidomella perminuta* Girty, U. S. Geol. Sur., Prof. Paper 146, pp. 25, 26, pl. 5, figs. 4-6.

Girty's description of this species was based on about 100 small specimens which this writer considers to be immature individuals, mainly because of the disproportionately coarse multicostella prosopon and small size. Although a growth series of topotype material is not available, the close similarity in outline between Girty's small specimens and larger mature specimens from other localities convinces the writer that the two growth stages represent a single species. The description given below is essentially Girty's, slightly emended to include the mature forms discussed above.

Average size for the genus, slightly wider than long, subelliptical to almost subtrigonal in outline; maximum width anterior to mid-length; beaks average size for the genus; hinge line short, straight, cardinal extremities compressed, subangular; posterolateral margins straight to concave; distinct sulcus on brachial valve; anterior commissure weakly sulcate, anterior margin may be emarginate; both valves multicostellate, other details of prosopon not discernable due to spalled surfaces.

Pedicle valve slightly gibbous in the umbonal region, compressed along the lateral margins as well as in the cardinal extremities; interarea narrow, low, orthocline or slightly apsacline; beak slightly incurved, projecting beyond that of the brachial valve; fold absent or poorly developed.

Brachial valve with small distinct, slightly incurbed beak; equally or slightly more convex than the pedicle valve; dorsal interarea low, anacline; sulcus narrow, shallow to moderately deep, originating in the dorsal umbo, becoming wider anteriorly.

Interior details of adult specimens unknown. Pedicle valve of immature specimens with large flabelliform muscle scars that extend about halfway to the anterior margin.

Table 2. — Measurements in millimeters of *Rhipidomella perminuta* Girty, 1926, from USNM locality 9048.

USNM No.	Length	Width	Thickness
154529	17.9	19.3	7.4
154530	13.8	14.9	6.6

Syntypes. — USNM Nos. 121171, 121172, 121173.

Distinguishing characters. — This species is characterized by its subelliptical to subtrigonal outline, short hinge line, compressed cardinal extremities and lateral margins, distinct sulcus on the brachial valve, and weakly sulcate anterior commissure.

Comparisons. — *Rhipidomella perminuta* Girty is most similar in size and outline to *Rhipidomella jerseyensis* Weller, 1914, from the Fern Glen Formation of Missouri, but the latter is more inflated with convex margins and rounded cardinal extremities.

Rhipidomella tenuicosta Weller, 1914, from the Chouteau Limestone of Missouri is similar to *R. perminuta* in size and in being slightly compressed at the margins, but differs in having a more circular outline, rounded cardinal extremities, and a poorly defined sulcus on the brachial valve.

Occurrence and abundance. — Although Girty's collection from near San Saba numbered some 100 specimens, this species is rare elsewhere in the Chappel Limestone. Four adults and three juveniles from USNM locality 9045, two nearly complete adults and several fragments from locality 9048, and six crushed shells from Cloud locality TF-386 constitute the entire collection.

Order STROPHOMENIDA Öpik, 1934

Suborder STROPHOMENIDINA Öpik, 1934

Superfamily **STROPHOMENACEA** King, 1846

Family **LEPTAENIDAE** Hall and Clarke, 1894

Genus **LEPTAGONIA** M'Coy, 1844

Leptagonia sp. Pl. 14, figs. 10a-10b

This genus is represented by one spalled shell, natural molds of four pedicle valves, and several fragments. The best preserved specimen (illustrated) is about 17.0 mm long, and 23.4 mm wide; small to medium in size, subquadrate in outline, with a small cordate ventral adductor field, costellate, and covered with numerous concentric rugae. Another specimen is biconvex with a geniculate pedicle valve and a weakly convex nongeniculate brachial valve.

Figured specimen. — USNM No. 154545.

Occurrence. — USNM localities 9045 (four specimens, eight fragments), 9043 (one natural mold of a pedicle valve).

Superfamily **DAVIDSONIACEA** King, 1850

Family **SCHUCHERTELLIDAE** Williams, 1953

Subfamily **SCHUCHERTELLINAE** Williams, 1953

Genus **SCHUCHERTELLA** Girty, 1904

Schuchertella? sp. Pl. 14, fig. 6

Two spalled imperfect brachial valves are the only representatives of the davidsonaceans in the Chappel Limestone. The largest and best preserved of these specimens is about 12.3 mm long and 22.5 mm wide. Although the shell surface was clearly costellate, and not plicate, most of the surface details are lacking. Since generic assignment in this superfamily depends so heavily on interior information, the specimens are questionably assigned to *Schuchertella* on the basis of valve shape and prosopon.

Figured specimen. — USNM No. 154544.

Occurrence. — USNM locality 9045.

Suborder CHONETIDINA Muir-Wood, 1955

Superfamily **CHONETACEA** Bronn, 1862

Family **CHONETIDAE** Bronn, 1862

Subfamily **ANOPLIINAE** Muir-Wood, 1962

Genus **ANOPLIOPSIS** Girty, 1938

Anopliopsis subcarinata (Girty) Pl. 14, figs. 7-9

1926. *Chonetina subcarinata* Girty, U.S. Geol. Sur., Prof. Paper 146, p. 27, pl. 5, figs. 10-16.

This rare species is the type for the unusual monotypic anopliid genus *Anopliopsis* Girty, 1938, which is characterized by having radial platelike septa inside both valves.

Girty (1926, p. 27; 1938, p. 281) based his species *Chonetina subcarinata* on specimens from the Fort Payne Chert and Ridgetop Shale of western Tennessee but he identified and illustrated as syntypes specimens from the Moorefield Shale of Oklahoma and the Chappel Limestone (Girty's Boone age limestone) of central Texas. Whether or not all of these collections represent one species cannot be determined due to lack of interior information from the Oklahoma and Texas specimens. The three illustrated syntypes from the Chappel Limestone near San Saba, San Saba County, Texas, are the only Chappel Limestone specimens of this species in the USNM collections.

Syntypes. — USNM Nos. 121197, 121198, 121199. Eight of Girty's illustrated specimens from the Fort Payne Chert are also now in the USNM collections.

Genus **TORNQUISTIA** Paeckelmann, 1930

Tornquistia? transversalis, n. sp. Pl. 14, figs. 15a-20

Average size for the genus, concavo-convex, twice as wide as long, acutely subtriangular to semicircular in outline; cardinal extremities angular, compressed, not mucronate; greatest width at the hinge line; fold and sulcus lacking; surface smooth or faintly capillate on spalled surfaces; anterior commissure rectimarginate.

Pedicle valve strongly convex in lateral profile, being slightly more inflated posteriorly; surface evenly convex except for the cardinal extremities; beak small; interarea slightly curved, low, acutely triangular; small pseudodeltidium in apex of delthyrium; spines or spine bases not observed.

Pedicle valve interior (known only from calcined molds) with short high median septum, thick lateral ridges diverging at low angle from the hinge line delineating the diductor muscle field; cardinal extremities also marked off by marginal ridges; diductor field large, flabellate; adductor scars consisting of two pairs located posteriorly on either side of the median septum.

Brachial valve evenly concave except in the cardinal extremities; interarea about the size of that of the pedicle valve, reflexed; chilidium not observed.

Brachial valve interior unknown.

Holotype. — USNM No. 154550.

Table 3. — Measurements in millimeters of *Tornquistia? transversalis*, n. sp. from USNM locality 9045.

USNM No.	Length	Width	Thickness
154550	4.9	10.0?	1.8
154556	5.2	8.5?	2.1
154551	5.6	9.9	2.1
154552	5.2	9.9	2.0

Distinguishing characters. — *T. ? transversalis* is characterized by its strongly transverse outline, angular compressed cardinal extremities, smooth surface, and reflexed dorsal interarea.

Comparisons. — The writer knows of no other smooth strongly transverse Mississippian anopliid species. Cooper (1957, p. 25) described a similar species from the Permian of Oregon as *Paeckelmannia* aff. *Chonetes alatus* Stuckenberg, 1898. However, that species has more acute mucronate cardinal extremities and a more transverse outline.

Occurrence and abundance. — This species was found only at USNM localities 9045 (23 specimens) and 9047 (two specimens).

Tornquistia? sp. Pl. 14, figs. 11a-14

Small, slightly wider than long, subtrigonal to semicircular in outline, maximum width at the hinge line; cardinal extremities acutely angular, compressed, relatively large; fold and sulcus lacking but pedicle valve strongly arched medially; anterior commissure sulcate; surface faintly capillate, growth lines irregularly spaced.

Pedicle valve strongly convex in lateral profile, strongly inflated in posterior profile with concave lateral slopes; umbo large, overhanging the hinge line, beak small; interarea unknown; hinge spines not observed.

Brachial valve unknown.

Figured specimens. — USNM Nos. 154546, 154547, 154548.

Table 4. — Measurements in millimeters of *Tornquistia*? sp. from USNM locality 9043.

USNM No.	Length	Width	Thickness
154547	4.0	5.5?	2.6
154546	4.6	?	2.4
154548	4.1	5.9	2.2

Comparisons. — This problematical little species can easily be distinguished from the other chonetid species in the Chappel Limestone by its small size, relatively large ears, greatly inflated pedicle valve, and faintly capillate prosopon.

Remarks. — Generic indentification of this species is particularly difficult because of the contradictory nature of the shape, prosopon, and pedicle interior. The shape and general aspect of these shells are anopliid, similar to that of *Anopliopsis* Girty, 1938. However, that genus is smooth, not capillate, and has strongly developed septum-like plates inside both valves. The interior of two pedicle valves of this species are smooth except for the median septum and muscle bounding ridges. The assignment of this species to *Tornquistia* Paeckelmann, 1939, is by default, and duly questioned. According to Muir-Wood (1962, p. 59) the surface of *Tornquistia* is capillate when decorticated. Furthermore, the pedicle interior lacks platelike septa and the muscle scars are obscure, as in the Chappel species.

Occurrence and abundance. — Eight pedicle valves from USNM locality 9043 make up the entire collection of this species.

Subfamily **RETICHONETINAE** Muir-Wood, 1962

Genus **RETICHONETES** Muir-Wood, 1962

Retichonetes? gibberulus, n. sp. Pl. 15, figs. 10a-17

Smaller than average for the genus, concavo-convex; wider than long; semicircular in outline, maximum width at the hinge line; cardinal extremities compressed, angular, small, not mucronate; fold and sulcus lacking but pedicle valve mesially inflated; anterior commissure sulcate or ventrally deflected; surface costellate, the costellae bifurcating; growth lines numerous, fine, forming a reticulate pattern with the costellae; anterior portions of both valves often lamellose.

Pedicle valve strongly convex in lateral profile, inflated posteriorly, mesially arched in anterior profile, compressed laterally; umbo of moderate size, beak small, incurved; interarea low, almost flat, presence of pseudodeltidium undetermined; single spine near each cardinal extremity, at 45-50° angle to the hinge line.

Pedicle valve interior (known from calcined molds) with short median septum; muscle field bounded by low ridges diverging at about a 30 degree angle from the hinge line and septum; diductor and adductor scars undifferentiated.

Brachial valve moderately concave, evenly curved except for the cardinal extremities which flex ventrad slightly; interarea low, catacline or slightly reflexed; presence of chilidium unknown.

Brachial valve interior unknown.

Table 5. — Measurements in millimeters of *Retichonetes? gibberulus,* n. sp.

USNM No.	Length	Width	Thickness	Locality
154571	6.1	8.8?	2.9	9045
154570	5.7	8.7	3.1	9045
154576	6.9		3.7	9045
154573	3.5	6.3	1.6	9045
154568	5.9	10.0	2.2	9043
154569	5.5	10.0	2.5	9043
154572	4.6	7.1	1.9	9043

Holotype. — USNM No. 154571.

Distinguishing characters. — *R.* ? *gibberulus,* n. sp., is characterized by its small size, mesially inflated pedicle valve, sulcate anterior commissure, and a single spine near each cardinal extremity.

Comparisons. — *Retichonetes*? *gibberulus,* n. sp., is not to the writer's knowledge closely similar to any previously described species from North America. *Chonetes shumardianus* de Koninck, 1847, from the Borden Group of Kentucky is often similar in outline and prosopon, but it is much larger and relatively less convex. *Chonetes elegans* de Koninck, 1847, from Tournaisian strata of Belgium is similar in outline, convexity and prosopon, but is much larger and lacks a sulcate anterior commissure. *Chonetes (Plicochonetes) waldschmidti* Paeckelmann, 1930, from the Posidonienschiefer of Germany is similar in size and outline but is much less convex and more coarsely costellate.

Remarks. — Generic assignment of this species is based on external characters, and as a consequence, is tentative. Final assignment cannot be made until the brachial interior of this species is elucidated.

Occurrence and abundance. — This species is not common at any locality, the only collections coming from USNM localities 9045 (four specimens), 9043 (ten specimens), 9047 (four specimens), and 9155 (one specimen).

Subfamily **RUGOSOCHONETINAE** Muir-Wood, 1962

Genus **RUGOSOCHONETES** Sokolskaja, 1950

Rugosochonetes burlingtonensis (Weller) Pl. 15, figs. 1-9

1901. *Chonetes burlingtonensis* Weller, Acad. Sci. St. Louis, Trans., vol. 11, No. 9, p. 184, pl. 16, fig. 9.

1914. *Chonetes burlingtonensis* Weller, Weller, Illinois Geol. Sur., Mon. 1, p. 93, pl. 8, figs. 18, 19.

1926. *Chonetes burlingtonensis* Weller, Butts, Geol. Sur. Alabama, Spec. Rep. 14, pl. 54, figs. 12, 13.

Weller's (1914) description of the exteriors of both valves does not require repetition or emendation here. Since Weller did not describe interiors of either valve, the following description of a brachial interior from the Chappel Limestone is given below.

Cardinal process bifid on internal face; alveolus developed;

median septum probably most elevated posteriorly (septum broken in this specimen) becoming lower anteriorly, reaching about three-fifths the length of the valve; lateral septa short, not prominent; accessory septa well developed, most elevated anteriorly, extending about to the end of the median septum; brachial ridges well developed, elevated, extending anteriorly beyond the median septum; socket ridges narrow, curved, diverging from the hinge line at a low angle; muscle scars obscure; internal shell surface finely papillate, those papillae on the brachial ridges being especially large and prominent.

Holotype. — Univ. Chicago, Walker Museum No. 6669. Now in the Field Museum of Natural History.

Distinguishing characters. — *R. burlingtonensis* is characterized by its small size, semielliptical outline, and narrow sharply defined capillae that increase by bifurcation on the pedicle valve and by intercalation on the brachial valve.

Table 6. — Measurements in millimeters of *Rugosochonetes burlingtonensis* (Weller), 1901.

USNM No.	Length	Width	Thickness	Locality
154558	5.6	8.9 ?	1.9	9045
154559	5.9	8.8 ?	2.1	9045
154562	6.3	9.7	2.4	9043
154566	7.2	9.8 ?	2.9	9043
154567	6.3	8.7	2.3	9155
154560	4.8	6.7	1.7	9046

Comparisons. — This species is not closely similar to previously described North American species of this genus. *Chonetes illinoisensis* Worthen, 1860, is often similar in outline but is larger, less convex, and much more finely capillate.

Occurrence and abundance. — Weller (1901) described *R. burlingtonensis* from bed 6 of the Kinderhook at Burlington, Iowa. Butts (1926) reported it from the Fort Payne Chert of Alabama. In the Chappel Limestone it has been found at USNM localities 9045 (12 specimens), 9043 (four specimens), 9046 (two specimens), and 9155 (nine specimens). A similar species also occurs in the Caballero Formation of New Mexico.

Genus **PLICOCHONETES Paeckelmann,** 1930 emend. Muir-Wood, 1962

Plicochonetes aff. **Chonetes ornatus** Shumard Pl. 13, figs. 8a-13

1855. *Chonetes ornata* Shumard, Missouri Geol. Sur., First and Second Ann. Repts., p. 202, pl. C., figs. 1a-c.

Slightly smaller than average for the genus, concavo-convex; wider than long; semicircular to subelliptical in outline, maximum width at the hinge line; cardinal extremities acutely angular, small, compressed, not mucronate; ventral sulcus lacking or some specimens mesially flattened or with a slight sulcus; anterior commissure rectimarginate; surface coarsely costellate, costellae bifurcating; growth lines numerous, evenly spaced, forming a reticulate pattern with the costellae.

Pedicle valve strongly convex, mesially inflated, compressed laterally, otherwise curving evenly to the front margin; umbo prominent, protruding beyond the hinge line; beak small.

Brachial valve moderately concave, curving evenly toward the lateral and front margins, reflexing at the cardinal extremities.

Interior details unknown.

Illustrated specimens. — USNM Nos. 154531-6.

Table 7. — Measurements in millimeters of *Plicochonetes* aff. *Chonetes ornatus* Shumard, 1855, from USNM locality 9045.

USNM No.	Length	Width	Thickness
154534	8.3	11.3	3.8
154535	8.3	11.2	3.2
154537	8.2	11.7?	3.4
154533	7.4	11.0?	2.8
154531	7.0	9.2	2.9

Remarks. — *Plicochonetes* aff. *Chonetes ornatus* is similar to the common Chouteau species, *Chonetes "glenparkensis"* Weller, 1906. However, Branson (1938, p. 30) and Williams (1943, p. 75) pointed out that Weller's holotype of *C. glenparkensis* is actually a Glen Park Limestone variant of *C. ornatus* Shumard, 1855. This writer regards the Chouteau species as being distinct from *C. ornatus* and possibly conspecific with *Chonetes logani* Norwood and Pratten, 1855, from the Kinderhook beds of Iowa.

In any case the Chappel Limestone specimens are too poorly preserved for accurate identification.

Occurrence and abundance. — This species has been collected only at USNM localities 9045 (66 specimens), 9043 (three specimens), 9046 (one specimen) and 9155 (one specimen).

Suborder PRODUCTIDINA Maillieux, 1940

Superfamily **STROPHALOSIACEA** Schuchert, 1913

Family **STROPHALOSIIDAE** Schuchert, 1913

Subfamily **HETERALOSIINAE** Muir-Wood and Cooper, 1960

Genus **CYPHOTALOSIA**, n. gen.

(Greek *kyphos*, bent; *otos*, ear; *alos*, disc)

Small for the family, concavo-convex, body cavity thin, nearly symmetrical, slightly wider than long, subcircular or slightly transversely subelliptical in outline; hinge width less than the maximum width, which is near mid-length.

Pedicle valve moderately to considerably convex, nonsulcate; ventral umbo small, beak usually slightly incurved; cicatrix small; ventral interarea slightly curved, twice as high as that of the brachial valve; pseudodeltidium narrow, convex, slightly raised above the level of the interarea; flanks evenly convex, ears small, delimited by flexures near the umbo; lateral extremities of ears characteristically bent sharply dorsad, forming two subparallel longitudinal flanges almost normal to the hinge line. Prosopon consisting of relatively long anteriorly curving spines sparsely scattered over much of the valve surface, and one or two similar posteriorly directed spines on each side of the umbo near the hinge line; few narrow irregular concentric growth lamellae and exceedingly fine sinuous growth lines; capillation lacking.

Pedicle valve interior with moderately deep mesial umbonal cavity; ears flattened and bent sharply dorsad; marginal and lateral ridges lacking; dentition and musculature unknown; no median ridge or septum.

Brachial valve moderately to considerably concave; dorsal interarea low, inclined at a low angle to that of pedicle valve; chilidium lacking. Prosopon consisting of few narrow irregular concentric rugae, best developed on the ears, few scattered rounded depressions or dimples, and irregular growth lamellae similar to that of the pedicle valve; no spines or spine bases observed; sinuous growth lines such as found on the pedicle valve not observed, probably poorly preserved.

Brachial valve interior with postero-ventrally directed heterolosiid-type cardinal process and lophidium; short median ridge (septum?) extending anteriorly from cardinal process between deeply impressed teardrop-shaped adductor muscle scars, the latter being impressed just anterior to the cardinal process with the posterior portion rounded and deeply impressed and the anteriorly directed tips somewhat shallower; complete sockets not observed, sockets anteriorly separated from adductor scars by short low transverse ridges. Other internal details not observed.

Type species. — *Cyphotalosia masonensis,* n. sp. from the Chappel Limestone of central Texas.

Distinguishing characters. — This genus is characterized by its small size, small cicatrix, sharply dorsally bent ears, and pedicle valve prosopon of long scattered anteriorly curving spines and one or two posteriorly directed spines on each side of the umbo near the hinge line, narrow irregular rugae near the ears, irregular growth lamellae and fine sinuous growth lines.

Comparisons. — *Cyphotalosia* is most similar to *Heteralosia* King, 1938, *Devonalosia* Muir-Wood and Cooper, 1960, *Eostrophalosia* Stainbrook, 1943, and *Lialosia* Muir-Wood and Cooper, 1960. All of these genera lack the dorsally bent ears and can be differentiated on that basis alone.

In addition, *Heteralosia* usually has a larger more conspicuous cicatrix and more numerous spines of two series, not one series as in *Cyphotalosia*. *Devonalosia* has more numerous curved recumbent spines, as well as a row of hooklike spines along the edge of the interarea. *Eostrophalosia* has spines on the brachial valve, and *Lialosia* is nonspinose, except for a row of laterally directed spines at a low angle to the hingeline.

Remarks. — The writer originally considered the type species of this new genus to be some form of the genus *Heteralosia* King, 1938, because the principle generic character, the sharply bent ears, is often not apparent in specimens that have been broken free from a hard limestone matrix. Unfortunately, a growth series of the type species is not available making it impossible to observe the development of the flanges during ontogeny. However, it is probable that the bent ears are an adult character only, because juveniles couldn't produce bent ears, a transverse shell outline and an extended hinge line simultaneously.

Heteralosiid brachiopods are rare in the early Mississippian strata of North America. To the writer's knowledge no previously described heteralosiid species possess sharply bent ears, but this may only reflect the size of the collections and the state of preservation of the specimens.

Range. — Late Kinderhookian.

Cyphotalosia masonensis, n. sp. Pl. 16, figs. 1a-7

Description and distinguishing characters same as for the genus.

Holotype. — USNM 154583, Plate 16, figs. 4a-d; from USNM locality 9045, near Brady, McCulloch Co., Texas.

Table 8. — Measurements in millimeters of *Cyphotalosia masonensis,* n. sp.

USNM No.	Length	Hinge width	Max. width	Height	USNM Loc.
154583	9.3	8.5	10.3	3.4	9045
154587	9.0?	9.4?	11.0?	3.0?	9045
		Pedicle Valves			
154580	14.7	12.0	15.1	5.4	9045
154582	13.3	11.8	13.8	4.6	9045
154581	12.3	12.9	14.6	4.2	9045
154584	12.9			4.5	9046
154588	9.8	8.5	10.6	3.1	9046
		Brachial Valves			
154585	10.2	11.0?	12.9		9046
154589	10.0		13.1		9046

Comparisons. — Few early Mississippian heteralosiid species have been described. The differences between these species and *Cyphotalosia masonensis* are readily apparent.

Strophalosia ? beecheri Rowley, 1893, from the Louisiana Limestone of Missouri is asymmetrical and lacks the sharply bent ears of *C. masonensis.*

Strophalosia cymbula Hall and Clarke, 1893, from the Borden Shale of Kentucky is larger, more spinose, and lacks sharply bent ears.

Occurrence and abundance. — This species is not common in the Chappel Limestone. Twenty-six specimens from USNM locality

9046 and 22 specimens from locality 9045 make up most of the collection. One specimen each from localities 9042 and 9048 have been assigned to this species.

Superfamily **PRODUCTACEA** Waagen, 1883

Family **PRODUCTELLIDAE** Schuchert and LeVene, 1929

Subfamily **CHONOPECTINAE** Muir-Wood and Cooper, 1960

Genus **QUADRATIA** Muir-Wood and Cooper, 1960

Quadratia egregia, n. sp. Pl. 17, figs. 1a-8

Average size for the genus, semicircular in outline, wider than long, concavo-convex, nongeniculate; maximum width at or just anterior to the hinge line; ears medium size, subangular or slightly rounded, delimited by broadly concave flexures; fold and sulcus lacking or weakly developed in some specimens.

Pedicle valve moderately and usually evenly convex anteriorly; beak small scarcely incurved, flanks spreading; interarea low but higher than that of the brachial valve; pseudodeltidium not observed, cardinal process protruding through delthyrium; prosopon of low narrow concentric rugae, irregularly overlapping growth lamellae and fine growth lines; spine bases small, sparsely scattered in several crudely concentric rows anteriorly; several small spine bases also arranged on each side of umbo close to posterior margin.

Pedicle valve interior with small closely set flattened teeth; adductor muscle impression elongated, divided into two pairs, the posterior pair being more deeply impressed and shorter than the anterior pair; diductor scars large, wide, subcircular in outline, laterally bounded by two prominent subparallel ridges that extend anteriorly from the umbo at about a 45 degree angle and terminate about halfway to the lateral margin.

Table 9. — Measurements in millimeters of *Quadratia egregia,* n. sp. from USNM locality 9045.

USNM No.	Length	Surface Length	Hinge Width	Maximum Width	Thickness at Mid-length	Height
154597	22.1	29.8	29.2?	31.1?	2.2	11.0?
154598	20.9	26.8		30.0	2.0	8.4
154599	20.8	27.0		26.5	2.2	7.5?
Pedicle Valve						
154600	21.7	29.5		31.4		11.1
Brachial Valve						
154602	19.4		25.7?	29.8		

Brachial valve usually moderately concave; low fold occasionally developed; interarea lower than that of pedicle valve; notothyrial details unknown; prosopon similar to that of pedicle valve but apparently lacking spines.

Brachial interior with small low bifid cardinal process supported by narrow medium septum which extends anteriorly about one-third length of valve; endospines numerous; other internal details unknown.

Holotype. — USNM 154597, Plate 17, figs. 1a-e, from USNM locality 9045, near Brady, McCulloch Co., Texas.

Distinguishing characters. — *Quadratia egregia,* n. sp. is characterized by having a semicircular outline, maximum width at or near the hinge line, and medium size subangular ears. Internally the ventral muscle field is bounded postero-laterally by two narrow prominent lateral ridges that extend anteriorly from the umbo at a 45 degree angle, terminating just beyond the muscle field.

Comparisons. — This species is most similar to *Quadratia batesvillensis* (Girty), 1911, from the Moorefield Shale of Arkansas. However, that species has large prominent ears and as a consequence, a smaller length-width ratio. Furthermore, the umbonal regions of both valves of *Quadratia batesvillensis* are usually more rounded than those of *Quadratia egregia,* and the outer surfaces of the valves are nearly smooth, not rugose.

Remarks. — Several small specimens, presumably juveniles or small adults, are closely similar to the large specimens described above. They differ mainly in being less convex, as one would suspect. Unfortunately, interiors of these small specimens are unknown.

Occurrence and abundance. — *Quadratia egregia,* n. sp. is fairly common at USNM locality 9045 which yielded 35 specimens. It has been found at only one other locality, USNM 9042, this collection consisting of only four specimens.

Family **LEIOPRODUCTIDAE** Muir-Wood and Cooper, 1960

Subfamily **LEIOPRODUCTINAE** Muir-Wood and Cooper, 1960

Genus **ACANTHOPLECTA** Muir-Wood and Cooper, 1960

1960. *Acanthoplecta* Muir-Wood and Cooper, Geol. Soc. America, Mem. 81, pp. 170-172, pl. 44, figs. 10-19.

Type species. — (By original designation) *Producta mesoloba*

J. Phillips, 1836, Lower Carboniferous (Viséan). Great Britain.

Distinguishing characters. — According to Muir-Wood and Cooper this genus is characterized by its geniculate valves, narrow body cavity, and median longitudinal spine-bearing ridge on the pedicle valve; prosopon of both valves with irregular undulating rugae posteriorly, smooth anteriorly or with longitudinal folds and row of spines near hinge line and down flanks of pedicle valve, spines less numerous on brachial valves; cardinal process short, bilobed, with alveolus; breviseptum short; adductors not dendritic; lateral ridges short, near hinge line.

Comparisons. — *Acanthoplecta* is most easily confused with *Mesoplica* Reed, 1943, an Upper Devonian genus, and *Plicatifera* Chao, 1927, restricted by Muir-Wood and Cooper to the Lower Carboniferous (Viséan).

Mesoplica can be differentiated by its costate prosopon, more elongate narrower trail, dendritic adductor scars in the pedicle valve, and massive, probably trilobed cardinal process supported by a median septum.

Plicatifera, which previously included some of the species now assigned to *Acanthoplecta,* has been newly interpreted by Muir-Wood and Cooper. They recognized only the type species, *Productus plicatilis* J. de C. Sowerby, 1824, and based their description of *Plicatifera* on that species alone.

As emended by Muir-Wood and Cooper, *Plicatifera* can be distinguished from *Acanthoplecta* by its less convex ventral visceral disc; shorter, more sulcate trail without a median ridge; less concave brachial valve with a concomitant larger body cavity; stronger more regular angular rugae on both valves; adductors set on a strong median ridge in the pedicle valve; and a trilobate cardinal process, supported by a broad-based median septum.

Remarks. — The degree to which the longitudinal median ridge is produced and the arrangement of spines in rows down the flanks appears to this writer to be variable in specimens assigned to *Productus mesolobus* in the USNM collections. This is also true for the Chappel Limestone species, *Acanthoplecta inopinata,* n. sp. It is possible that these characters are not diagnostic of the genus.

Range. — The type species, *Acanthoplecta mesoloba* (Phillips) is Viséan in age. Its distribution is not clearly understood, but it probably is limited to Great Britain and possibly western Europe.

Muir-Wood and Cooper (plate 44, figs. 18, 19) illustrated a specimen from the Upper Tournaisian of Russia and referred to it (page 383) as *Acanthoplecta hyperborea* (Nalivkin).

Acanthoplecta inopinata, n. sp. is late Kinderhookian or early Osagian and is identified only from the Chappel Limestone.

Acanthoplecta inopinata, n. sp. Pl. 18, figs. 1a-8d

1948. *Plicatifera* aff. *P. calhounensis* (Moore), Cloud and Barnes, Univ. Texas, Pub. 4621, pl. 44, figs. 22, 23 (not fig. 26).

Average size for the genus, concavo-convex, semicircular to subovate in outline, wider than long; maximum width at the hinge line; ears large, flattened, or weakly convex, tapered, subangular; both valves geniculate, trail moderately long; venter nonsulcate; body cavity thin.

Pedicle valve with almost evenly convex, broad, posteriorly tapering, umbonal region; beak small, incurved, slightly overhanging the hinge line; flanks steep, spreading; ears sharply delimited by concave flexures; venter usually with weak or obscure sometimes asymmetrical median longitudinal ridge, extending from the middle of the visceral disc to the anterior margin; no interarea. Prosopon consisting of numerous low narrow uneven rounded rugae on the visceral disc and extending to the hinge line; numerous sinuous growth lines; spalled surfaces faintly costellate; spines sparsely scattered on rugae of visceral disc and irregularly on trail; three or four spine bases on longitudinal ridge; often a row of several spine bases on the flexure forming the ears.

Pedicle valve interior poorly known from calcined molds. Muscle field obscure, longitudinally striated; other details not observed.

Table 10. — Measurements in millimeters of pedicle valves of *Acanthoplecta inopinata*, n. sp. from USNM locality 9044.

USNM No.	Length	Surface Length	Hinge Width	Height
123969	19.7	33.0	30.8	10.0
154604	19.1	31.5	29.3	9.6
154605	20.1	33.0	29.0 ?	10.2
154606	18.5	30.2	27.0 ?	9.6
154607	17.0	29.0	22.4	8.9

Brachial valve strongly geniculate with flattened ears and postero-median depression; trail almost touching pedicle valve; prosopon of rugae on visceral disc similar to those on pedicle valve and scattered dimples; spine bases not observed.

Brachial interior with short bilobed cardinal process with alveolus, the lobes of which are conspicuously separated; breviseptum short, less than half the length of the visceral disc; lateral ridges close to hinge line; other internal details unknown.

Holotype. — USNM 123969 from USNM locality 9044, McCulloch Co., Texas. Illustrated as *Plicatifera* aff. *calhounensis* (Moore) by Cloud and Barnes (1948, pl. 44, figs. 22-23).

Distinguishing characters. — This species is characterized by its semicircular to subovate outline, nonsulcate venter with weak or obscure, sometimes asymmetrical, median longitudinal ridge extending from the middle of the visceral disc to the anterior margin. Spines sparsely scattered on rugae and trail, with three or four spine bases on the longitudinal ridge, often with a row of several spines in the flexure that forms the ears. Brachial valve with sparsely scattered dimples.

Comparisons. — No other species of this genus has been recognized in North America.

Acanthoplecta mesoloba (Phillips) has a more elongate subquadrate outline, longer trail, flattened or sulcate venter, more prominent symmetrical median longitudinal ridge, more numerous spines, sometimes arranged in rows near the ears and down the flanks, and more numerous dimples on the brachial valve.

Remarks. — Although substantial collections of this species are available, apparently none of the specimens represent early growth stages. This fact and the overall uniformity in size and shape of the individuals in the collection inhibit ontogenetic and population studies.

Occurrence and abundance. — *Acanthoplecta inopinata,* n. sp. is common at USNM localities 9044 (73 specimens) and 9048 (26 specimens). Smaller collections were made at localities 9042, 9045, and 9047.

Family **LEIOPRODUCTIDAE** Muir-Wood and Cooper, 1960

Subfamily **PRODUCTININAE** Muir-Wood and Cooper, 1960

Genus **PRODUCTINA** Sutton, 1938

Productina sampsoni (Weller) Pl. 19, figs. 1a-2d

1909. *Productus sampsoni* Weller, Geol. Soc. America, Bull., vol. 20, p. 300, pl. 12, figs. 18-22.
1914. *Productus sampsoni* Weller, Weller, Illinois Geol. Sur., Mon. 1, pp. 129, 130, pl. 13, figs. 30-35.
1915. *Productus sampsoni,* Weller, Girty, Geol. Sur., Bull. 598, p. 34.
1928. *Productus sampsoni* Weller, Moore, Missouri Bur. Geol. Mines, 2d series, vol. 21, p. 265.
1937. (?) *Productus (Linoproductus) sampsoni* Weller, Nalivkin, Geol. Prosp. Inst., Trans. Cent., p. 56, pl. 6, figs. 21-24.
1938. *Productus sampsoni* Weller, Branson, Univ. Missouri Studies, vol. 13, No. 3, p. 33, pl. 2, figs. 26-30.
1938. *Productina sampsoni* (Weller), Sutton, Jour. Paleont., vol. 12, No. 6, p. 552, pl. 63, figs. 1-4.
1956. (?) *Productus (Linoproductus) sampsoni* Weller, Simorin, Akad. Nauk Kazakhstan S.S.R., p. 134, pl. 7, figs. 14-15, pl. 8, figs. 1-6.
1960. (?) *Productina sampsoni* (Weller), Sarytcheva, *in* "Osnovi Paleontologi," pl. 35, figs. 7, 8.
1960. *Productina sampsoni* (Weller), Muir-Wood and Cooper, Geol. Soc. America, Mem. 81, pl. 123, figs. 1-10.

The following description is based only on the Chappel Limestone collections.

Small, concavo-convex, usually longitudinally elongated, subcircular or subovate in outline, body cavity small; maximum width usually near mid-length, occasionally at the hinge line; ears small, angular, sharply delineated by abrupt flexures; venter nonsulcate and nongeniculate.

Pedicle valve relatively thick-shelled, strongly convex in mature specimens, much less convex in juveniles; venter arched, almost lobate in some specimens; umbo inflated, beak strongly incurved, overhanging the hinge line; flanks steep, spreading moderately, slightly in the sublobate forms; prosopon of fine rounded closely set bifurcating costae that gradually increase in width anteriorly; growth lamellae prominent, regularly spaced posteriorly, less regular anteriorly; fine growth lines closely set; spine bases apparently confined to ears.

Pedicle valve interior not observed.

Brachial valve moderately to strongly concave posteriorly, not geniculate; visceral area lamellose, anterior portion of valve costate; spines apparently lacking.

Brachial valve interior not observed.

Table 11. — Measurements in millimeters of *Productina sampsoni* (Weller) from the Chappel Limestone.

USNM No.	Length	Width	Height	USNM Locality
123970 b	11.4	12.6	5.6	9046
123970 c	10.6	11.1	4.3	9046
154611	14.0	12.4	7.0	9043
154612	11.6	11.2	5.2	9047

Holotype. — Univ. Chicago, Walker Museum 9695, from the Chouteau Group of Pettis Co., Missouri. (Now in the Field Museum of Natural History.)

Distinguishing characters. — This species is characterized by its subcircular or longitudinally subovate outline, with the maximum width usually near mid-length, small ears, and strongly convex pedicle valve with an arched venter, often becoming almost lobate anteriorly.

Comparisons. — *Productina sampsoni* is a particularly distinctive species. It does not, to the writer's knowledge, resemble any other North American species, except possibly *Productina parvula* (Winchell), 1863, from the Kinderhook beds of Iowa. The latter species is rare and poorly known but apparently is smaller with relatively larger ears than *Productina sampsoni.*

Occurrence and abundance. — *Productina sampsoni* is a widely distributed late Kinderhookian and early Osagian species. It has been reported from several North American formations, *viz.,* the Chouteau Group of Missouri, Fern Glen Formation of Missouri, Fern Glen Formation of Oklahoma, Caballero Formation of New Mexico, Lake Valley Formation of New Mexico, and the Chappel Limestone of Texas.

In the Chappel Limestone it has been found at USNM localities 9042, 9043, 9045, 9046, and 9047, the entire collection amounting to 21 specimens.

Family **OVERTONIIDAE** Muir-Wood and Cooper, 1960

Subfamily **OVERTONIINAE** Muir-Wood and Cooper, 1960

Genus **AVONIA** Thomas, 1914, emend. Muir-Wood, 1928

Avonia cf. **A. pustulifera** Moore Pl. 19, fig. 8a-d

1928. *Avonia pustulifera* Moore, Missouri Bur. Geol. Mines, 2d series, vol. 21, pp. 271, 272, pl. 11, figs. 7, 11, 12, 16, 17, 20, 21.

1938. *Avonia pustulifera* Moore, Branson, Univ. Missouri Studies, vol. 13, No. 3, p. 39, pl. 2, figs. 4-10.
1938. *Avonia pustulifera* Moore, Sutton, Jour. Paleont., vol. 12, No. 6, p. 565, pl. 62, figs. 12-15.

A single incomplete pedicle valve from USNM locality 9048 is similar to Moore's syntype (Univ. Chicago, Walker Museum No. 32113. Now in the Field Museum of Natural History.) from the Lower Burlington Limestone of Missouri.

According to Moore (1928, p. 272) this species is characterized by its small size, strong convexity, low full umbonal region, prominent spine bases, and pustulate anterior costae.

Moore identified the species in the Sedalia Limestone (Chouteau Group) and the lower Lower Burlington Limestone. Branson (1938a, p. 39) reported it from several of his "Chouteau" Limestone localities.

Measurements.—USNM 154620, length 8.7 mm, width 9.2? mm, height 5.0 mm.

Figured specimen.—USNM 154620.

Avonia? honeycreekensis, n. sp. Pl. 19, figs. 5a-7b

Average size for the genus, concavo-convex, subcircular to subovate in outline, length and width about equal; maximum width at or slightly posterior to mid-length; ears small, rounded or subangular, slightly compressed; nongeniculate and nonsulcate.

Pedicle valve evenly convex, subhemispherical; ears delimited by small flexures; beak small, slightly incurved, overhanging the hinge line; venter slightly lobate; no trail produced; no interarea; prosopon of numerous low narrow regular continuous rugae on the visceral disc; low indistinct costae may be present on anterior portion of valve; minute scattered spine bases posteriorly set on concentric rugae, anteriorly scattered or set on indistinct costae, if present.

Table 12.—Measurements in millimeters of *Avonia? honeycreekensis,* n. sp.

USNM No.	Length	Width	Height	USNM Locality
154615	9.1	10.2	4.8	9045
154616	8.6	8.5	4.3	9046
154618	8.2	8.1	3.9	9046
154619	8.3	8.2?	3.9	9046

Pedicle valve interior unknown.

Brachial valve with gently concave visceral disc, weakly geniculated; trail short and slightly lobate medially; prosopon of numerous low narrow rugae on the visceral disc and sparsely scattered dimples; trail weakly costate; spine bases not observed.

Brachial valve interior unknown.

Holotype. — USNM 154615, from USNM locality 9045, near Brady, McCulloch Co., Texas.

Distinguishing characters. — This species is characterized by having a subcircular outline with the maximum width at or slightly posterior to mid-length, small rounded or subangular ears, small slightly incurved beak, slightly lobate venter, ventral prosopon of numerous narrow regular rugae on the visceral disc and indistinct costae, sometimes absent, anteriorly. Brachial valve exterior with similar rugae and sparsely scattered dimples.

Comparisons. — To the writer's knowledge no similar productoid species have been described from early Mississippian strata, at least in North America.

Remarks. — This species has been questionably referred to the genus *Avonia* Thomas, 1914, mainly for want of any better choice. Although *Avonia*? *honeycreekensis* agrees with the type species of *Avonia* in some respects, such as size, outline, proportions, and spinosity, it is nevertheless dissimilar in having a small lightly incurved beak, a slightly lobate venter, and conspicuously rugose visceral disc. As interior information is completely lacking, it seems advisable to assign the species questionably to that genus most similar externally, until new material reveal its true relationships.

Occurrence and abundance. — This species is rare. It has been identified only from USNM locality 9045 (one specimen, the holotype) and locality 9046 (13 specimens, two figured).

Family **OVERTONIIDAE** Muir-Wood and Cooper, 1960

Subfamily **OVERTONIINAE** Muir-Wood and Cooper, 1960

Genus **GENICULIFERA** Muir-Wood and Cooper, 1960

Geniculifera brevicula, n. sp. Pl. 20, figs. 1a-12c

Average size for the genus, concavo-convex, semicircular to subelliptical in outline, wider than long, maximum width usually near mid-length, occasionally at the hinge line; ears small but well developed, subangular; venter evenly convex posteriorly; occasionally weakly lobate anteriorly.

Pedicle valve evenly convex in umbonal region, weakly geniculate; ears delimited by flexures near the hinge line; flanks steep, flattened, curving inwards slightly to form a weak median anterior lobe; trail short or lacking; ventral beak small incurved, slightly overhanging hinge line; no interarea. Prosopon consisting of numerous, narrow, low, discontinuous, concentric rugae well developed over the entire visceral disc; small rarely elongate spine bases usually evenly scattered over the whole valve; rare weak short costae anteriorly.

Pedicle valve interior unknown.

Brachial valve slightly concave or flattened on visceral disc, with small mesial depression near the hinge line; ears flattened and set off from the visceral disc by a low flexure; anteriorly geniculate; trail short; prosopon of rugae on the visceral disc and numerous scattered dimples; broad short uneven costae rarely developed; no spines.

Table 13.—Measurements in millimeters of *Geniculifera brevicula*, n. sp.

USNM No.	Length	Surface Length	Hinge Width	Width at Mid-length	Height	Locality
154629	12.7	19.0	15.7	15.6	6.2	9045
154630	13.2	19.0	15.4?	14.0	7.9	9045
154631	11.2	16.0	13.0?	12.3	6.5	9045
154626	15.1	22.0	15.5?	17.9	7.0	9048
154627	12.4	18.0	15.3	15.2	5.6	9048
154628	12.2	16.5	15.5?	14.4	6.7	9048
154622	12.7	19.2	14.5	14.9	5.9	9044
154623	9.3	14.0	12.1	11.6	5.0	9044

Brachial Valves

USNM No.	Length	Hinge Width	Width at Mid-length	Locality
154633	12.4	15.2	16.6	9045
154632	11.8	16.9	15.7	9045
154624	9.6	12.5?	11.7	9044
154625	8.1	11.4	11.8	9044

Brachial valve interior with small, short, sessile, bilobed cardinal process and narrow lateral ridges that diverge little from the hinge line. Other internal details unknown.

Holotype. — USNM 154622.

Distinguishing characters. — This species is characterized by the weak geniculation of the pedicle valve, steep flattened flanks which converge to form a weak median lobe, short trail if developed, well-developed concentric rugae extending over the visceral disc of both valves, usually noncostate anterior regions, and numerous scattered dimples on the visceral disc of the brachial valve.

Comparisons. — *Geniculifera boonensis* (Branson), 1938, from the Chouteau Group of Missouri and the Caballero Formation of New Mexico can be distinguished from *Geniculifera brevicula* by its strongly geniculate pedicle valve with a moderately long trail and evenly flattened flanks and venter, irregularly developed costae on both valves, and less numerous dimples on the visceral disc of the brachial valve.

Occurrence and abundance. — *Geniculifera brevicula,* n. sp. is common in the Chappel Limestone at USNM localities 9042, 9044, 9045, 9047, and 9048.

Family **OVERTONIIDAE** Muir-Wood and Cooper, 1960

Subfamily **OVERTONIINAE** Muir-Wood and Cooper, 1960

Genus **RHYTIOPHORA** Muir-Wood and Cooper, 1960

Rhytiophora calhounensis (Moore) Pl. 21, figs. 1a-11

1928. *Productus calhounensis* Moore, Missouri Bur. Geol. Mines. 2d ser., vol. 21, pp. 266, 267, pl. 10, figs. 1-6.
1938. *Productus calhounensis* Moore, Branson, Univ. Missouri Studies, vol. 13, No. 3, pp. 31, 32, pl. 2, figs. 1-3.
1948. *Plicatifera* aff. *P. calhounensis* (Moore), Cloud and Barnes, Univ. Texas, Pub. 4621, pl. 44, fig. 26 (*not* figs. 22, 23).

This species is variable in size, degree of costation, and external proportions. Small collections of similar specimens from the Chouteau Group of Missouri, Caballero Formation of New Mexico, and the Chappel Limestone of central Texas all appear to be assignable to this species. A detailed study of the species is greatly hampered by a lack of interiors and the small size of the collections available.

Although *Productus blairi* Miller, 1881, the type species of the genus *Rhytiophora,* is considerably more spinose near the anterior margins of both valves than is *Productus calhounensis,* Muir-Wood's and Cooper's (1960, p. 201) assignment of the latter species to their genus seems to be correct. The following description is based solely on Chappel Limestone specimens.

Larger than average for the genus; length-width ratio variable, especially with age, generally subquadrate to semicircular in outline; maximum width near the anterior margin in large adults or near the hinge line in small individuals and trail-less (incomplete) adults; ears of moderate size, angular, compressed, slightly convex; venter flattened or weakly sulcate; both valves geniculate; body cavity large.

Pedicle valve usually strongly and evenly convex posteriorly but becoming straighter anteriorly and forming a moderately long trail in mature specimens; umbonal region rounded; beak incurved and overhanging hinge line; flanks steep and spreading slightly anteriorly. Prosopon consists of numerous low narrow irregular discontinuous concentric rugae covering the visceral disc, most prominent on the ears; weakly expressed irregularly formed growth lamellae which in turn are covered with numerous fine closely set growth lines; variably expressed broad flattened rounded irregular often discontinuous costae on the trail and often extending onto the visceral disc; spine bases small, rounded, sparsely and irregularly scattered, and set on the rugae and costae.

Pedicle valve interior with obscure undifferentiated muscle scars (as determined from calcined molds); other internal details not observed.

Table 14.—Measurements in millimeters of *Rhytiophora calhounensis* (Moore).

USNM No.	Length	Surface Length	Maximum Width	Hinge Width	Height	Thickness	Locality
154645	31.0	53.0	35.3		17.4	8.3	9045
154634	33.8	61.0	36.5		19.6	9.4	9046
			Pedicle Valves				
154638	30.1		37.1	37.1			9045
154639	17.2	28.0	23.7	23.0?	9.3		9045
154640	18.6	33.3	22.4	22.4?	10.4		9045
154635	31.2	49.5	35.3		15.7		9046
154636	23.4	42.0	27.4	26.0?	13.7		9046

		Brachial Valves		
154644	20.2	30.2	24.5	9045
154643	16.5	24.5	21.8	9045
154642	15.4	24.0	23.6	9045
154641	16.0	23.6	22.0?	9045

Brachial valve strongly geniculate, with a weakly concave visceral disc and postero-median depression near the hinge line under the beak; ears reflexed slightly ventrally, gently convex; trail moderately long, weakly concave or almost flat; prosopon similar to that of pedicle valve but with numerous irregularly scattered dimples and fewer spines apparently confined to the trail.

Brachial interior with small sessile cardinal process supported by a posterior platform (coalescing of lateral ridges and median septum). Other details unknown.

Holotype. — Univ. Chicago, Walker Museum No. 32118, from the Chouteau Group, near Grafton, Calhoun Co., Illinois. (Now in the Field Museum of Natural History.)

Distinguishing characters. — *Rhytiophora calhounensis* is characterized by its strongly and evenly convex pedicle valve, moderately long trail, and steep slightly spreading flanks; numerous low narrow irregular discontinuous rugae covering the visceral disc; variably expressed broad flattened rounded irregular often discontinuous costae on the trail and often extending onto the visceral disc; small rounded sparsely and irregularly scattered spine bases set on rugae and costae.

Comparisons. — *Rhytiophora blairi* (Miller), 1881, from the Chouteau Group of Missouri and *Rhytiophora raricostatus* (Herrick), 1888 from the Waverly Group of Ohio are most similar to *Rhytiophora calhounensis.*

Rhytiophora blairi can be distinguished by its lack of an appreciable trail, numerous longitudinally elongate spine bases on the rugae of the visceral disc, and smaller more rounded anterior costae, if present. *Rhytiophora raricostatus* is most similar to *Rhytiophora calhounensis* in size, shape, and proportions. It can be distinguished only in details of the ventral prosopon. In *Rhytiophora raricostatus* the costae are similar in size but instead of being broad and flattened with narrow interspaces as in *Rhytiophora calhounensis,* its costae tend to be sharper, more angular with wide gently concave interspaces. The distinctive difference is that the spine bases on the visceral disc are longitudinally elongated, to the extent that they could qualify as costae. Some spalled specimens of *Rhytiophora raricostatus* have hollow spine canals exposed in the umbonal region, a feature that the writer has never seen thus far in *Rhytiophora calhounensis.* However, this feature may merely reflect a different mode of preservation, not a difference in the direction of the spines.

The brachial valves of all three above mentioned species are similar at least in external details. The density of dimples seems to be the only variable character that might be used to distinguish them.

Remarks. — Paucity of well-preserved specimens and lack of early growth stages do not permit ontogenetic or population studies of this species.

Occurrence and abundance. — *Rhytiophora calhounensis* is common and widely distributed in the Chouteau Group of the Mississippi Valley. Moore (1928) reported it from two localities in Illinois and one in Missouri. Branson (1938a, p. 32) reported it as being common in the Chouteau of several Missouri counties and also found it in the Northview Sandstone of Missouri and the Kinderhook of Illinois.

In the Chappel Limestone about 60 specimens, mostly single valves, were collected at USNM locality 9045. Eleven specimens have been identified from locality 9046 and one specimen from 9043.

The writer has examined small USNM collections of this species or a similar species from the Caballero Formation of New Mexico.

Rhytiophora cf. **R. blairi** (S. A. Miller) Pl. 19, figs. 9a-b

1891. *Productus blairi* Miller, Geol. Sur. Indiana, Adv. Sheets, 17th Rept., p. 79, pl. 13, fig. 16 (? fig. 17).
1892. *Productus blairi* Miller, Miller, Geol. Sur. Indiana, 17th Rept., p. 689, pl. 13, fig 16 (? fig. 17).
1914. *Productus blairi* Miller, Weller, Illinois Geol. Sur., Mon. 1, pp. 110, 111, pl. 14, figs. 14-21.
1938. *Avonia blairi* (Miller), Branson, Univ. Missouri Studies, vol. 13, No. 3, p. 36, pl. 2, figs. 15-17.
1950. *Avonia blairi* (Miller), Plummer, Univ. Texas, Pub. 4329, pl. 5, fig. 5.
1960. *Rhytiophora blairi* (Miller), Muir-Wood and Cooper, Geol. Soc. America, Mem. 81, p. 192, pl. 51, figs. 6-16.

Two pedicle valves were collected by F. B. Plummer from the

Chappel Limestone at or near USNM locality 9043 (= Plummer 153-T-110). These specimens are similar to the common Chouteau species, *Rhytiophora blairi* (Miller), and agree in all ascertainable respects with several good specimens in the USNM collections from various localities in Missouri. Unfortunately, brachial valves and interiors are lacking, making an unequivocal assignment impossible.

Figured specimen. — USNM 154621.

Locality. — USNM locality 9043 (= Plummer locality 153-T-110).

Rhytiophora sp. Pl. 19, figs. 3a-4d

In degree of convexity, length of trail, and coarseness of costae the two problematical pedicle valves considered here are somewhat similar to *Rhytiophora calhounensis* (Moore). However, the numerous longitudinally elongated spine bases set on irregular discontinuous rugae are much different from the prosopon of that species. In fact this type of prosopon is characteristic of *Rhytiophora blairi* (Miller), a much less convex form with a short trail and narrower less distinct costae. It is possible, nevertheless, that these specimens represent a morphological end member of one of the above mentioned species. It seems doubtful that the question can be resolved without much larger collections than those presently available to the writer. In the meantime these specimens are illustrated separately and left unassigned as to species.

Measurements. — USNM 154613, length 21.4 mm, width 24.4 mm, surface length 38.5 mm, height 12.9 mm; USNM 154614, length 16.5 mm, width 21.2 mm, surface length 27.8 mm, height 9.2 mm.

Figured specimens. — USNM 154613, 154614.

Locality. — USNM 9045.

Family **BUXTONIIDAE** Muir-Wood and Cooper, 1960

Subfamily **BUXTONIINAE** Muir-Wood and Cooper, 1960

Genus **MARGINATIA** Muir-Wood and Cooper, 1960

Marginatia sp. Pl. 17, figs. 9a-c

A single well-preserved natural mold of the brachial valve exterior is assigned to an unidentified species of the genus *Margin-*

atia Muir-Wood and Cooper. The slightly concave visceral disc, short geniculate trail, numerous rugae, sparsely scattered minute spines, and larger scattered dimples of this specimen are characteristic of both species assigned to the genus by Muir-Wood and Cooper, *viz. Marginatia fernglenensis* (Weller), 1909, from the Fern Glen Formation of Missouri, and *M. burlingtonensis* (Hall), 1858, from the Burlington Limestone of Iowa, Missouri, and Illinois.

Figured specimen. — USNM 154603.

Locality. — USNM 9045.

Family **LINOPRODUCTIDAE** Stehli, 1954
Subfamily **LINOPRODUCTINAE** Stehli, 1954
Genus **OVATIA** Muir-Wood and Cooper, 1960

Ovatia sp. Pl. 40, figs. 8a-10c

Several presumably conspecific pedicle valves found at various localities in the Chappel Limestone are assigned to the genus *Ovatia* Muir-Wood and Cooper. Three of the specimens are nearly complete valves but they show considerable discrepancy in size and shape, thus making a specific assignment difficult, especially in view of the fact that comprehensive descriptions are not available for most previously described species of this genus. However, it is interesting to note the similarity in general proportions between these shells and Weller's (1914, pl. 16, figs. 12-15) illustrations of *Productus laevicostus* White (as *Productus ovatus* Hall).

The smallest of the Chappel specimens illustrated herein (Plate 40, fig. 9) is noticeably wider than long and lacks a trail. It is obviously a juvenile. The other illustrated specimens possess a good trail and are more nearly equidimensional. They are probably mature specimens, and if so, may represent a small species.

Measurements. — USNM 154872, length 16.5 mm, width 18.3 mm, height 6.8 mm; USNM 154870, length 17.3 mm, width 17.0? mm, height 8.7 mm; USNM 154871, length 8.5 mm, width 9.2 mm, height 3.7 mm.

Figured specimens. — USNM 154870-2.

Occurrence and abundance. — One nearly complete pedicle valve from USNM locality 9045; two nearly complete pedicle valves from USNM locality 9047; four fragmentary pedicle valves from localities 9042, 9045 and 9047.

Order RHYNCHONELLIDA Kuhn, 1949

Superfamily **RHYNCHONELLACEA** Gray, 1848

Family **TRIGONIRHYNCHIIDAE** McLaren, 1965

Genus **CUPULAROSTRUM** Sartenaer, 1961

Cupularostrum? sp. Pl. 23, figs. 6a-10e; Text-fig. 2

Small, subequally biconvex; outline subtrigonal, slightly transverse in large specimens, slightly elongate in juveniles; anterior commissure uniplicate; fold low, moderately broad, originating anterior to mid-valve; sulcus shallow, broad, extended dorsally; surface multicostate, the costae being angular and simple; four to seven costae on the fold, three to six costae in the sulcus, and six to eight costae per ventral flank in adults; growth varices weak, infrequent, irregularly spaced; growth lines not observed.

Pedicle valve moderately convex, slightly tumid in the rostral region, sloping evenly to the lateral margins; beak suberect, small, acute; beak ridges, short, rounded; delthyrial details unknown.

Pedicle valve interior with short dental plates.

Brachial valve with distinct umbonal groove, most convex at the umbo and near the lateral margins, venter often slightly flattened; beak small, usually obscured by the pedicle valve.

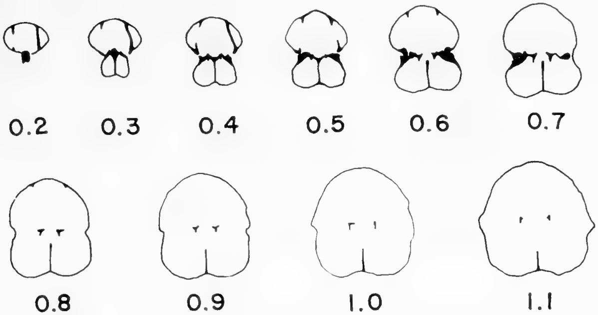
Table 15. — Measurements in millimeters of *Cupularostrum?* sp. from USNM locality 9043.

USNM No.	Length	Width	Thickness
154666	9.0	9.9	5.9
154667	8.8	9.5	5.3
154668	7.8?	8.2	4.7
154669	6.0?	6.0	3.4
154670	5.0	4.6	2.9

Brachial valve interior with short shallow septalium supported by a moderately high median septum; crural bases well developed, obliquely directed ventromedially, projecting dorsally from the hinge plates; crura short, diverging slightly, projecting slightly ventrad.

Illustrated specimens. — USNM Nos. 154666-70.

Remarks. — Sanders (1958, p. 52) described a similar species from the Represo Limestone of Sonora, Mexico, as *Camarotoechia* sp. He noted that his specimen might belong to *Camarotoechia tuta*



Text-figure 2.—Transverse serial sections of *Cupularostrum*? sp. ×5, USNM No. 154671, from USNM locality 9043. Measurements in millimeters from ventral beak.

Miller, 1881, or *Camarotoechia mutata* (Hall), 1856, but declined to assign the specimen to either. This writer is similarly unable to assign his collection specifically. Furthermore, generic assignment is particularly difficult because *Camarotoechia sensu strictu,* has been restricted to Middle Devonian species of the *Atrypa congregata* Conrad type.

Occurrence and abundance.—This species has been found only at USNM locality 9043, the collection consisting of 17 specimens that are mostly incomplete.

Family **PUGNACIDAE** Rzhonsnitskaya, 1956

Genus **SHUMARDELLA** Weller, 1910

Shumardella obsolescens Weller Pl. 22, figs. 1a-8e; Text-fig. 3

1855. ? *Atrypa obscuraplicata* Swallow *in* First and Second Annual Reports, Geol. Sur. Missouri, Part 1, p. 102 (*nomen nudum*).

1855. ? *Rhynchonella obscuraplicata* Shumard, Meek, *idem,* Part 2, p. 102 *(nomen nudum).*

1855. ? *Rhynchonella obscura-plicata* Shumard, *idem,* Part 2, p. 218 *(nomen nudum).*

1855. *Rhynchonella missouriensis* Shumard, *idem,* Part 2, pl. C, fig. 5a (not figs. 5b, 5c).

1860. ? *Rhynchonella (Eatonia) obsolescens* Hall, 13th Ann. Rep., New York State Cab. Nat. Hist., p. 111 *(nomen dubium).*

1866. *Rynchonella missouriensis* Shumard, Meek and Worthen, Paleont. Illinois, vol. 2, p. 153, pl. 14, figs. 4a-4b.

1898. ? *Rhynchonella obsolens* Hall, Weller, U.S. Geol. Sur., Bull. 153, p. 534 (incorrect spelling).

1910. *Shumardella obsolescens* Weller, Geol. Soc. America, Bull., vol. 21, p. 513, fig. 15.

1914. *Shumardella obsolens* (Hall), Weller, Illinois Geol. Sur., Mon. 1, p. 224, pl. 26, figs. 1-9 (incorrect spelling).

1938. *Shumardella obsolens* Weller, Branson, Univ. Missouri Studies, vol. 13, Part 1, p. 51, pl. 5, figs. 11-13 (incorrect spelling).

1938. *Shumardella obsolens* Weller, Branson, Univ. Missouri Studies, vol. 13, Part 2, p. 21, pl. 21, figs. 14, 15 (incorrect spelling; cited as *S. obsolens* (Hall) on plate 21).

1948. *Shumardella obsolens* Weller, Cloud and Barnes, Univ. Texas, Pub. 4621, pl. 44, figs. 17-21.

1950. *Shumardella obsolens* Weller, Plummer, Univ. Texas, Pub. 4329, pl. 5, figs. 23a-b.

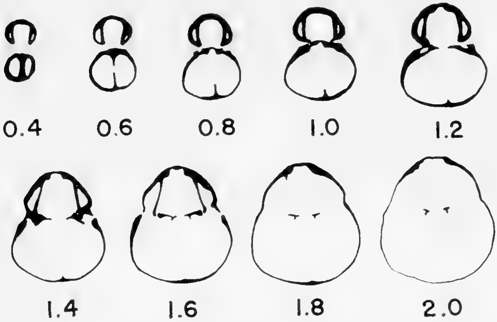
Distinguishing characters. — Outline subelliptical to subcircular but anteriorly emarginate; lateral and anterior profiles subglobose; fold and sulcus originating at mid-length or slightly posterior to mid-length; pedicle valve gently convex; sulcus broad, shallow, rounded, with large linquiform extension normal to the lateral commissure; ventral beak small, sharp, suberect or sometimes touching the dorsal umbo; brachial valve gibbous, strongly convex; fold low, moderately wide, rounded; radial prosopon poorly developed, two to five weak, short rounded costae on the linguiform extension, one or two obscure costae on each lateral slope.

Table 16. — Measurements in millimeters of *Shumardella obsolescens* Weller, 1910 from the Chappel Limestone.

USNM No.	Length	Width	Thickness	Locality
154646	16.7	18.7	14.4	9048
154647	16.5	17.9	12.8	9048
154648	15.5	16.7	13.1	9045
154649	14.3	15.4	10.1	9048
154650	13.9	15.9	7.7	9045
154651	12.0	11.5	9.6	9048
154652	11.4	11.8	7.3	9045
154653	10.3	11.0	5.6	9048

Type material. — Weller (1910, p. 513) did not mention the repository of his study specimens or sectioned material, but presumably all of this material was in the Walker Museum collections. (Now in the Field Museum of Natural History.) The specimens illustrated by Weller in 1914 are Collection No. 9668, Walker Museum, Univ. Chicago. Although one of these specimens could be designated as the type, the writer considers this action unnecessary inasmuch as the species is well known and easily recognized.

Comparisons. — *S. obsolescens* is a particularly distinctive species and easily differentiated from *Shumardella missouriensis*



Text-figure 3.—Transverse serial sections of *Shumardella obsolescens* Weller. Measurements in millimeters from ventral beak. USNM 154644 from USNM locality 9048. × 2.5.

(Shumard), 1855, which is a larger more strongly costate species.

Rhynchonella greenana Ulrich, 1886, from the Borden Group of Indiana is similar in outline and prosopon to *S. obsolescens* but is much larger, with an extremely gibbous brachial valve, and smooth lateral slopes.

Remarks. — Branson's synonymy and discussion of the authorship of this species is for the most part correct in that he recognized the dubious nature of Hall's species, *Rhynchonella (Eatonia) obsolescens.* He also attributed the species name *obsolens* to Weller. However, because Weller established the species in 1910 (p. 513) as *S. obsolescens,* that name must be correct and (according to the code of Zool. Nomenclature) is applied here.

Occurrence and abundance. — *S. obsolescens* is common in the Chouteau Group of Missouri, and according to Branson (1938, p. 52) has been found in all the Chouteau members. In the Chappel Limestone it is common at USNM locality 9045 (72 specimens) and 9048 (40 specimens); but rare elsewhere. There are large collections of this species in the USNM from the Caballero Formation of New Mexico.

Family **TETRACAMERIDAE** Likharev in Rzhonsnitskaya, 1956

Genus **ROTAIA** Rzhonsnitskaya, 1959

Rotaia sp. Pl. 26, figs. 9a-e; Text-fig. 4

Average size for the genus, unequally biconvex, transversely subtrigonal to subpentagonal in outline; anterior commissure uniplicate; fold low, broad, flattened anteriorly; sulcus shallow, broad, rounded with a dorsally deflected linquiform extension; both valves slightly compressed posteriorly on either side of the beaks, forming a slight flange; surface multicostate, there being 14 simple rounded costae on the pedicle valve and a corresponding number on the brachial valve; sulcus with seven costae, fold with six; front margin serrate; growth varices coarse, widely spaced.

Pedicle valve gently convex posteriorly, slightly tumid umbonally, sloping evenly toward the lateral margin, then being deflected to form a low flange with the brachial valve; surface in lateral profile medially concave due to lateral crests formed on each side of the sulcus; anterior margin of valve sharply deflected normal to the lateral commissure, including portions on either side of the sulcus to form with a similar portion of the brachial valve, a flattened anterior surface normal to the lateral commissure; beak small, suberect, sharply pointed.

Pedicle valve interior with ventrally converging dental plates that form a sessile spondylium anteriorly; spondylium supported posteriorly by two lateral buttressing plates almost normal to the plane of symmetry and the lateral commissure.

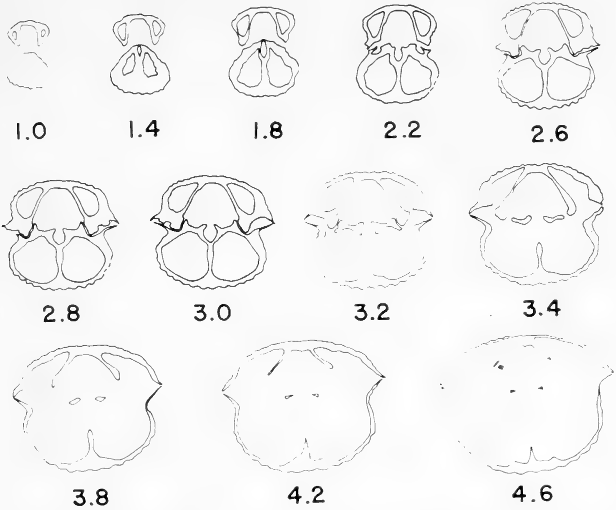
Brachial valve greatly inflated, most convex near the beak and posterolateral margins; lateral profile subtrigonal; posterior profile semicircular to subtrigonal; flanks strongly convex, being deflected sharply ventrad forming the flattened anterior surface; beak small, incurved, obscured by the pedicle valve.

Brachial valve interior with a deep septalium supported by a high median septum; crural bases originating near the posterior portion of the septalium, extending along the ventro-lateral edges of the hinge plates, being directed ventro-medially, almost forming a cover over the septalium; crura wedge-shaped, flattened, subparallel, not curved, short.

Illustrated specimen. — USNM No. 154697.

Measurements in millimeters. — Length — 25.4, width — 32.0, thickness — 22.9.

Comparisons. — This specimen is similar to a shell illustrated



Text-figure 4.—Tranverse serial sections of *Rotaia* sp. × 1.5, USNM 154697, from USNM locality 9046, measurements (mm) from ventral beak.

by Weller (1914, pl. 29, figs. 1-5) and identified as *Tetracamera subtrigona* (Meek and Worthen), 1860, from the Keokuk Limestone of Illinois. It differs from that specimen in being slightly smaller, has a smaller less tumid ventral beak, a low flange along the postero-lateral margin, and a relatively shorter brachial valve.

Remarks. — Transverse serial sections of the specimen described above differ in some respects from those illustrated by Weller (1914, p. 219). In the pedicle valve of the Chappel Limestone specimen the lateral buttressing plates are almost normal to the plane of symmetry and the lateral commissure whereas in Weller's text-figure (which appears to be idealized) the buttressing plates appear to extend anteriorly from near the beak. On first examination Weller's text-figure 17 seems to have been based on a specimen or specimens having an unusually large inflated pedicle valve. However, it seems more likely that the plane of orientation was at an angle to the lateral commissure, producing a disproportionately large pedicle valve profile. Specimens of *Rotaia subtrigona* in the U.S. Geological Survey collections from the Keokuk Limestone of Illinois and the Boone Chert of Arkansas show the buttressing plates to be antero-dorsally directed although not to the degree shown in Weller's sections. All the Upper Osagian specimens of this genus that the author has examined have sharp beak ridges and concave postero-lateral margins. It is the writer's opinion that the Chappel Limestone specimen probably represents an early undescribed species of the genus *Rotaia* Rzhonsnitskaya, 1959.

Occurrence and abundance. — Two specimens each have been found at USNM localities 9046 and 9045. Only the illustrated specimen described above and one weathered specimen from locality 9045 are actually suitable for generic identification.

Superfamily **STENOCISMATACEA** Oehlert, 1887 (1883)

Family **ATRIBONIIDAE** Grant, 1965

Subfamily **ATRIBONIINAE** Grant, 1965

Genus **SEDENTICELLULA** Cooper, 1942

Sedenticellula sacra Grant Pl. 24, figs. 1a-4e

1965. *Sedenticellula sacra* Grant, Smith. Misc. Coll., vol. 148, No. 2, p. 75, pl. 5, figs. 1-9.

Holotype. — USNM No. 142040.

Distinguishing characters. — According to Grant (1965, p. 76) this species is characterized by its large adult size, transversely subelliptical to subpentagonal outline, numerous coarse costellae that originate near the beaks and bifurcate as well as intercalate anteriorly.

Remarks. — Large specimens of this species are rare in the Chappel Limestone, there being only seven specimens in the USNM collections, five from near Johnson City, Blanco County, Texas, and two from USNM locality 9044. The coarseness of the costellae also varies considerably in this species; the writer has no reason to believe that these specimens represent other than normal infraspecific variation.

Occurrence and abundance. — *S. sacra* is common at USNM localities 9045, 9155, and 9047, and less common at localities 9043, 9048, and 9046. Two large specimens from 9044 and the aforementioned specimens from Blanco County constitute the rest of the collection.

Family **STENOSCISMATIDAE** Oehlert, 1887 (1883)

Subfamily **STENOSCISMATINAE** Oehlert, 1887 (1883)

Genus **Coledium** Grant, 1965

Coledium evexum Grant Pl. 24, figs. 5a-7e

1965. *Coledium evexum* Grant, Smith. Misc. Coll., vol. 148, No. 2, p. 112, pl. 15, figs. 1-10; Text-fig. 26.

Holotype. — USNM No. 142147.

Distinguishing characters. — This species is characterized by its swollen pedicle valve, transversely subpentagonal outline, weak costae, flanks commonly smooth, entire surface sometimes completely noncostate, slightly protruding anterior margins, short spondylium, and long intercamarophorial plate.

Comparisons. — *C. evexum* occurs with four other species of this genus in the Chappel Limestone. *Coledium undulatum* Grant, 1965, is usually larger, more transversely elongated, and has stronger more numerous costae. *Coledium vadosulcatum,* n. sp., is larger, much more transverse, and is usually entirely smooth; *Coledium altisulcatum,* n. sp., is similar in size and costation but has a greatly inflated dorsal umbo, a much smaller ventral beak, and the valve edges meet at an acute angle at the lateral and anterior margins, not obtusely as in *C. evexum. Coledium? costatulum,* n. sp., is completely costate and has a smaller ventral beak.

Occurrence and abundance. — Grant (1965, p. 114) listed only two localities for this species, USNM localities 9045 (50 specimens), and 9042 (two specimens). The writer found this species also at USNM localities 9044 (three specimens), 9047 (12 specimens), 9155 (one specimen), and 9048 (12 specimens).

Coledium undulatum Grant Pl. 25, figs. 1a-3e

1965. *Coledium undulatum* Grant, Smith. Misc. Coll., vol. 148, No. 2, p. 135, pl. 14, figs. 1-2a; Text-fig. 32.

Holotype. — USNM No. 142501.

Distinguishing characters. — This species is characterized by its broadly subpentagonal outline, strongly convex brachial valve, numerous fine costae on the fold and flanks, short ventral beak, and flattened fold and sulcus in large specimens.

Comparisons. — As noted above, this species differs from *C. evexum* Grant, in its greater size, transverse outline, smaller ventral beak, and costate flanks and fold-sulcus. *C. vadosulcatum,* n. sp., has much less convex valves, a lower broader fold and sulcus, and usually lacks a radial prosopon. *C. altisulcatum,* n. sp., is similar in size, outline, and strongly inflated dorsal umbo but differs in having smooth flanks, and a rounded fold and sulcus. *C. ? costatulum,* n. sp., is smaller, less transverse, with a more rostrate ventral beak, the costellae reach to the beaks of both valves, and the fold and sulcus are usually not so broadly and distinctly flattened as in *C. undulatum.*

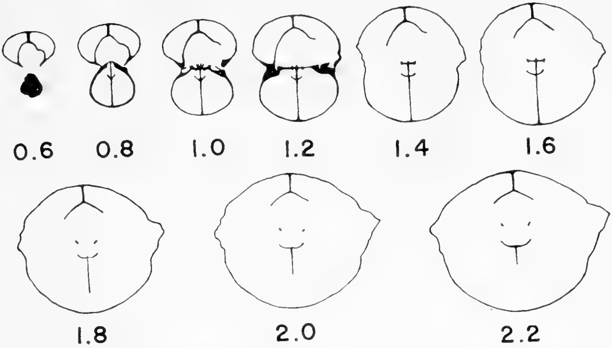
Occurrence and abundance. — Grant (1965, p. 137) reported this species from USNM localities 9045, 9046, 9044, and from near Johnson City, Blanco Co., Texas. The writer also has collections from localities 9047 (14 specimens), and 9043 (eight specimens).

Coledium altisulcatum, n. sp. Pl. 22, figs. 9a-12e; Text-fig. 5

Average size for the genus, unequally biconvex, the brachial valve being much more inflated than the pedicle valve; outline subpentagonal to subelliptical, slightly transverse, greatest width near mid-length; fold and sulcus well developed; fold moderately high, narrow, rounded, originating at the umbo, the crest extending forward about parallel to the lateral commissure; sulcus deep, rounded, narrow, curving almost normal to the lateral commissure; flanks smooth, fold and sulcus with two to four rounded, weak short costae near the anterior margin; anterior commissure uniplicate almost parasulcate; incipient stolidium produced at the anterior margin; growth varices irregularly spaced.

Pedicle valve thin and medially concave in lateral profile, flanks being slightly reflexed antero-laterally; anterior profile slightly concave or sinuous; beak small, incurved, almost touching the dorsal umbo; beak ridges rounded, short; delthyrium obscured by beak; foramen slit-shaped, not penetrating the apex of the beak.

Pedicle valve interior with spondylium supported by a median septum duplex that rises moderately anteriorly (note the pathologically deformed spondylium in Text-figure 5).



Text-figure 5.—Transverse serial sections of *Coledium altisulcatum,* n. sp. × 4, USNM 154659 from USNM locality 9048, measurements (mm) from ventral beak. The spondylium in sections 0.6 to 1.4 is pathologically deformed.

Brachial valve strongly inflated umbonally, sometimes medially arched in posterior profile; beak small, incurved against the delthyrium; flanks strongly convex to the valve margins.

Brachial valve interior with posteriorly fimbriate cardinal process; hinge plate narrow, flat, supported by the relatively long intercamarophorial plate; crural bases well developed posteriorly, almost vertical or diverging slightly; camarophorium narrow, weakly concave, supported on a high median septum that rises anteriorly; crura slightly flattened, diverging and rising slightly anteriorly, relative to the camarophorium.

Holotype. — USNM No. 154655.

Table 17.—Measurements in millimeters of *Coledium altisulcatum,* n. sp. from USNM locality 9048.

USNM No.	Length	Width	Thickness
154655	11.0?	11.8	7.4
154656	10.0?	10.8	6.7
154657	10.0	10.6	5.7
154658	7.7	9.2	4.1

Distinguishing characters. — This species is characterzed by its thin pedicle valve with concave smooth flanks, greatly inflated brachial valve, high narrow fold with two to four weak costae, and corresponding deep narrow sulcus.

Comparisons. — *C. altisulcatum,* n. sp., is not closely similar to other stenoscismatacean species in the Chappel Limestone. It is most similar to *Coledium bowsheri* (Cooper), 1956, from the Magdalena Group (Pennsylvanian) of New Mexico, *Coledium erugatum* Grant, 1965, from the Moorefield Formation of Oklahoma, and *Coledium explanatum* (McChesney), 1860, from the Chester Series of the Mississippi Valley. *C. bowsheri* is similar to *C. altisulcatum* in size, outline, incurvature of the ventral beak, and degree of costation, but differs in having a much less inflated dorsal umbo and a lower, broader, flattened fold and sulcus. Some specimens of *C. erugatum* are similar to *C. altisulcatum* in size and outline and fold-sulcus but *C. erugatum* differs in having a much less inflated brachial umbo, and lacks costae on the fold-sulcus. *C. explanatum* is similar in size, outline, inflation of the dorsal umbo but differs in having costae on the flanks, a suberect ventral beak, and a lower, wider fold and sulcus.

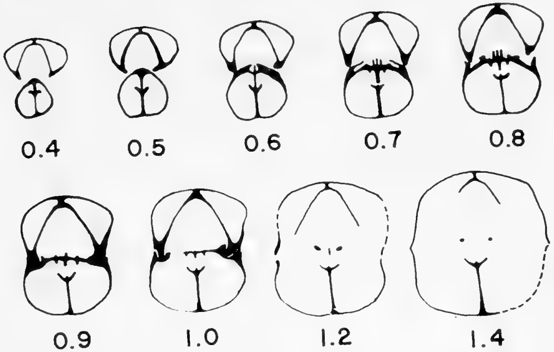
Occurrence and abundance. — Thirty-three specimens from USNM locality 9048 constitute the only collection of this species.

Coledium vadosulcatum, n. sp. Pl. 25, figs. 4a-8e; Text-fig. 6

Average size for the genus, moderately biconvex in large adults or flattened in small specimens; wider than long, outline transversely subelliptical to subpentagonal; anterior commissure uniplicate, fold low, slightly flattened or rounded, confined to anterior third of valve; sulcus broad, shallow, flattened anteriorly; radial prosopon absent; growth varices coarse, irregular spaced; growth lines fine, regularly spaced; valve margins meeting at an acute angle; stolidium not observed.

Pedicle valve gently and evenly convex in both anterior and lateral profile; cardinal extremities slightly compressed in some specimens; beak small, short, erect, with sharp apex; beak ridges poorly defined, short; delthyrium relatively large, triangular; deltidial plates small disjunct; foramen triangular, not impinging on the beak.

Pedicle valve interior with deep spondylium duplex, sessile or



Text-figure 6.—Transverse serial sections of *Coledium vadosulcatum*, n. sp. ×5, USNM 154686 from USNM locality 9047, measurements (mm) from ventral beak.

nearly sessile posteriorly, never rising much off the floor of the valve.

Brachial valve evenly convex in both lateral and anterior profile, much more inflated than pedicle valve; cardinal extremities slightly compressed; beak small, obscured by pedicle valve.

Brachial valve interior with moderately curved camarophorium on a high median septum; camarophorial trough narrow, shallow, not touching the hinge plate; intercamarophorial plate short, supporting the hinge plate forward from the beak for only part of its length; hinge plate clearly defined (in sections) by stout crural bases, thickened posteriorly to form deeply striated cardinal process; crura short, slightly diverging and flattened posteriorly, becoming rodlike anteriorly.

Table 18.—Measurements in millimeters of *Coledium vadosulcatum*, n. sp., from USNM locality 9047.

USNM No.	Length	Width	Thickness
154681	11.0?	14.7	6.8
154682	10.7	13.7	6.2
154683	9.0?	11.8	4.7
154684	8.2	9.5	3.7
154685	7.0	8.4	3.1

Holotype. — USNM No. 154681.

Distinguishing characters. — This species is characterized by its lack of radial prosopon, transversely subelliptical to subpentagonal outline, and broad flattened fold and sulcus confined to the anterior third of the shell.

Comparisons. — *C. vadosulcatum,* n. sp., is not closely similar to any other species from the Chappel Limestone. *Coledium angarium* Grant, 1965, from the Barnett Shale of central Texas, is similar in lacking radial prosopon but it is elongate not transverse in outline, smaller, and the fold and sulcus are narrower and better developed in adult specimens. *Coledium dutroi* Grant, 1965, from Upper Mississippian strata of Alaska, is similar in outline but differs in being larger, more inflated, the fold and sulcus are narrower and better developed, and it has weak costae or grooves on the fold and sulcus.

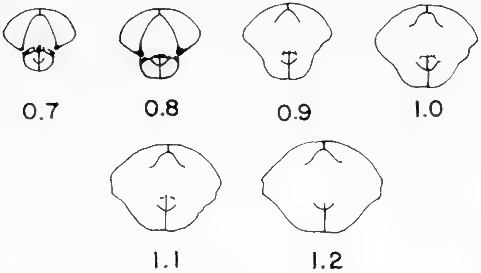
Occurrence and abundance. — This species was found only at USNM localities 9047 (ten specimens), 9045 (three specimens), and Cloud locality TF-395 (one specimen). Three distorted specimens from locality 9048 may belong to this species but are too poorly preserved for accurate identification.

Coledium? costatulum, n. sp. Pl. 23, figs. 1a-5e; Text-fig. 7

Smaller than average for the genus, usually moderately biconvex; subpentagonal in outline, greatest width at about mid-length; anterior commissure uniplicate; fold well developed anteriorly, moderately high, narrow, often flattened; sulcus shallow, often flattened; both valves finely costate, the costae originating near the beaks of both valves, there being about five—nine on the fold and six—eleven on each dorsal flank; costation of pedicle valve similar to that of brachial valve; stolidium not produced; growth lines fine, numerous regularly spaced; growth varices irregularly spaced.

Pedicle valve moderately convex, often anteriorly flattened in lateral profile; beak small, slightly incurved, not touching dorsal umbo; deltidial plates not observed; foramen mesothyridid, oval; beak ridges well developed; sulcus originating in posterior third of shell.

Pedicle valve interior with boat-shaped spondylium, elevated



Text-figure 7.—Transverse serial sections of *Coledium? costatulum*, n. sp. × 5, USNM 154665 from USNM locality 9155, measurements (mm) from ventral beak.

for its entire length on a moderately high median septum duplex; sides of spondylium flaring anteriorly.

Brachial valve more convex than pedicle valve, sometimes inflated umbonally, most convex posterior to mid-length; fold originating in anterior portion of dorsal umbo; beak small, obscured by pedicle valve.

Brachial valve interior with flat or slightly concave hinge plate and thick fimbriate cardinal process; posterior edges of camarophorium supporting hinge plate, continuing free and rising slightly anteriorly into umbonal cavity; intercamarophorial plate moderately long, touching the hinge plate for most of its length; other internal details unknown.

Table 19.—Measurements in millimeters of *Coledium? costatulum*, n. sp., from USNM locality 9155.

USNM No.	Length	Width	Thickness
154660	9.1	8.9	6.3
154661	8.0	8.7	4.7
154662	7.4	8.0	3.7
154663	7.6	7.4	4.3
154664	7.3	7.3	4.3

Holotype. — USNM No. 154661.

Distinguishing characters. — This species is characterized by its entirely or almost entirely costate valves, small size, moderately high, narrow, flattened fold and corresponding sulcus. Internally the posterior edges of the hinge plate are supported by the camarophorium which does not rise much anteriorly.

Comparisons. — *C.* ? *costatulum,* n. sp. is easily distinguished from other species of *Coledium* by its multicostate valves. In the Chappel Limestone only *Sedenticellula sacra* resembles it in being costate. However, that species is much larger, with a low wide fold and sulcus, and internally has a sessile spondylium posteriorly.

Remarks. — Stenoscismatacean species with well-developed costae that reach almost to the beak of both valves are rare, especially in Mississippian strata. Generic assignment of such species is particularly difficult on that basis alone. This Chappel Limestone species, *Coledium*? *costatulum,* n. sp., further differs from Grant's diagnosis of *Coledium* in that the camarophorium does not rise markedly from the floor of the valve. Because of these differences the generic assignment is tentative, and it is duly questioned by the writer.

Occurrence and abundance. — *C.*? *costatulum,* n. sp. has been found only at USNM locality 9155 (fourteen specimens).

Superfamily **RHYNCHOPORACEA** Muir-Wood, 1955

Family **RHYNCHOPORIDAE** Muir-Wood, 1955

Genus **RHYNCHOPORA** King, 1865

Rhynchopora sansabensis, n. sp. Pl. 26, figs. 1a-8b; Text-figs. 8,9

Average size for the genus, unequally biconvex, transversely subpentagonal to subtrigonal in outline; anterior commissure uniplicate; fold low, broad, flattened anteriorly; sulcus shallow, broad, flattened, with dorsally deflected linguiform extension; surface multicostate with six to twelve, usually eight or nine simple subangular costae on the sulcus, and four to seven, usually five or six costae on each lateral slope in adult specimens; front margin serrate; growth varices coarse, widely and irregularly spaced; inner shell substance finely pitted, presumably punctate.

Pedicle valve gently convex posteriorly, sloping evenly to the lateral margins, then being sharply deflected normal to the plane of lateral commissure, forming with the linguiform extension of the sulcus a flattened posteriorly tapering surface, extending around much of the valve; surface in lateral profile convex posteriorly, often concave anteriorly due to the sharp antero-lateral extremities; beak small, suberect; foramen not observed; beak ridges short, subangular; posterior margin near the beaks slightly compressed to form with a similar portion of the brachial valve a laterally grooved small flange on either side of the beak.

Pedicle valve interior with short slightly diverging dental plates that extend anteriorly about one-sixth the valve length; teeth small.

Brachial valve much more convex than the pedicle valve, greatly inflated anteriorly, being deflected normal to the plane of lateral commissure and forming a flattened or slightly convex surface with the tongue of the pedicle valve sulcus; lateral slopes similarly deflected; umbo medially grooved or flattened; lateral profile subtrigonal; beak small, obscured by the pedicle valve.

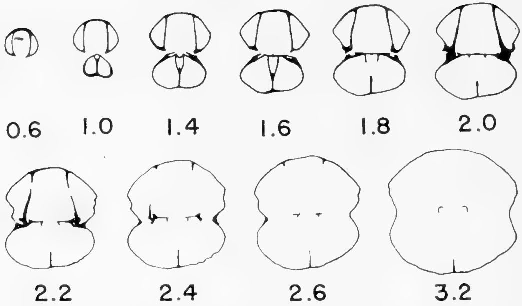
Brachial valve interior with short deep septalium, supported by a moderately high long median septum that extends forward about one-third the length of the valve; septalium covered by a posteriorly concave, anteriorly flattened or concave hinge plate; hinge plate medially thickened to form a small elongated knoblike cardinal process; walls of septalium formed by crural bases; crura acutely hook-shaped posteriorly, becoming arcuate anteriorly, diverging slightly, and rising ventrally.

Table 20.—Measurements in millimeters of *Rhynchopora sansabensis*, n. sp., from USNM locality 9045.

USNM No.	Length	Width	Thickness
154687	18.3	22.6	14.7
154688	18.9	22.0	13.7
154689	17.9	20.6	16.3
154690	16.6	18.5	14.0
154691	15.0	17.1	12.4
154692	12.9	14.1	9.7
154693	9.9	10.6	4.4
154694	6.5	7.2	2.0

Holotype.—USNM No. 154688.

Distinguishing characters.—This species is characterized by its broad flattened fold and sulcus, with eight or nine costae in the sulcus and five or six costae on each lateral slope in adult specimens.

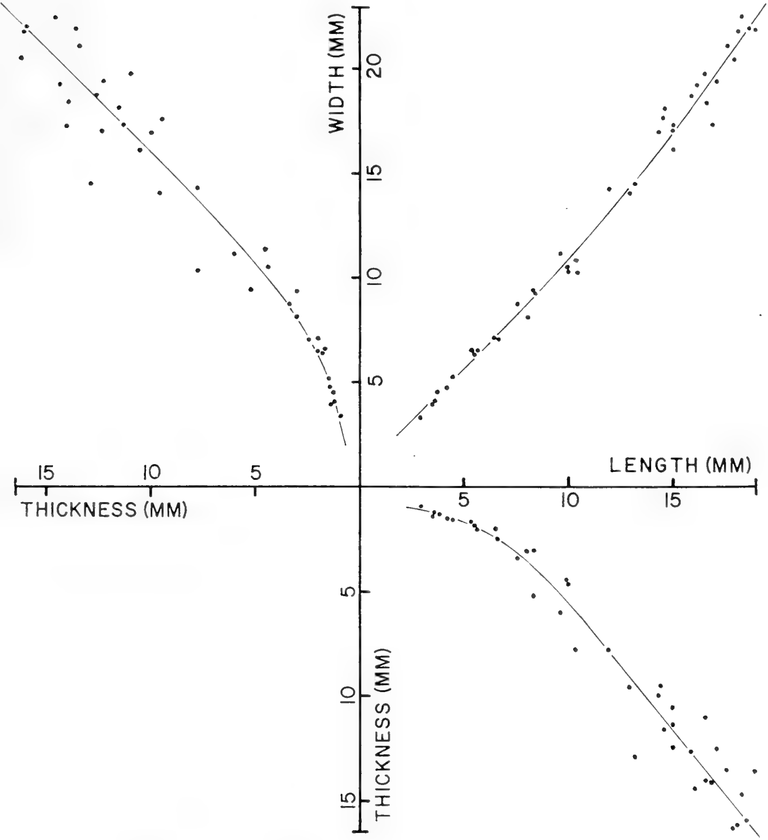


Text-figure 8.—Transverse serial sections of *Rhynchopora sansabensis,* n. sp. × 2, USNM 154695 from USNM locality 9045, measurements (mm) from ventral beak.

Internally the hinge plate is concave posteriorly and flattened or concave anteriorly with simple elongate cardinal process.

Comparisons. — *R. sansabensis,* n. sp. is most similar to *Rhynchopora persinuta* (Winchell), 1865, from the Kinderhook of Iowa, and the Byer Member of the Logan Formation of Ohio, and *R. cooperensis* (Shumard), 1855, from the Chouteau Group of Missouri. *R. persinuta* differs from *R. sansabensis* in being smaller and in having a narrower more rounded fold and sulcus, with about seven costae in the sulcus, according to Weller (1914, p. 234) [or six or seven according to Hyde (1953, p. 283)], and about seven or eight costae per lateral slope, according to Weller (*idem*) [or five or six according to Hyde (*idem*)]. *R. cooperensis* differs from *R. sansabensis* in having a narrower fold and sulcus with about six to eight costae in the sulcus and about six or seven per lateral slope; internally the hinge plate is distinctly convex, and a cardinal process is lacking.

Remarks. — This species is highly variable in its proportions during ontogeny and in adulthood. Text-figure 9 constructed from data taken from a well-preserved collection from USNM locality 9045, illustrates this variation. Note that there is a distinct tendency in adult specimens for the shells to become relatively more transverse. Juveniles remain flat relative to length and width until they attain a length of about five to six millimeters at which time relative increase in thickness is accelerated. When a length of about one centimeter is attained, increase in thickness relative to length and width becomes isometric.



Text-figure 9.—Scatter diagrams of dimensions of *Rhynchopora sansabensis*, n. sp. from USNM locality 9045.

The nature of the "punctation" of this species is not clearly understood by the writer. A few specimens with spalled surfaces are finely papillose, these tiny papillae appearing to be infillings of punctae. However, the writer has in no case observed typical densely spaced rhynchoporid punctae.

Occurrence and abundance. — *R. sansabensis*, n. sp. is common at USNM localities 9045 (108 specimens), 9048 (32 specimens), and 9046 (40 specimens), and less common at localities 9044 (six specimens), 9047 (three specimens), 9043 (five specimens), and 9155 (seven specimens).

Order SPIRIFERIDA Waagen, 1883

Suborder RETZIIDINA Boucot, Johnson, and Staton, 1964

Superfamily **RETZIACEA** Waagen, 1883

Family **RETZIIDAE** Waagen, 1883

Genus **HUSTEDIA** Hall and Clarke, 1893

1893. *Hustedia* Hall and Clarke, Nat. Hist. New York, Pal., vol. 8, pt. 2, pp. 120-122.

1914. *Hustedia* Hall and Clarke, Weller, Illinois Geol. Sur., Mon. 1, p. 451.

Diagnosis. — Small, finely punctate, rostrate, costate, with a narrow straight hinge line; ventral interarea smooth, usually curved; delthyrium closed by a flat deltidial plate (symphytium?); apical foramen round. Ventral interior lacking dental plates; incomplete pedicle collar fused to inner surface of deltidial plate. Dorsal interior with ventro-posteriorly recurved hinge plate and ventro-anteriorly directed curved "ligulate" process, all supported by a median septum; crura nearly erect; jugum complete, fimbriate or spinose, median process directed ventrally or posteroventrally.

Type species. — *Terebratula mormoni* Marcou, 1858, Geology of North America, p. 51, pl. 6, fig. 11. Pennsylvanian of North America.

Remarks. — The species considered herein differs substantially from the type species and many other Pennsylvanian and Permian species of *Hustedia*. The Chappel Limestone species, *H.? texana* Girty, apparently lacks a pedicle collar and has a slightly concave deltidial plate. Furthermore the costation is somewhat finer than in most of the stratigraphically higher species. For these reasons the writer has followed Girty in leaving the assignment questionable.

Range. — ?Mississippian, Pennsylvanian — Permian. Distribution cosmopolitan.

Hustedia? texana Girty Pl. 27, figs. 1a-11c; Text-figs. 10, 11

1926. *Hustedia? texana* Girty, U.S. Geol. Sur., Prof. Paper 146, pp. 34, 35, pl. 6, figs. 1-4d.

Girty's description of this species was based on exteriors of several small specimens. He assigned the form questionably to the genus *Hustedia,* mainly because he lacked interior information.

Substantially larger collections from additional localities as well as serial sections of several specimens showing interior details make redescription of the species necessary.

Small, slightly longer than wide, subequally biconvex, subcircular to suboval in outline, greatest width near mid-length; anterior profile elliptical; ventral beak small for the genus, slightly incurved, with round apical foramen; dorsal beak small and inconspicuous; hinge line narrow, straight or slightly curved, ears not produced; valves slightly compressed at the shell margin making a sharp angle at the point of juncture; brachial valve often with a weak shallow median sulcus or groove, the pedicle valve rarely so, occasionally producing an emarginate anterior commissure, the latter being otherwise recti-marginate; both valves costate, there being about 18 to 22 simple slender rounded costae per valve in mature shells; entire surface finely punctate.

Pedicle valve with greatest convexity slightly posterior to mid-length; interarea small, curved, often obscured by beak incurvature, delthyrium closed by a slightly concave deltidial plate.

Pedicle valve interior simple, lacking dental plates; no pedicle collar present in sectioned specimens; musculature obscure; teeth of moderate size.

Brachial valve exterior with a somewhat inflated umbonal region marked by recurvature of the surface posterolaterally, otherwise similar to the pedicle valve.

Brachial valve interior with posteriorly recurved hinge plate and antero-ventrally projecting "ligulate" process, supported by a short median septum; inner socket ridges thick; crural bases curved, high, laterally directed posteriorly, becoming ventrally directed anteriorly; crura descending almost vertically into the pedicle valve;

details of brachidium not observable in specimens sectioned; musculature obscure in sections.

Table 21.—Measurements in millimeters of *Hustedia*? *texana* Girty.

USNM No.	Length	Width	Thickness	Locality
121185	3.8	3.2	1.9	USGS 2623
121186	4.2	3.7	2.3	USGS 2623
121187	4.6	3.9	2.5	USGS 2623
121188	4.6	4.3	2.3	USGS 2623
154698	6.8	6.7	4.1	USNM 9045
154699	5.4	5.2	3.3	USNM 9045
154700	4.9	4.0	2.4	USNM 9045
154701	3.4	2.8	1.7	USNM 9045
154702	7.2	6.8	4.6	USNM 9048
154703	6.2	5.9	3.7	USNM 9048
154704	5.8	5.2	3.7	USNM 9048

Types. — Girty's syntype suite of four specimens is in the USNM collections, Nos. 121185-121188.

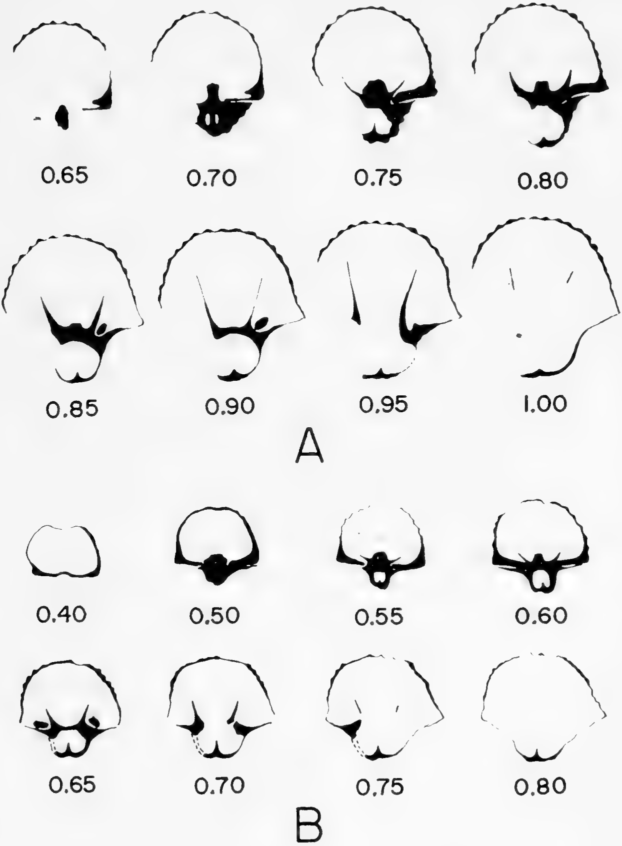
Distinguishing characters. — *H.*? *texana* is characterized by its small size, subcircular outline, the length only slightly exceeding the width, the common presence of a median sulcus on both valves, especially on the brachial valve, and 18 to 22 rounded costae per valve.

Comparisons. — *Retzia circularis* Miller, 1892, from the Chouteau Limestone of Missouri is similar and probably related to *H.*? *texana* but can be distinguished by its fewer coarser costae, the complete lack of a ventral median sulcus, and the dorsal median sulcus is inconspicuous and restricted to the umbonal region.

Retzia triangularis Miller, 1892, also from the Chouteau Limestone (or Sedalia Limestone?) has an elongate subtriangular outline, fewer costae, and lacks a median sulcus in both valves.

Hustedia pygmaea Rowley, 1900, from the Lower Burlington Limestone of Missouri has fewer coarser costae and both valves apparently lack a median sulcus.

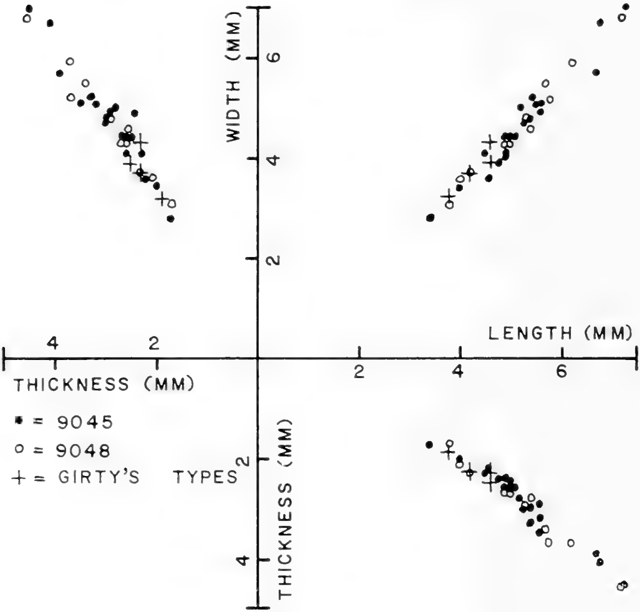
Remarks. — Including Girty's types, 35 specimens from three localities were measured and plotted as a scatter diagram in Text-figure 11. Other growth information is lacking. It is apparent from this diagram that individuals of this species are proportionately nearly the same in all ascertainable growth stages. Note that Girty's



Text-figure 10.—Transverse serial sections of *Hustedia*? *texana* Girty × 9, measurements (mm) from ventral beak. (A) An adult specimen, USNM 154705, from USNM locality 9048, showing the high crural bases. (B) A smaller specimen, USNM 154706, from USNM locality 9045, showing the weakly concave deltidial plate.

types are relatively small and may even represent a juvenile growth stage.

Occurrence and abundance.—Girty's four types are all that remain of his original study suite. The writer failed to obtain more material from Girty's USGS locality 2623. USNM localities 9045 and 9048 yielded more substantial collections, there being about 12 specimens from 9048 and 28 specimens from 9045.



Text-figure 11.—Scatter diagrams of dimensions of *Hustedia? texana* Girty from USNM localities 9045 and 9048 and USGS locality 2623.

Genus **PLECTOSPIRA** Cooper, 1942

1893. *Ptychospira* Hall and Clarke, Pal. New York, vol. 8, pt. 2, p. 112.
1914. *Ptychospira* Hall, Weller, Illinois Geol. Sur., Mon. 1, p. 435.
1942. *Plectospira* Cooper, Jour. Washington Acad. Sci., vol. 32, No. 8, p. 228.

Diagnosis. — Small, subequally biconvex, rostrate, finely punctate, subcircular to subtrigonal in outline, with few strong rounded costae; hinge line narrow, ears not developed; ventral interarea narrow (or lacking?); deltidial plate flat (symphytium?) closing the delthyrium; apical foramen round. Ventral interior lacking dental plate and pedicle collar. Dorsal interior with hinge plate supported by median septum; spiralia with four or five whorls; jugum complete, apparently nonfimbriate, broadly curved postero-ventrally, with a simple median process.

Type species. — (By original designation) *Terebratula ferita* von Buch, 1834, Uber Terebrateln, p. 76, pl. 2, fig. 37. Middle Devonian of Germany.

Remarks. — The Chappel Limestone species assigned here, *Plectospira problematica,* not only possesses a definite sulcus with disproportionately large sulcus-bounding costae, but lacks any trace of a median costa in the sulcus such as occurs in the type species, *P. ferita.* Although these differences may have considerable systematic significance the writer can do no more than illustrate them because his understanding of the type species of the genus is not complete.

Range. — Middle Devonian—Lower Mississippian of Europe, Asia, and North America.

Plectospira problematica (Girty) Pl. 28, figs. 1a-10e; Text-figs. 12-14

1926. ***Hustedia? problematica*** Girty, U.S. Geol. Sur., Prof. Paper 146, p. 35, pl. 6, figs. 6a-7c.

Girty apparently described this species from two small broken specimens. His holotype, USNM No. 121190, is smaller and narrower than the average adults found at most other localities but it clearly is conspecific with the form found at USNM locality 9045, from which a large excellent collection was obtained.

Because Girty's description was based on relatively poorly preserved material, the writer deems it useful to redescribe the species, both externally and internally.

Average size for the genus, subcircular to subpentagonal in outline, length and width about equal, subequally biconvex, the pedicle valve being slightly more convex than the brachial valve; anterior profile subelliptical; ventral beak small, slightly incurved, with round apical foramen; dorsal beak small and inconspicuous; hinge line narrow, straight or slightly curved, ears lacking; valves not compressed at the margin; moderately wide conspicuous sulcus in the pedicle valve produced between two disproportionately large bounding costae; macroprosopon consisting of six simple rounded costae per pedicle valve and five per brachial valve, those on the flanks being much smaller than the middle costae, and irregularly spaced growth varices; microprosopon (in exceptional specimens only) consisting of numerous fine punctae.

Table 22.—Measurements in millimeters of *Plectospira problematica* (Girty) from USNM locality 9045.

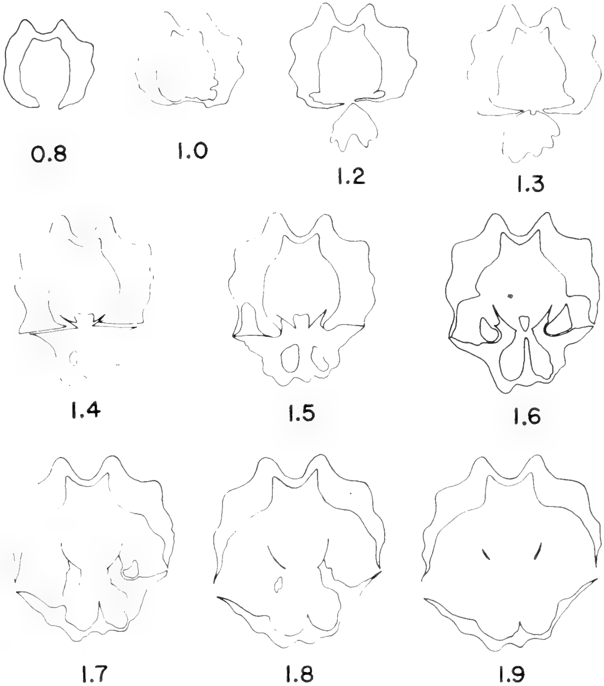
USNM No.	Length	Width	Thickness
154725	8.8	9.3	5.3
154726	8.4	8.6	5.0
154727	7.8	7.9	4.9
154728	7.5	7.2	4.7
154729	6.7	6.6	4.0
154730	6.0	5.9	4.1
154731	5.7	5.0	3.7
154732	4.8	4.1	3.3
154733	4.4	4.0	2.6

Pedicle valve with greatest convexity near the beak; interarea apparently lacking; delthyrium closed by what appears in section to be a single slightly concave plate; convexity variable, some specimens being flattened near mid-valve; postero-lateral margin slightly compressed but ears not formed.

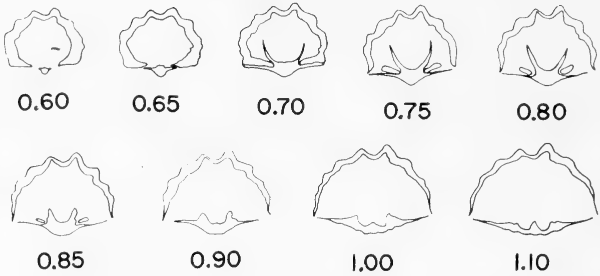
Pedicle valve interior simple, lacking dental plates and pedicle collar; muscle scars deeply impressed in mesial portion of the valve between inner edges of sulcus-bounding costae; teeth wide, bladelike.

Brachial valve less convex than pedicle valve, most convex near the dorsal beak, somewhat compressed near the posterolateral margin; dorsal costae much lower than those of the pedicle valve.

Brachial valve interior with high triangular flattened cardinal process, becoming narrower anteriorly, supported by a strong high median septum that extends anteriorly about one-third the valve length; socket ridges thick and massive, supporting the curved



Text-figure 12.—Transverse serial sections of *Plectospira problematica* (Girty) × 6, USNM 154734 from USNM locality 9045, measurements (mm) from ventral beak. A large specimen.



Text-figure 13.—Transverse serial sections of *Plectospira problematica* (Girty) × 6, USNM 154735 from USNM locality 9045, measurements (mm) from ventral beak. A small specimen.

crural bases and cardinal process; crura projecting laterally posteriorly but descending anteriorly, becoming ventrally directed; spiralia and jugum not observed; muscle scars defined by two distinct ridges that extend forward from the bases of the socket ridges.

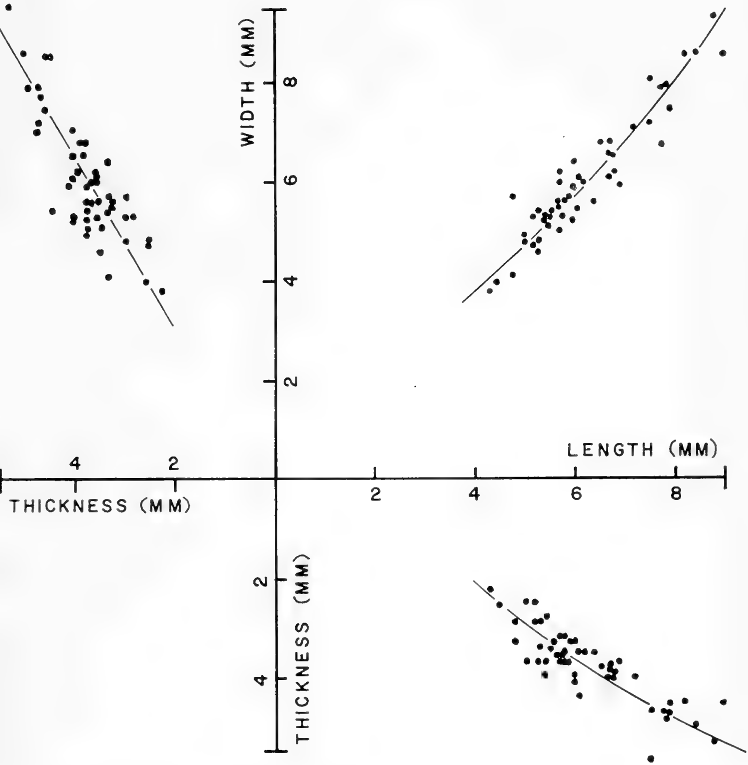
Holotype. — USNM No. 121190 collected from USGS locality 2623.

Distinguishing characters. — *Plectospira problematica* is characterized by its ventral sulcus and disproportionately large sulcus-bounding costae.

Comparisons. — This species might be confused with *Plectospira sexplicata* (White and Whitfield), 1862, from Kinderhookian strata of the Mississippi Valley, but the latter does not have a sulcus and strong bounding costae. Furthermore, *P. sexplicata* may have up to 12 costae on the pedicle valve, whereas *P. problematica* never has, to this writer's knowledge, more than six.

Remarks. — Measurements of 50 well-preserved shells of various growth stages were plotted as a scatter diagram (Text-figure 14). Although the species is variable in shape it is concluded that there is a tendency during ontogeny for the shells to become relatively wider and thinner. Serial sections of large and small specimens as seen in Text-figures 12, 13 show that in juveniles the cardinal process is indistinct, and the other cardinal structures are low, resting on the floor of the brachial valve.

Occurrence and abundance. — This species is common at USNM locality 9045 where over 100 specimens were collected. Excellent specimens were also collected from USNM localities 9043, 9047, and 9048. Girty's types from USGS locality 2623 are, to the writer's knowledge, unique.



Text-figure 14.—Scatters diagrams of dimensions of *Plectospira problematica* (Girty) from USNM locality 9045.

Suborder ATHYRIDIDINA Boucot, Johnson, and Staton, 1964

Superfamily **ATHYRIDACEA** M'Coy, 1844

Family **MERISTELLIDAE** Waagen, 1883

Subfamily **MERISTINAE** Hall and Clarke, 1895

Genus **MERISTA** Suess, 1851

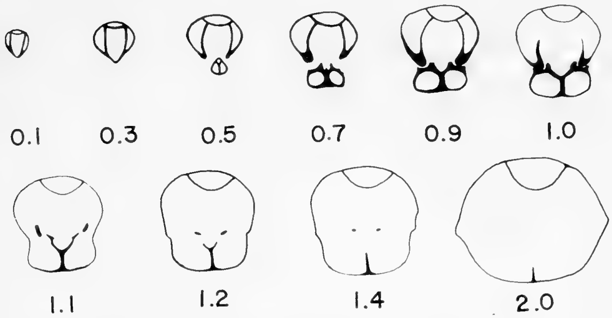
Merista maccullochensis, n. sp. Pl. 29, figs. 1a-10e; Text-figs. 15, 16

Smaller than average for the genus, subequally biconvex, the pedicle valve being slightly more inflated than the brachial valve; commonly asymmetrical; outline highly variable, ranging between subcircular and transversely or longitudinally subpentagonal; greatest width variable, usually near mid-length; pedicle valve commonly with a shallow sulcus confined to the anterior half of the valve although many specimens have little more than a slight flattening near the front margin; brachial valve completely lacking a fold but many specimens are flattened anteriorly, forming an emarginate front margin; other specimens with an evenly rounded front margin; anterior commissure rectimarginate or weakly uniplicate; radial prosopon lacking, growth varices strong, irregularly spaced; shell substance impunctate.

Pedicle valve evenly convex in lateral and anterior profile; cardinal extremities slightly compressed in some specimens, evenly convex in others; lateral slopes curving evenly to the margin from the sulcus; sulcus never deep, originating well in front of the umbo, becoming moderately broad at the front margin; umbo moderately inflated, beak small, acute, suberect to erect or slightly incurved in some large specimens; delthyrium small, acutely triangular, open;

Table 23.—Measurements in millimeters of *Merista maccullochensis,* n. sp.

USNM No.	Length	Width	Thickness	Locality
154737	7.8	7.1	4.9	9048
154738	7.7	6.8	4.7	9046
154739	7.5	6.9	4.3	9045
154740	7.0	5.6	4.3	9048
154741	6.8	6.9	4.1	9046
154742	6.5	6.3	4.0	9045
154743	6.4	5.7	4.2	9045
154744	6.0	4.8	3.7	9045
154745	5.2	4.8	3.1	9048
154746	4.1	3.6	2.1	9045



Text-figure 15.—Transverse serial sections of *Merista maccullochensis,* n. sp. × 5, USNM 154747 from USNM locality 9046, measurements (mm) from ventral beak.

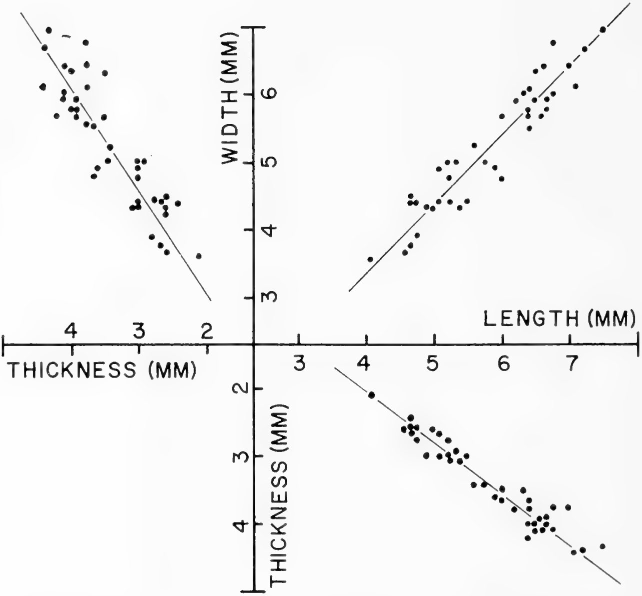
foramen not produced; short subangular beak ridges produced in some specimens.

Pedicle valve interior with large convex shoelifter process originating in the ventral umbo and becoming broader anteriorly; dental plates short, meeting the shoelifter process above the floor of the valve, except in the beak; cella wider than deep, long, extending anteriorly about one-third the length of the valve.

Brachial valve shorter than the pedicle valve, usually considerably inflated in the umbonal region; lateral and anterior profiles usually evenly convex, although the dorsum may be slightly depressed medially in some specimens; cardinal extremities often slightly compressed in average specimens or evenly convex in more tumid individuals; beak small, incurved, obscured by the pedicle valve.

Brachial valve interior with concave hinge plate supported by a high long median septum, extending forward about one-third the length of the valve; simple ridgelike cardinal process produced at the posterior end of the hinge plate; crural bases flat, directed dorsomedially in transverse view, originating on the antero-ventral edges of the inner socket ridges; crura rodlike, spiralia with four whorls, jugum not observed.

Holotype.—USNM No. 154738.



Text-figure 16.—Scatter diagrams of dimensions of *Merista maccullochensis*, n. sp. from USNM locality 9045.

Distinguishing characters.—This species is characterized by its small size, commonly asymmetrical subcircular to transversely subpentagonal outline, shallow sulcus in the pedicle valve, nonfolded or slightly flattened brachial valve, and small suberect to erect beak with an open delthyrium.

Comparisons.—The writer knows of no other occurrence of this genus in Mississippian strata.

Remarks.—Assignment of this species to the genus *Merista* Suess, 1851, is based on the presence of a shoelifter process in the pedicle valve and a concave hinge plate supported by a high median septum in the brachial valve. Its growth form and spiral brachidia demonstrate that it is unquestionably a meristid relative. The common asymmetry of the shells, and lack of a well-developed fold and sulcus are not typical of the genus *Merista;* similarly the small ventral beak and open delthyrium suggest that this species has evolved from the Siluro-Devonian meristid stock. Whether these changes are sufficient to justify the erection of a new genus requires further study.

This species is unusually variable in its proportions at all growth stages. The scatter diagrams in Text-fig. 16 do not show any appreciable trend during ontogeny, all the curves being essentially isometric.

Occurrence and abundance.—M. macculochensis is common at USNM locality 9045 (135 specimens) and less common at localities 9046 (21 specimens), 9048 (11 specimens), and 9043 (one specimen).

Subfamily **CAMAROPHORELLINAE** Schuchert and LeVene, 1929

Genus **CAMAROPHORELLA** Hall and Clarke, 1893

Camarophorella dorsata, n. sp. Pl. 30, figs. 1a-7e; Text-fig. 17

Average size for the genus, lenticular in form; subcircular to subpentagonal in outline; usually wider than long, nearly equidimensional in some specimens, or rarely longer than wide; greatest width usually near mid-length, posterior to mid-length in subpentagonal specimens; valves subequally biconvex, the pedicle valve usually sightly more inflated than the brachial valve; fold and sulcus usually lacking but both valves medially grooved or the pedicle valve may have a shallow sulcus; anterior commissure rectimarginate or weakly uniplicate; faint capillae present on decorticated surfaces of some specimens; growth lines closely set, irregularly spaced; surfaces finely pustulose; shell substance impunctate.

Pedicle valve most convex in the umbonal region; medial groove or sulcus originating at the beak, becoming a shallow moderately broad sulcus in large specimens; cardinal extremities slightly compressed in some individuals; lateral slopes evenly convex to the margins; beak small, suberect; foramen small, ovate; delthyrium obscured by the dorsal beak.

Pedicle valve interior with a deep short spondylium duplex that rises slightly on a long low median septum extending forward about one-third to one-half the length of the valve; dental plates laterally buttressed by short mystrochial plates confined to the umbonal region ~~and~~ extending anteriorly about parallel to the plane of the lateral commissure.

Brachial valve nearly as long as the pedicle valve; dorsal umbo greatly swollen, nearly as inflated as the ventral umbo; median ridge originating in the dorsal beak, not becoming significantly broader anteriorly; lateral slopes evenly convex; cardinal extremities slightly compressed; beak small, acute, incurved against the delthyrium, usually touching the delthyrium at the dorsal edge of the foramen.

Brachial valve interior with a slightly concave hinge plate extending between the dorsal inner edges of the inner socket ridges and supported by a long high median septum extending anteriorly about one-third the length of the valve; cardinal process simple, platelike, extending anteriorly the length of the hinge plate, probably merely a vertical extension of the median septum; crural bases originating on the inner ventral edges of the inner socket ridges, ventrad to the hinge plate, being directed medially; crura converge posteriorly as flattened rodlike plates, the axis of flattening rapidly becoming vertical, then diverging and rising anteriorly; other brachidial details unknown; adductor muscle field supported on a short shoelifter process, the cella being penetrated by the median septum.

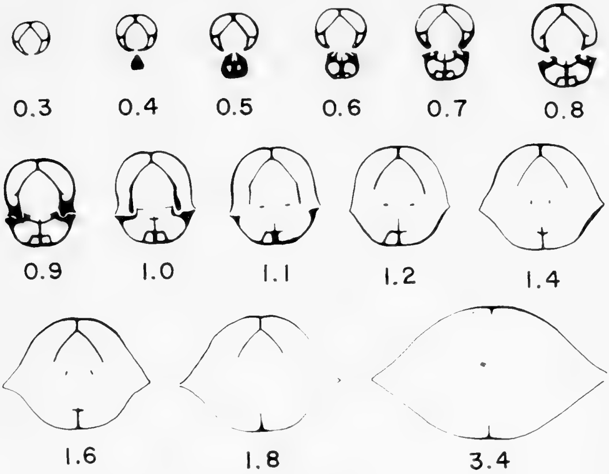
Holotype.—USNM No. 154749.

Table 24.—Measurements in millimeters of *Camarophorella dorsata,* n. sp.

USNM No.	Length	Width	Thickness	Locality
154749	15.8	17.6	9.6	9045
154750	12.0	11.5	6.2	9047
154751	9.9	10.7	5.5	9048
154752	9.7	9.6	5.2	9047
154753	7.8	7.7	4.1	9048
154754	5.7	5.7	3.0	9048
154755	4.2	4.2	2.1	9048

Distinguishing characters.—This species is characterized by its moderate size, subcircular to subpentagonal outline, umbonally inflated brachial valve that is nearly as long as the pedicle valve, and poorly developed sulcus in the pedicle valve.

Comparisons.—*C. dorsata* is most similar to *Camarophorella mutabilis* Hyde, 1908, from the Waverly Group of Ohio. *C. mutabilis*



Text-figure 17.—Transverse serial sections of *Camarophorella dorsata,* n. sp. ×4, USNM 154756 from USNM locality 9048, measurements (mm) from ventral beak.

differs from *C. dorsata* in being larger, with a pedicle valve that is considerably longer than the brachial valve, a longer ventral beak, a less tumid dorsal umbonal region, and the anterior commissure is usually uniplicate.

The type species, *Camarophorella lenticularis* (White and Whitfield), 1862, from Kinderhook bed No. 5 of Iowa, differs from *C. dorsata* in being smaller, with a pedicle valve longer than the brachial valve, and it completely lacks median grooves or a fold-sulcus.

In the Chappel Limestone fauna individuals of this species can be confused with collections of *Cleiothyridina tenuilineata* (Rowley), 1900, however, that species can be differentiated by its larger ventral beak, less tumid dorsal umbo and costellate surfaces, when decorticated, or lamellose surfaces when well preserved. Internally the two species are much different.

Remarks.—All known species of this genus are highly variable in their external proportions throughout ontogeny. It is noteworthy that in this species as in *C. mutabilis,* there is a definite tendency for the small shells to have a rounded subcircular or slightly elongated outline, whereas large adults of both species tend to be transverse with subpentagonal outlines. Unfortunately, none of the collections of this species is large enough to allow quantification of this tendency.

Occurrence and abundance.—This species has been found at USNM localities 9048 (24 specimens), 9045 (11 specimens), 9047 (seven specimens), and 9044 (one specimen).

Family **ATHYRIDIDAE** M'Coy, 1844

Subfamily **ATHYRIDINAE** M'Coy, 1844

Genus **ATHYRIS** M'Coy, 1844

1844. *Athyris* M'Coy, Synopsis of the Carboniferous Limestone Fossils of Ireland, Dublin, pp. 128, 146.
1847. *Spirigera* d'Orbigny, Acad. Sci. Paris, Compt. Rend., vol. 25, p. 268.
1850. *Athyris* M'Coy, King, Mon. Permian Fossils of England, Palaeontogr. Soc., London, p. 136.
1868. *Spirithyris* Quenstedt, Die Brachiopoden, Petref. Deutsch., vol. 2, p. 30.
1869. *Euthyris* Quenstedt, Die Brachiopoden, Petref. Deutsch., vol. 2, p. 442.
1893. *Athyris* M'Coy, Hall and Clarke, Nat. Hist. New York, Pal., vol. 8, pt. 2, pp. 83-90.
1914. *Athyris* M'Coy, Weller, Illinois Geol. Sur., Mon. 1, pp. 464, 465.

Small to medium-sized; subequally biconvex, transversely subellipsoidal to subcircular in outline; ventral beak moderately or strongly incurved; foramen round, somewhat obscured by beak incurvature; hinge line short, subterebratuloid; delthyrium open; ears rounded, both valves regularly convex except for the fold-sulcus and slight lateral flexures at the cardinal extremities; anterior commissure uniplicate; fold-sulcus weakly or moderately developed anteriorly and faint or obsolete posteriorly; prosopon consists of broad, often frilled extensions of the growth lamellae; spalled shells smooth or marked only by even concentric corrugations.

Ventral interior with short stout dental plates confined to costral area; teeth large, broad, recurved at the tips; diductor scars flabellate and poorly defined; adductor scars narrow and well defined.

Dorsal interior with subquadrate apically perforate hinge plate; sockets broad and deep; crura produced from the thickened lateral edges of the hinge plate; primary lamellae abruptly recurved posteriorly; jugum complex, with long recurved posterior processes; spiralia directed laterally or postero-laterally; low but well-defined median ridge confined to dorsal umbonal region.

Type species.—(By subsequent designation, King, 1850) *Terebratula concentrica* von Buch, 1835 (separate, 1834, Über Terebrateln. Abh. physik. Akad. Wiss., Berlin, for 1833, p. 103).

Distinguishing characters.—This genus is characterized by its broad, often frilled, but never spinose extensions of the growth lamellae, often concentrically corrugated shell surface, apically perforate subquadrate hinge-plate, and dorsal median ridge.

Comparisons.—The Paleozoic athyrid genera, ranging in age from Silurian to Permian, are similar internally, varying mainly in details of the hinge plate and jugum. Consequently, generic distinctions are made mainly on the basis of exterior ornament and shape. Only Carboniferous genera need be considered here for the purposes of comparison.

Cleiothyridina Buckman, 1906, differs from *Athyris* in having the lamellar extensions fringed with flat spines.

Actinoconchus M'Coy, 1844, has exceptionally broad flat lamellar extensions that give the appearance of being radially striated. According to Hall and Clarke (1893, pt. 2, p. 92) these lamellar extensions may actually be fine tubular spines imbedded in a thin calcareous plate. Observations of several specimens in the USNM collections of *A. planosulcata* Phillips, 1836, seem to corroborate this interpretation although the tubular nature of the rods or spines is questionable. The spines may merely be composed of clear calcite and just appear to be tubular.

Composita Brown, 1849, is similar to *Athyris* but completely lacks lamellose extensions. Furthermore, in the brachial valve, the hinge plate is ordinarily not perforate and usually a dorsal median ridge is lacking.

Remarks.—M'Coy (1844, p. 128, 146) distinguished this group of shells from the terebratulids mainly on the basis of their possessing spiralia, and assigned several diverse species to the new genus. King (1850, p. 136), however, fixed the type species and clearly pointed out the unique characters of this genus. *Spirigera* d'Orbigny, 1847, an objective synonym of *Athyris,* is still occasionally used by some workers, although the name is not valid. Since King's time many workers have used the name *Athyris* in a broad sense, including species now placed in *Cleiothyridina, Composita,* and *Actinoconchus.* Hall and Clarke (1893, pt. 2, pp. 83-101) for instance, included *Cleiothyridina* (as *Cleiothyris*), *Composita* (as *Seminula* M'Coy, 1844), *Actinoconchus,* and *Spirigerella* Waagen, 1883, as subgenera of *Athyris* but restricted the generic diagnosis to the type species, *Terebratula concentrica* von Buch. Their diagnosis of *Athyris s. s.* is essentially unchanged. Since Weller (1914, pp. 464, 465) the majority of workers have interpreted the genus in the strict sense.

Range.—Middle Devonian to Mississippian. Distribution cosmopolitan.

Athyris bradyensis, n. sp. Pl. 31, figs. 1a-11; Text-figs. 18, 19

Average size, subequally biconvex, transversely ellipsoidal in outline, lenticular in profile; ventral beak incurved tightly over the dorsal umbo; hinge line straight or slightly curved, subterebratulid, the greatest width being attained posterior to mid-length; cardinal extremities rounded, delineated by concave flexures of the posterolateral portions of the shell; exterior surfaces of both valves evenly convex, excepting the beaks and fold-sulcus; anterior commissure slightly sinuous or weakly uniplicate; weakly rounded sulcus in anterior half of shell; dorsal fold usually lacking or weakly expressed except at the anterior commissure, a weak dorsal sulcus or groove usually present instead; prosopon consisting of five to eight, moderate to strong, concentric corrugations in large spalled specimens, or a similar number of broad, frilled, radially wrinkled, lamellar extensions of growth lamellae in exceptionally well-preserved specimens.

Pedicle valve most convex posteriorly, scarcely inflated; beak small; foramen small, round, usually obscured by incurvature of the beak; interarea apparently lacking; delthyrium open but completely obscured by dorsal umbo; sulcus originating as a faint groove in the beak or as far forward as midvalve; sulcus rounded, shallow posteriorly; sulcal angle 20-25° in large specimens.

Interior of pedicle valve with thick, short, slightly divergent dental plates which curve inward near the floor of the valve; teeth large; area between dental plates thickened.

Table 25.—Measurements in millimeters of *Athyris bradyensis* from USNM locality 9045.

USNM No.	Length	Width	Thickness
154761	21.8	28.7	12.5
154762	20.2	27.3	11.6
154763	20.3	25.8	10.7
154764	17.8	21.5	9.3
154765	15.4	18.6?	8.3
154766	13.4	17.2	7.0
154767	12.3	14.4	6.4
154768	9.0	10.8	4.4
154769	6.2	6.0	3.1

Brachial valve evenly convex posteriorly, usually more inflated in the umbo than the pedicle valve; dorsal beak small, incurved, covered by the ventral beak; small specimens and medium-sized specimens usually with a weak dorsal groove or sulcus rather than a fold, except at the anterior margin where the shell may flex slightly dorsad; a few medium and large specimens are merely flattened medianly or have a low fold.

Interior of brachial valve with large apical perforation; hinge plate subquadrate, thickened posteriorly; concave anteriorly, with a low median undulation; short median ridge present only in posterior portion of umbo.

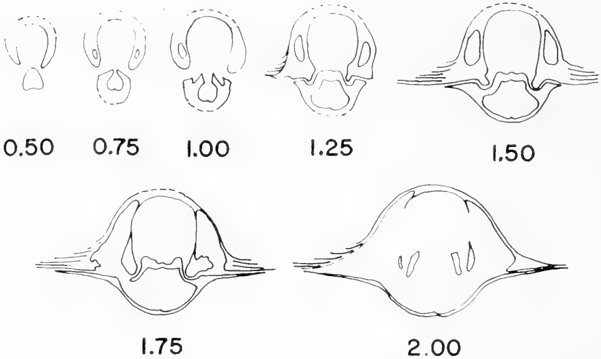
Holotype.—USNM 154761.

Distinguishing characters.—This species is characterized by its moderate size, transversely ellipsoidal outline with the maximum width posterior to mid-valve, compressed ears, shallow ventral sulcus, a shallow median dorsal groove or sulcus in moderate-sized specimens which may be obscure in large specimens, and five to eight moderate to strong concentric lamellar corrugations in large spalled specimens.

Comparisons.—This species is somewhat similar to *Athyris hannibalensis* (Swallow), 1860, from the Louisiana Limestone of Missouri and other Kinderhookian strata, and so-called *Athyris "lamellosus"* (Léveillé), 1835, as used by Meek and many others from the Burlington and other Osagian formations in North America.

Athyris hannibalensis however, is usually smaller, has a subcircular outline, with the maximum width near mid-length of the shell, and lacks compressed ears. It does have a dorsal median flattening but this is often inconspicuous.

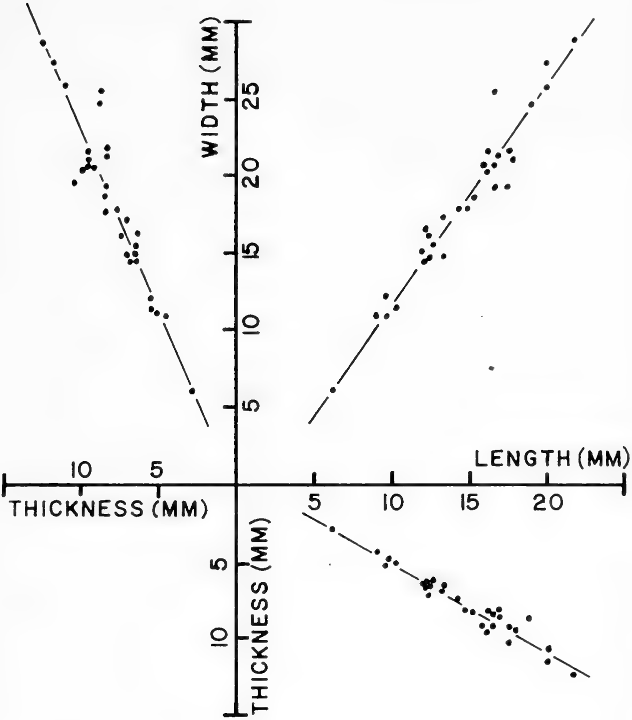
Athyris "lamellosus" as it is usually interpreted is much larger than *A. bradyensis*, has a pronounced fold in the brachial valve, a well-developed sulcus in the pedicle valve, the commissure is more strongly uniplicate, and in all cases lacks a dorsal median flattening or a sulcus in the brachial valve.



Text-figure 18.—Transverse serial sections of *Athyris bradyensis*, n. sp. ×3, USNM 154772 from USNM locality 9045, measurements (mm) from ventral beak.

Remarks.—It has been a usual practice to assign almost all Mississippian species of *Athyris* that somewhat resemble *A. lamellosus* to that species. *A. lamellosus* was well illustrated by Léveillé (1835, pl. 2, figs. 21-23). It differs somewhat in its proportions and in other respects from the forms usually assigned to it from this country. It seems advisable to discontinue use of this name inasmuch as this broad interpretation is systematically meaningless. The application of other names to Kinderhookian and Osagian species of *Athyris* other than from the Chappel Limestone is beyond the scope of this paper.

The growth patterns of *A. bradyensis* are entirely isometrical with respect to shell outline and profile as seen in Text-figure 19. However, other ontogenetic changes are worth noting. The ventral sulcus appears only as a shallow groove of the anterior margin of the smallest specimens. It broadens by the time the shells are about



Text-figure 19.—Scatter diagrams of dimensions of *Athyris bradyensis*, n. sp. from USNM locality 9045.

one centimeter long but is never deep in any growth stage. The dorsal flattening or groove is present in the umbo of the smallest spalled specimens and can be distinguished there in most adults. This dorsal groove often develops into a shallow sulcus similar in size and position to that of the pedicle valve. The conjunction of these sulci forms an emarginate anterior margin and a subpentagonal outline in small and medium-sized specimens (note figs. 4-8, Plate

31). A slight dorsal flexure is usually present at the anterior margin even in these specimens, giving the appearance of a fold in anterior profile. In larger shells the shallow dorsal sulcus becomes gradually less noticeable and is finally lost anteriorly, only a flattening remaining.

Occurrence and abundance.—This species is fairly common at USNM locality 9045. Besides the 32 types and measured specimens, there are 45 fragmentary shells or disarticulated valves. One specimen each is identified from USNM localities 9043 and 9044; locality 9046 yielded three poor specimens.

ACTINOCONCHUS M'Coy, 1844

1842. *Actinoconchus* M'Coy *in* Griffith, Notice respecting the fossils of the Mountain Limestone of Ireland, p. 18. (*Nomen nudum fide* Schuchert and LeVene, 1929).

1844. *Actinoconchus* M'Coy, Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland, p. 149.

Type species.—(By subsequent monotypy) *Actinoconchus paradoxus* M'Coy, 1844, Syn. Char. Carb. Ls. Foss. Ireland, p. 150, pl. 21, figs. 6a-c.

Davidson (1858-63, pp. 80, 81) placed M'Coy's type species, *Actinoconchus paradoxus,* in synonomy with *Athyris planosulcata* Phillips, 1836. Many subsequent authors followed Davidson.

In the writer's opinion M'Coy's (1844, p. 150, pl. 21, figs. 6a-c), Phillips (1836, pl. 10, fig. 15), and Davidson's (1858-63, pp. 80, 81, pl. 16, figs. 2-13, 15) descriptions and illustrations do not appear to support Davidson's synonomy. *Actinoconchus paradoxus* may well prove to be a valid type species and the genus may have to be reappraised in order to determine its relationships to the other athyrid genera. Because to the writer's knowledge, interiors of *A. paradoxus* are unknown, assignment of species to this genus is speculative, although the interior details of the type species are in all likelihood similar to those of *A. planosulcata* as illustrated by Davidson (1882, p. 98).

Despite apparent differences in size, shape, and fold-sulcus development, *A. paradoxus* and *A. planosulcata* do share the diagnostic generic character, that is, the unusual lamellar development near the shell margin. This lamellar extension is broad, flat, and apparently imbedded with rather widely spaced thin flattened rods (or spines?).

The structure is so unlike the lamellar extensions of either *Athyris s. s.* or *Cleiothyridina* that it is probably proper to recognize *Actinoconchus* on that basis. Because the lamellar frill is so delicate and rarely preserved, assignment of species to the genus without a similar lamellar extension is speculative until such time as a complete generic description can be obtained.

Actinoconchus? sp. Pl. 42, figs. 7a-8e; Text-fig. 20

This problematical athyrid species is tentatively assigned to *Actinoconchus* M'Coy, 1844. It possesses lamellar extensions that are not spinose, and a slightly elongate outline, as does the type species of *Actinoconchus*. However, none of the specimens of this species is well enough preserved to be positive of even the external prosopon and as a consequence, generic as well as specific, assignment is difficult. In the writer's opinion it is likely that these few specimens represent a new species. Until larger collections are obtained, and until the exact status of *Actinoconchus* is known it is advisable to leave it unnamed and questionably assigned generically.

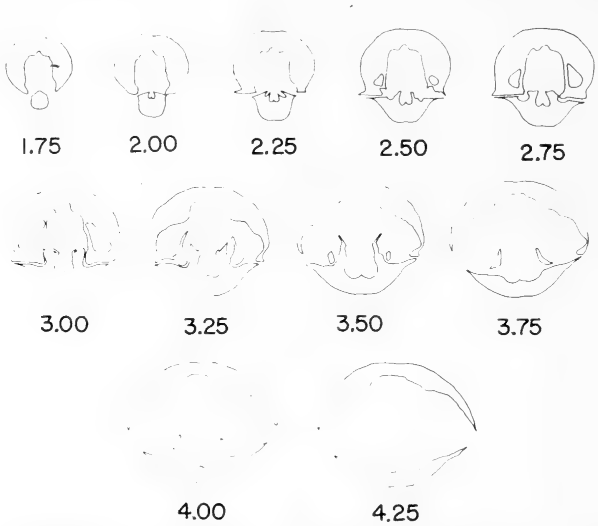
The following short description is based on the entire Chappel Limestone collection, consisting of two good but spalled specimens (figured), two other nearly complete shells, and three broken specimens, two of which were sectioned (one illustrated in Text-figure 20).

Shell of average size for athyrid genera; subequally biconvex; subcircular to slightly longitudinally subellipsoidal in outline, greatest width attained at or just anterior to mid-valve; profile lenticular; ventral beak small, incurved, with small rounded foramen touching the dorsal beak; delthyrium open but covered by dorsal valve; dorsal beak small, incurved, somewhat obscured by the ventral beak; ears small, slightly compressed, both valves evenly convex except for beaks and fold-sulcus; anterior commissure uniplicate; sulcus narrow, shallow; fold low, anteriorly flattened; prosopon poorly known but consisting of smooth lamellar extensions of unknown breadth; spalled shells show weak radial markings or costae on the fold and anterior portions of the flanks.

Interior of shell much thickened with columnar tissue.

Pedicle interior as in *Athyris*.

Brachial interior apparently without transverse hinge plate;



Text-figure 20.—Transverse serial sections of *Actinoconchus?* sp. ×2, USNM 154904 from USNM locality 9045, measurements (mm) from ventral beak.

inner socket ridges thick and high, supporting the crural bases; short median ridge present only in umbonal region.

Occurrence.—All seven specimens are from USNM locality 9045.

Genus **CLEIOTHYRIDINA** Buckman, 1906

1841. *Non Cleiothyris* Phillips, Paleozoic Foss. Cornwall, Devon, and West Somerset, p. 55. (*?Athyris* or unrecognizable).
1850. *Cleiothyris* Phillips, King, Palaeontogr. Soc., Mon. Permian Foss. England, pp. 137, 138.
1893. *Cleiothyris* Phillips, Hall and Clarke, Nat. Hist. New York, Pal., vol. 8, pt. 2, p. 90.
1906. *Cleiothyridina* Buckman, An. Mag. Nat. Hist., ser. 7, vol. 18, p. 324.
1914. *Cleiothyridina* Buckman, Weller, Illinois Geol. Sur., Mon. 1, pp. 472, 473.

Small to large, subequally biconvex, lenticular, transversely to longitudinally ellipsoidal in outline; ventral beak weakly to strongly incurved; foramen round, usually small to medium-sized, and somewhat obscured by beak curvature in some species; hinge line narrow, subterebratulid; delthyrium open, concealed by ventral beak; cardinal extremities rounded; both valves convex on the flanks, reflexing slightly postero-laterally near the ears of some species; anterior commissure uniplicate; fold and sulcus rounded, weakly to well developed anteriorly, usually obsolete or lacking posteriorly; prosopon consists of moderately broad extensions of the growth lamellae, the free edges of which are fringed with numerous flattened spines.

Pedicle valve interior as in *Athyris,* that is, with short thick dental plates, large teeth, poorly defined flabellate adductor scars, and well-defined narrow diductor scars.

Brachial valve interior of type species with an acutely triangular, apically perforate hinge plate; primary lamellae broadly united to crura, recurved, but not forming nooses; jugum similar to that of *Athyris;* spiralia pectinated on outer edges. In other species the hinge plate may be more subquadrate than triangular and the apical perforation may be large and triangular. Median ridge apparently present in all species.

Type species.—(By original designation). *Atrypa pectinifera* J. de C. Sowerby, 1841, Min. Conch., vol. 7, p. 14, pl. 616 (all figs.). Permian of England.

Distinguishing characters.—Cleiothyridina is characterized by its lamellar extensions, the free edges of which are fringed with numerous flattened spines.

Comparisons.—The distinctions between this and other athyrid genera are discussed under the genus *Athyris.*

Remarks.—King (1850, p. 137) used Phillips' name *Cleiothyris* for a group of shells formerly placed in *Atrypa* rather than a new name saying that it is "a step which has one recommendation in its favour, that of using up a synonym." He clearly designated the type species (p. 138) as *Atrypa pectinifera* J. de Carle Sowerby, 1841.

As Buckman (1906, pp. 323, 324) pointed out, Phillips' name *Cleiothyris* must remain invalid, as a *nomen nudum,* or it might be construed as a synonym of *Athyris* M'Coy. He proposed a new name, *Cleiothyridina,* because, "it seems to be generally agreed that the *A. Royssii* series requires a separate name from *A. concentrica,* . . ." Buckman then unfortunately designated *Athyris Royssii* Davidson (should be *Spirifer deroissyi* Léveillé), 1835, as type species. Davidson (1858, pt. V, p. 85) noted that some of his contemporary paleontolologists considered *A. deroissyi* and *A. pectinifera* synonymous, although he did not (pt. IV, pp. 21-23, pt. V, p. 85). Buckman may have been of such a mind or else he assumed that he could choose a new type species for his substitute name. Many subsequent authors have followed Buckman's designation causing some confusion. Article 67i of the International Code of Zoological Nomenclature requires that King's designation of type species be used.

King's original diagnosis did not include the diagnostic character of this genus, that is, the lamellae fringed with flat spines. Hall and Clarke (1893, pp. 90, 91) correctly diagnosed *Cleiothyris*, pointing out the importance of the spinose lamellae, but considered it a subgenus of *Athyris*. Since Weller (1914, pp. 472, 473) most authors have recognized *Cleiothyridina* as a genus, more or less using Hall and Clark's diagnosis, although many have mistakenly followed Buckman and considered *C. deroissyi* the type species.

Range.—Mississippian to Permian. Distribution cosmopolitan.

Cleiothyridina tenuilineata (Rowley) Pl. 16, figs. 8a-13e; Text-fig. 21

1900. *Athyris tenuilineata* Rowley, Am. Geol., vol. 25, p. 264, pl. 5, figs. 31-33.
1901. *Cleiothyris hirsuta,* Weller, St. Louis Acad. Sci., Trans., vol. 11, p. 187, pl. 16, figs. 25-27.
1914. *Cleiothyridina tenuilineata* (Rowley), Weller, Illinois Geol. Sur., Mon. 1, p. 478, pl. 80, figs. 1-12.
1937. (?) *Cleiothyridina tenuilineata* (Rowley), Nalivkin, Cent. Geol. Prosp. S.S.S.R., Trans., p. 126, pl. 38, figs. 7, 8.
1938. *Cleiothyridina tenuilineata* (Rowley), Branson, Univ. Missouri Studies, vol. 13, No. 3, p. 75, pl. 9, figs. 21, 22.
1956. (?) *Athyris* (*Cleiothyridina*) *tenuilineata* Rowley, Simorin, Akad. Nauk Kazakhstan S.S.S.R., Izd-vo, p. 217, pl. 20, figs. 9-12.

Small for the genus; subequally biconvex, neither valve much inflated; subcircular or slightly elongated transversely or longitudinally; maximum width attained near mid-length; profile lenticular; beaks small; hinge line short, subterebratulid; both valves evenly convex except for the beaks; anterior commissure rectimarginate; fold and sulcus usually lacking although there may be a narrow mesial flattening of one or both valves, or more rarely faint mesial grooves or sulcuses; growth lamellae closely spaced, fringed with numerous fine spines that are arranged in radial rows; spalled shells occasionally marked by faint costae (these presumably being impressions on inner layers of the radially arranged spines).

Pedicle valve moderately thin-shelled, greatest convexity near the beak; beak small, slightly incurved, with a small subcircular foramen which touches the brachial valve; delthyrium open, obscured by the brachial valve. Interior with short, thickened, slightly diverging dental plates that flare slightly antero-dorsally; teeth large, medially incurved under the lateral edges of the inner socket ridges; muscle scars indistinct.

Brachial valve thin-shelled; convexity variable, some spalled valves being tumid posteriorly and others low and evenly convex; dorsal beak small, narrow, slightly incurved, usually obscured by the ventral beak; fold lacking but a mesial flattening or weak groove common in spalled specimens. Interior with a small apical perforation; hinge plate subquadrate, short, with a mesial undulation; short median ridge present in umbonal region; two low, subparallel, closely set ridges flanking the median ridge and presumably marking the adductor muscle field.

Table 26.—Measurements in millimeters of *Cleiothyridina tenulineata* (Rowley).

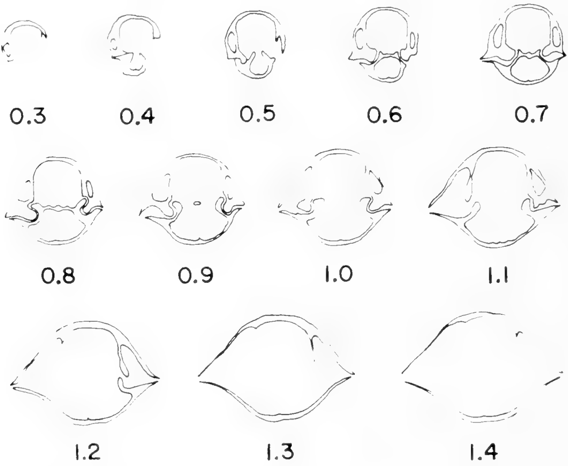
USNM No.	Length	Width	Thickness	USNM Locality
154590	12.8	12.7	6.3	9045
154591	10.7	11.8	5.8	9045
154592	10.1	10.1?	5.1	9045
154593	8.7	9.1	4.4	9045
154594	7.6	8.2	4.0	9047
154595	6.3	6.6	3.0	9047

Types.—Rowley based this species on 12 specimens from the Lower Burlington Limestone near Louisiana, Missouri. Apparently only metatypes, or topotypes identified by R. R. Rowley, were available to both Weller (1914, p. 478) and Branson (1938, p. 75). Eight probable topotype specimens are in the USNM collections.

Distinguishing characters.—This species is distinguished by its smaller size, subcircular or subellipsoidal outline, lenticular profile, subequally biconvex valves; rectimarginate anterior commissure; no fold and sulcus, although a mesial flattening may be present on one or both valves, and lamellar bands of fine spines arranged in radial rows.

Comparisons.—*Cleiothyridina tenuilineata* was considered by both Weller (1914, p. 478) and Branson (1938, p. 75) to be a possible or even probable synonym of *Cleiothyridina hirsuta* (Hall), 1856, from the St. Louis Limestone of Indiana and other Meramecian formations. The two species do seem to be closely related. However, *C. hirsuta* is ordinarily longer, has coarser spines, and commonly has a subpentagonal outline, especially in larger specimens.

Cleiothyridina parvirostra (Meek and Worthen), 1860, from the Keokuk Limestone of the Mississippi Valley, is somewhat similar to *C. tenuilineata*, but is considerably larger, has a subpentagonal outline, and a wider ventral beak.



Text-figure 21.—Transverse serial sections of *Cleiothyridina tenuilineata* (Rowley) ×5, USNM 154596, from USNM locality 9045, measurements in millimeters from ventral beak.

Cleiothyridina glenparkensis Weller, 1914, from the Fern Glen Formation of Missouri is much larger than *C. tenuilineata* and has a transversely elongated outline.

Remarks.—There does not appear to be much variation in shell shape during ontogeny. Eight probable topotype specimens from Louisiana, Missouri, corroborate this.

Occurrence and abundance.—This species is widely identified in most late Kinderhookian and early Osagian formations from the central and southwestern states. In the Chappel Limestone it was found at USNM localities 9045 (35 specimens), 9048 (4 specimens), and 9047 (3 specimens).

Cleiothyridina aff. **C. prouti** (Swallow) Pl. 32, figs. 1a-4e; Text-fig. 22

1860. *Spirigera Proutii* Swallow, St. Louis Acad. Sci., Trans., vol. 1, p. 649.
1881. (?) *Spirifera temeraria* Miller, Cincinnati Soc. Nat. Hist., Jour., vol. 4, p. 314, pl. 7, figs. 9-9b.
1894. *Athyris proutii* (Swallow), Keyes, Missouri Geol. Sur., vol. 5, p. 91.
1909. *Cleiothyris prouti* (Swallow), Weller, Geol. Soc. America, Bull., vol. 20, p. 314, pl. 14, figs. 12-15.
1914. *Cleiothyridina prouti* (Swallow), Weller, Illinois Geol. Sur., Mon. 1 p. 474, pl. 79, figs. 13-16.
1950. (*Non*) *Cleiothyridina prouti* (Swallow), Plummer, Univ. Texas, Pub 4329, pl. 5, figs. 21a-b.

The following description is based on five spalled but otherwise nearly complete specimens from the Chappel Limestone. One of these specimens was sectioned and is now preserved only as a plastic cast. The small number of Chappel specimens prevents the erection of a new species. G. A. Cooper collected several closely similar specimens from the Caballero Formation of New Mexico. That material has not been studied in detail.

Small to medium, subequally biconvex, both valves moderately inflated, lenticular to globular in profile, transversely subellipsoidal to subcircular in outline; both beaks considerably incurved, that of the brachial valve being obscured by the ventral beak; hinge line subterebratulid; cardinal extremities rounded, scarcely compressed; surfaces of both valves evenly convex except for fold and sulcus; anterior commissure uniplicate to parasulcate; fold and sulcus moderately to well developed in anterior half of shell; prosopon consisting of irregularly spaced growth varices and faint radial markings which presumably are inner shell impressions of radially arranged spines.

Pedicle valve thick-shelled, subconical in anterior profile; greatest convexity near the beak; surface with even curve anterior to beak and abruptly toward the posterior margin; foramen small and rounded, touching the brachial umbo; delthyrium open but obscured by incurvature of the beaks; interarea apparently lacking; median sulcus well developed, originating as a groove in the beak that widens and deepens gradually to the anterior margin, forming a moderate to deep rounded sulcus with rounded shoulders and in some cases a moderate tongue; sulcal angle highly variable in the specimens studied, averaging about 36 degrees.

Pedicle valve interior with short slender dental plates that converge slightly dorsad posteriorly, being subparallel anteriorly; bases of dental plates obscured by a thick deposit of shell tissue; teeth large, bladelike.

Table 27.—Measurements in millimeters of *Cleiothyridina* aff. *C. prouti* (Swallow), 1860.

USNM No.	Length	Width	Thickness	USNM Locality
154774	13.5?	14.7	10.2	9048
154775	12.7	14.9	8.7	9045
154776	12.8	13.6	9.2	9045
154778	11.3?	13.7	8.9	9045
154777	9.8	10.5	5.8	9045

Brachial valve with an inflated umbo; profile similar to that of the pedicle valve; beak small, incurved, and hidden by the ventral beak; surface evenly convex except for the fold-sulcus and beak area; fold highly variable, inconspicuous or lacking posteriorly and poorly to well developed anteriorly; fold when present, rounded, never flattened.

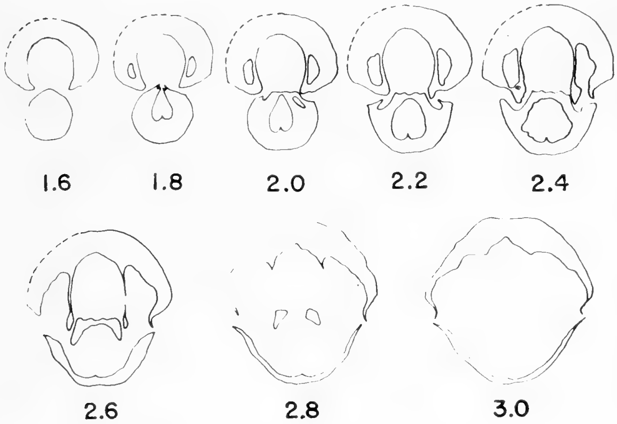
Interior of brachial valve with small apical perforation; hinge plate subquadrate; short median ridge present in umbonal region; muscle scars indistinct.

Distinguishing characters and comparisons.—*Cleiothyridina prouti s. s.* is characterized by its thick globular profile in adults, uniplicate to parasulcate commissure, rounded, well-developed fold and sulcus, and prosopon in which the flat spines of each lamella are arranged in a radial series, producing a characteristic fine reticulate pattern. In worn or occasionally even in spalled specimens, the surface may be weakly costate.

The Chappel-Caballero species approximates these characteristics, but it is smaller, has a greater length-width ratio, and both valves have relatively longer narrower umbones.

Cleiothyridina humerosa Stainbrook, 1950, from the Aplington Formation of Iowa is similar and related to these forms. It can be distinguished by its greater length-width ratio, better defined fold, more pronounced lateral sulci in the brachial valve, and a nonreticulate surface in worn or denuded shells.

Remarks.—The above mentioned closely related species appear, at least superficially, to form an off-shoot from the typical *Cleiothyridina* lineage, and it is possible that these species should be separated generically.



Text-figure 22.—Transverse serial sections of *Cleiothyridina* aff. *C. prouti* ×3, USNM 154774, from USNM locality 9048, measurements (mm) from ventral beak.

Occurrence and abundance.—Cleiothyridina prouti s. s., is a Fern Glen species. A similar form occurs in the Lake Valley Formation of New Mexico. S. A. Miller proposed a name for this Lake Valley form, *Spirifera temeraria* Miller, 1881, but it may prove to be a junior synonym of *C. prouti.*

The unnamed Chappel species also occurs in the Caballero Formation of New Mexico. It is not common in either formation.

Suborder SPIRIFERIDINA Waagen, 1883

Superfamily **CYRTIACEA** Frederiks, 1919 (1924)

Family **AMBOCOELIIDAE** George, 1931

Genus **CRURITHYRIS** George, 1931

Crurithyris parva (Weller) Pl. 33, figs. 1a-8e; Text-figs. 23, 24

1899. *Ambocoelia parva* Weller, Trans. St. Louis Acad. Sci., vol. 9, p. 20, pl. 4, figs. 1-4.

1914. *Ambocoelia parva* Weller, Weller, Illinois Geol. Sur., Mon. 1, p. 424, pl. 77, figs. 32-35.

The following description is based upon a large collection of spalled but otherwise complete specimens from the Chappel Limestone. Weller based *Ambocoelia parva* on only two pedicle valves which were preserved as external casts from the Northview Sandstone. The pedicle valve extensions are closely similar, and a comparison between the two forms is clearly in order. The obvious lack of dorsal valves and interiors of *C. parva* makes unequivocable identification difficult at the present time.

Smaller than average for the genus, unequally biconvex, the brachial valve being low but not flat; outline rounded, width usually slightly greater than length, greatest width at or near mid-length; hinge line straight; cardinal extremities rounded; ventral beak prominent, incurved, overhanging the hinge line, dorsal beak tiny, inconspicuous; both valves with a shallow median groove extending from the beaks to the anterior margin; anterior commissure rectimarginate; surfaces of both valves smoothly convex, except for the median grooves and umbonal regions; no external prosopon preserved in the specimens studied.

Pedicle valve subconical in posterior profile, greatest convexity posterior to the hinge line; ears faintly delimited by a slight compression or reflexing of the shell surface; interarea triangular, curved, apsacline delthyrium higher than wide, with narrow deltidial plates that are best seen in transverse sections.

Pedicle interior simple; teeth wide, bladeshaped, low median ridge present in the umbonal regions, sometimes extending forward to mid-valve.

Brachial valve low, gently convex in posterior profile; ears a little better defined than in the pedicle valve by a reflexing of the shell surface; dorsal beak narrow, small, set off by the reflexing that forms the ears; dorsal interarea low, anacline.

Table 28.—Measurements in millimeters of *Crurithyris parva* from USNM locality 9045.

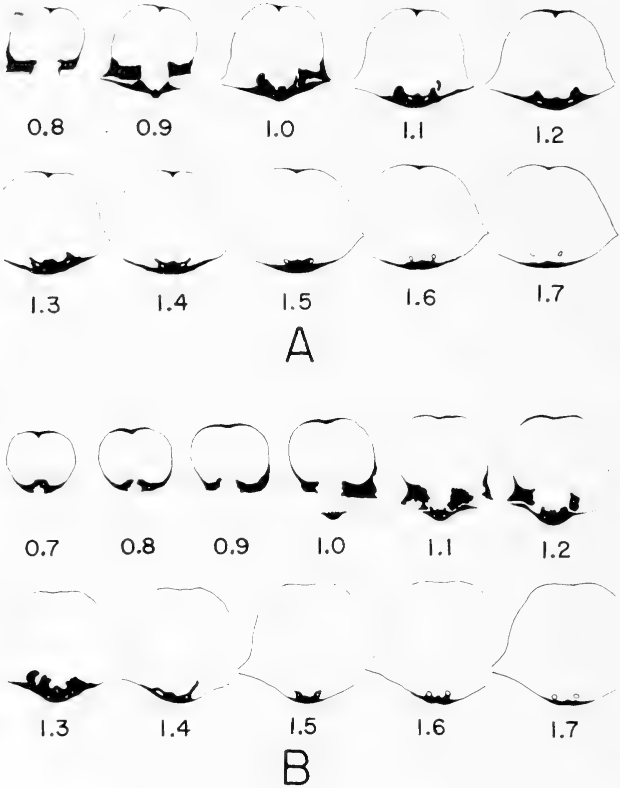
USNM No.	Length	Width	Thickness
154780	6.8	7.7	4.0
154781	6.8	7.0	3.9
154782	6.1	6.7	3.7
154783	5.7	6.0	3.1
154784	4.8	5.0	2.8
154785	4.0	4.6	2.6
154786	3.3	3.4	2.0
154787	2.6	2.8	1.7

Brachial interior with simple moderately large clublike cardinal process which rests on the floor of the valve near the hinge line; socket ridges large, thick, subparallel, diverging slightly, extending anteriorly from either side of the cardinal process, completely enclosing the crural bases which exist merely as rods lying on the floor of the valve; crural bases originating in the dorsal beak on either side of the cardinal process and emerging anterior to the socket ridges (see Text-figure 23); crura long, also rodlike or somewhat flattened; spiralia not observed; sockets nearly parallel to the hinge line, wide, delimited anteriorly by high fulcral plates; muscle impressions consisting of a low wide median ridge extending anteriorly from the cardinal process, two lower accessory ridges on either side of the median ridge, all of which form a thickened crest that extends forward to about mid-valve.

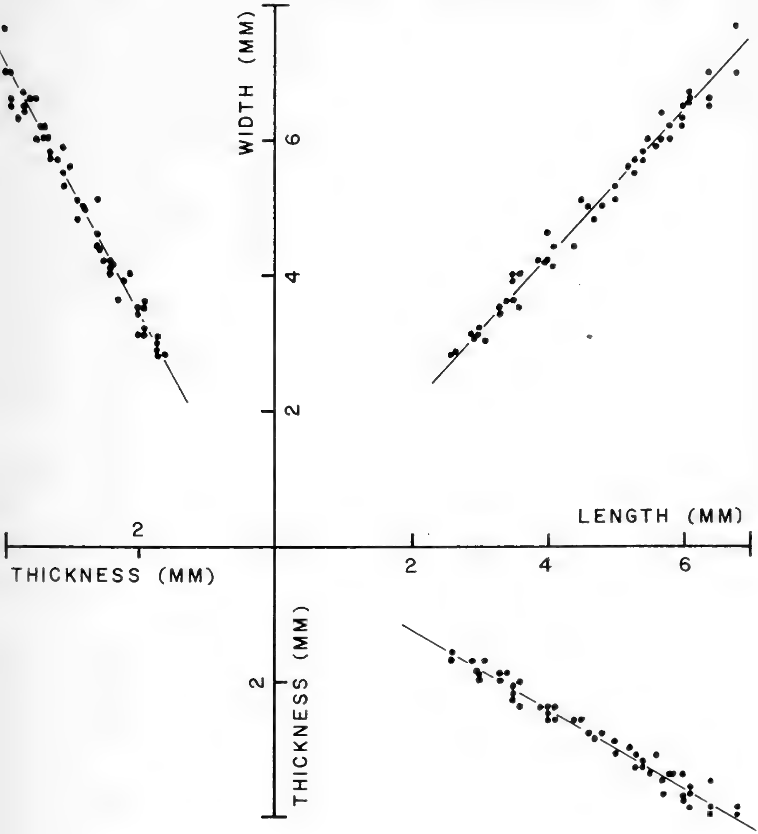
Comparisons.—According to Weller (1914, p. 425) *Ambocoelia parva* differs from *A. minuta* White, 1862, "in its larger size, its less gibbous pedicle valve with the umbonal region projecting farther posteriorly, and in the absence of the covering of fine surface spines." The last named distinction is probably not valid but a limitation of the mode of preservation of Weller's specimens.

The Burlington species, *Ambocoelia laevicula* Rowley, is similar to *C. parva* but is transversely elongated, with a weakened ventral sinus, and the ventral beak does not extend far beyond the hinge line.

Remarks.—Although a large collection of specimens of this



Text-figure 23.—Transverse serial sections of *Crurithyris parva* (Weller) ×6, measurements (mm) from ventral beak. (A) An average specimen, USNM 154788 from USNM locality 9047, showing the median ridge in the pedicle valve and rodlike crural bases originating near the dorsal beak. (B) Another specimen, USNM 154789 from USNM locality 9045, with a short ventral median ridge and a subdelthyrial plate.



Text-figure 24.—Scatter diagrams of dimensions of *Crurithyris parva* (Weller) from USNM locality 9045.

species is available from the Chappel Limestone collections, observations of ontogeny proved to be unsatisfactory. Text-figure 24 shows how little the form varies in its proportions at various growth stages.

Because most specimens have a recrystallized matrix inside, preparation of transverse sections proved to be a laborious task, too difficult in fact to derive much information about the development of various internal structures.

Occurrence and abundance.—This form is common at USNM localities 9045, 9043, 9046, and somewhat less common at locality 9047, and 9048. The collection from locality 9045 consists of over 150 good specimens.

Superfamily **SUESSIACEA** Waagen, 1883

Family **CYRTINIDAE** Frederiks, 1912

Genus **CYRTINA** Davidson, 1858

Cyrtina burlingtonensis Rowley Pl. 34, figs. 1a-8e; Text-figs. 25, 26

1893. *Cyrtina burlingtonensis* Rowley, Am. Geol., vol. 12, p. 308, pl. 14, figs. 15-17.

1914. *Cyrtina burlingtonensis* Rowley, Weller, Illinois Geol. Sur., Mon. 1, pp. 288, 289, pl. 35, figs. 22-31.

1958. *Cyrtina burlingtonensis* Rowley, Sanders, *in* Easton, *et. al.,* Smith. Misc. Coll., vol. 119, No. 3, pp. 63, 64, pl. 7C, figs. 9-24.

Although this well-known little cyrtinid species is easily recognized from exteriors, none of the authors cited above has given a complete description including interiors of both valves.

Smaller than average for the genus, unequally biconvex, hemipyramidal, slightly wider than long, with the greatest width near the hinge line; cardinal extremities small and rounded; ventral beak large, incurved over the apex of the interarea; anterior commissure uniplicate to parasulcate; fold and sulcus moderately developed, narrow, and rounded; macroprosopon consisting of three coarse rounded costae per ventral flank (two per dorsal flank), the lateral ones being relatively weak, and irregularly spaced growth varices, which are usually crowded near the anterior margin; entire shell coarsely punctate.

Pedicle valve deep with convex lateral slopes; greatest convexity posterior to mid-length; interarea clearly defined, high, curved, triangular; delthyrium narrow, covered by a convex pseudodeltidium which is pierced by an elongate moderately large foramen; sulcus narrow and shallow, originating as a groove in the beak; bounding costae much stronger than those on the flanks.

Table 29.—Measurements in millimeters of *Cyrtina burlingtonensis* from the Chappel Limestone.

USNM No.	Length	Width	Thickness	USNM Locality
154797	9.9	10.9	6.9	9045
154798	8.4	10.0	5.8	9047
154799	8.8	9.0	5.4	9045
154800	6.3	6.6	4.4	9045
154801	5.3	5.8	3.5	9045
154802	4.3	4.8	2.9	9045
154803	3.9	4.2	2.7	9045
154804	2.8	3.1	1.9	9045

Pedicle valve interior with short convergent dental plates and a high long median septum, forming a spondylium and tichorhinum; teeth small; muscle scars indistinct.

Brachial valve low with slightly concave lateral extremities, forming small ears; greatest convexity near the small inconspicuous dorsal beak; fold low, rounded, originating in the dorsal umbo; delineated by disproportionately wide deep bounding grooves.

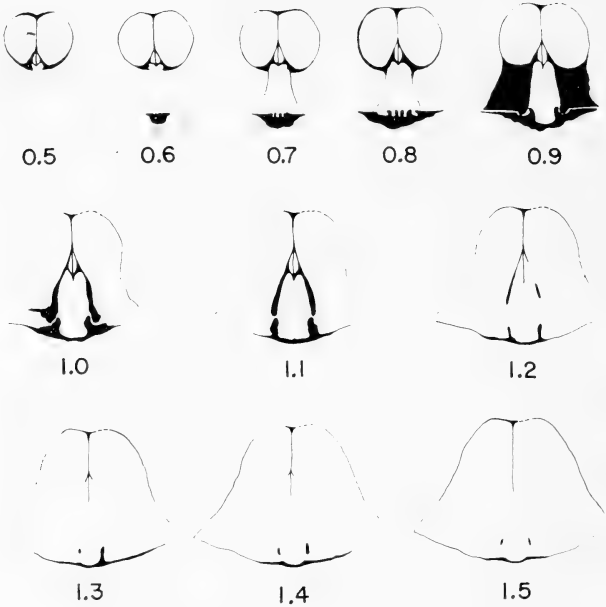
Brachial interior with low bifid cardinal process composed of two coarse vertical plates and resting on the floor of the valve; socket ridges large, relatively high, nearly vertical, enclosing the posterior portions of the crural plates, which extend anteriorly directly from the anterior portions of the socket ridges; crura narrow but thickened, low; muscle impressions formed in depression between two low subparallel ridges which extend forward from the anterior edges of the socket plates; spiralia and jugum unknown.

Holotype.—Rowley's holotype is presumably in the University of Illinois collections.

Distinguishing characters.—*Cyrtina burlingtonensis* is characterized by its nearly equal length and breadth, few costae, and rounded ears.

Comparisons.—*Cyrtina acutirostris* (Shumard), 1855, from the Louisiana Limestone of Missouri, is wider, has more numerous costae, angular ears, and extremely disproportionately large sulcus bounding costae.

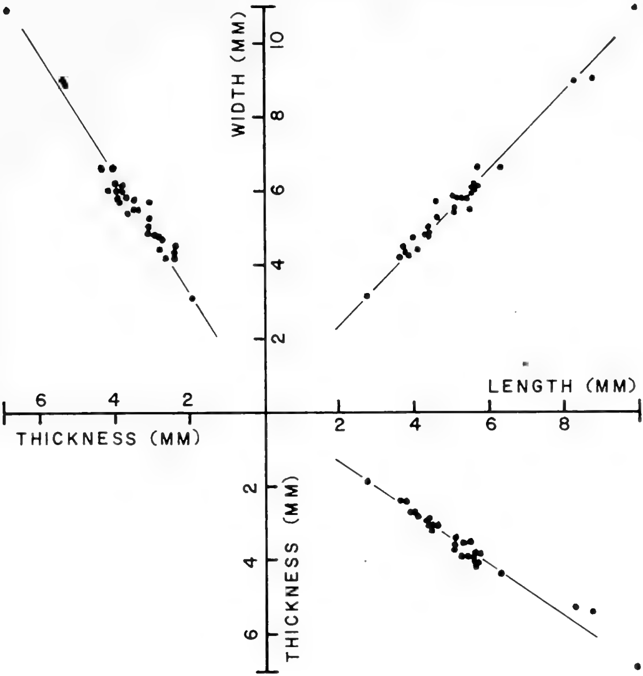
Remarks.—Observations of growth varices, as well as measurements of some 30 individuals from USNM locality 9045, show that



Text-figure 25.—Transverse serial sections of *Cyrtina burlingtonensis* Rowley ×6, USNM 154805 from USNM locality 9045, measurements (mm) from ventral beak.

most of the specimens are remarkably similar in their proportions and general appearance in all known growth stages. The smallest specimen in the Chappel Limestone collection has only two costae per ventral flank but except for size this is the only discernible difference between it and the largest specimen, which has three costae per flank. As Sanders (1958, p. 64) pointed out, there are some differences in the outline and profile of the pedicle valves (of larger specimens) due to variation in growth rate of the anterior margin.

Occurrence and abundance.—Seventy specimens from locality 9045 constitute the only adequate collection from the Chappel Lime-



Text-figure 26.—Scatter diagrams of dimensions of *Cyrtina burlingtonensis* Rowley from USNM locality 9045.

stone. Localities 9047 and 9048 have yielded one good specimen each.

Superfamily **SPIRIFERACEA** King, 1846

Family **MUCROSPIRIFERIDAE** Pitrat, 1965

Genus **TYLOTHYRIS** North, 1920

1920. *Tylothyris* North, Quart. Jour. Geol. Soc., London, vol. 76, p. 195.

Spiriferoid, small to medium-sized, biconvex; pedicle valve more inflated than the brachial; transversely elongated in outline, greatest width at or just anterior to the hinge line; ears angular or somewhat rounded; hinge nondenticulate; anterior commissure uniplicate; fold and sulcus moderately to well developed, noncostate; flanks costate, the costae being simple and subangular or rounded; surface lamellose or imbricate but not capillate or spinose; impunctate.

Pedicle valve subconical in anterior profile; lateral slopes gently convex or almost flat; beak small and usually slightly incurved; interarea sharply defined, low to high, flat to curved, smooth; delthyrium higher than wide, apparently open.

Pedicle valve interior with short divergent dental plates and apical callosity; median septum well developed and longer than the dental plates.

Brachial valve gently convex; fold low posteriorly, flattened and elevated anteriorly; dorsal interarea low and obscured by the pedicle valve.

Brachial valve interior with a spiriferoid cardinal process and a short low median ridge; spiralia and jugum unknown.

Type species.—(By original designation) *Cyrtia laminosa* M'Coy, Syn. Characters Carb. Limestone Fossils of Ireland, p. 137, pl. 21, fig. 4.

Distinguishing characters.—This genus is characterized by its high subconical pedicle valve and low gently convex brachial valve, short dental plates and well-developed median septum in the pedicle valve, a nondenticulate hinge, the noncostate fold and sulcus, and simple imbricate growth lamellae.

Comparisons.—In Mississippian strata *Tylothyris* can be confused only with *Punctospirifer* North, 1920, "*Spiriferina*" d'Orbigny, and *Amesopleura*, n. gen. The first two genera are coarsely punctate and can be easily distinguished on that basis. Forms assigned herein to *Amesopleura* can be distinguished by their denticulate hinge, capillate microprosopon, and lack of a true ventral median septum.

Range.—? Upper Devonian, Mississippian (Lower Carboniferous). The species assigned to *Tylothyris* from the Upper Devonian of North America are somewhat different from Mississippian forms and may not belong in this genus.

Tylothyris brevaurita, n. sp. Pl. 35, figs. 1a-9e; Text-figs. 27, 28

Small for the genus; biconvex, the pedicle valve considerably more inflated than the brachial; transversely elongated, subquadrate to semielliptical in outline; maximum width attained posterior to mid-length or near the hinge line; ventral beak of moderate size and incurved; dorsal beak inconspicuous or lacking; hinge brachythyrid; ears small, subangular, attenuated, and slightly or negligibly compressed; anterior commissure uniplicate, almost parasulcate; fold and sulcus moderately developed, rounded; prosopon consisting of four or rarely five simple rounded costae per ventral flank (and three or four per dorsal flank), and evenly spaced imbricating growth lamellae, there being about two or three per millimeter.

Pedicle valve subconical in posterior profile, the flanks sloping evenly to the anterior margin; interarea sharply defined, smooth, concave, and relatively low; delthyrium open; sulcus originating in the beak as a well-defined groove, widening evenly to form a sulcal angle of about 25 degrees at the anterior margin; bounding costae noticeably larger than those of the flanks.

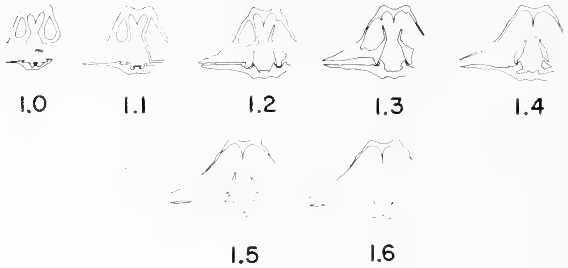
Table 30.—Measurements in millimeters of *Tylothyris brevaurita*, n. sp. from USNM locality 9045.

USNM No.	Length	Width	Thickness
154812	7.5	10.9	5.1
154813	7.6	10.5	5.2
154814	7.4	9.5	4.9
154815	6.4	8.7	4.0
154816	5.6	8.3	3.6
154817	5.3	7.7	3.6
154819	4.4	5.9	3.0
154820	3.6	4.9	2.4

Pedicle valve interior with short slender subparallel dental plates; median septum of moderate height, long, extending anteriorly about one-third to one-half the length of the valve; apical callosity relatively small; teeth small.

Brachial valve low, gently convex, ears slightly compressed; dorsal interarea low and inconspicuous; fold low, originating as a simple costa posteriorly but being delineated by costal grooves that are somewhat deeper than those of the flanks; fold rising anteriorly and becoming flattened.

Brachial valve interior with a flattened cardinal process that is supported by an umbonal callosity; crural plates wide, obliquely



Text-figure 27.—Transverse serial sections of *Tylothyris brevaurita*, n. sp. ×3, USNM 154821 from USNM locality 9045, measurements (mm) from ventral beak.

imbedded on their inner edges in fibrous shell tissue; short low median ridge present in dorsal umbo; spiralia unknown.

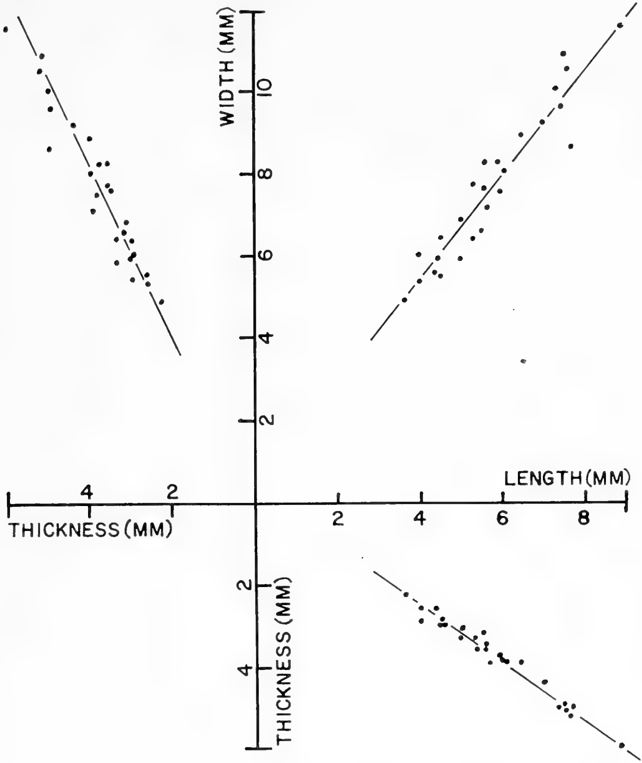
Holotype.—USNM No. 154813, Plate 35, figs. 2a-e.

Distinguishing characters.—This species is characterized by its small size, subquadrate to semielliptical outline, small subangular attenuated ears, four or rarely five costae per ventral flank, and prominent bounding costae and grooves.

Comparisons.—*Tylothyris brevaurita* is distinctive and easily recognized in the Chappel Limestone collections. Forms from other strata bear some resemblance to it but are usually easily distinguished in the following manner.

Tylothyris clarksvillensis (Winchell), 1865, from the Louisiana Limestone of Missouri, is larger with a rounded semicircular outline, the brachial valve is more convex, its ears are angular or somewhat rounded but not attenuated, the sulcus is narrower, and the fold-sulcus bounding costae and grooves are not significantly different in size from those of the flanks.

Delthyris missouriensis Weller, 1906, from the Glen Park Limestone and Hamburg Oolite of Missouri, and possibly Chappel Limestone of Texas, is also larger with a semicircular outline, lacks prominent fold-sulcus bounding costae and grooves, its ears are narrowly rounded and not attenuated and the brachial valve is more convex than in *T. brevaurita.*



Text-figure 28.—Scatter diagrams of dimensions of *Tylothyris brevaurita*, n. sp. from USNM locality 9045.

Delthyris farmeri Branson, 1938, from the Bushberg Sandstone of Missouri, has a much more convex brachial valve, six to eight costae per flank, and the bottom of the sulcus is flattened.

Remarks.—An examination of 27 good specimens of various sizes from USNM locality 9045 failed to reveal any significant morphological differences between the larger and smaller specimens. The ears in small specimens are often not so sharply attenuated as in large specimens, but otherwise there is little external difference between large and small specimens. Information on the ontogeny of the interior details is unfortunately lacking due to the poor preservation of the interiors of most specimens. Scatter diagrams comparing measurements of the above mentioned specimens from locality 9045 are illustrated in Text-figure 28.

Occurrence and abundance.—Identifiable specimens of *T. brevaurita* have been found only at USNM localities 9042, 9043, 9045, and 9047. It is common only at locality 9045; this collection consisting of the 27 measured shells plus several scores of fragmentary specimens or disarticulated valves.

Tylothyris cf. **T. missouriensis** (Weller) Pl. 34, figs. 9a-9e

1906. *Delthyris missouriensis* Weller, St. Louis Acad. Sci., Trans., vol. 16, p. 445, pl. 6, figs. 23-26.

1914. *Delthyris missouriensis* Weller, Weller, Illinois Geol. Sur., Mon. 1, p. 302, pl. 36, figs. 9-14.

1922. (*Non*) *Delthyris missouriensis* Tansey, Missouri Bur. Geol. Mines, vol. 17, p. 199, pl. 51, figs. 1-11 (primary homonym).

1938. (In part) *Delthyris clarksvillensis,* Branson, Univ. Missouri Studies, vol. 13, No. 3, p. 137, pl. 16, fig. 10, *non* fig. 9.

1938. *Delthyris suborbicularis,* Branson, Univ. Missouri Studies, vol. 13, No. 3, pl. 16, figs. 12, 13.

Several problematical specimens of *Tylothyris* from USNM locality 9045 appear to be comparable to *Tylothyris missouriensis* described by Weller. The Chappel Limestone collection consists of only one complete specimen and 15 fragmentary or poorly preserved similar specimens, some of which may not be conspecific.

The illustrated specimen agrees in most respects to Weller's description although an accurate comparison is impossible, mainly because of the small collections available for comparison.

The only discrepancy between this specimen and Weller's description is in the nature of the growth lamellae. Weller described *T. missouriensis* as having three or four lamellae per millimeter whereas the specimen illustrated here has much coarser, more widely spaced lamellae, there being about two per millimeter or three per two millimeters.

Genus **AMESOPLEURA,** n. gen.

(*A,* Gr., without; *mesos,* Gr., middle; *pleuron,* Gr., rib)

Moderately to strongly biconvex, fusiform to subellipsoidal; outline subtrigonal, transversely elongated, greatest width at the hinge line; both beaks, especially the ventral, considerably incurved giving a nearly ovate lateral profile in adult specimens; cardinal extremities often somewhat mucronate, not much compressed; posterior portions of shell evenly convex except near the hinge line and beaks, convexity even or increasing considerably anteriorly forming a truncated anterior margin; anterior commissure uniplicate, lateral commissure straight or slightly curved; fold and sulcus relatively narrow, noncostate; fold low, often flattened, not elevated posteriorly, becoming moderately elevated anteriorly, often with a shallow or obscure median groove; sulcus shallow, rounded, originating in the beak as a narrow but deeply impressed groove, delineated by bounding costae that are slightly to considerably larger than those of the flanks; flanks costate, costae simple, rounded and radiating from near the beak, originating posteriorly near the edge of the ventral interarea; surface lamellose or imbricate and capillate; impunctate.

Pedicle valve more inflated than the brachial valve; beak small, strongly incurved; surface evenly convex or with slight reflexing near the ears; interarea low, sharply defined, acutely triangular or narrowly rectangular, vertically grooved, often truncated at the lateral extremities; hinge line denticulate; delthyrium apparently open or partially filled with columnar tissue deposits.

Pedicle valve interior with slender moderately long dental plates that originate in the beak and extend anteriorly along the inner grooves formed by the external sulcus-bounding costae; dental plates considerably thickened by columnar shell tissue; dental flanges convergent and partially buried within the dental plates; median ridge usually poorly developed.

Brachial valve inflated but less convex than the pedicle valve; beak small; interarea low, triangular; notothyrium more or less closed by the cardinal process; inner edge of interarea pitted, forming tiny sockets for the denticles.

Brachial interior with spiriferoid cardinal process, supported by a thick, elongate mass of columnar or fibrous shell tissue, deposited between two platelike ridges that usually extend one-third to one-half the length of the valve along the inner crests of the fold-bounding grooves; these platelike ridges may be obscured by massive columnar tissue deposits supporting the cardinalia but can invariably be distinguished in thin sections or cellulose peels.

Type species.—*Spirifera novamexicana* Miller, 1881, Cincinnati Soc. Nat. Hist., Jour., vol. 4, p. 314, pl. 7, figs. 10-10b. Lake Valley Formation (Osagian) of New Mexico.

Distinguishing characters.—This genus can be distinguished externally from related genera by its elongate narrowly rectangular interarea, moderately incurved ventral beak, slightly mucronate ears, and somewhat disproportionately large sulcus-bounding costae (a weak median groove in the dorsal fold ?). Internally, the dental plates are long, set close together, and follow the inner surfaces of the sulcus-bounding costae, and the cardinalia are supported by a thick elongate mass of shell tissue deposited more or less between two platelike ridges that usually extend forward one-third to one-half the length of the valve.

Comparisons[1].—*Amesopleura* is most similar to *Strophopleura* Stainbrook, 1947, from the Percha Shale (Upper Devonian) of New Mexico; *Eleutherokomma* Crickmay, 1950, from the Middle and Upper Devonian of North America; *Acuminothyris* Roberts, 1963,

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[1] After this genus was in manuscript the author was informed of the establishment of a similar new genus, *Voiseyella* Roberts, 1964, from the Middle Viséan of Australia. Roberts assigned only the type species, *Strophopleura anterosa* Campbell, 1957, to his genus although he noted the external similarity between the latter and *Spirifer mundulus* Rowley from the Burlington Limestone of Missouri. The cursory diagnosis given by Roberts fits in general many delthyrid and spiriferid genera. His (pl. 3, figs. 1-7) and Campbell's (1957, pl. 15, figs. 15-23) illustrations of the type species leave much to be desired in terms of showing interior details, and serial sections have not been illustrated. From these illustrations there is no indication that the brachial valve of *Voiseyella* possesses a thick elongate mass of shell tissue deposited between two platelike ridges as in *Amesopleura*, a difference that the writer considers to be of generic importance.

The Chappel Limestone species described herein, *Amesopleura texana*, in some respects is more similar externally to *Voiseyella anterosa* than to *Amesopleura novamexicana*. However, early growth stages of the Texas and New Mexico species are remarkably similar and the brachial interiors of adults are comparable.

No North American species can be unequivocably assigned to *Voiseyella* Roberts, although admittedly the interiors of few spiriferoid species are known from Mississippian strata.

from the Upper Tournaisian of New South Wales, Australia; and *Pterospirifer* Dunbar, 1955, from the Permian of Greenland, the Arctic, and Europe.

Strophopleura has a peculiarly discordant costation on the flanks of both valves and is distinguishable on that basis alone. Internally it also has short buried dental plates that can be seen only in transverse sections. In the dorsal valve the cardinal process is partially supported by shell tissue posteriorly and the longitudinal ridges on the crests of the fold-bounding grooves are low and inconspicuous. Furthermore, the unsupported or free end of the cardinal process splits medially and is attached to the socket and crural plates by layers of fibrous shell tissue that are wrapped around free portions of the latter structures.

Eleutherokomma looks much like *Mucrospirifer* hence can be distinguished by its extremely mucronate ears and regular imbricate prosopon. Internally the cardinal process is essentially unsupported and there does not appear to be any prominent longitudinal ridges on the fold-bounding grooves.

Acuminothyris has regular lamellae and acutely angular, but never mucronate, ears. Internally the dental plates are short, set relatively far apart, and do not follow the sulcus-bounding costae, and the callus supporting the cardinal process is relatively short. The ventral interarea is acutely triangular and the ventral beak is strongly incurved over the dorsal umbo.

Pterospirifer is relatively large, the sulcus has a low narrow median rib or ridge as does the dorsal fold, and the ventral interarea is relatively high and nearly flat.

Amesopleura can easily be distinguished from similar appearing but unrelated delthyridid and mucrospiriferid genera by its denticulate hinge and capillate microprosopon.

Remarks.—Assignment of species to the genus, besides the type, is particularly frustrating due to the lack of interior details and knowledge of microprosopon for most similar species. However, it is possible to assign with little equivocation a new species from the Chappel Limestone, *Amesopleura texana*, n. sp.

Sanders (1958) described a brachial valve from the Represso Limestone of Sonora, Mexico, as *Tylothyris* ? sp. that belongs here. *Spirifera mundula* Rowley, 1893, from the Lower Burlington Limestone of Missouri should probably be assigned to *Amesopleura*, but unfortunately the holotype is too poorly preserved to determine the nature of the prosopon. *Spirifer piersonensis* Moore, 1928, from the Pierson Limestone of Missouri may also eventually be assigned to this genus. However, the holotype is apparently the only specimen known and it is not well preserved. In the USNM collections there are several poorly preserved specimens of a large species from the Borden Group of Indiana and Kentucky that shows affinities with *Amesopleura*. It and other Borden forms often called *Spirifer novamexicana* may eventually be assigned here. An undescribed species from the Caballero Formation of New Mexico may also be placed in this genus at a later time.

The geniculation of one or both valves in the type species of this genus may prove to be more significant than is regarded here. Also, the nature of the shell tissue that supports the cardinalia seems to be different in the type species from that of the Chappel Limestone species. It is possible that recrystallization has taken place in the type species, and it is true that the shells are partially silicified, which may indicate that the shells were treated to some chemical alteration even in the nonsilicified limy tissues. If unaltered shells unequivocally show that the cardinalia supporting tissue is columnar and not fibrous as in *Amesopleura texana*, n. sp., then this may be another reason for further subdivision of the genus, although Williams and Rowell (1965, p. 64) considered the third shell layer (called columnar herein) to be ". . . simply a modification of the secondary layer."

Range. — Lower Mississippian.

Amesopleura novamexicana (Miller) Pl. 33, figs. 9a-12e; Text-fig. 29

1881. *Spirifera novamexicana* Miller, Cincinnati Soc. Nat. Hist., Jour., vol. 4, p. 314, figs. 10-10b.
1909. (?) *Spiriferina magnicostatus* Weller, Geol. Soc. America, Bull., vol. 20, p. 307, pl. 13, figs. 12-15.
1914. *Delthyris novamexicana* (Miller), Weller, Illinois Geol. Sur., Mon. 1, pp. 304, 305, pl. 36, figs. 15-24.
1930. *Delthyris novamexicana* (Miller), Croneis, Arkansas Geol. Sur., Bull. 3, pl. 11, figs. 21-23.
1938. (?) *Delthyris novamexicana* (Miller), Branson, Univ. Missouri Studies, vol. 13, No. 3, p. 58, pl. 6, figs. 8-10.
1938. (?) *Delthyris novamexicana* (Miller), Branson, Univ. Missouri Studies, vol. 13, part 4, pp. 21, 22, pl. 22, figs. 3-8.

1947. (*Non*) *Tylothyris novamexicana* Stainbrook, Jour. Paleont., vol. 21, p. 323, pl. 47, figs. 31-33.
1950. (*Non*) *Delthyris novamexicana,* Plummer, Univ. Texas, Pub. 4329, pl. 5, fig. 11.
1962. (?) *Tylothyris* cf. *T. novamexicana* (Miller), Armstrong, New Mexico Bur. Mines Min. Res., Mem. 8, p. 53, pl. 6, fig. 26.

Although this species name has been applied by various authors, as seen in the summary above, a proper description based on a reasonably large collection and including interior details has never been given. Such a description based on several dozen fairly good topotype (or presumably topotype) specimens from Apache Hill near Lake Valley, New Mexico, is given below in order to establish the new genus *Amesopleura* more satisfactorily.

Slightly smaller than average size for the family; subequally biconvex, the pedicle valve is somewhat more inflated than the brachial; considerably transversely elongated in outline, the greatest width at the hinge line, the length-width ratio is approximately 0.43; lateral profile subovate; ventral beak small to moderate in size and incurved over the apex of the delthyrium; dorsal beak small or obscure; ears slightly mucronate in earlier growth stages, becoming acutely angular in adults, often slightly compressed anterior to the ventral interarea; convexity of both valves uneven in adults, the valves bending sharply toward each other posterior to mid-length, forming a gently convex anterior surface, the two valves meeting each other at a high angle; anterior commissure uniplicate, almost parasulcate in some specimens; fold and sulcus narrow, moderately developed; macroprosopon consists of regularly spaced subimbricate growth lamellae about 4-5 per millimeter (anterior to the abrupt change in growth direction, the lamellae may be less regularly spaced), irregular corrugations or growth varices, and seven to nine simple costae per flank in large specimens; microprosopon consists of fine capillae about 20 per millimeter and faint rarely preserved, growth lines that form a reticulate pattern when viewed under high magnification.

Pedicle valve subconical in posterior profile, lateral slopes appearing weakly concave in most specimens; greatest convexity anterior to mid-length at the point of geniculation; sulcus shallow, rounded, originating as a narrow groove at the beak and forming a small tongue anteriorly; sulcus bounding costae noticeably larger than those of the flanks, especially in juvenile specimens; sulcal angle about 18-19 degrees; interarea low, catacline to slightly procline in adults, apsacline to catacline in juveniles, curved, often vertically grooved, narrowly subrectangular, the extremities being abruptly truncated; delthyrium triangular, higher than wide, with what appears to be a short thin strongly convex plate at the apex and a thick longer plate beneath it that protrudes above the edges of the delthyrium nearer the hinge line (the shell tissue that makes up this lower plate appears to be continuous with that of the dental plates) but leaving most of the delthyrium open.

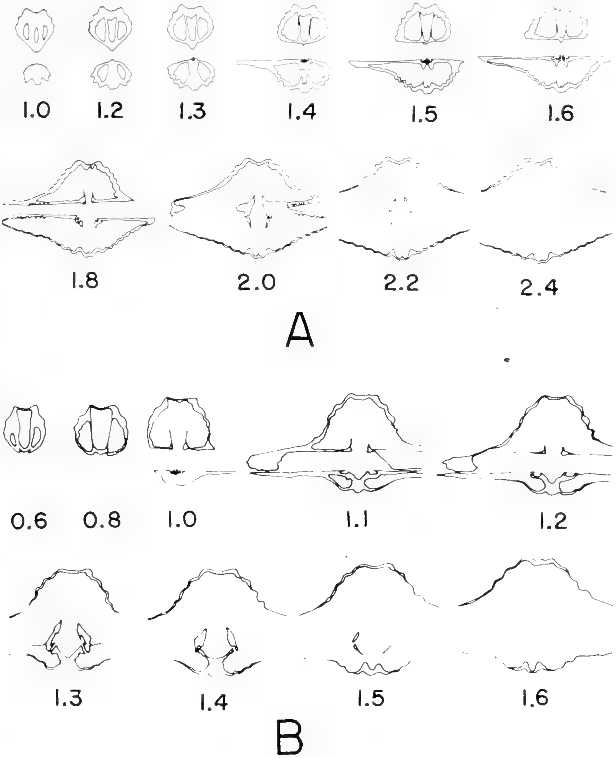
Table 31. — Measurements in millimeters of *Amesopleura novamexicana* (Miller) from Apache Hill, 1 mile North of Lake Valley, New Mexico.

USNM No.	Length	Width	Thickness
154791	9.3	24.2?	8.9
154792	10.3	20.1	8.9
154793	7.4	18.4?	7.5
154794	7.8	18.3	7.2

Pedicle valve interior with slender moderately long closely set dental plates that are mostly composed of columnar tissue and which follow the inner trace of the sulcus-bounding costae; median ridge low or often lacking; dental flanges short, oblique, with thin ventral tips enclosed by the dental plates; teeth small, pointed; hinge line denticulate.

Brachial valve less inflated than the pedicle valve, more convex in posterior profile, also geniculate anterior to mid-length but often to a lesser degree; dorsal interarea low, acutely triangular, orthocline or slightly apsacline; fold low, narrow, with a distinct median groove that originates very near the dorsal beak.

Brachial valve interior with spiriferoid cardinal process composed of eight plates, closely set inner socket ridges which are medianly bounded by vertical crural plates; sockets small; cardinalia supported by a high thick mass of shell tissue (not a septum) which divides under the cardinal process forming two prominent ridges that follow the fold-bounding grooves for about one-third to one-half the length of the valve (these ridges can ordinarily be seen externally through the fibrous shell layers and appear as dark lines); median ridge well developed, obscured posteriorly by the above



Text-figure 29.—Transverse serial sections of *Amesopleura novamexicana* (Miller) from Apache Hill, 1 mile north of Lake Valley, New Mexico. (A) Large specimen, USNM 154795, ×2, showing mature internal structures. (B) Juvenile specimen, USNM 154796, ×4, showing a solid mass of shell tissue supporting the cardinalia, and short dental plates.

mentioned mass of shell tissue; muscle scars not distinguishable in section; spiralia not preserved in material sectioned.

Types.—S. A. Miller's types are apparently lost. Weller illustrated three specimens from Lake Valley, New Mexico. Two of these are now in the Field MNH collections and one specimen presumably is in the Yale Peabody Museum.

Distinguishing characters.—This species is characterized by its relatively small length-width ratio, the abrupt geniculation of both valves in adults, seven to nine costae per flank, the narrowly subrectangular procline to catacline ventral interarea with abruptly truncated lateral extremities in adults, slender closely set dental plates, short dental flanges, closely set socket plates and vertical crural plates.

Comparisons.—This species is not easily confused with other forms of *Amesopleura* despite the broad application of the species name by earlier workers. *Amesopleura texana,* n. sp., from the Chappel Limestone has a larger length-width ratio, evenly convex valves, apsacline ventral interarea, thicker dental plates, longer dental flanges and more widely spaced socket plates. *Strophopleura anterosa* Campbell, 1957, from the upper Tournaisian of New South Wales is smaller, has fewer costae, and lacks a median groove in the fold.

Remarks.—The status of *Spiriferina magnicostatus* Weller, 1909, is uncertain. Two specimens of lamellose spiriferoids from the Fern Glen Formation in the USNM are similar externally to Weller's syntypes. They are too poorly preserved for certain identification, but they and Weller's syntypes appear to be juveniles of *A. novamexicana*. It seems that only a large collection of the Fern Glen Formation can resolve the status of *Spiriferina magnicostatus* and in the meantime it is left as a questionable synonym of *A. novamexicana*.

Observations on the ontogeny of this species are restricted by a lack of good juvenile specimens and otherwise poor exterior preservation of most of the USNM specimens. Few specimens have even one ear completely intact making width measurements impossible. For this reason only the four illustrated specimens were measured although many otherwise excellent specimens were available for study.

Growth varices on several specimens indicate that the outline changed little during ontogeny. The most significant ontogenetic changes noticed are these: 1. The dental plates apparently developed late in ontogeny and are short except in large adults; 2. The geniculation of both valves occurs late in ontogeny occuring anterior to mid-length; 3. In juvenile shells, the valves being much less convex, the mass of shell tissue supporting the cardinalia does not split into two ridges under the cardinalia as in adults but remains a solid mass up to the bases of the crura.

Occurrence and abundance.—Although this species has been reported from Osagian formations in the mid-continent, the author has identified it only from the Lake Valley Formation of New Mexico where it is presumably common.

Amesopleura texana, n. sp. Pl. 15, fig. 20; Pl. 27, figs. 12a-26; Text-fig. 30

Medium size, biconvex, pedicle valve slightly more inflated than the brachial valve, transversely elongated in outline, length width ratio approximately 0.62; greatest width at the hinge line; lateral profile subovate; ventral beak small to moderate-sized, incurved over the apex of the delthyrium; dorsal beak inconspicuous; ears of moderate size, mucronate in most growth stages, often becoming angular in large adults, usually slightly compressed; umbonal and anterior portions evenly convex anterior to the beaks; ears set off by reflexing of the shell surface; anterior commissure uniplicate; fold and sulcus moderately developed, narrow, rounded; macroprosopon consisting of nine or ten costae per flank in large specimens, those bounding the sulcus being somewhat larger than the rest, irregularly spaced growth varices, and evenly spaced subimbricate lamellae about two or three per millimeter that cover the entire surface, except for the interarea; microprosopon consists of fine capillae, about 20 per millimeter.

Pedicle valve most convex in the umbonal region, compressed laterally; sulcus originates as a groove in the beak, widens evenly anteriorly forming a sulcal angle of about 18 or 19 degrees; interarea low, vertically grooved, curved, apsacline, sharply defined, somewhat truncated at the extremities, forming an obtuse triangle; delthyrium triangular, occluded apically by a thick mass of shell tissue.

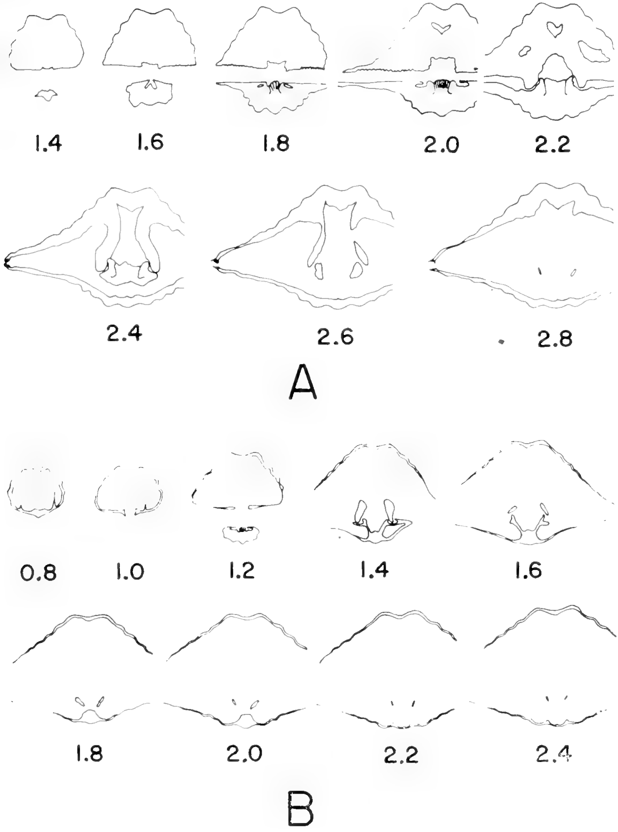
Pedicle interior often greatly thickened posteriorly by columnar shell tissue; dental plates of moderate length, thick, slightly divergent, following the sulcus-bounding costae, obscured for most of their length; muscle field deeply impressed between the dental plates; low median ridge present; teeth large, dental flanges thick, long, and oblique; hinge line denticulate; lateral edges just inside the valve margin fringed with very small thin lamellose platelets (see Plate 15, fig. 20).

Brachial valve less inflated than the pedicle valve, more evenly rounded in posterior profile; greatest convexity near or posterior to mid-length; ears as in the pedicle valve; dorsal interarea low, inconspicuous; fold low, marked only by bounding grooves in the umbo, usually slightly flattened with a weak median groove.

Table 32.—Measurements in millimeters of *Amesopleura texana,* n. sp. from USNM localities 9045 and 9048.

USNM No.	Length	Width	Thickness	Locality
154709	13.2	18.4?	10.5?	9045
154710	9.2	16.2?	6.9?	9045
154711	8.3	12.6?	5.5	9045
154712	5.6	8.2?	3.9	9045
154713	5.7	10.6?	4.2	9048
Pedicle Valves				
154716	12.7	20.1		9045
154714	13.8	21.0?		9045
154718	10.2	15.4?		9045
154723	6.4	11.0		9045
154717	11.5	20.0?		9048
154720	9.5	15.1		9048
154719	8.4	15.4?		9048
154721	9.4	16.4?		9048
Brachial Valves				
154715	10.1	20.8		9045
154722	6.8	14.1?		9048

Brachial interior posteriorly thickened by (fibrous?) shell tissue; cardinal process relatively large, composed of about ten plates, supported by a thick (fibrous?) elongate shell deposit that extends forward beyond the cardinal process; socket ridges thick, also imbedded in fibrous tissue, free only anteriorly; crural plates thin, short, slightly oblique, attached laterally to the inner socket ridges; median ridge present in posterior half of valve, ridges extend from the shell mass under the cardinalia anteriorly for about one-third the length of the valve, often obscured by shell tissue in very large specimens but well defined in moderate sized specimens; lateral edges of valve margin fringed with tiny platelets as in the pedicle valve; spiralia and muscle scars not distinguishable in sections.



Text-figure 30.—Transverse serial sections of *Amesopleura texana,* n. sp. measurements (mm) from ventral beak. (A) Large specimen, USNM 154579, ×3, from USNM locality 9045, showing the massive thickening of the shell in late ontogeny. (B) Juvenile specimen, USNM 154724 from USNM locality 9048, ×4, showing callus supporting the cardinalia and short dental plates.

Holotype.—USNM 154709, Pl. 37, figs. 12a-e.

Distinguishing characters.—The length-width ratio, nine to ten costae per flank, greatly thickened umbones, deeply impressed ventral muscle field, and massive tissue deposits supporting the cardinalia characterize this species.

Comparisons.—*Strophopleura anterosa* Campbell is smaller, more transversely elongated, and has more mucronate ears.

Remarks.—A closely similar species is found in the New Providence Shale of Indiana and Kentucky. This form is invariably crushed, the brachial valve being especially poorly preserved. The mucronate ears and larger size of this form probably indicate that it should be given a separate name.

Observations on ontogenetic development of *A. texana* are limited by paucity of well-preserved specimens. Growth varices appear to indicate that in the later stages the shells grow in length much more rapidly than in width. The smallest specimen sectioned, about 6 mm long, did not have fully developed dental plates, that is, they did not reach the floor of the valve and there was little columnar tissue in the ventral umbo.

Occurrence and abundance.—This species is not common at any locality in the Chappel Limestone, although fair collections were obtained at USNM localities 9045 and 9048. Nine complete and nearly complete specimens, two of which were sectioned, 35 pedicle and 16 brachial valves are identified from locality 9045. Two complete specimens, one of which was sectioned, 17 pedicle and 13 brachial valves were collected at USNM locality 9048. Localities 9043, 9044, 9046, and 9047 each produced several fragmental specimens.

A. texana is not identified outside the Chappel Limestone. The similarities between this species and undescribed forms from the Borden Group of the Midwest were noted previously.

Family **SYRINGOTHYRIDIDAE** Frederiks, 1926

Genus **SYRINGOTHYRIS** Winchell, 1863

Syringothyris sp. Pl. 32, figs. 5a-d

One spalled but otherwise complete specimen and 14 disarticulated valves and fragments from USNM locality 9045 constitute the entire Chappel Limestone collection of syringothyrids. The paucity of specimens makes their specific identification difficult.

Although interiors *per se* are not available the pedicle valve definitely bears a syrinx, dental plates, and lacks a septum. Since the outer shell layers have been spalled away, it is impossible to determine whether there was a "twilled-cloth" prosopon, a supposed generic character. There is little doubt, however, that these specimens belong in *Syringothyris*.

The spalled surfaces are finely pitted and one specimen appears to be endopunctate, that is, the punctae occur in fibrous shell tissue.

The ventral interarea is strongly procline, being inclined only about 35 degrees above the lateral margin.

Family **SPIRIFERIDAE** King, 1846

Genus **SPIRIFER** J. Sowerby, 1816

1816. *Spirifer* Sowerby, J., Mineral Conchology of Great Britain, London, vol. 2, p. 41.
1844. *Spirifera* M'Coy, Synopsis of the Carboniferous Limestone Fossils of Ireland, London, p. 128.
1924. *Spirifer* Fredericks, Izvestya, Geol. Komm. S.S.S.R., vol. 38, No. 3, p. 307.
1941. *Spirifer* Sokolskaja, Akad. Nauk. S.S.S.R., Paleont. Inst., Trudy, vol. 12, No. 2, pp. 8-12, 118.
1941. *Spirifer* Semichatova, Akad. Nauk. S.S.S.R., Paleont. Inst., Trudy, vol. 12, No. 3, pp. 23, 24, 153, 154.
1959. *Spirifer* Besnossova, Akad. Nauk. S.S.S.R., Paleont. Inst., Trudy, vol. 75, pp. 81-83.
1960. *Spirifer* Ivanova, Osnovi Paleont., Mshanki Brachiopody., p. 269.
1965. *Spirifer* Pitrat, Treatise on Invertebrate Paleontology, Part H, Brachiopoda, vol. 2, p. 704.

Medium to large, subequally biconvex, usually wider than long; maximum width attained at or slightly in front of the hinge line; ears acute or blunt; ventral beak slightly to considerably incurved; anterior commissure uniplicate; fold and sulcus poorly defined to prominent and angular; ventral interarea well defined, curved, vertically grooved, triangular in alate forms or laterally truncated in elongate forms; delthyrium open or with a small transverse subdelthyrial plate at the apex in early growth stages; hinge denticulate; dental plates short, reaching to the ventral muscle field; low median ridges often present in both valves; brachial valve apparently free of floor-touching plates; macroprosopon consisting of numerous simple or bifurcating costae on the flanks, more or less numerous freely bifurcating costae on the fold and sulcus, and prominent growth varices; microprosopon consisting of capillae and irregularly spaced fine growth lines.

Type species.—(By suspension of the rules of zoological nomenclature, I.C.Z.N. Opinion 100) *Conchyliolithus Anomites striatus* Martin, W., 1793, Figures and Descriptions of Petrefactions Collected in Derbyshire, pl. 23, figs. 1, 2.

Distinguishing characters.—*Spirifer* is characterized by having a hinge width equal to or less than the maximum width, short divergent dental plates in the pedicle valve, apparently no basal plates in the brachial valve, freely bifurcating lateral and sulcal costae, and a simple capillate microprosopon.

Comparisons.—Although *Spirifer s. s.* is not strictly definable, it is still desirable to differentiate those species commonly assigned to it from other genera that are similar but seemingly distinct. The following differentiation is based on the preceding description and is hence tentative.

Spirifer differs from *Cyrtospirifer* Nalivkin, 1918, in having a denticulate hinge line and usually low median ridges in both valves. *Cyrtospirifer* lacks a denticulate hinge, a ventral median ridge, and has weaker more numerous costae.

Fusella M'Coy, 1844, is commonly smaller, usually transversely extended, has simple lateral costae, usually a simple median costa in the sulcus, a relatively low ventral interarea, and a reticulate microprosopon formed by intersecting radial capillae and fine regularly spaced growth lines.

Imbrexia Nalivkin, 1937, is similar to *Spirifer* but displays a pronounced imbrication of the growth lamellae, shows radial capillae only in the grooves between costae, if present at all, and has a simple median costa in the sulcus.

Neospirifer Fredericks, 1924, is differentiated on the basis of macroprosopon; that is, the costae are bundled or fasciculate. It may also have a lamellose pseudodeltidium. Some species of *Neospirifer* have imbricate growth lamellae.

Choristites Fischer de Waldheim, 1825, is distinguished by its long subparallel dental plates which impinge on the muscle field and elongate outline.

Ectochoristites Campbell, 1957, can be distinguished by its short thick dental plates, simple median sulcal costa, and the presence of short basal plates in the dorsal umbo.

Remarks.—The type of *Spirifer striatus* (Martin) has apparently been lost and a neotype has not been selected, making positive identification of this species difficult. Harrington and Leanza (1952) described and illustrated the ventral interior of British Museum (Nat. Hist.) specimens of *S. striatus* as having short divergent dental plates and lacking a delthyrial plate; apparently no brachial valves were sectioned. Semichatova (1941, p. 33, pl. 17, figs. 1c, 2) found more or less the same structures in specimens from Derbyshire, England. This information is useful but insufficient. Detailed brachial interiors of topotype material have still never been illustrated to the writer's knowledge. Under the circumstances then, the preceding description is incomplete and actually a consensus of most recent authors.

Range.—Lower Carboniferous. Upper and lower limits indeterminate at present.

Spirifer chappelensis, n. sp.

Pl. 23, fig. 12; Pl. 36, figs. 1a-4e; Pl. 37, figs. 1a-4e; Text-figs. 31-33

Medium size, subquadrate to semicircular in outline; valves about equally convex, moderately inflated; hinge submegathyrid, greatest width anterior to the hinge line but usually slightly posterior to mid-valve; ears usually rounded but often angular in juveniles and occasionally in adults; macroprosopon consisting of numerous simple or bifurcating costae on both valves, and prominent irregularly spaced growth varices; the costae being somewhat flattened and rounded. A paratype USNM No. 154824 (Pl. 36, figs. 2a-e) has sinuous costae but this is unusual; microprosopon consisting of radial capillae (Pl. 23, fig. 12), about seven or eight capillae per costa.

Pedicle valve with greatest convexity posterior to mid-valve; beak moderately incurved; surface of valve regularly convex except for a slight flexure near the ears; interarea curved and of moderate height; vertically grooved, and truncated at the extremities in most adults, the vertical grooves being external ramifications of calcite rods which are embedded in the interarea and which project as denticles at the hinge (Text-fig. 31); delthyrium an equilateral triangle or slightly higher than wide; dental ridges or the growth track of the teeth are present but no trace of a delthyrial plate was found, although a subdelthyrial plate is present; sulcus extending from near the beak to the anterior margin making an angle of about 39 degrees, and forming a subquadrate tongue in many adults, although this is a variable character, as in some adults the sulcus is rather uniformly rounded; median costa bifurcating at the beak, lateral sinal costae bifurcating, and several costae also bifurcating from the bounding costae; lateral slopes marked by flattened rounded costae which occasionally bifurcate, there being about 17 to 27 costae at the anterior margin of each flank.

Table 33.—Measurements in millimeters of *Spirifer chappelensis,* n. sp.

USNM No.	Length	Width (max.)	Hinge Width	Thickness	USNM Loc.
154823	33.8	46.3	41.8	28.2	9045
154824	30.9	46.2	41.8?	24.4	9045
154831	28.0	40.4	34.5?	20.4	9043
154825	25.9	40.6	40.6	21.1	9043
154826	20.8	32.3	29.6?	16.7	9045
154827	16.0	25.1	23.5?	11.9	9045
154828	12.6	17.2	16.4?	8.9	9045
154829	9.2	13.4?	13.4?	6.6	9045
154830	7.3	11.7?		5.1	9045

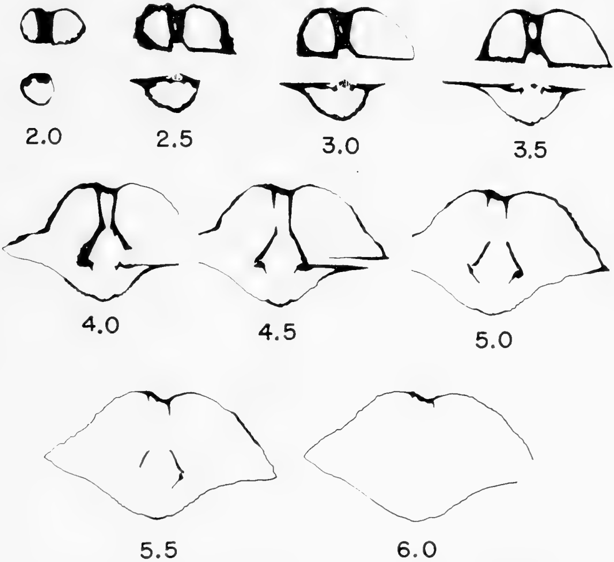
Interior of pedicle valve bearing short, slender, parallel dental plates; dental flanges meeting the dental lamellae at an angle; apical portion of shell not markedly filled with callus tissue as in many spiriferids although the cavity between dental plates may be lined with callus for two or three millimeters in the beak. Short low median ridge in the fibrous shell layers between the dental plates, this ridge being covered by callus in all sectioned specimens; muscle scars narrow and indistinctly impressed in serial sections.

Brachial valve with greatest convexity slightly anterior to that of pedicle valve; umbo slightly swollen but beak inconspicuous; interarea low; fold originating at the apex of the valve but not prominent until mid-valve; fold often flattened anteriorly in adults and marked off by lateral depressions somewhat deeper and wider than those separating the costae; prosopon similar to that of pedicle valve.

Interior of brachial valve with inner socket ridges that unite beneath the umbo supporting the cardinal process, which consists of a dozen or more vertical plates; socket ridges not reaching valve floor; sockets wide; descending lamellae forming at the inner edges of the socket ridges, however, no spiralia seen; low median ridge several millimeters long present but adductor muscle scars indistinct.

Holotype.—USNM 154823.

Distinguishing characters.—This species is characterized by its subquadrate transversely elongate outline, submegathyrid hinge, subquadrate fold and sulcus in large adults, 17 to 27 costae per lateral slope, 11 to 14 costae per ventral sulcus, the median costa bifurcating, short slender subparallel dental plates, and an inconspicuous narrow ventral muscle field.



Text-figure 31.—Transverse serial sections of *Spirifer chappelensis,* n. sp. ×1, USNM 154832 from USNM locality 9045, measurements (mm) from ventral beak.

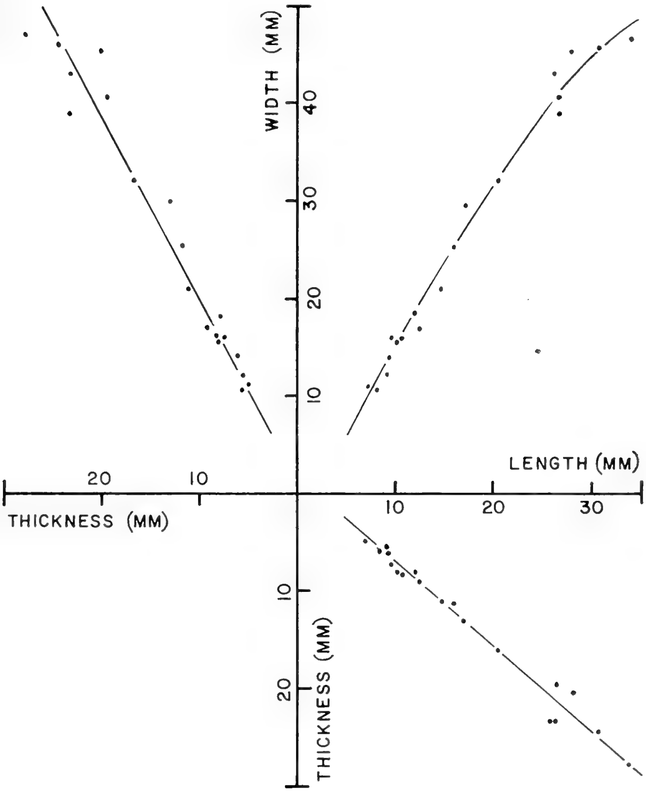
Comparisons.—Adults of this species are easily distinguished from adults of other related species in the Chappel fauna. Juveniles are easily confused with specimens of *Fusella llanoensis,* n. sp. and *Ectochoristites inflatus,* n. sp. Juveniles of *S. chappelensis* are much wider in proportion to their length, less thick, have slender parallel dental plates and inconspicuous fold. Similar stages of *F. llanoensis* are thicker and more inflated, narrower, have slender divergent dental plates, conspicuous fine growth lines and a conspicuous fold. Those of *Ectochoristites inflatus,* n. sp. have an inflated pedicle valve and a somewhat flatter brachial valve, thick divergent dental plates, and a low fold slightly recessed between bordering grooves.

Spirifer vernonensis Swallow, 1860, a Fern Glen species, has a similar outline but has a smaller length-width ratio, a rounded fold and sulcus, a simple median costa in the sulcus, divergent dental plates, and imbricate growth lamellae.

Spirifer shepardi Weller, 1914, from the Pierson Limestone of Missouri is somewhat similar to *S. chappelensis* but is widest at the hinge with angular ears and has a shallow narrowly rounded sulcus.

Spirifer striatiformis Meek, 1875, from the Waverly Group of Ohio has a more rounded subellipsoidal outline, a larger length-width ratio, a smaller more rounded fold and sulcus, divergent dental plates, and finely imbricate growth lines.

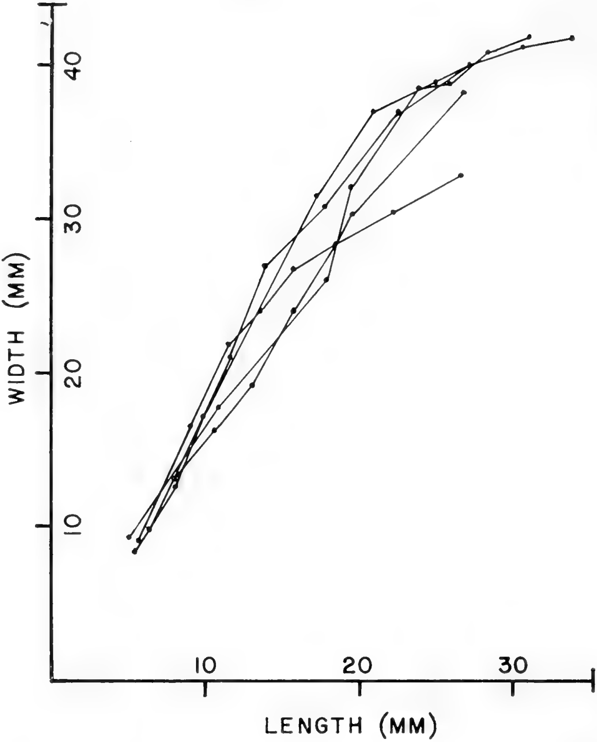
Remarks.—Studies of size and gross shape variation in this species are limited by the size of the collection and preservation of specimens but a scatter diagram comparing standard dimensions of 17 complete specimens from a population is reproduced in Text-figure 32. Ontogenetic development of external growth form can be seen in Text-figure 33. Early stages are somewhat alate, maximum width usually being attained at the hinge with angular ears the rule. When the shells are 20-25 millimeters long hinge growth nearly ceases while growth along the antero-lateral and anterior margins continues resulting in a subquadrate outline, truncation of the ventral interarea, and bunching of the growth lines near the ears in adults. The fold becomes noticeable about 8-10 millimeters from the dorsal beak, but the sulcus is present in the earliest recognizable stages.



Text-figure 32.—Scatter diagrams of dimensions of *Spirifer chappelensis*, n. sp. from USNM locality 9045.

Occurrence and abundance.—Chappel Limestone, USNM localities 9045, 9043, and 9044.

This species is not common except at USNM locality 9045. Besides the ten types and measured specimens, this locality has pro-



Text-figure 33.—Plots of length/width measurements of *Spirifer chappelensis,* n. sp. taken from growth varices of five large pedicle valves (USNM locality 9045), illustrating variation in the proportions of these shells during ontogeny and a general trend toward truncation of the lateral extremities in later growth stages.

duced eight other complete shells and more than 40 incomplete specimens and disarticulated valves.

There are two superior specimens from USNM locality 9043.

Spirifer cf. **S. gregeri** Weller Pl. 41, fig. 13

1914. *Spirifer gregeri* Weller, Illinois Geol. Sur., Mon. 1, p. 359, pl. 55, figs. 1-8.
1938. *Spirifer gregeri* Weller, Branson, (*pars*) Univ. Missouri Studies, vol. 13, No. 3, p. 59, pl. 7, figs. 15, 16 (*non* Figs. 1-3, ? *Ectochoristites inflatus,* n. sp.).
1938. (? *Non*) *Spirifer gregeri,* Branson, Univ. Missouri Studies, vol. 13, No. 4, p. 22, pl. 21, fig. 22.
1948. *Spirifer gregeri* Weller, Laudon, Jour. Geol., vol. 56, No. 4, fig. pl. 1.
1960. [?] *Spirifer gregeri* Weller, Balashova, Vopros. Paleont., S.S.S.R., vol. 3, p. 94, pl. 1, fig. 34.
1962. [?] *Spirifer* cf. *gregeri* Weller, Armstrong, New Mexico Bur. Mines Min. Res., Mem. 8, p. 49, pl. 7, figs. 22, 23.

Material.—Two incomplete pedicle valves from USNM locality 9045 and one incomplete pedicle valve from USNM locality 9043 appear to represent this species.

Description.—Pedicle valve moderately convex, the greatest convexity being posterior of mid-valve; beak incurved, small; interarea sharply delineated, triangular, curved, and vertically grooved; median sulcus narrow, rounded, moderately shallow in those portions of the shell preserved, with a bifurcating median costa; numerous other sulcal costae bifurcate from the sulcus-bounding costae and may also bifurcate occasionally; costae rounded and flattened; entire surface costate and capillate; dental plates of moderate length, thin, subparallel near the beak but becoming moderately divergent anteriorly.

Remarks.—These specimens agree in all respects to Weller's types of *S. gregeri* in so far as they can be compared without brachial exteriors or complete interiors. Branson (1938, plate 7, figs. 1-3) illustrated specimens which he assigned to this species that are clearly different from Weller's syntypes. These specimens are assigned to a new species, *Ectochoristites inflatus,* that also occurs in the Chappel Limestone and the Lake Valley Beds of New Mexico.

Spirifer gregeri is most similar and probably closely related to *Spirifer rowleyi* Weller, 1914, of the Fern Glen Formation of the Mississippian Valley and the Lake Valley Formation of New Mexico. It is distinguished from the latter by its smaller size, greater length-width ratio, smaller ears, and less conspicuous brachial fold.

Spirifer esplanadensis Brown, 1952, from the Banff Formation of Alberta is closely related to *S. gregeri* but differs in being longitudinally elongated with a more inflated pedicle umbo.

Genus **FUSELLA** M'Coy, 1844

1844. *Fusella* M'Coy, Synopsis of the Carboniferous Limestone Fossils of Ireland, London, pp. 128, 132.
1908. *Fusella* M'Coy, Buckman, Quart. Jour. Geol. Soc. London, vol. 64, p. 29.
1924. *Fusella* M'Coy, Fredericks, Geol. Com., S.S.S.R. Izvestya, vol. 38, No. 3, p. 303.
1929. *Fusella* M'Coy, Schuchert and LeVene, Foss. Cat., pars 42, Brachiopoda, pp. 20, 61.
1954. [?] *Prospira* Maxwell, Univ. Queensland, Dept. Geol., vol. 4, No. 5, p. 35.
1957. [?] *Unispirifer* Campbell, Jour. Paleont., vol. 31, p. 67.
1959. *Fusella* M'Coy, Besnossova, Akad. Nauk S.S.S.R., Paleont. Inst., Trudy, vol. 75, pp. 58-60.
1960. *Fusella* M'Coy, Ivanova, Osnovy Paleont.: Mshanki, Brachiopody, p. 269.

Description.—(Modified after Besnossova, p. 58). Small to medium-sized, multicostate, subequally biconvex, uniplicate; usually more or less transversely elongated; maximum width usually attained at the hinge line; ventral beak incurved, tapering; ventral interarea relatively low, concave; lateral costae usually simple; sulcal costation consisting of a median costa that is simple in most species, bounding costae that bifurcate on either side, and one, two, or rarely three pairs of secondary costae that bifurcate from the bounding costae; microprosopon consisting of finely imbricate growth lines and radial capillae.

Dental plates divergent, thin, short, skirting the muscle scars as low ridges; subdelthyrial plate present in early stages; apical thickening of ventral umbo developed; teeth small, rounded; sockets shallow and rounded; cardinal process relatively low, flattened; hinge plate elevated above the valve floor.

Type species.—(By original designation) *Spirifer fusiformis* J. Sowerby, 1836 (*in* Phillips, p. 217, pl. 9, figs. 10-11). Lower Carboniferous of Yorkshire, England.

Distinguishing characters.—*Fusella* is characterized by its transversely elongate shell, long angular ears, simple lateral costae, a simple median costa in the sulcus, and a finely reticulate microprosopon formed by capillae and fine regularly spaced growth lines.

Although most species assigned to this genus in recent years fit this characterization, a number of species with relatively narrow hinges and small ears have been assigned to *Fusella* on the basis of the other diagnostic characters, as for example, *Fusella llanoensis*, n. sp. While it is possible that some of the narrow species do not belong in this genus, it is this writer's opinion that in many spiriferoid groups hinge width varies so greatly from population to population, growth stage to growth stage, and species to species, that it is usually unsafe to use it as a generic character except in conjunction with other more stable characters.

Comparisons.—*Fusella* is most easily confused with *Spirifer* J. Sowerby, 1816, and *Imbrexia* Nalivkin, 1937.

Spirifer s. s. is usually larger, has freely bifurcating lateral and sulcal costae, a bifurcating median costa in the sulcus, a higher interarea, and usually lacks the reticulate pattern formed by capillae and growth lines. Instead the capillae are simple and uninterrupted.

Imbrexia has conspicuously imbricate growth lamellae and the lateral costae bifurcate freely. Furthermore, if capillae are present, they are confined to the grooves or interspaces between the costae.

Remarks.—In using this genus the author has reluctantly followed the Russian authors G. A. Besnossova (1959) and E. A. Ivanova (1960), who have more or less resurrected it in recent years. M'Coy originally proposed it as a subgenus of *Spirifer* defining it (p. 128) as "including those little shells allied to *Spirifer fusiformis* and *rhomboidea* of Phillips, Geol. Yorkshire, having a regular fusiform outline, with a very wide and hollow cardinal area, the sides of which are parallel." He further characterized it thus (p. 132), "Gen. Ch.—Shell elongate transversely, fusiform; cardinal area wide, much curved; beaks incurved." This proposal met with little success as most nineteenth century workers suppressed the name as a synonym of *Spirifer*. However, in 1908 Buckman (p. 29) revived the name and gave it generic status, redefining it as having a "Wide extended hinge line; ribs coarse laterally, tending to be deficient medianly, the type is in the smooth stage when nearly all ribs have been lost."

Buckman's reference to the type without further comment on its state of preservation is unfortunate. Davidson (1858, p. 56) pointed out the poor preservation of the type noting the spalled nature of the exterior. Furthermore, M'Coy obviously referred to specimens from Ireland in his description of *Spirifer fusiformis* and clearly stated that it possessed three ribs on the fold and up to eight ribs on each flank. M'Coy's intentions are clear; it is a pity that the type species is so poorly known.

Schuchert and LeVene (1929, p. 20, 61) recognized *Fusella* without comment. Fredericks (1924, p. 303) ascribed a septum and dental plates to *Fusella* and later recanted (1926, p. 405), deciding that it was a synonym of *Eospirifer.*

Maxwell (1954, p. 35) restricted *Fusella* to species similar to the holotype, that is, nearly smooth and finely striate, and proposed a new name, *Prospira,* for species which more or less fulfilled Buckman's diagnosis of *Fusella.* By taking this action Maxwell implied that *Fusella fusiformis* is unidentifiable. In a later paper (1961, p. 89) Maxwell said ". . . the true characters of *Fusella* cannot be established until the type species has been identified in well preserved material from the type area of Balland, Yorkshire." Maxwell further pointed out that such a revisionary study may be difficult if not impossible. This writer is not aware of any such attempt at revision of *F. fusiformis* and hence prefers to interpret *Fusella* in the broad sense until such time as the genus can be restricted and clearly defined.

Campbell's genus *Unispirifer* (1957, pp. 67, 68) appears to be a subjective synonym of *Fusella* and *Prospira,* but usage of it too awaits clarification of *Fusella fusiformis.*

Range.—Mississippian.

The distribution of this genus, as here defined, is probably cosmopolitan. It is especially common in strata of Tournaisian age (Kinderhookian and Osagian).

Fusella llanoensis, n. sp. Pl. 23, fig. 11; Pl. 38, figs. 1a-9e; Text-figs. 34-36

Medium size, subelliptical in outline; subequally biconvex; relatively thick, moderately to strongly inflated, globose in profile; beaks small and incurved; brachial umbo relatively tumid; hinge submegathyrid, greatest width at about mid-valve; ears small and angular; anterior commissure uniplicate; fold and sulcus narrow, well developed, sharply defined, V-shaped; macroprosopon consisting of numerous simple rounded costae and irregularly spaced growth varices; costae of the flanks simple and rounded but those of the fold and sulcus tending to be flattened; median sulcal costa simple; microprosopon consisting of radial capillae and fine regularly spaced growth lines, there being about 11 or 12 capillae per costa and six to eight growth lines per millimeter. The capillae and growth lines intersect to form a characteristic fine reticulate pattern.

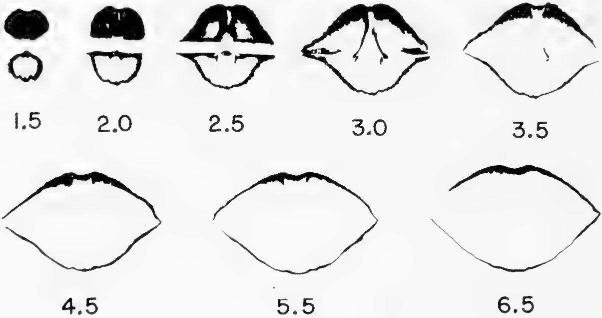
Pedicle valve with greatest convexity at the anterior and posterior extremities; beak moderately incurved; entire surface convex except for the ears; interarea low to medium in height; vertically grooved, curved, and usually somewhat truncated at the lateral extremities; hinge line denticulate; sulcus beginning at the beak and extending to the anterior margin as an acute triangle, making a sulcal angle of about 29 degrees; shoulders and bottom of the sulcus usually slightly rounded; median costa simple, lateral sulcal costae bifurcating from the bounding costae near the beak. In most adults two more costae bifurcating from each bounding costa. Lateral slopes marked by 13 to 18 simple rounded costae that rarely bifurcate; delthyrium slightly higher than wide or equilateral, and possessing dental ridges; no deltidium present; subdelthyrial plate or thickening formed in the beak between the dental plates (see Text-figure 34—2.0, 2.5).

Interior of pedicle valve bearing moderately divergent dental plates of medium length; posterior portions of these plates and rear one-third of valve greatly thickened with callus in adults; dental flanges also thickened and meeting the dental plates at a slight angle; free portions of these structures slender; short low median ridge usually buried in callus; deeply impressed area between the dental plates presumably representing muscle scars (Text-figure 34—3.5); small groove in the median portion of this area probably representing adductor scars (Text-figure 34—3.5); the peculiarly irregular interior surface lateral to the muscle scars possibly representing ovarian impressions.

Table 34.—Measurements in millimeters of *Fusella llanoensis*, n. sp.

USNM No.	Length	Width (max.)	Hinge Width	Thickness	USNM Loc.
154839	24.7	34.0?	23.6?	19.8	9044
154840	23.2	28.2	21.0	19.4	9045
154841	18.4	26.2	20.8	15.4	9045
154842	15.6	18.6	16.8?	12.0	9048
154843	14.0	15.9	12.2?	10.5	9044
154844	12.1	15.2	12.3	10.0	9048
154845	10.1	11.9		6.1	9045
154846	7.4	7.4	6.0?	5.5	9045
154847	6.3	6.6		4.1	9045

Brachial valve with greatest convexity at the umbo, which is somewhat swollen; dorsal beak incurved and inconspicuous; dorsal interarea low and acutely triangular; fold inconspicuous at the umbo but becoming high and carinate at the anterior margin of adult specimens; costae on the fold usually low and often indistinct; lateral costae similar to those of the pedicle valve.



Text-figure 34.—Transverse serial sections of *Fusella llanoensis,* n. sp. ×1, USNM 154848 from USNM locality 9045, measurements (mm) from ventral beak.

Interior of brachial valve with a spiriferoid cardinal process composed of ten or a dozen thin vertical plates; socket ridges uniting beneath the umbo to form an apical callosity just below the cardinal process; sockets of moderate size, open posteriorly; crural bases produced from inner surfaces of the socket ridges; spiralia unknown; low median ridge extending anteriorly four or five millimeters from the dorsal umbo; two low subparallel ridges marking the edge of the fold.

Holotype.—USNM No. 154840.

Distinguishing characters.—This species is characterized by its inflated valves, elliptical outline, relatively narrow hinge, sharp high fold, posteriorly closely spaced moderately diverging dental plates, and characteristic microprosopon formed by capillae intersecting fine growth lines.

Comparisons.—This species is similar to *Spirifer vernonensis* Swallow, 1860, from the Fern Glen Formation of the Mississippi Valley, *Spirifer floydensis* Weller, 1914, from the Borden Group of Indiana, *Spirifer marionensis* Shumard, 1855, from the Louisiana Limestone of the Mississippi Valley, and *Spirifer striatiformis* Meek, 1875, from the Waverly Group of Ohio.

Spirifer vernonensis has a wider hinge, is usually larger, has more widely divergent dental plates, prominent coarse imbricate prosopon, a semicircular outline, and usually much less inflated valves.

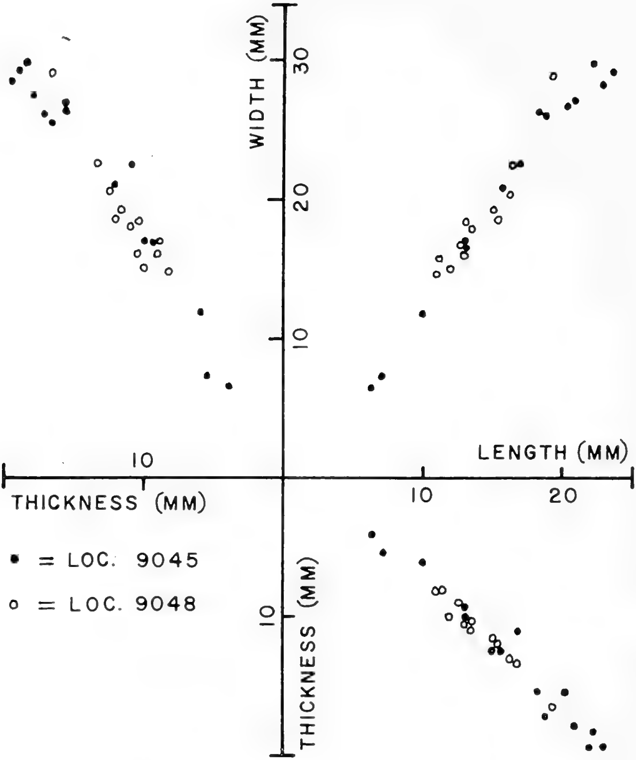
Spirifer floydensis is wider at the hinge, has larger ears, a shallower, less angular sulcus, and is less inflated.

Spirifer marionensis has finer, more numerous costae, an extended nearly mucronate hinge line, a characteristically extended quadrate interarea that is abruptly truncated at the extremities, less pronounced fold and sulcus, and is usually less inflated.

Spirifer striatiformis is larger, less inflated, usually has a less pronounced fold and sulcus, thicker more divergent dental plates, a wider ventral muscle field, more numerous costae on the flanks and usually more in the sulcus. Hinge width is apparently highly variable (Hyde, 1953, p. 260) and the ears may be rounded or angular.

Juveniles of *Fusella llanoensis* can be confused with similar stages of *Spirifer chappelensis,* n. sp. and *Ectochoristites inflatus,* n. sp. Differentiation of the growth stages is discussed under *Spirifer chappelensis.*

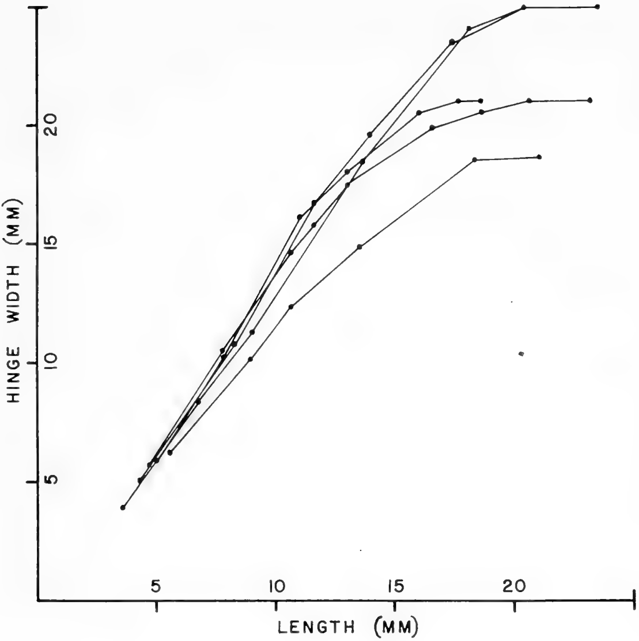
Remarks.—None of the samples from single populations was large enough to permit ordinary studies of size variation. Text-figure 35 is a composite scatter diagram of individuals measured from five scattered localities or populations. Growth varices of well-preserved specimens were also measured and plotted in Text-figure 36 to illustrate ontogenetic change in shell shape. These examinations have shown that in the early growth stages of this species the shell is nearly as long as wide with the maximum width anterior to the hinge. The ears are rounded and inconspicuous. In later stages the shells become relatively wider until they are about 17 to 20 millimeters wide at the hinge. At this time hinge growth slows down in relation to the rest of the shell and after one or two more millimeters hinge growth ceases entirely while the rest of the shell grows linearly in all dimensions forming a nearly subelliptical outline. Pronounced ears are formed at the time the shells are about 12 to 15 millimeters



Text-figure 35.—Scatter diagrams of dimensions of *Fusella llanoensis,* n. sp. from USNM localities 9045 and 9048.

wide at the hinge. As the hinge growth slows down the ears become vestigial and the interarea becomes somewhat truncated.

The fold is low but recognizable in all growth stages but does not become prominent until the shells are about 12 to 14 millimeters



Text-figure 36.—Plots of length/hinge-width measurements of *Fusella llanoensis*, n. sp. taken from growth varices of five pedicle valves, illustrating variation in the proportions of these shells during ontogeny and a general trend toward truncation of the lateral extremities in later growth stages.

long. The sulcus develops more evenly and is conspicuous in the earliest known stages.

Occurrence and abundance.—This species is fairly common at several localities in the Chappel Limestone. Besides 35 types, sectioned, measured, or otherwise excellent specimens from USNM localities 9045, 9048, 9042, and 9044, there are about 150 additional fragmental specimens or disarticulated valves from these localities as well as a few poor specimens from localities 9046 and 9047. This species has not been identified outside the Chappel Limestone.

Family **BRACHYTHYRIDIDAE** Frederiks, 1919 (1924)

Genus **BRACHYTHYRIS** M'Coy, 1844

1844. *Brachythyris* M'Coy, A Synopsis of the Characters of the Carboniferous Fossils of Ireland, p. 128.
1908. *Brachythyris* M'Coy, Buckman, Quart. Jour. Geol. Soc. London, vol. 64, p. 30.
1913. *Brachythyis* M'Coy, Schuchert, *in* Zittle-Eastman, Textbook of Paleontology, vol. 1, p. 410.
1914. *Brachythyris* M'Coy, Weller, Illinois Geol. Sur., Mon. 1, pp. 370, 371.
1924. *Brachythyris* M'Coy, Fredericks, Geol., Comm. S.S.S.R., Izvestya, vol. 38, No. 3, p. 316.
1926. *Brachythyris* M'Coy, Fredericks, Akad. Nauk S.S.S.R., Izvestya, p. 401.
1927. *Brachythyris* M'Coy, George, Geol. Mag., vol. 64, p. 107.
1929. *Brachythyis* M'Coy, Chao, Paleont. Sinica, ser. B, vol. 11, fasc. 1, pp. 54, 55.
1932. *Brachcythyis* M'Coy, Paeckelmann, Neues Jhr. Mineral. Geol., Paläont., vol. 67, B, pp. 37, 38.
1937. *Ovalia* Nalivkin, Cent. Geol. Prosp., S.S.S.R., Trans., vol. 99, p. 107.
1941. *Brachythyris* M'Coy, Sokolskaja, Akad. Nauk S.S.S.R., Paleont. Inst., Trudy, vol. 12, No. 2, p. 35.
1944. *Brachythyris* M'Coy, Cooper, "Phylum Brachiopoda," *in* Shimer and Shrock, Index Fossils of North America, New York, p. 327.
1948. *Brachythyris* M'Coy, Muir-Wood, Malayan Lower Carboniferous Fossils, British Museum (Nat. Hist.), London, p. 44.
1949. *Brachythyris* M'Coy, Simorin, Izd-vo Kazakhstan SSR, Akad. Nauk, p. 43.
1952. *Brachythyris* M'Coy, Roger, Brachiopods, *in* Piveteau, J., Traité dé' Paléontologie, vol. 2, p. 101.
1954. *Brachythyris* M'Coy, Maxwell, Univ. Queensland, Dept. Geol., vol. 4, No. 5, pp. 26, 27.
1959. *Brachythyris,* M'Coy, Besnossova, Akad. Nauk S.S.S.R., Paleont. Inst., Trudy, vol. 75, pp. 122, 123.
1960. *Brachythyris* M'Coy, Ivanova, *in* Sarycheva, T. G., Osnovy Paleont., Mshanki, Brachiopody, p. 270.
1962. *Brachythyris* M'Coy, Armstrong, New Mexico Bur. Mines and Min. Res., Mem. 8, pp. 53, 54.

Small to large, rounded in outline, subequally biconvex, the ventral valve usually slightly more inflated than the brachial; ventral beak incurved; ears small and rounded; hinge line straight, submegathyrid; ventral interarea small, concave, triangular, vertically grooved; hinge line partially denticulate; anterior commissure uniplicate; fold and sulcus weak to well developed; surface multicostate, lateral costae broad, flattened, simple; those of the fold and sulcus often increasing by bifurcation or indistinct; microprosopon consisting of fine growth lines (and possibly capillae?); dental lamellae completely lacking; delthyrial carinae may be present on the inner edges of the delthyrium; brachial interior typically spiriferoid with a low short median ridge.

Type species.—(By original designation) *Spirifera ovalis* Phillips, 1836, p. 219, pl. 10, fig. 5, Lower Carboniferous of England.

Distinguishing characters.—This genus is characterized by its submegathyrid denticulate hinge line, broad, flattened, simple lateral costae, bifurcating sulcal costae that may be indistinct, and a complete lack of dental plates.

Comparisons.—*Brachythyris* M'Coy is not easily confused with *Martinia* M'Coy, 1844, despite George's implication that the two are end products of closely related lineages. It is this writer's opinion that the absence of hinge denticulation, the presence of shagreen microprosopon, the characteristic transversely elongate tooth-socket development, and lack of costae in the martiniids are characters sufficiently distinct to place these two genera in different families.

Brachythyrina Frederiks, 1929, from the Permian of Russia is similar to *Brachythyris* internally, that is, it also lacks dental plates, however, externally it is wide-hinged and is similar in appearance to the wide-hinged spirifers.

Ella Frederiks, 1918, from the Permian of Russia is apparently similar to *Brachythyris* externally as well as internally, but it possesses radial lirae that intersect the growth lines to form a so-called "shagreen" microprosopon.

Eochoristites Chu, 1933, a Lower Carboniferous genus from China, has simple lateral costae and somewhat similar proportions, but the costae are more numerous and narrower, the ears are subangular, and internally it possesses well-developed dental plates.

Remarks.—This genus was proposed by M'Coy (1844, p. 128) for forms "in which we find the longitudinally ribbed surface of *Spirifera* [sic], united with the short hinge line of Martinia." Most of M'Coy's contemporaries rejected this diagnosis based on exterior details and considered the name a subjective synonym of *Spirifer*. It remained for Buckman (1908, p. 30) to revive the name, noting that the dental plates were small or lacking. Weller (1914, p. 370) further noted the simple nature of the lateral costae, the common presence of delthyrial carinae, and the poorly defined ventral muscle field. Simorin (1949, p. 43) stated that the microprosopon consists only of fine growth lines.

Many specimens of *Brachythyris chouteauensis* Weller, 1909, have a vertically grooved interarea similar to that of *Spirifer*. Cellulose peels made normal to the interarea show these grooves to be typically spiriferid external ramifications of calcite rods and apparently represent the growth tracks of hinge denticles. These vertical grooves have been observed on well-preserved specimens of several species including specimens in the USNM collections of *B. ovalis* (Phillips) from Derbyshire, England.

Attempts to determine the exact nature of the microprosopon were not conclusive due to the spalled nature of much of the external shell layers. However, Simorin's (1949, p. 49) observation of fine growth lines is correct. Because some specimens of *B. chouteauensis* seemed to show a capillate microprosopon, although admittedly not well, knowledge of this feature may be incomplete.

Range.—Mississippian. Distribution cosmopolitan.

Brachythyris chouteauensis (Weller) Pl. 39, figs. 1a-9e; Text-figs. 37, 38

1909. *Spirifer chouteauensis* Weller, Geol. Soc. America, Bull., vol. 20, p. 305, pl. 13, fig. 11.
1914. *Brachythyris chouteauensis* (Weller), Weller, Illinois Geol. Sur., Mon. 1, pp. 373, 374, pl. 57, figs. 4-11.
1938. *Brachythyris chouteauensis* (Weller), Branson, Univ. Missouri Studies, vol. 13, No. 3, pp. 65, 66, pl. 6, figs. 1-4.
1941. *Brachythyris* cf. *chouteauensis* (Weller), Sokolskaja, Akad. Nauk S.S.S.R., Paleont. Inst., Trudy, vol. 12, pp. 36, 37, pl. 4, figs. 1a-c.
1948. *Brachythyris chouteauensis* (Weller), Cloud and Barnes, Univ. Texas, Publ. No. 4621, pl. 44, figs. 24, 25, 27.
1950. [*Non*] *Brachythyris chouteauensis* (Weller), Plummer, Univ. Texas, Pub. No. 4329, pl. 5, No. 22.
1950. *Brachythyris suborbicularis* (Weller), Plummer, Univ. Texas, Pub. No. 4329, pl. 5, No. 15.
1952. *Brachythyris chouteauensis* (Weller), Brown, Geol. Sur. Canada, Mem. 264, p. 101.
1952. *Brachythyris chouteauensis* (Weller), Sarycheva and Sokolskaja, Akad. Nauk S.S.S.R., Paleont. Inst., Trudy, vol. 38, p. 193, pl. 54, fig. 312.

Medium size, relatively thin-shelled, biconvex, pedicle valve inflated or subconical in posterior outline, brachial valve much less convex; maximum width anterior to the hinge line but rarely as far forward as mid-valve; beaks relatively small and proximate; ears rounded and usually small; surface of both valves regularly convex except for a slight flexure near the ears; uniplicate, fold of medium height, rounded or flattened, and narrow; sulcus shallow and narrow; both valves costate, although those costae in the fold and sulcus are usually indistinct; lateral costae large, rounded, slightly flattened, and rarely bifurcate, those of the fold and sulcus usually indistinct and bifurcating from the fold-bounding costae; growth varices prominent, irregularly spaced. Surface in exceptional specimens covered by faint radial capillae and exceedingly fine concentric growth lines.

Pedicle valve most convex at the umbo; beak considerably incurved; flanks evenly convex in inflated specimens or nearly flat in anterior or posterior profile of some specimens; interarea sharply defined, triangular, low, some well-preserved specimens showing vertical grooves similar to those of true spiriferids, indicating that the hinge is probably denticulate; delthyrium apparently open although dental ridges are present; median sulcus originating as a groove at the beak of moderate width and depth, becoming evenly concave anteriorly and with three to five indistinct costae; 11 to 15 usually simple lateral costae on each flank.

Interior of pedicle valve simple; dental plates and septa lacking; muscle scars indistinct in serial sections; inner edges of delthyrium thickened near the teeth proper and form the so-called "dental carinae;" teeth slender except for the articulating surface which is of moderate size.

Brachial valve considerably less inflated or convex than the opposing valve; dorsal umbo of moderate size but dorsal beak small and slightly incurved; dorsal interarea present but exceedingly low; fold originating at dorsal beak as a low ridge and rising evenly anteriorly, often producing a slight dorsal flexure near the anterior edge; lateral plications similar to those of pedicle valve; fold bearing from two to four indistinct plicae but with a distinct median groove.

Interior of brachial valve simple; spiriferoid cardinal process partially supported by socket ridges, crural bases, and in many specimens by a small thickening of fibrous shell tissue; sockets moderately wide and open on their inner edges except at their anterior tips; descending lamellae produced from dorsal inner edges of divided hinge plate; spires unknown; adductor muscle scars indistinct in transverse serial sections.

Table 35.—Measurements in millimeters of *Brachythyris chouteauensis* from USNM locality 9045.

USNM No.	Length	Width (max.)	Width (hinge)	Thickness
154851	31.6	33.9	39.0	24.3
154852	28.9	30.3	22.9	21.2
154853	23.2	27.7	21.3	16.4
154854	19.2	21.1	17.4	13.3
154855	16.8	19.3	13.6	11.4
154856	12.4	14.8	11.0?	8.5
154857	9.9	12.3	9.4	6.2
154858	7.1	8.6	5.6	4.8
154859	5.7	6.3	4.6	3.7

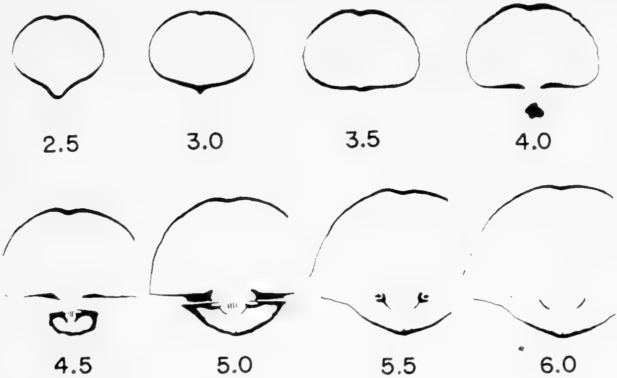
Holotype.—Univ. Chicago, Walker Museum No. 9664, now Field Nat. Hist. Mus., from Chouteau Springs, Missouri.

Distinguishing characters.—This species is characterized by its considerably inflated pedicle valve, small proximate beaks, sharply defined interarea, rounded or flattened fold which has a distinct median groove, 11 to 15 costae per flank and three or five faint costae in the sulcus.

Comparisons.—*Brachythyris chouteauensis* is easily distinguished from most Lower Mississippian species but can be confused with *B. peculiaris* (Shumard), 1855, which is smaller, more equally biconvex, the ventral beak is much larger, interarea is higher less sharply defined and the beaks are usually farther apart than in *B. chouteauensis.*

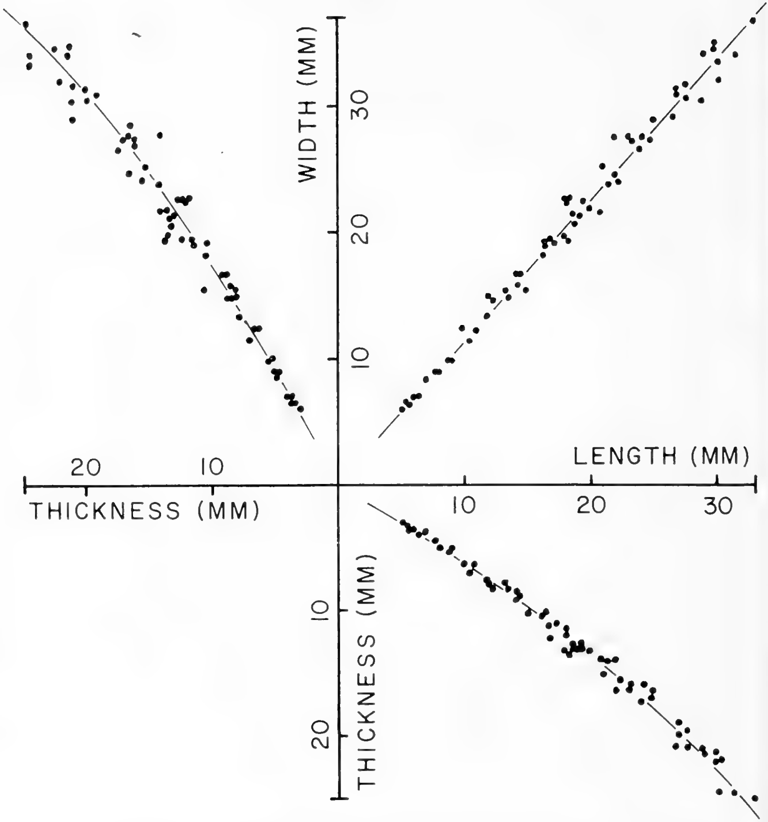
An Osagian species, *B. suborbicularis* (Hall), 1858, is usually considerably larger than *B. chouteauensis* and has flatter, weaker, lateral costae and a much wider and higher ventral interarea than that species.

Remarks.—The relative abundance of well-preserved exteriors from one population permits a limited analysis of the variation in size and gross shape of several of these shells. A scatter diagram of the standard measurements taken from this sample has been reproduced in Text-figure 38. The prominent growth varices also permit one to observe growth stages of well-preserved adults. There is little variation in the proportions of these varices. It is apparent that the length-width ratio remained relatively constant in all measurable growth stages. The slight curves shown on Text-figure 38 show that the species became relatively thicker late in ontogeny. The most



Text-figure 37. — Transverse serial sections of *Brachythyris chouteauensis* (Weller) X1.5, USNM 154860 from USNM locality 9045, measurements (mm) from ventral beak.

conspicuous ontogenetic changes occur in the ornament and fold development. The smallest specimens of this species are nearly smooth and often almost impossible to distinguish from similar stages of *Eomartiniopsis girtyi* (Branson), 1938. The latter species has dental plates, however, and preservation permitting, the writer segregated some specimens on this basis. In these smallest specimens the fold is absent and only a narrow median groove represents the ventral sulcus. The costae are usually weak until the shells are nearly a centimeter wide. The strength of the costae increases concurrently with shell growth, the costae being added along the hinge at the lateral edges of the beak. Bifurcation of costae is rare on the flanks. The fold does not become conspicuous until the shells are commonly more than a centimeter wide, many larger shells displaying only bounding grooves to indicate its presence. The fold remains low and inconspicuous in most specimens nearly to maturity at which time the fold rises anteriorly somewhat and often forms a dorsal flexure near the shell margin. The ventral sulcus corresponds to the fold and remains a shallow narrow groove until the shells are more than a centimeter wide. After the fold is developed, the



Text-figure 38.—Scatter diagrams of dimensions of *Brachythyris chouteauensis* (Weller) from USNM locality 9045.

sulcus widens, deepens, and forms a moderate-sized semicircular or slightly flattened tongue.

Occurrence and abundance.—According to Branson (1938, p. 66) *Brachythyris chouteauensis* occurs at many localities in the

Chouteau Limestone of Missouri. Brown (1952, p. 101) identified it from the Lower Banff Formation of Alberta. Sokolskaja (1914, p. 36, 37) reported a comparable form from the Lower Carboniferous of the Moscow Basin.

This species is relatively common and well represented in the Chappel Limestone, occurring at almost every locality, being especially abundant at USNM locality 9045. The collection from this locality consists of 15 types and measured specimens, 47 other well-preserved specimens of various growth stages and several dozen incomplete specimens and disarticulated valves. USNM localities 9046 and 9048 also produced good collections of this species.

Genus **ECTOCHORISTITES** Campbell, 1957

1957. *Ectochoristites* Campbell, Jour. Paleont., vol. 31, pp. 71, 72.
1961. *Ectochoristites* Campbell, Maxwell, Jour. Paleont., vol. 35, pp. 92, 93.

Diagnosis.—(After Maxwell, 1961.) Shell subequally biconvex, maximum width at hinge line; ventral interarea high, curved, subrectangular, grooved; entire surface costate, with bifurcations; dental plates short, thick; crural plates short.

Type species.—(By original designation) *Ectochoristites wattsi* Campbell, 1957, Jour. Paleont., vol. 31, pp. 73-76, pl. 15, figs. 1-7, Upper Tournaisian of Watts, Babbinboon, New South Wales, Australia.

Comparisons.—*Ectochoristites* is similar to several Carboniferous and Permian spiriferid genera, most notably *Spirifer* J. Sowerby, 1816, a supposedly common Mississippian genus; *Choristites* Fischer de Waldheim, 1825, from the Upper Carboniferous and Permian of Europe, Asia, and Greenland; *Palaeochoristites* Sokolskaja, 1941, from the Lower Carboniferous of the Moscow Basin; *Eochoristites* Chu, 1933, from the Lower Carboniferous of China; and some species of *Fusella* M'Coy, 1844, another Mississippian genus.

Spirifer s. s. possesses short divergent dental plates and apparently lacks dorsal basal plates that support the hinge plate.

Choristites has long subparallel dental plates that impinge on the ventral muscle field and lacks basal plates.

Palaeochoristites has long dental plates, long basal plates as well, lacks a ventral median ridge, and possesses simple costae that rarely bifurcate and a triangular ventral interarea.

Eochoristites may be closely related to *Ectochoristites*. However, the costae of *Eochoristites* are invariably simple, the interarea is not vertically grooved, and it has much longer basal plates. A narrow hinged species assigned herein to *Fusella* is similar to this genus exteriorly but internally it has longer more slender dental plates and lacks dorsal basal plates.

Remarks.—Until the genus *Spirifer s. s.* is thoroughly understood the status of *Ectochoristites* and many other spiriferid genera is uncertain. In the meantime it seems to be useful, stratigraphically as well as paleontologically, to assign many spiriferid species to somewhat restricted genera. Rather than propose new generic names for species that are different from seemingly typical Spirifers, this writer has chosen a more conservative solution, namely, to equivocally expand several existing generic concepts so as to include, in some cases, geographically widely separated species. In this manner the name *Ectochoristites* is questionably applied to North American species.

Campbell, (1957, pp. 75, 76) noted the general external similarity between the type species, *E. wattsi* Campbell, and *Spirifer gregeri* Weller, 1914. *Spirifer gregeri s. s.* is unlike *E. wattsi* internally, having long slender divergent dental plates in the pedicle valve, and lacking basal plates in the brachial valve.

Range.—Lower Carboniferous (Upper Tournaisian) of Australia, possibly Upper Kinderhookian and Lower Osagian of North America.

Ectochoristites inflatus, n. sp. Pl. 37, figs. 5a-6e; Text-figs. 39, 40

Medium to large, transversely subelliptical in outline; biconvex, pedicle valve subconical in profile and more inflated than the brachial valve; hinge submegathyrid, greatest width being attained posterior to mid-valve; ventral beak strongly incurved; ears small and rounded or slightly angular; anterior commissure uniplicate; fold and sulcus well developed, V-shaped; entire surface costate, with 19 to 21 rounded, usually simple costae per flank and 9 to 11 costae in the sulcus; prominent growth varices present at irregular intervals; microprosopon consisting of capillae and regularly spaced growth lines, the latter forming a fine but conspicuous herringbone pattern in well-preserved specimens; juveniles much less inflated with relatively larger more angular ears.

Pedicle valve subconical in anterior profile; flanks convex, beak strongly incurved; interarea of adults relatively short, curved, abruptly truncated at the extremities and marked by irregular vertical grooves; interarea of juveniles wider and nearly triangular; delthyrium usually wider than high, open, or with a small convex pseudodeltidium; narrow dental ridges present; sulcus starts near the beak and broadens to form an angle of about 28 to 30 degrees at the anterior margin; sulcus deep, broadly V-shaped with flat sides and simple median costa; other sulcal costae bifurcating from sulcus-bounding costae and rarely also bifurcating; sulcal costae tending to be flattened and indistinct at the anterior margin.

Table 36.—Measurements in millimeters of *Ectochoristites inflatus*, n. sp., from USNM locality 9045.

USNM No.	Length	Width (max.)	Width (hinge)	Thickness
154834	38.4	46.8	32.5?	31.0
154836	35.0?	41.0	34.0?	27.2
154837	32.8	41.4?	30.4?	26.7
154835	24.8	30.0	27.0	19.4
154838	20.0	28.0?	21.4?	15.9

Pedicle interior bearing widely spaced, slightly divergent, thick, short dental plates; beak filled with columnar tissue which obscures the anterior ends of the dental plates; muscle scars deeply impressed between thick ridges of columnar tissue; dental flanges also thickened forming a right angle with the hinge line near the beak, intersecting the dental plates near the floor of the valve at an angle; dental flanges converging and forming obtuse angles anteriorly; short low median ridge buried in columnar tissue posteriorly or exposed anteriorly; entire hinge line denticulate, the denticles having external expression in the interarea as vertical grooves; adductor scars *per se* indistinct.

Brachial valve much less inflated than the pedicle valve, forming a semicircular anterior profile; dorsal umbo blunt, beak small, incurved; interarea low with acute extremities; fold narrow, usually inconspicuous, being bounded posteriorly by grooves which are deeper and more conspicuous than those between costae; fold often slightly recessed between these grooves posteriorly and thus inconspicuous one or two centimeters from the dorsal beak; fold in adults often slightly flexed dorsally at the anterior margin to form a flat or slightly concave lateral profile; costae on fold often less distinct than those of the flanks especially at the anterior margin; other prosopon similar to that of the pedicle valve.

Brachial interior with dorsally thickened hinge plates which reach floor of the valve as two short septa or basal plates; cardinal process composed of about 15 or 16 parallel vertical plates, supported by the hinge plate; sockets of moderate size and open anteriorly for most of their length; crura or descending lamellae produced from the slightly thickened inner dorsal edges of the hinge plate; two low ridges marking the margins of the fold and forming a rounded median groove; adductor scars not distinguishable in serial sections but presumably lying in this median groove; short low conspicuous median ridge present in posterior portion of groove.

Holotype. — USNM 154834.

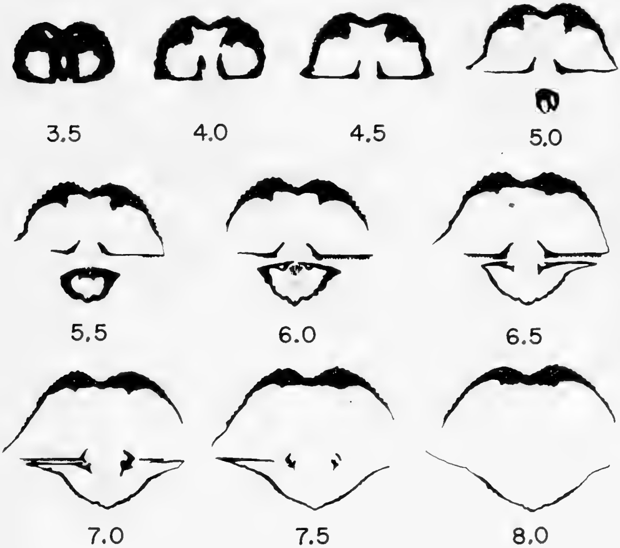
Distinguishing characters. — The subelliptical outline, 19 to 21 simple rounded lateral costae on each flank, 9 to 11 sulcal costae with a simple median costa, relatively deep V-shaped sulcus with somewhat angular shoulders, short basal plates in the brachial valve, and herringbone pattern formed by growth lines characterize this species.

Comparisons. — The similarities of juveniles of this species with those of *Spirifer chappelensis*, n. sp. and *Fusella llanoensis,* n. sp. are discussed under *S. chappelensis.*

Spirifer rowleyi Weller, 1914, from the Fern Glen Formation of Missouri and the Lake Valley Formation of New Mexico is much larger than *E. inflatus,* the lateral costae are more numerous and bifurcate freely, has a rounded sulcus with 20 or more costae, and the postero-lateral flanks are thin and slightly concave.

Spirifer striatiformis Meek, 1875, from the Waverly Group of Ohio is much thinner, relatively shorter compared to the width, relatively wider at the hinge, has a shallower sulcus with a bifurcating median costa, more slender and more divergent dental plates, and usually more numerous costae on the flanks.

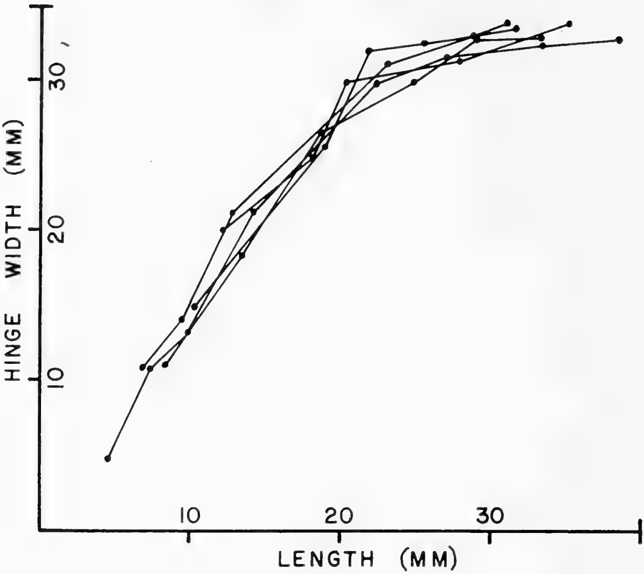
Specimens in the USNM collection of *Spirifer floydensis* Weller, 1914, from the Borden Group of Indiana appear to be similar to juveniles of *Ectochoristites inflatus*. However, they are wider with larger more angular ears, have a more rounded and more shallow sulcus and the dental plates are thinner and more divergent.



Text-figure 39.—Transverse serial sections of *Ectochoristites inflatus*, n. sp. ×1, USNM 154836 from USNM locality 9045, measurements (mm) from ventral beak.

The type species of *Ectochoristites, E. wattsi* Campbell, 1957, from the Upper Tournaisian of New South Wales, Australia, is considerably longer relative to width and the maximum width is at or near the hinge, is thinner and has a much shallower, more rounded sulcus.

Remarks. — There is too little material to permit statistical analysis of size variation. However, growth varices do permit study



Text-figure 40.—Plots of length-hinge-width measurements of *Ectochoristites inflatus,* n. sp. taken from growth varices of five pedicle valves (USNM locality 9045), illustrating variation in the proportions of these shells during ontogeny and a general trend toward truncation of the lateral extremities in later growth stages.

of ontogenetic changes in growth form as shown in Text-figure 40. In early stages the hinge width exceeds length in a ratio of about 3:2 and maximum width is at the hinge. The ears are angular but not mucronate. This condition prevails until the shells are about half or two-thirds grown at which time lateral growth at the hinge nearly ceases while antero-lateral growth continues causing abrupt truncation of the ventral interarea. Anterior growth continues and length usually exceeds or equals hinge width in adults. With the maximum width moving anteriorly, the ears become small and almost rounded.

The fold in juveniles is low and usually recessed between the fold-bounding costae. It may remain inconspicuous except at the anterior margin where it rises slightly in specimens more than 25 millimeters long. Except at the anterior margin of the holotype, the fold is never high.

The sulcus on the other hand is present on the ventral beak as a distinct groove and rapidly becomes deep and angular, forming a characteristic angular V-shaped sulcus in shells about 25 millimeters long or longer.

Occurrence and abundance. — Chappel Limestone of central Texas and the Lake Valley Formation of New Mexico. This species is rare. The Chappel Limestone material consists of 7 more or less complete shells and 47 incomplete specimens and disarticulated valves from USNM locality 9045, and one complete shell from USNM locality 9046. One nearly complete specimen in the USNM collections from the Lake Valley Formation of New Mexico is similar to the holotype.

Superfamily **SPIRIFERINACEA** Davidson, 1884

Family **SPIRIFERINIDAE** Davidson, 1884

Genus **PUNCTOSPIRIFER** North, 1920

Punctospirifer ? sp. Pl. 34, figs. 10-13

Two badly spalled pedicle valves and two brachial valves, both spalled, from USNM locality 9045 and two spalled pedicle valves from locality 9048 are possibly representatives of this genus in the Chappel Limestone. The poor preservation of these specimens prevents accurate specific as well as generic identification.

These specimens are questionably referred to *Punctospirifer* North on the basis of shell shape, costation, and coarse punctation. The pedicle valves bear dental plates and a median septum but other internal details are lacking. Whether the original external surface was imbricate and spinose is not known.

Superfamily **RETICULARIACEA** Waagen, 1883

Family **RETICULARIIDAE** Waagen, 1883

Genus **RETICULARIA** M'Coy, 1844

Reticularia? cooperensis (Swallow) Pl. 40, figs. 1a-7d; Text-fig. 41

1860. *Spirifer cooperensis* Swallow, St. Louis Acad. Sci., Trans., vol. 1, p. 643.

1914. *Reticularia cooperensis* (Swallow), Weller, Illinois Geol. Sur., Mon. 1, pp. 428, 429, pl. 75, figs. 21-33.
1956. (?) *Reticularia cooperensis* (Swallow), Simorin, Akad. Nauk Kazakh. SSR, p. 196, pl. 17, figs. 12-15.
1958. *Reticularia cooperensis* (Swallow), Sanders, *in* Easton, *et al.*, Smith. Misc. Coll., vol. 119, No. 3, pp. 58, 59, pl. 6, figs. 21-30.

Sanders (1958) adequately described this species both externally and internally. His description was based on silicified specimens from the Represo Limestone of Sonora, Mexico.

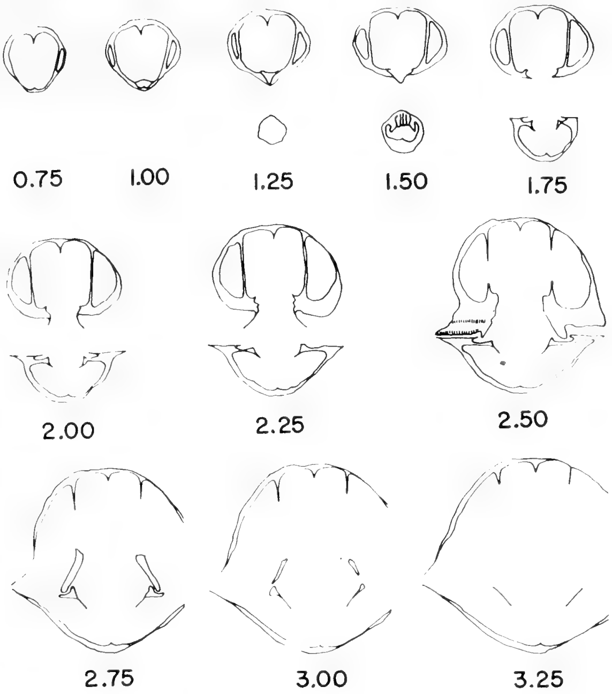
The Chappel Limestone collection of reticulariids agrees with Weller's (1914) and Sanders' descriptions of exteriors. Serial peels (Text-figure 41) of Chappel material agree with Sanders' description and illustrations of the interior details. These serial peels revealed two additional details ordinarily missed in conventional examinations. First, there are thin deltidial plates (or plate?) that project somewhat above the surface of the ventral interarea. These plates appear as curved lines between the valves in Text-figure 41, 2.00 and 2.25. (It is interesting to note that George (1931, p. 526) found similar plates in *Phricodothyris*). Second, the hinge line is finely denticulate (as Sanders hypothesized). The denticles can be seen in Text-figure 41 — 2.50 as vertical grooves near the hinge line.

Table 37.—Measurements in millimeters of *Reticularia? cooperensis* (Swallow) from the Chappel Limestone.

USNM No.	Length	Width	Thickness	USNM Locality
154862	19.3	23.3	13.0	9045
154863	17.5	21.1	11.7	9048
154864	15.9	20.4	12.3	9045
154865	14.5	16.8	10.2	9045
154866	12.1	14.6	8.1	9045
154867	9.7	10.6	5.8	9045
154868	6.4	7.2	3.8	9045

Types. — Swallow's types were lost in a fire in 1892. However, the species is so well known it seems unnecessary to designate a neotype. Weller's hypotypes are in the Field Natural History Museum, Walker Museum Coll. No. 9701. Sanders' Represo Limestone hypotypes and the Chappel specimens are in the USNM.

Remarks. — Besnossova (1963, p. 304) assigned this species to the genus *Torynifer* Hall and Clarke, 1894. However, none of the



Text-figure 41.—Transverse serial sections of *Reticularia? cooperensis* (Swallow) ×3, USNM 154869 from USNM locality 9045, measurements (mm) from ventral beak.

several dozen specimens in the USNM collections from the Chouteau Limestone of Missouri has a dorsal median septum. In fact, most do not even have a conspicuous median ridge. As Sanders (1958, p. 59) pointed out, Weller may well have described a ridge instead of a septum in his description of this species. In any case it is safe to say that this species does not possess a dorsal septum and hence, does not belong in *Torynifer*.

Occurrence and abundance. — This species has been widely identified in Kinderhookian formations of North America. It is fairly common in the Chouteau Limestone of Missouri, the Chappel Limestone of Texas, occurring at almost every locality in the latter formation. If the form identified by Besnossova has a dorsal septum, it is not this species and requires another name.

Genus **CRASSUMBO**, n. gen.

(Latin *crassus* = thick; *umbo* = shield)

Smooth, spiriferoid, medium-sized; subequally biconvex; uniplicate; usually wider than long; ears rounded, hinge line shorter than the maximum width; beaks slightly to considerably incurved; fold and sulcus poorly to well defined; ventral interarea relatively small, triangular, open; posterior portions of both valves much thickened with columnar tissue; dental plates thin, subparallel, partially or completely buried in columnar tissue; ventral muscle field narrow and considerably incised posteriorly; no median ridge apparent in either valve or mature specimens, however, a prominent ventral ridge appears in juveniles; cardinal process and sockets spiriferoid; inner socket ridges much reduced; crural bases large, high, thickened by columnar tissue, reaching floor of valve in juveniles; pallial sinuses not positively identified but may be martinioid; macroprosopon consisting of irregularly spaced growth varices; some spalled specimens show a few vague low rounded radial wrinkles on the flanks (these may prove to be manifestations of the pallial sinuses); microprosopon consisting of radial capillae and sparse, irregularly scattered nodes or spine bases.

Type species. — *Crassumbo inornatus,* n. gen., n. sp. from the Chappel Limestone of central Texas.

Distinguishing characters. — The great thickening of the umbos of both valves obscuring internal structures in adults, the prominent ventral median ridge and well-developed crural plates in juveniles, and capillate, nodose or spinose, microprosopon characterize this genus.

Because assignment to this genus depends on both interior details, as well as a well-preserved exterior surface prosopon, it is usually difficult to assign from the literature old spiriferid and martiniid species. Whether the genus includes more than the two new species described herein has not been determined.

Comparisons. — This genus is similar exteriorly to many martinioid, reticulariid, and ambocoeliid genera. However, the capillate, sparsely nodose microprosopon and massive umbonal regions serve to distinguish it from most of these genera that are grossly similar exteriorly.

Crassumbo is associated with *Eomartiniopsis* Sokolskaja, 1941, in the Chappel Limestone. Because the microprosopon is rarely preserved, it is necessary to determine whether the umbos are thickened in order to distinguish it from *Eomartiniopsis* which is thin-shelled.

Several somewhat similar genera from the Devonian of Czechoslovakia have been described by Havliček. *Pinquispirifer* Havliček, 1957, has faint costae on the flanks, a strong fold and sulcus, lacks well-developed crural plates, the brachial umbo is much less thickened with columnar tissue, and the hinge plate is free. In external form, microprosopon, and thickened ventral umbo *Pinquispirifer* shows obvious similarities to *Crassumbo* and *Warrenella* Crickmay, 1953, and may be related to them, although Havliček placed it with the Eospiriferinae.

Undispirifer Havliček, 1957, also has low flat indistinct costae on the flanks, and a prominently marked off fold and sulcus, but has concentric rows of minute, single, longitudinally elongated spines, lacks the great thickening of the umbos, and lacks well-developed crural bases.

Eoreticularia Nalivkin, 1930, has concentric rows of fine granules or spines and furthermore, is relatively thin-shelled, and internally lacks crural plates that touch the floor of the dorsal valve.

Fredericksia Paeckelmann, 1932, from the Permian of Russia, has a ventral median septum and a "shagreen" (martiniid) microprosopon.

Remarks.—Crassumbo is most similar and possibly related to *Warrenella* Crickmay, 1953, a genus now widely identified in the Devonian of North America. *Warrenella,* however, does not display the unusual degree of umbonal thickening in the brachial valve as seen in *Crassumbo,* possesses a deltidial plate, and apparently lacks well-developed crural bases. Crickmay, (1953, p. 599, figure 19) illustrated a transverse section in which rudimentary plates are developed on the dorsal edges of the inner socket ridges. The microprosopon, that is, capillation of the two genera is nearly identical, but *Warrenella* apparently lacks the scattered nodes (or spine bases) seen in *Crassumbo inornatus*, n. sp.

Tingella Grabau, 1931, a Devonian form from Asia and Europe, is similar to *Crassumbo* in that it possesses well-developed crural plates that touch the floor of the dorsal valve and is thickened by columnar tissue. The fold and sulcus are more weakly developed, columnar tissue deposits thinner, and apparently the microprosopon consists of fine spines and not true capillae.

Despite the lack of preservation of actual spines, the nodes or spine bases, capillate ornament, prominent median ridge in the juveniles and general form all indicate reticulariid affinities. Consequently *Crassumbo* is assigned to that family. However, the unusual thickening of the shell with columnar tissue, the sharp delineation of the ventral interarea, presence of well-developed crural plates in the brachial valve, and lack of obvious concentric prosopon (*e.g.* rows of spines) make subfamilial assignment uncertain.

Range.—Lower Mississippian of central Texas.

Crassumbo inornatus, n. gen., n. sp. Pl. 23, fig. 14; Pl. 41, figs. 1a-12; Text-fig. 42

Martiniid in aspect, small to medium in size, smooth, thick-shelled, transversely ovate or subelliptical in outline; subequally biconvex, neither valve much inflated; beaks small; hinge brachythyrid, considerably less than the maximum width which is attained near mid-length; cardinal extremities rounded in all growth stages but more acute in juveniles than in adults; macroprosopon consists of irregularly spaced growth varices and on inner shell layers of a few specimens there are faint low costae or costellae on the flanks. Microprosopon consists of fine radial capillae and sparsely scattered nodes or spine bases (see Text-fig. 42).

Pedicle valve most convex in the umbo; beak slightly incurved and small; sulcus a shallow groove posteriorly, becoming broader but not deep anteriorly; flanks gently convex or nearly flat near the ears; interarea low, sharply defined, smooth, triangular; delthyrium apparently open.

Interior of pedicle valve with slender, subparallel, short dental plates that are partly or completely buried in columnar tissue (the actual dental plates composed of fibrous tissue are represented as single lines in Text-fig. 42A); subdelthyrial thickening of columnar tissue present below the delthyrium in the beak; teeth small; median ridge not discernible in later growth stages but prominent in juveniles; ventral muscle field moderately incised between dental plates.

Brachial valve similar to pedicle valve in convexity; beak slightly swollen, anterior extremity of shell bent slightly dorsad; fold absent in umbonal region, low, confined to anterior two-thirds of the valve; flanks slightly concave posteriorly near the ears, otherwise gently concave; dorsal interarea low, triangular, inconspicuous; prosopon similar to that of the pedicle valve.

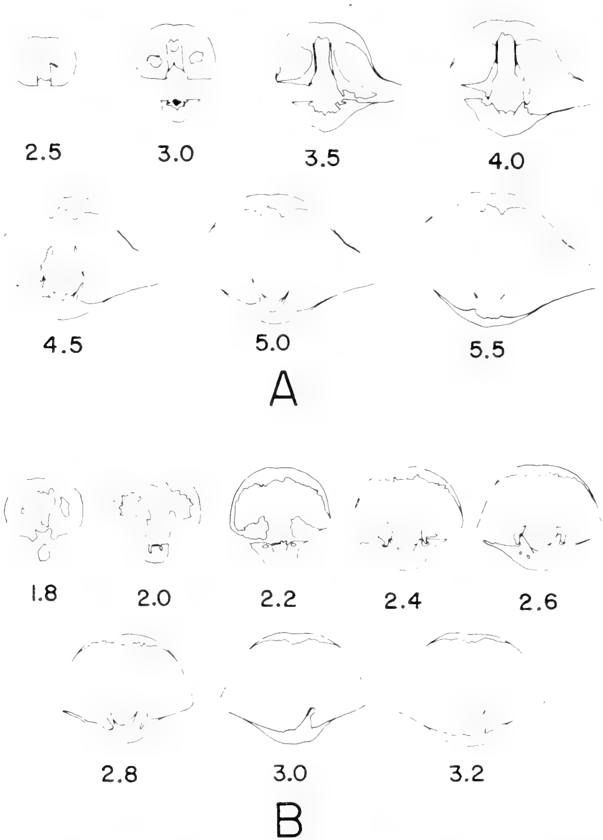
Interior of dorsal valve with greatly thickened umbo; cardinal process spiriferoid, that is, composed of shelly plates; sockets relatively small, completely enclosed posteriorly and dorsally by columnar tissue, at least in adults; socket ridges greatly thickened with columnar tissue; crural plates short and buried or greatly thickened by columnar tissue in adults; in large specimens crural bases thickened by columnar tissue (see Text-fig. 42A—5.0 and 5.5); no median ridge present; dorsal muscle scars indistinct in serial sections; no spiralia observed.

Holotype.—USNM No. 154873, Plate 41, figs. 1a-e.

Distinguishing characters.—This species is characterized by its relatively low uninflated valves, the pedicle valve being considerably longer than the brachial valve, smaller beaks, a poorly defined fold and sulcus, rounded ears, and a gently convex pedicle valve.

Table 38.—Measurements in millimeters of *Crassumbo inornatus,* n. sp.

USNM No.	Length (pedicle)	Length (brachial)	Width (max.)	Hinge Width	Thickness	USNM Loc.
154873	18.5	16.8	23.3	16.6	13.8	9045
154874	17.2	14.4	20.8	14.6	12.9	9045
154675	17.3	14.8	20.8	14.8	11.4	9046
154875	17.5	14.3	18.9	9.5	10.2	9045
154876	9.8	8.3	9.8	7.1	6.9	9045
154877	5.6	5.0	6.0	4.5	3.7	9045



Text-figure 42.—Transverse serial sections of *Crassumbo inornatus,* n. sp. from USNM locality 9045, measurements (mm) from ventral beak. (A) Large specimen, USNM 154884, ×1.5. (B) Large juvenile or small adult, USNM 154885, ×3. Dental plates and crural bases are represented as lines.

Comparisons.—This species is readily distinguished from *Crassumbo turgidus,* n. sp. with which it occurs at USNM localities 9043 and 9046. *C. turgidus* has more swollen umbos in both valves, the brachial valve is nearly as long as the pedicle valve, the sulcus is deeper, and the cardinal extremities more acute and slightly reflexed from the rest of the shell. *C. inornatus* has a brachial valve that is considerably shorter than the pedicle valve, a less swollen dorsal umbo, a shallow sulcus, and the cardinal extremities are rounded and evenly adjoin the rest of the shell.

Remarks.—The small number of well-preserved specimens available makes a complete description and analysis of this species impossible. However, it is possible to add a few remarks about some of the small individuals available from USNM locality 9045. The smallest specimens are only a few millimeters long, but unfortunately they are not well enough preserved to insure good interior information. A good cellulose peel of one small specimen about five millimeters long shows a prominent ventral median ridge in the beak area, similar to that found in juveniles of *C. turgidus*. The smallest completely sectioned specimen was about nine millimeters long and it varied little internally from a typical adult (Text-fig. 42B). Exteriors of small specimens are similar in their proportions to those of adults although the fold and sulcus are less pronounced. The growth varices of adults bear this out also. In the latest growth stages there is a tendency toward crowding of the growth varices especially near the ears resulting in a slightly narrower hinge line. Several specimens have a noticeably larger ventral beak, but this is assumed to be normal infra-specific variation.

Occurrence and abundance.—Chappel Limestone of central Texas. This is a relatively common species of USNM locality 9045 (61 disarticulated valves or fragmentary adult specimens and four complete adults, 47 juveniles and small individuals); rare at location 9046—three more or less complete adults and two fragmentary specimens; rare or unidentified elsewhere.

Crassumbo turgidus, n. gen., n. sp. Pl. 42, figs. 1a-6e; Text-figs. 43, 44

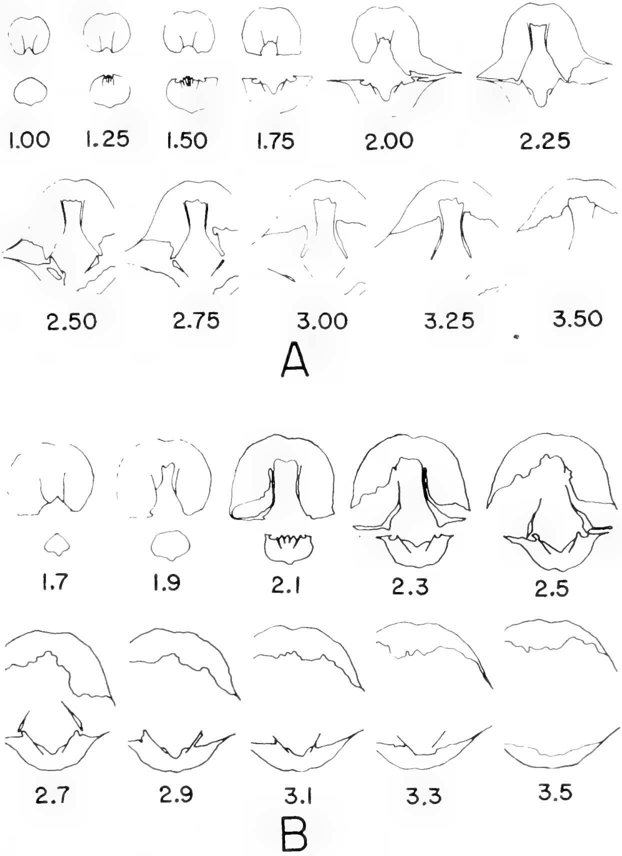
Martiniid in general aspect, small to medium size; thick-shelled; transversely ovate or subquadrate in outline; subequally biconvex, both valves much inflated and nearly equal in length; beaks conspicuous; hinge brachythyrid, maximum width attained more or less near mid-length; cardinal extremities angular and delineated by a slight reflexing of the outer surface of both valves; macroprosopon consisting of irregularly spaced growth varices and on inner shell layers of some specimens faint radial costae on the flanks; microprosopon consisting of fine capillae preserved only on outermost shell layers and hence rarely observed.

Pedicle valve most convex posteriorly; subconical in posterior profile, the flanks being slightly concave posteriorly; beak moderately incurved and small; sulcus beginning in the beak as a shallow narrow groove becoming much broader but not deeper at mid-length, forming a moderately deep rounded sulcus near the anterior commissure; flanks slightly concave to slightly convex in anterior outline; interarea low, well defined, triangular, delthyrium apparently open; marks of pallial sinuses not observed unless represented by the faint fine costae on the flanks.

Interior of pedicle valve with slender subparallel or slightly convergent short dental plates that are partially or nearly completely buried in columnar tissue in adults; dental plates free in earliest growth stages observed; teeth relatively small; thick prominent median ridge present in earliest known growth stages, buried in columnar tissue in adults; ventral muscle field deeply incised between dental plates.

Brachial valve more convex than pedicle valve, being strongly convex in the umbo and reflexing or concave only in the ears, the flanks forming a moderately convex slope to the anterior commissure; dorsal beak somewhat incurved, considerably swollen; fold not apparent in the dorsal umbo, first appearing at about mid-length or even slightly anterior to mid-length as a posterior flexure in the growth varices, gradually becoming higher anteriorly, being well delineated only in the anterior one-third or so of the shell; dorsal interarea low, triangular, inconspicuous; prosopon similar to that of pedicle valve.

Interior of dorsal valve with greatly thickened umbonal region; cardinal process spiriferoid; sockets small, posteriorly enclosed by columnar tissue in adults; crural plates short but touching the dorsal inner surface in juveniles, buried in adults; crural bases also partially buried and thickened in large adults; dorsal muscle scars indistinct, no spiralia observed.



Text-figure 43.—Transverse serial sections of *Crassumbo turgidus*, n. sp. from USNM locality 9043, measurements (mm) from ventral beak. (A) Large specimen, USNM 154899, ×2; (B) Small adult, USNM 154900, ×3.

Table 39.—Measurements in millimeters of *Crassumbo turgidus,* n. sp.

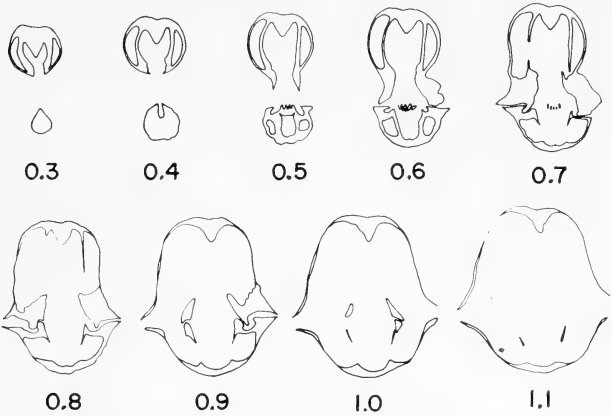
USNM No.	Length (pedicle)	Length (brachial)	Width (max.)	Width (hinge)	Thickness	USNM Loc.
154887	18.8?	16.9?	24.0	18.2?	15.3	9043
154888	17.6	16.3	23.0?	17.1	14.6	9043
154889	16.3	13.9	18.0?	14.1	11.9	9043
154890	16:6	14.5	17.7	13.0	10.5	9043
154891	11.2	9.6	11.6	8.3	8.0	9046
154893	9.7	8.7	11.1	7.8	7.2	9046
154894	8.9	8.2	9.5	6.2	6.3	9046
154895	8.3	7.9	8.9	5.6	6.1	9046
154896	6.4	6.3	6.9	4.1	4.5	9046
154892	6.0	5.7	6.1	3.7	4.4	9046
154897	4.4	4.4	4.4	2.7	3.2	9046
154898	3.7	3.8	3.7	2.0	2.1	9046

Holotype.—USNM 154887.

Distinguishing characters.—This species is characterized by its inflated valves, swollen umbos, considerably incurved beaks, well-developed fold and sulcus, well-delineated semiangular cardinal extremities and a brachial valve that is nearly as long as the pedicle valve.

Comparisons.—This species is similar to and associated with *Crassumbo inornatus,* n. sp. which can be distinguished by its less evenly and less inflated valves, relatively smaller brachial valve, lesser incurvature of both beaks, less swollen umbos, less prominent fold and sulcus, and less angular and more poorly defined cardinal extremities.

Remarks.—Unfortunately no single locality has produced a population sample large enough for statistical analysis. The collection from USNM locality 9046 of small adults and juveniles provides useful information concerning the development of the columnar tissue thickening and the pre-deposition structures present in both beaks. The smallest of these specimens sectioned (Text-fig. 44) was about 5.5 millimeters long and similar in appearance to the specimen shown on Plate 42, figure 6. This specimen clearly displays a prominent median ridge in the pedicle valve and short crural plates in the brachial valve, structures only suspected to exist in adults. The progressive deposition of columnar tissue in specimens only slightly larger than this obscures these details. By the time the individuals are a centimeter long most interior details are obscured by



Text-figure 44.—Transverse serial sections of *Crassumbo turgidus,* n. sp. a small juvenile, USNM 154901, from USNM locality 9046, ×6, measurements (mm) from ventral beak. Note the massive ventral median ridge and crural bases that reach the floor of the brachial valve.

this deposition. (Sexual maturity is, of course, impossible to demonstrate but for the purposes of description the specimens have been referred to as adults if they have been sufficiently thickened to bury or greatly thicken the dental plates and cardinalia). The length-width ratios of juveniles are substantially larger than those of large adults. The length-width ratios of the largest adults are 0.77-0.78 with those of juveniles averaging around 0.98. The fold and sulcus of juveniles are also poorly produced, the sulcus being a shallow narrow groove, and the fold scarcely discernible.

Occurrence and abundance.—Chappel Limestone of central Texas, USNM localities 9043, 9046, and 9042.

This species is not common. Besides the types there are two nearly complete specimens and seven disarticulated valves or fragmentary specimens from USNM locality 9043. From USNM locality 9046, excepting the types, there are eight complete or nearly complete small adults, 52 disarticulated valves or fragmentary specimens of small adults and 64 complete juveniles. Two imperfect specimens from USNM locality 9042 are assigned to this species.

Family **MARTINIIDAE Waagen,** 1883

Genus **EOMARTINIOPSIS** Sokolskaja, 1941

1941. *Eomartiniopsis* Sokolskaja, Akad. Nauk SSSR, Paleont. Inst., Trudy, vol. 12, No. 2, pp. 78-80, 123.
1952. *Eomartiniopsis* Sokolskaja, Rzhonsnitskaja, Trudy, Vsesoiuznyi Nauehnoissled. Geol. Inst. (VSEGEI), p. 144.
1952. *Eomartiniopsis* Sokolskaja, Sarycheva and Sokolskaja, Akad. Nauk SSSR, Paleont. Inst., Trudy, vol. 38, pp. 216, 217.
1959. *Eomartiniopsis* Sokolskaja, Havlíček, Ústredníko ústavu geologického, Rozpravy, Svazek 25, pp. 185, 259, 260.
1960. *Eomartiniopsis* Sokolskaja, Ivanova, Osnovi Paleont., Mshanki, Brachiopody, Moscow, pp. 274, 275.
1963. *Eomartiniopsis* Sokolskaja *in* Sarycheva, Sokolskaja, Besnossova, and Maximova, Akad. Nauk SSSR, Paleont. Inst., Trudy, vol. 95, p. 299.
1965. *Eomartiniopsis* Sokolskaja, Pitrat, Treatise on Invertebrate Paleontology, Part H, Brachiopoda, vol. 2, p. 726.

Thin, lacking columnar tissue, small to medium size; outline ovate or transversely to longitudinally rounded; hinge line short, much less than the maximum shell width, cardinal extremities rounded; sinus and fold usually well developed; ventral interarea of moderate size, curved, triangular, smooth; delthyrium large, triangular, open; dorsal interarea low and inconspicuous; macroprosopon consisting of growth varices and in some species, low, broad, indistinct costae or radial undulations on the flanks of large specimens; microprosopon consisting of fine pits on inner shell layers.

Pedicle valve with thin, medium to long, subparallel to slightly divergent dental plates; no median ridge, but the oblong muscle scar is longitudinally divided by two low narrow ridges (not seen in serial sections).

Brachial valve with martiniid cardinalia, that is, the cardinal process is spiriferoid or composed of several vertical shelly plates; sockets narrow and transversely elongated; crural bases arising from dorsal edges of inner socket ridges, directed dorso-medially; short "basal" plates arising and diverging dorso-laterally from the crural bases in the dorsal beak but not reaching the floor of the valve. No median ridge present.

Type species.—Eomartiniopsis elongata Sokolskaja, 1941, pp. 82-85, pl. 7, figs. 2-4, pl. 12, figs. 1, 2. Lower Carboniferous (Tournaisian) of the Moscow Basin.

Distinguishing characters.—The thin shell, transversely to longitudinally ovate outline, usually well-developed fold and sulcus in adults, indistinct broad flat costae commonly found on the flanks, thin slender, subparallel dental plates in the ventral valve, incipient "basal" plates in the brachial valve, and microprosopon of numerous fine pits on the inner shell layers characterize this genus.

Comparisons.—The presence of dental plates and lack of well-developed "basal" plates easily distinguish this genus from *Martinia* M'Coy, 1844, and *Martiniopsis* Waagen, 1883, respectively.

The capillate irregularly nodose microprosopon and the massive shell development in the umbones of *Crassumbo,* n. gen., another Chappel genus, serve to distinguish it from *Eomartiniopsis.*

Pinquispirifer Havliček, 1959, *Undispirifer* Havliček, 1959, and *Eoreticularia* Nalivkin, 1930, appear similar to *Eomartiniopsis* in outline and general aspect; they can be distinguished by the following; *Pinquispirifer* has a capillate surface ornament, the shell is posteriorly thickened with columnar tissue, the dental plates are buried in this tissue, and crural plates are partally buried. *Undispirifer* possesses concentric rows of minute, simple, elongated spines and is thus a reticulariid as in *Eoreticularia* which lacks low broad costae on the flanks in all cases, has concentric rows of fine spines or papillae, and the fold and sinus are poorly developed or even lacking.

Remarks.—Sokolskaja (1941, pp. 79, 80) and Havliček (1959, p. 260) speculated that this genus may prove to be synonymous with *Martiniella* Grabau, 1931, but reserved judgment due to the scanty description given by Grabau. It would seem that the type species given for *Martiniella* by Grabau, *Martiniella nasuta* Grabau, is a *nomen nudum.* Therefore, *Martiniella* appears to be an invalid name according to the International Code of Zoological Nomenclature (Articles 13 b and 68).

Range.—Lower, Middle, and Upper Devonian of Czechkoslovakia, Tournaisian of the Moscow Basin, and Kinderhookian of Texas.

Eomartiniopsis girtyi (Branson) Pl. 23, fig. 13; Pl. 43, figs. 1a-7d; Text-figs. 45-47

1938. *Brachythyris girtyi* Branson, Univ. Missouri Studies, vol. 13, No. 3, pp. 66, 67, pl. 9, figs. 31-33.

Medium-sized, thin-shelled, subequally biconvex, transversely ovate in outline, the pedicle valve being somewhat more inflated in profile; hinge brachythyrid, considerably less than the maximum width which is attained at or somewhat posterior to mid-valve; cardinal extremities rounded in all growth stages; beaks incurved; fold and sulcus well developed in mature specimens; macroprosopon consisting of about 12 or 13 costae on each flank, the costae being simple, low, broad, and indistinct especially near the umbones, and prominent irregularly spaced growth varices; surface of inner shell layers densely covered with fine pits (see Plate 23, fig. 13) as in *Martinia* (so-called "shagreen" ornament).

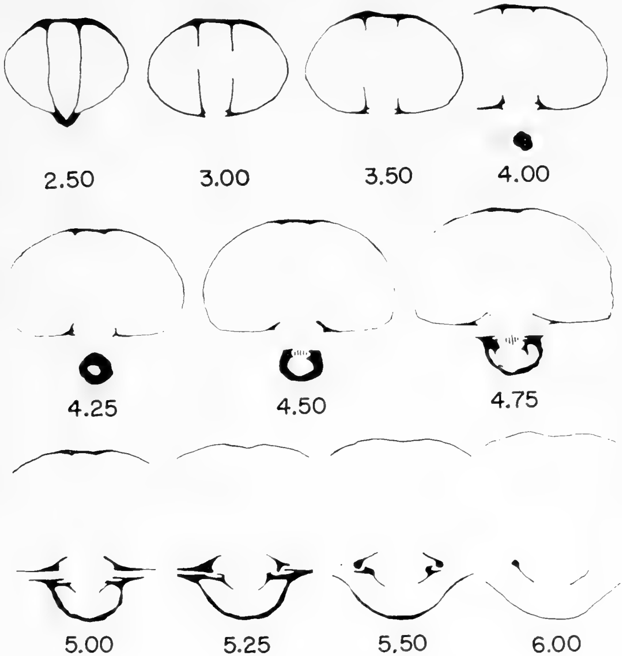
Pedicle valve most convex at the anterior and posterior extremities, the beak being tumid and somewhat incurved; flanks almost flat in posterior profile from the edges of sulcus to valve margins; interarea relatively small, curved, triangular, smooth, and not sharply delineated in most specimens; delthyrium large, triangular and apparently open; sulcus originating as a groove on the beak but by mid-valve is a rounded sulcus of moderate depth with slightly rounded shoulders, forming a moderate tongue anteriorly.

Interior of pedicle valve with slender, subparallel, moderately long dental plates which extend about one-third of the valve length but appear only as ridges for much of their extent in serial sections. No median ridge, lateral crests or muscle scars discernible in serial sections.

Table 40.—Measurements in millimeters of *Eomartiniopsis girtyi* from USNM locality 9045.

USNM No.	Length	Width (max.)	Width (hinge)	Thickness
154905	29.7	39.2	29.3	21.4
154906	29.8	35.1	24.6	22.1
154907	27.2	34.7	24.2	19.6
154908	23.9	30.2	21.0	18.0
154909	20.0	27.1	18.5	13.8
154910	15.7	20.2	11.8	9.4
154911	11.0	13.5	7.7	6.6

Brachial valve less inflated; dorsal beak small and scarcely incurved; dorsal interarea low and inconspicuous; fold originating just anterior to the dorsal umbo but remaining inconspicuous for much of its length. At about mid-valve a median groove appearing (simi-



Text-figure 45.—Transverse serial sections of *Eomartiniopsis girtyi* (Branson) ×2, USNM 154912 from USNM locality 9045, measurements (mm) from ventral beak.

lar to that of *Brachythyris)* and the fold is slightly flattened at the anterior commissure. Prosopon similar to that of the pedicle valve.

Interior of brachial valve with a spiriferoid cardinal process; sockets transversely elongated; short "basal" plates (Text-fig. 45—4.75) diverging dorso-laterally from the crural bases but not touching the floor of the valve except in the umbo proper. Crura originating antero-dorsally from the inner socket ridges. No median ridge; muscle scars not distinguishable in serial sections.

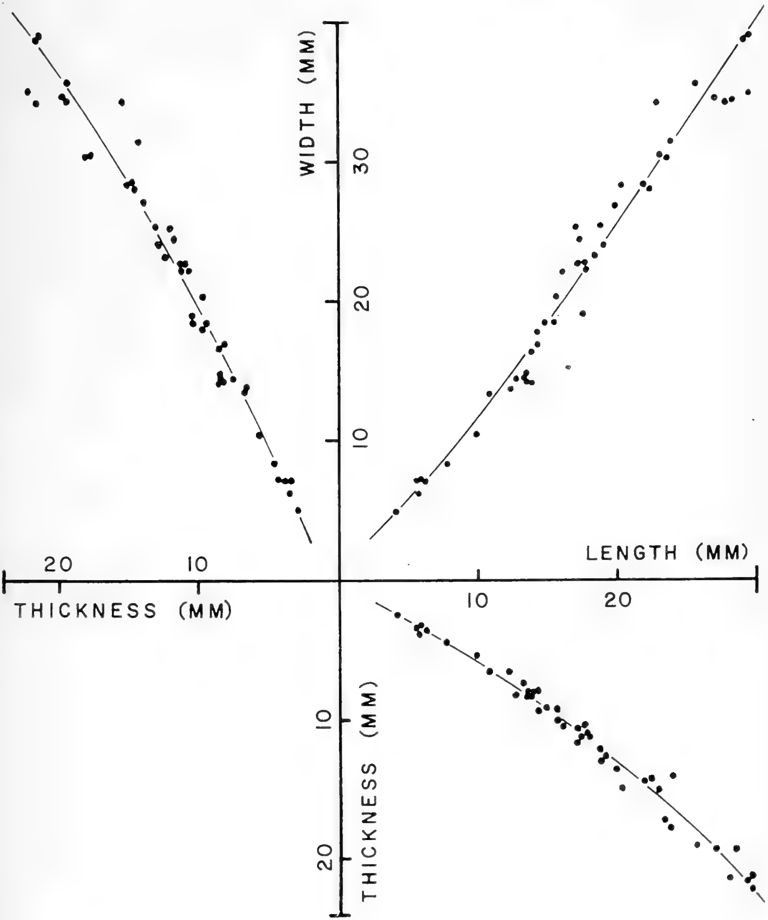
Syntypes.—University of Missouri, collection 4267, Chouteau Limestone, near Williamsburg, Missouri. (One syntype illustrated in Brañson, 1938, plate 9, figs. 31-33).

Distinguishing characters.—*Eomartiniopsis girtyi* is characterized by its transversely ovate outline, somewhat inflated pedicle valve, relatively well-developed fold and sulcus, costate flanks with 12 or 13 broad simple costae per flank and slender subparallel dental plates.

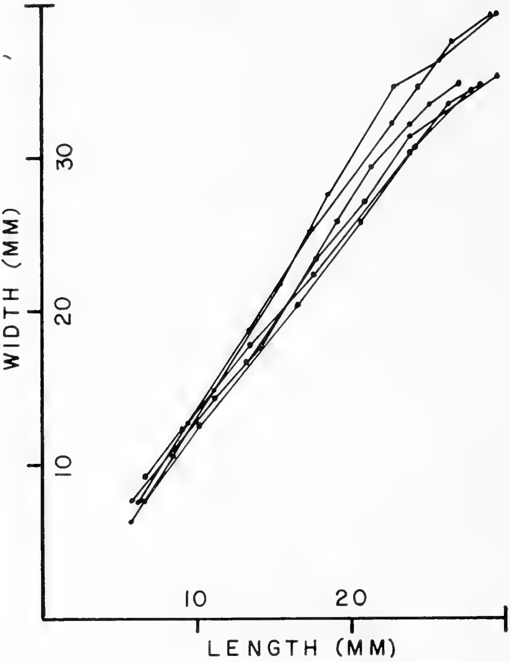
Comparisons.—*Eomartiniopsis girtyi* is the only previously described Mississippian species of this genus in North America.

Havliček (1959, p. 185) placed *Delthyris laevis* Hall, 1843, and *Martinia kirki* Merriam, 1940, in this genus, however, both are reticulariids. *Delthyris laevis* Hall is probably a *Warrenella* Crickmay, 1953, and *M. kirki* Merriam is similar to *Tingella* Grabau, 1931.

Remarks.—A large sample of reasonably well-preserved nearly complete specimens from a single population (locality 9045) affords an opportunity for an unsophisticated analysis of size variation and growth characteristics. Text-figure 46 is a scatter diagram comparing the standard dimensions of length, width, and thickness. From this diagram it can be seen that although shell growth is linear, in general, there is a tendency for shells to become relatively wider and thicker compared to the length. More conspicuous ontogenetic changes are apparent in the development of the fold and sulcus and flank costation. In small juveniles the fold is poorly developed and the sulcus is merely a median groove. By the time individuals are about a centimeter long the fold appears and the sulcus begins to widen anteriorly. Smaller shells are nearly smooth and extremely difficult to identify unless one can observe the presence of dental plates or pitted inner shell layers. The weakly developed lateral costa apparently appear late in ontogenetic development. Most specimens less than 20 millimeters long do not have recognizable costae and the ribbing in larger specimens is sometimes indistinct. Text-figure 47 is a graph of length-width measurements taken from growth varices of the pedicle valve of several specimens. It more or less duplicates the information of the scatter diagram but in addition shows a marked tendency for the growth varices to become crowded posterolaterally, that is, growth in width nearly terminates



Text-figure 46.—Scatter diagrams of dimensions of *Eomartiniopsis girtyi* (Branson) from USNM locality 9045.



Text-figure 47.—Plots of length-width measurements of *Eomartiniopsis girtyi* (Branson) taken from growth varices of six pedicle valves (USNM locality 9045), illustrating variation in the proportions of these shells during ontogeny and a slight trend toward truncation of the lateral extremities.

in full maturity although length increases. This tendency is typical of round-eared spiriferoid brachiopods.

Occurrence and abundance.—This species occurs in the Chouteau Limestone of Missouri and the Chappel Limestone of central Texas. Branson (1938, p. 67) listed only one collecting locality in the Chouteau, University of Missouri locality 4267, and did not comment on the size or extent of his collection.

In the Chappel Limestone *E. girtyi* is a relatively common species and occurs at nearly every Chappel locality.

Besides the 41 types and measured specimens from USNM locality 9045, there are also several scores of incomplete specimens and disarticulated valves. The USNM locality 9048 collection is also large and includes 13 excellent shells and several dozen more or less perfect specimens.

Order TEREBRATULIDA Waagen, 1883

Suborder TEREBRATULIDINA Waagen, 1883

Superfamily **DIELASMATACEA** Schuchert, 1913

Family **CRANAENIDAE** Cloud, 1942

Subfamily **CRANAENINAE** Cloud, 1942

Genus **CRANAENA** Hall and Clarke, 1893

Cranaena texana, n. sp. Pl. 44, figs. 1a-10e; Text-fig. 48

Smaller than average for the genus, strongly but unequally biconvex, pedicle valve usually more inflated than brachial valve; longitudinally subelliptical in outline, sometimes vaguely subpentagonal; longer than wide, greatest width near mid-length, greatest thickness near mid-length or slightly posterior to mid-length; anterior profile subelliptical to subcircular; lateral profile subelliptical to lenticular; fold and sulcus lacking; anterior commissure rectimarginate; in thick specimens the anterior third of both valves may be flattened forming a truncated anterior margin; radial prosopon lacking, growth varices strong, irregularly spaced, growth lines not observed.

Pedicle valve moderately to strongly convex, evenly curved in lateral profile; umbonal region moderately swollen, evenly convex; anterior third slightly flattened medially in some large specimens; beak erect, foramen elongate, ovate; delthyrium not observed.

Pedicle valve interior with short rudimentary dental plates, reaching the ventral floor only in the beak.

Brachial valve usually less convex than the pedicle valve, often weakly convex in moderate-sized and small specimens; umbonal region most convex, broad, not much swollen in most specimens, tumid in thick specimens; medial portion of valve evenly convex; anterior third evenly rounded or medially flattened in some large specimens; beak small, obscured by the pedicle valve beak.

Brachial valve interior with strongly concave free medial hinge plate and oval apical perforation; outer hinge plates slightly concave, weakly depressed; crural bases originate at juncture between inner and outer hinge plates, becoming high anteriorly; crura high and vertical posteriorly, gradually becoming horizontal and short anteriorly, forming a short terebratuliform loop with ventrally deflected transverse band.

Holotype.—USNM No. 154915.

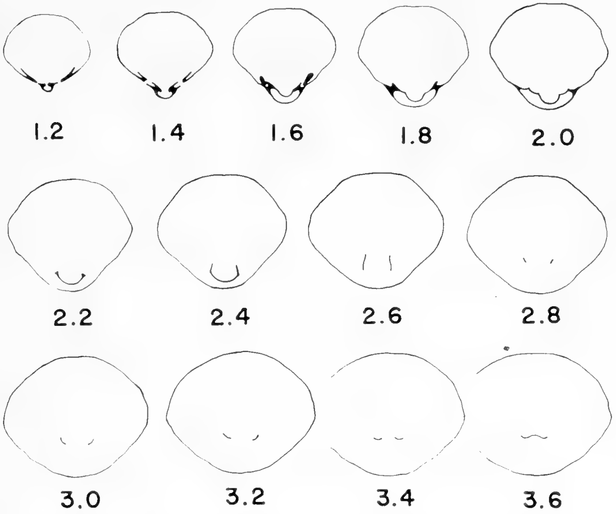
Distinguishing characters.—This species is characterized by its small size, strongly but unequally biconvex valves, the pedicle valve being more convex than the brachial, longitudinally subelliptical or obscurely subpentagonal outline, no fold and sulcus, and occasionally flattened anterior portions forming a truncated front margin. Internally the dental plates are short and rudimentary, and the medial hinge plate is strongly concave.

Table 41.—Measurements in millimeters of *Cranaena texana,* n. sp. from USNM locality 9045.

USNM No.	Length	Width	Thickness
154914	9.9	8.7	5.9
154915	9.8	7.1	5.8
154916	8.9	7.1	6.1
154917	8.9	6.8	4.7
154918	8.9	6.6	4.9
154919	8.3	6.1	4.5
154920	8.0	6.1	4.6
154921	6.1	4.9	3.9
154922	5.7	4.7	3.2
154923	5.5	4.7	3.3

Comparisons.—*C. texana,* n. sp. is most similar and closely related to *Cranaena globosa* Weller, 1914, from the Burlington Limestone of Missouri. That species differs from *C. texana* in being larger with a relatively more convex brachial valve, and in general, a more inflated lateral profile. Internally, the dental plates of *C. globosa* are well developed and the medial hinge plate is weakly concave.

Some specimens of *Cranaena occidentalis* (Miller), 1892, from the Chouteau Group of Missouri are similar in outline and lateral



Text-figure 48.—Transverse serial sections of *Cranaena texana,* n. sp. ×4, USNM 154924 from USNM locality 9045, measurements (mm) from ventral beak.

profile to some small thin specimens of *C. texana* but in general this species is much larger, relatively thinner, with a narrow ventral umbonal region, rounded front margin, and the maximum width is usually attained anterior to mid-length.

Remarks.—Although large collections of this species are available, the writer can contribute little about its ontogenetic development due to the unusual variability in its proportions at all known growth stages. Some attempt is made to illustrate this variability on Plate 44. Although there are strongly inflated individuals with truncated front margins in all growth series, as well as thinner rounded forms, a complete gradation exists between these extremes, making further taxonomic subdivision impossible and inappropriate.

Occurrence and abundance.—*C. texana* is common at USNM locality 9045 (126 specimens), and less common at localities 9046

(15 specimens), 9048 (13 specimens), 9047 (seven specimens), 9042 (four specimens), and 9043 (one specimen).

Cranaena cf. **C. hannibalensis** Moore Pl. 30, figs. 8a-10e; Text-fig. 49

1928. *Cranaena hannibalensis* Moore, Missouri Bur. Geol. Mines, vol. 21, 2d series, p. 273, pl. 12, figs. 9, 10.
1938. *Cranaena hannibalensis* Moore, Branson, Univ. Missouri Studies, vol. 13, No. 4, p. 51.

The following description is based on several Chappell Limestone specimens that vary considerably in size and outline. These specimens presumably represent a single species but the collection is too small to properly assess this variation in terms of species characters. Comparison with *Cranaena hannibalensis* Moore is based mainly on external similarity, as Moore did not adequately describe the interior details of his species.

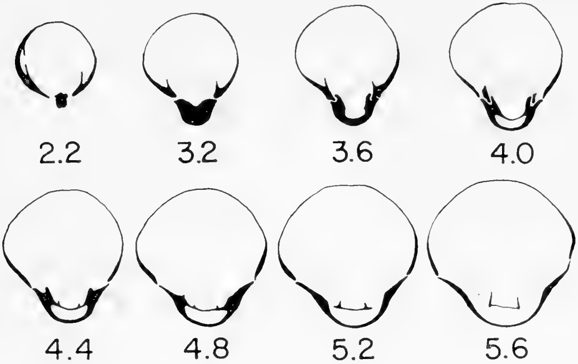
Average size for the genus, almost equally biconvex, longitudinally subovate to almost subcircular in outline; slightly to moderately longer than wide, greatest width attained near mid-length; anterior profile lenticular, the valves meeting at an acute angle; lateral profile sublenticular or almost oval; fold and sulcus completely lacking; anterior commissure rectimarginate; some specimens slightly flattened in the dorsal umbonal region; anterior and lateral margins evenly rounded; radial prosopon lacking; growth varices prominent, irregularly spaced.

Pedicle valve moderately convex, most convex in umbonal region, being weakly convex anteriorly in lateral profile; lateral slopes weakly convex, flaring in some specimens; beak erect, foramen ovate, epithyridid.

Pedicle valve interior with short rudimentary dental plates confined to the beak.

Brachial valve similar in convexity and lateral profile to that of the pedicle valve; dorsal umbo narrow, tumid; beak small, narrow, obscured by the pedicle valve.

Brachial valve interior with thickened umbonal region; inner socket ridges massive; medial hinge plate slightly concave; outer hinge plates posteriorly thickened by secondary shell tissue, inclined slightly dorsad anteriorly; crural bases well developed apically but



Text-figure 49.—Transverse serial sections of *Cranaena* cf. *C. hannibalensis* Moore ×2, USNM 154760 from USNM locality 9045, measurements (mm) from ventral beak.

obscured by secondary tissue, becoming thick vertical plates anteriorly; crura high and directed ventrally; loop unknown.

Illustrated specimens—USNM Nos. 154757, 154758, 154759, 154760.

Table 42.—Measurements in millimeters of *Cranaena* cf. *C. hannibalensis* Moore, 1928, from USNM locality 9045.

USNM No.	Length	Width	Thickness
154757	20.8	17.3	11.7
154758	17.8?	16.6	9.9
154759	12.0	9.9	6.1

Remarks.—Although Moore did not describe the brachial interior of *C. hannibalensis* the Chappel Limestone specimens agree with his description in most other respects. The mesial flattening of the brachial valve is much less pronounced in the Chappel specimens than is shown by Moore's illustration (pl. 12, fig. 10).

Occurrence and abundance.—Including those described there are 17 specimens assigned to this species from USNM locality 9045.

One specimen each from localities 9048 and 9043 may also belong here.

Cranaena? dorsisulcata, n. sp. Pl. 44, figs. 11a-15e; Text-fig. 50

Average size for the genus, unequally biconvex, the pedicle valve being more inflated than the brachial valve; outline longitudinally subtrigonal to obscurely subpentagonal, considerably longer than wide in large specimens, nearly equidimensional in some small specimens; greatest width anterior to mid-length in large individuals, near mid-length or even posterior to mid-length in small specimens; greatest thickness near or posterior to mid-length in all known growth stages; anterior profile subovate in large adults, more lenticular in small individuals; lateral profile thickly lenticular; fold lacking; sulcus developed in brachial valve in all known growth stages; anterior commissure sulcate; front margin slightly emarginate; radial prosopon lacking, growth varices strong, irregularly spaced; shell substance finely punctate.

Pedicle valve moderately to strongly convex, evenly curved posteriorly in lateral profile, being somewhat less convex anteriorly in some specimens; venter may be slightly flattened anteriorly; lateral slopes evenly convex; umbonal region broad, elongate, tumid; beak nearly straight to suberect, foramen elongate-ovate, epithyridid, deltidial plates conjunct.

Pedicle valve interior with short but well-developed dental plates confined to the umbonal region.

Brachial valve most convex in the umbonal region, curving evenly to the front margin in lateral profile; sulcus originating near or just anterior to the dorsal umbo, becoming broad but shallow anteriorly; lateral slopes evenly convex; beak small, curved in against the delthyrium.

Brachial valve interior with moderately concave apically perforate short hinge plate; crural bases originate on the inner edges of the inner socket ridges; crura rodlike near the hinge plate, becoming broad and vertically directed anteriorly; loop short, centronelliform in juveniles, the main bands forming a short union; adult loop unknown.

Holotype.—USNM No. 154925.

Table 43.—Measurements in millimeters of *Cranaena? dorsisulcata,* n. sp. from USNM locality 9047.

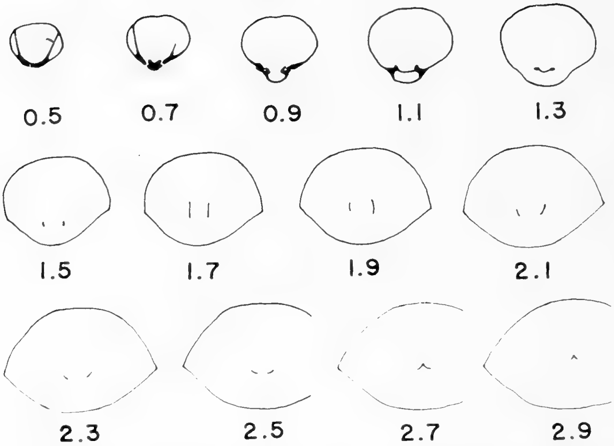
USNM No.	Length	Width	Thickness
154925	18.5	14.4	10.3
154926	8.4?	8.1	4.3
154927	8.4	7.6	4.6
154928	6.8	5.6	3.5
154929	5.9	5.8	3.0

Distinguishing characters.—This species is characterized by its longitudinally subtrigonal to subpentagonal outline with greatest width anterior to mid-length in large adults, sulcate anterior commissure, emarginate front margin, brachial valve with a broad shallow sulcus in all growth stages, straight to suberect beak, epithyridid foramen, and conjunct deltidial plates.

Comparisons.—In the Chappel Limestone *C.? dorsisulcata* can be distinguished from other species of the genus *Cranaena* by its sulcate anterior commissure. Small individuals of *Dielasmella larga,* n. sp. may have a weak shallow dorsal sulcus, but these specimens are more compressed, especially in the lateral extremities, and have a small narrow suberect beak, and often are costate. Internally, *Dielasmella larga* has a long cryptonelliform loop, not a short loop as in *C.? dorsisulcata.*

C.? dorsisulcata, n. sp. is most similar externally to *Centronella louisianensis* Weller, 1914, from the Louisiana Limestone of Missouri, and *Centronelloidea rowleyi* (Worthen,) 1884, from the Lower Burlington Chert of Missouri. According to Sanders (1958, pp. 53, 54) *Centronella louisianensis* is an impunctate rhynchonellid and the type species for the genus *Dorsisinus* Sanders, 1958. *Centronelloidea rowleyi* is greatly different internally from *C.? dorsisulcata* having a sessile hinge plate and a peculiar terebratuliform loop with long anterior projections.

Remarks.—Generic assignment of this species is tentative until such time as the nature of the adult loop is elucidated. Assignment to the genus *Cranaena* is based on the presence of an apically perforate free hinge plate in *C.? dorsisulcata.* However, the epithyridid foramen and sulcate anterior commissure of this species are not usual for the genus.



Text-figure 50.—Transverse serial sections of *Cranaena? dorsisulcata,* n. sp. ×5, USNM 154930 from USNM locality 9047, measurements (mm) from ventral beak.

Occurrence and abundance.—Eleven specimens from USNM locality 9047 constitute the only collections of this species.

Genus **HAMBURGIA** Weller, 1911

Hamburgia chappelensis, n. sp. Pl. 45, figs. 1a-5e; Text-figs. 51, 52

Larger than average, subequally biconvex, longitudinally subpentagonal to subovate in outline; greatest width near mid-length, greatest thickness near or slightly posterior to mid-length; anterior profile thickly ovate, lateral profile subelliptical; anterior commissure rectimarginate; fold and sulcus lacking but both valves usually flattened anteriorly forming a truncated front margin in adults; radial prosopon usually lacking, some specimens faintly costellate on decorticated surfaces; growth varices strong, growth lines faint, irregularly spaced.

Pedicle valve moderately and evenly curved in lateral profile; umbonal region narrowly swollen, median region evenly convex, anterior third often medially flattened; beak erect, foramen large, ovate, slightly marginate.

Pedicle valve interior with short dental plates, separated from lateral walls by narrow umbonal cavities; large specimens often with narrow medial muscle impression in posterior portion of the valve.

Brachial valve slightly less convex than pedicle valve, broadly convex umbonally, evenly convex medially, usually flattened in anterior half of the valve; beak small, obscured by the ventral beak.

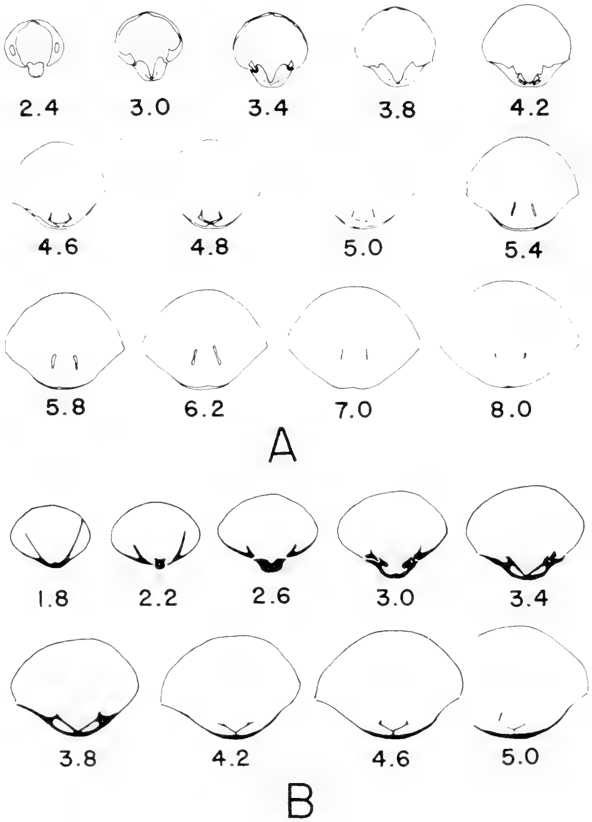
Brachial valve interior of small specimens with open notothyrial cavity; hinge plates flat, meeting posteriorly at their juncture with the floor of the valve, rising on a low thin ridge anteriorly, being entirely free anteriorly in some specimens; large specimens with greatly thickened umbonal region, small narrow notothyrial cavity, hinge plates and crural bases buried in fibrous tissue for much of their length, being supported anteriorly on a thick median ridge; crural bases originating near the floor of the dorsal umbo as vertical, slightly ventro-medially converging plates on the outer edges of the hinge plates; crura broad vertical bands, converging ventrally, complete loop not obtained.

Holotype.—USNM No. 154931.

Distinguishing characters.—This species is characterized by its large size, almost equally convex valves, longitudinally subpentagonal outline with greatest width near mid-length, lack of fold and sulcus but anteriorly flattened valves form a truncated front margin, rectimarginate anterior commissure, and narrowly swollen ventral umbo. Internally the hinge plates meet at their juncture with the floor of the valve posteriorly and rise anteriorly on a narrow or thick median ridge.

Table 44.—Measurements in millimeters of *Hamburgia chappelensis,* n. sp. from USNM locality 9045.

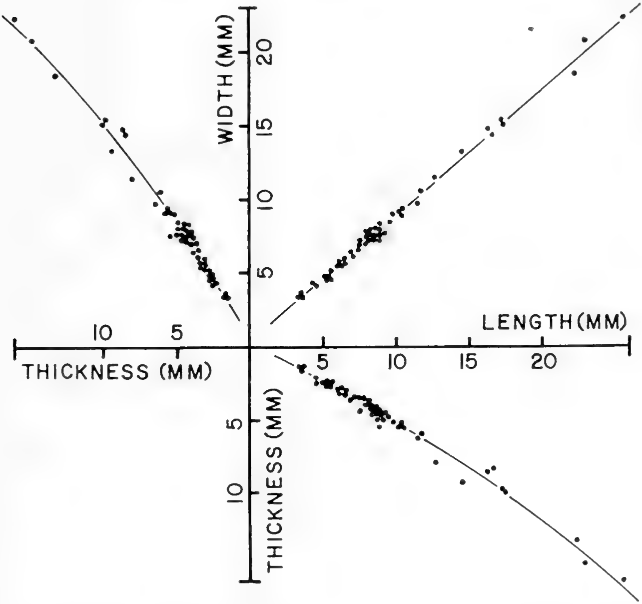
USNM No.	Length	Width	Thickness
154931	25.6	22.4	16.0
154932	22.3	18.6	13.2
154933	17.2	15.5	9.8
154934	11.6	9.8	6.2
154935	7.1	6.1	3.4



Text-figure 51.—Transverse serial sections of *Hamburgia chappelensis*, n. sp. measurements (mm) from ventral beak. (A) Large specimen, USNM 154936 from USNM locality 9045, ×1.5. (B) Small adult, USNM 154937 from USNM locality 9048, ×2.

Comparisons.—*H. chappelensis*, n. sp. is most similar and closely related to *Hamburgia flora* (Winchell), 1870, from the Logan Formation of Ohio. That species differs from *H. chappelensis* in being larger, relatively thinner, with a broader ventral umbo, and usually a more rounded front margin. Internally the two species are closely similar.

Small juveniles of this species are not easily confused with other small smooth shells in the Chappel Limestone, although small cranaenids and meristids may occasionally be misidentified as hamburgiids. These shells can be segregated by their strongly inflated valves and uniplicate anterior commissure respectively.



Text-figure 52.—Scatter diagrams of dimensions of *Hamburgia chappelensis*, n. sp. from USNM locality 9045.

Remarks.—Ontogenetic development of internal characters has not been observed. However, a scatter diagram of measurements of 50 individuals from a single collection are shown in Text-figure 52.

Occurrence and abundance.—This is a relatively common species in the Chappel Limestone, having been found at USNM localities 9045 (529 specimens), 9048 (97 specimens), 9046 (55 specimens), 9047 (44 specimens), 9155 (32 specimens), 9043 (27 specimens), 9042 (seven specimens), and 9044 (one specimen). In addition, three large specimens from near Johnson City, Blanco County, Texas, are in the USNM collections.

Subfamily **GIRTYELLINAE** Stehli, 1965

Genus **GIRTYELLA** Weller, 1911

Girtyella aff. **G. cedarensis** Weller Pl. 45, figs. 6a-7d; Text-fig. 53

1914. *Girtyella cedarensis* Weller, Illinois Geol. Sur., Mon. 1, p. 272, pl. 34, figs. 48-50.

1938. *Girtyella cedarensis* Weller, Branson, Univ. Missouri Studies, vol. 13, No. 4, p. 30, pl. 22, figs. 34-38.

1956. [?] *Girtyella cedarensis* Weller, Simorin, Akad. Nauk Kazakh. S.S.R., p. 263, pl. 27, figs. 9-12.

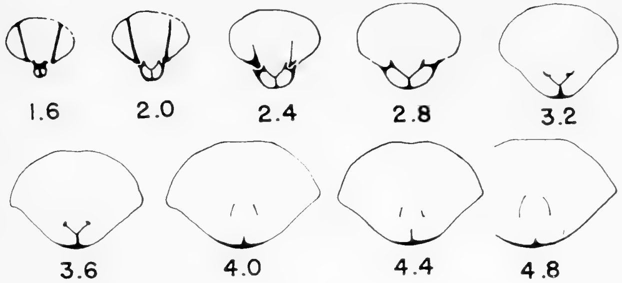
Holotype.—Yale Peabody Museum (D. K. Greger No. 1402).

Distinguishing characters.—This species is characterized by its large size, shallow rounded ventral sulcus, medially flattened or slightly grooved brachial valve, slightly emarginate front margin, weakly uniplicate or rectimarginate anterior commissure, and obscure radiating grooves on the medial portions of one or both valves of some specimens.

Measurements (mm) *of illustrated specimens.*—USNM No. 154940, length 14.6, width 13.2, thickness 8.5; USNM No. 154939, length 15.4, width 13.5?, thickness 8.4.

Remarks.—The Chappel Limestone specimens of *Girtyella* agree in most respects with Weller's and Branson's descriptions of *G. cedarensis.* The Chappel Limestone shells, however, are somewhat smaller and less inflated than the specimens from Missouri as illustrated by Weller and Branson. The Chappel specimens are, if not conspecific, at least closely related to the Northview Shale Species.

Occurrence and abundance.—*Girtyella cedarensis* was described by Weller from the Northview Shale of Missouri. In the Chappel



Text-figure 53.—Transverse serial sections of *Girtyella* aff. *G. cedarensis* Weller ×2.5, USNM 154941 from USNM locality 9045, measurements (mm) from ventral beak.

Limestone *Girtyella* aff. *G. cedarensis* has been found only at USNM localities 9045 (six specimens), 9047 (one specimen), and 9048 (one specimen).

Family **DIELASMATIDAE** Schuchert, 1913

Subfamily **DIELASMATINAE** Schuchert, 1913

Genus **DIELASMA** King, 1859

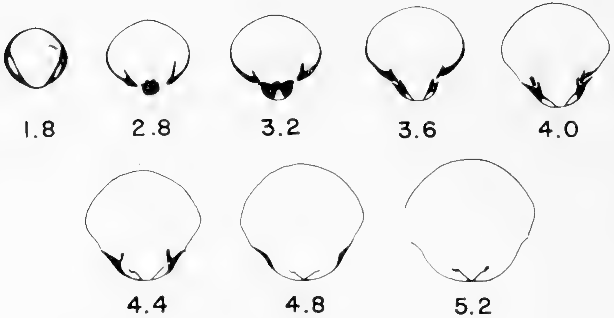
Dielasma sp. Text-fig. 54

Two fragmentary specimens from USNM localities 9045 and 9048, and a single brachial valve from locality 9047 appear to be assignable to the genus *Dielasma* King, 1859, on the basis of interior details as developed from serial transverse sections made from the specimen from locality 9048. These sections show the hinge plates to be divided reaching the floor of the valve separately posteriorly, converging and touching anteriorly, but not rising above the floor of the valve as in *Hamburgia chappelensis,* n.sp. Although these three specimens are poorly preserved, they appear to represent a species that is relatively tumid or inflated posteriorly.

Illustrated specimen.—USNM No. 154942.

Family **HETERELASMINIDAE** Likharev, 1956

Genus **BEECHERIA** Hall and Clarke, 1893



Text-figure 54.—Transverse serial sections of *Dielasma* sp. ×2, USNM 154942 from USNM locality 9048, measurements (mm) from ventral beak.

Beecheria chouteauensis (Weller) Pl. 45, figs. 8a-e; Text-fig. 55

1914. *Dielasma chouteauensis* Weller, Illinois Geol. Sur., Mon. 1, p. 257, pl. 32, figs. 1-17, text-fig. 29.
1937. (*Non*) *Dielasma chouteauensis* Weller, Nalivkin, Tsentral. nauch. Geol. Inst., Trudy, vol. 99, p. 128, pl. 32, fig. 3; pl. 34, figs. 1, 2.
1938. *Dielasma chouteauensis* Weller, Branson, Univ. Missouri Studies, vol. 13, No. 3, p. 55, pl. 5, figs. 28-30.
1956. (?) *Dielasma chouteauensis* Weller, Simorin, Akad. Nauk Kazakhstan SSR, p. 256, pl. 26, figs. 13-20.
1958. *Dielasma chouteauensis* Weller, Armstrong, New Mexico Bur. Mines Min. Res., Mem. 5, pp. 26, 27, pl. 2, figs. 1-7, 11-14, 17-28, 31.
1962. *Beecheria* cf. *B. chouteauensis* (Weller), Armstrong, New Mexico Bur. Mines Min. Res., Mem. 8, p. 63, pl. 9, fig. 20.

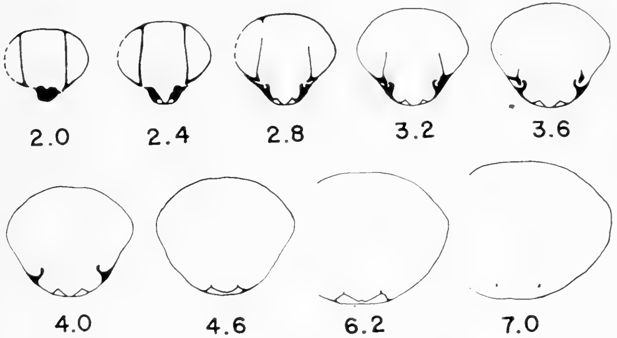
Types.—Weller (1914, p. 257) did not designate a holotype. His suite of syntypes are in the Univ. Chicago Walker Museum collections, numbers 12237, 9703, 9666, and 8547. (Now in the Field Natural History Museum.)

Distinguishing characters.—This species is characterized by its subequally biconvex moderately compressed valves, subovate outline, evenly convex surfaces, rectimarginate anterior commissure, rounded front margin, and faintly costellate prosopon; internally the inner hinge plates unite posteriorly and rise slightly off the floor of the valve.

Measurements (mm.) *of illustrated specimen.*—USNM No. 154943. Length 29.9; width 22.5; thickness 12.7.

Comparisons.—*B. chouteauensis* is most similar to *B. osceolensis* (Weller), 1914, from the Lower Burlington Limestone of Missouri. That species, however, differs in being larger, proportionately narrower, more inflated, with a wider more truncated front margin.

Occurrence and abundance.—Two well-preserved specimens from USNM locality 9045 are assigned to this species, one of these was sectioned serially. A single brachial valve from USNM locality 9046 may also belong here.



Text-figure 55.—Transverse serial sections of *Beecheria chouteauensis* (Weller) ×1.5, USNM 154944 from USNM locality 9045, measurements (mm) from ventral beak.

Branson (1938, p. 56) found *B. chouteauensis* at all of his collecting localities in the Chouteau. Armstrong (1958, p. 27; 1962, p. 63) identified this species from the Caloso Formation of New Mexico, and tentatively from the Keating Formation of Arizona and New Mexico. Brown (1952) reported it in the Banff Series of Alberta.

Suborder TEREBRATELLIDINA Muir-Wood, 1955

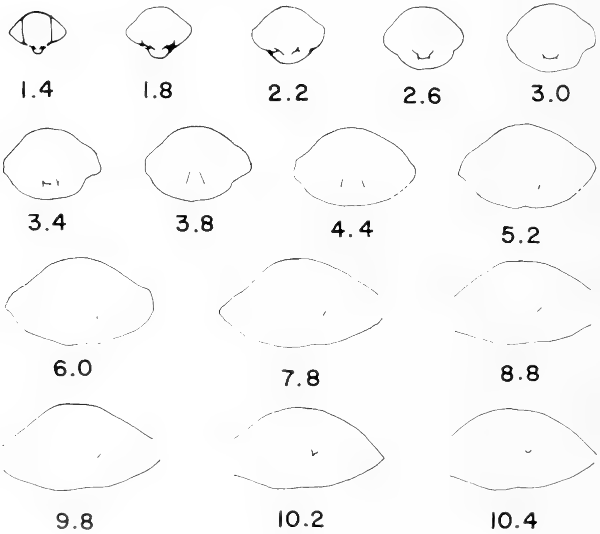
Superfamily **CRYPTONELLACEA** Thompson, 1926

Family **CRYPTONELLIDAE** Thompson, 1926

Genus **DIELASMELLA** Weller, 1911

Dielasmella larga, n. sp. Pl. 14, figs. 1a-5e; Text-fig. 55

Larger than average for the genus, unequally biconvex, the pedicle valve being more inflated than the brachial valve; subpentagonal in outline, longer than wide, greatest width and greatest thickness posterior to mid-length; anterior and lateral profiles sublenticular; fold and sulcus lacking, anterior commissure rectimarginate; pedicle valve arched umbonally but becoming medially flattened anteriorly in large specimens; brachial valve may also be medially flattened or weakly grooved, ordinarily forming a moderately to sharply truncated front margin; flanks of large specimens obscurely costate, the costae being simple, widely spaced and originating near the umbones; umbones and flattened medial portions of valves smooth; growth varices strong, irregularly and infrequently spaced.



Text-figure 56.—Transverse serial sections of *Dielasmella larga,* n. sp. ×2, USNM 154542 from USNM locality 9042, measurements (mm) from ventral beak.

Pedicle valve most convex in the umbonal region, curving sharply, from the median arched portion and reflexing slightly on the lateral slopes to form slightly compressed lateral extremities; beak suberect, narrow, sharp, foramen not observed; beak ridges sharp, subangular, extending forward to the compressed lateral extremities.

Pedicle valve interior with short but well-developed dental plates; teeth small, directed medially.

Brachial valve less inflated than the pedicle valve, broadly rounded in the umbonal region, flattened medially and antero-laterally in large specimens; beak small, acute; small specimens weakly convex anteriorly or with a shallow medial depression.

Brachial valve interior with short medially depressed outer hinge plates, extending dorsomedially from the inner socket ridges; inner hinge plate short, slightly concave, slightly recessed between the vertical crural bases; apical perforation large; crural bases extending both above and below the inner hinge plate in transverse sections; descending branches of loop originate as high ventrally converging processes, rapidly narrowing and diverging slightly; loop long, not completely observed, but probably cryptonelliform.

Table 45.—Measurements in millimeters of *Dielasmella larga*, n. sp.

USNM No.	Length	Width	Thickness	Locality
154538	20.4?	17.2	9.6	9047
154542	12.2	10.3	4.8	9047
154539	17.6?	13.7?	7.9	9048
154540	11.1?	10.7	4.9	9048
154541	13.6	11.7	5.6?	9042

Holotype.—USNM No. 154538.

Distinguishing characters.—This species is characterized by its large size, costate flanks, antero-medially flattened valves, moderately to sharply truncated front margin, and compressed lateral extremities.

Comparisons.—*Dielasmella compressa* (Weller), 1906, from the Glen Park Limestone of Missouri, and *Dielasmella calhounensis* Weller, 1914, from the Hamburg Oolite of Illinois, can easily be distinguished from *D. larga* by their much smaller size and smooth flanks.

Centronella emaciata Rowley, 1900, from the Lower Burlington Chert of Louisiana, Missouri, is similar to small specimens of *D. larga* in outline, profile, and lateral compression of the valves. Stehli (1961, p. 459) suggested that this species may belong in the genus *Gacina* Stehli, 1961. Rowley in describing the species had only two specimens and this writer knows of no other specimens. Since the interior details of *Centronella emaciata* are unknown its relationships cannot be assessed. It is entirely possible that additional collections might show this species to be conspecific with *D. larga*. In the meantime the Chappel Limetone species can at least be assigned with reasonable confidence to the genus *Dielasmella*.

Occurrence and abundance.—D. larga is not common in the Chappel Limestone. Six specimens from USNM locality 9047, two specimens from locality 9048, and two specimens from locality 9042 constitute the entire collection.

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PLATES

EXPLANATION OF PLATE 13

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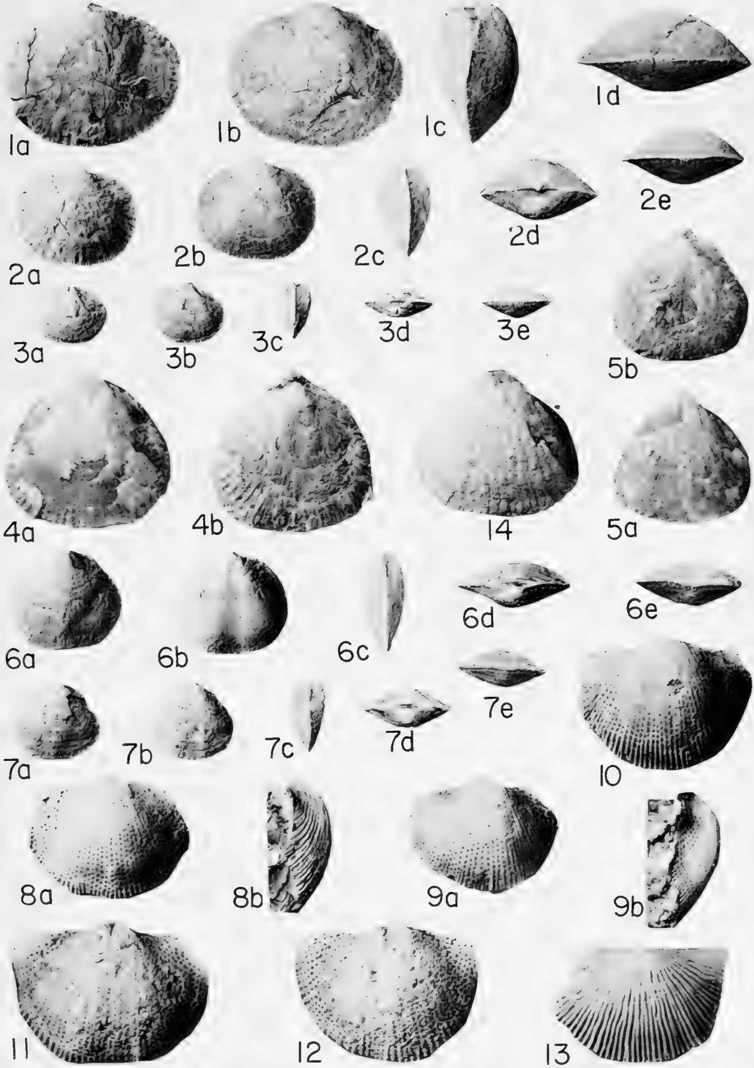
1a-3e. **Schizophoria** sp. 270
Ventral, dorsal, lateral, anterior, and posterior (only figs. 2, 3) views, three specimens, USNM 154526-8, respectively, USNM locality 9045; ×1.

4a-7e,14. **Rhipidomella perminuta** Girty 271
4a-5b. Ventral and dorsal views, two syntypes; ×6, USNM 121171 and 121172, respectively, USGS locality 2623. 14. Ventral view, third syntype; × 6, USNM 121173, USGS locality 2623. 6a-7e. Ventral, dorsal, lateral, posterior, and anterior views; × 1, two mature specimens, USNM 154529-30, respectively, USNM locality 9045.

8a-13. **Plicochonetes** aff. **Chonetes ornatus** Shumard 280
USNM locality 9045; × 3. 8a-9b. Ventral and lateral views, two spalled specimens, USNM 154531-2, respectively. 10-12. Three spalled pedicle valves, USNM 154533-5, respectively. 13. Natural mold, brachial valve exterior, USNM 154536.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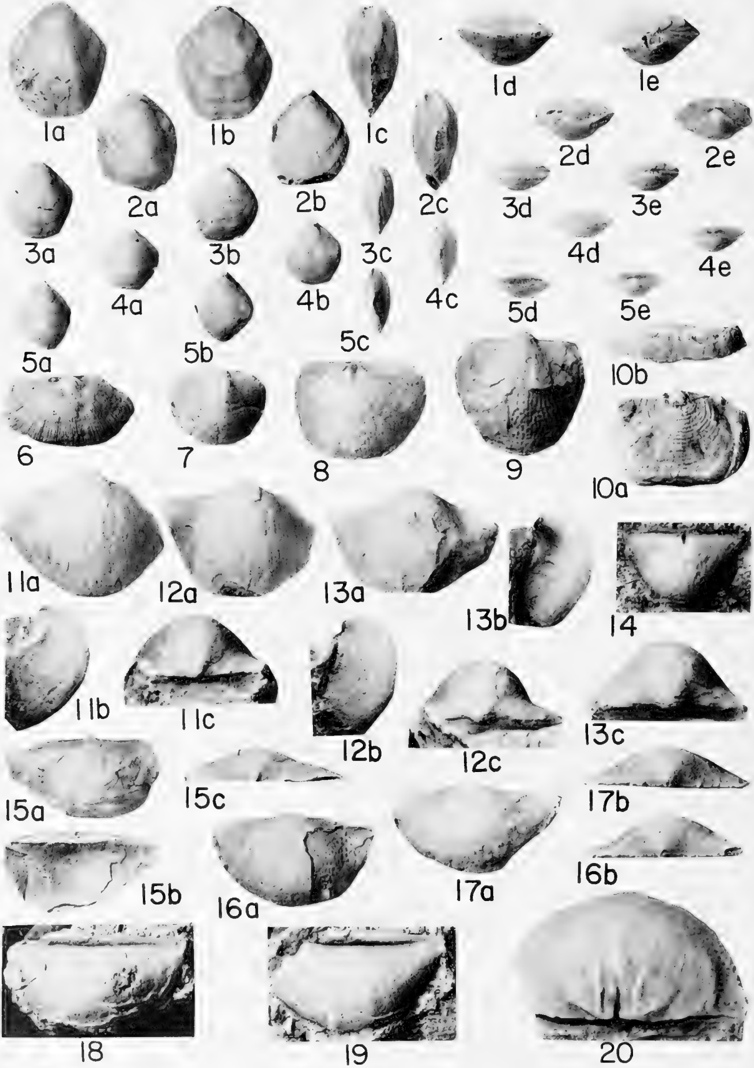
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EXPLANATION OF PLATE 14

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1a-5e. **Dielasmella larga,** n. sp. 440
Ventral, dorsal, lateral, anterior, and posterior views, five specimens; × 1. 1a-e. Holotype, USNM 154538, USNM locality 9047. Although the ventral beak is missing, this specimen is otherwise well preserved. 2a-e, 4a-e. Two specimens, USNM 154539-40, respectively, USNM locality 9048. Note weak costae on the lateral slopes of the larger specimen. 3a-e. Well-preserved specimen, USNM 154541, USNM locality 9042. 5a-e. Small specimen, USNM 154542, USNM locality 9047.

6. **Schuchertella** ? sp. 273
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7-9. **Anopliopsis subcarinata** (Girty) 274
Chappel Limestone syntypes, USGS locality 2623; × 6. 7, 9. Pedicle valves, USNM 121198 and 121199, respectively. 8. Spalled brachial valve, USNM 121197, showing some internal structures.

10a-b. **Leptagonia** sp. 273
Ventral and anterior views of spalled specimen, USNM 154545, USNM locality 9043; × 1. Note the small chordate muscle impression.

11a-14. **Tornquistia** ? sp. 276
USNM locality 9043; × 5. 11a-13c. Ventral, lateral, and posterior views, three specimens, USNM 154546-8, respectively. 14. Natural mold of pedicle valve interior, USNM 154549.

15a-20. **Tornquistia** ? **transversalis,** n. sp. 274
(No. 20 × 5), USNM locality 9045; × 3. 15a-c. Ventral, dorsal, and posterior views, holotype, USNM 154550. 16a-17b. Ventral and posterior views, two pedicle valves, USNM 154551-2, respectively. 18, 19. Two natural molds of brachial valve exterior, USNM 154553-4, respectively, showing impressions of both interareas and cardinal process. 20. Calcined mold of pedicle valve interior, × 5, USNM 154555, showing lateral and marginal ridges and muscle field.

EXPLANATION OF PLATE 15

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1-9. **Rugosochonetes burlingtonensis** (Weller) 278
Chappel Limestone. 1. Brachial valve interior, USNM 154557; × 5, showing the cardinalia, lateral and accessory septa, and brachial ridges. 2a-c. Ventral, lateral, and posterior views, pedicle valve, USNM 154558; × 3, USNM locality 9045. 3a-d. Ventral, dorsal, lateral, and posterior views, nearly complete specimen, USNM 154559, USNM locality 9045. 4a-e. Ventral, dorsal, lateral, posterior, and anterior views, small but well-preserved specimen, USNM 154560, USNM locality 9046. 5, 6. Two spalled pedicle valves, USNM 154561-2, respectively, USNM locality 9043. 7-9. Three natural molds, brachial valve exteriors, USNM 154563-5, respectively, USNM locality 9045.

10a-17. **Retichonetes ? gibberulus,** n. sp. 277
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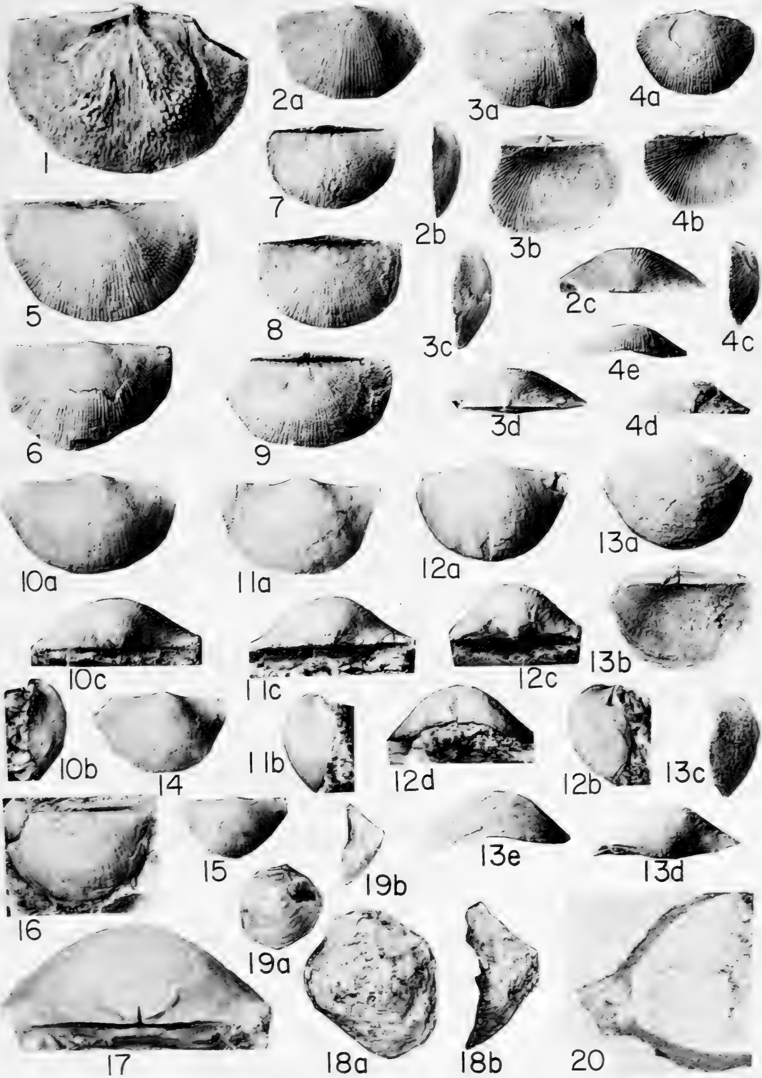
18a-19b. **Philhedra** sp. 270
Dorsal and lateral views, two brachial valves, USNM 154577-8, respectively, USNM localities 9048 (fig. 18) and 9045 (fig. 19); × 2.

20. **Amesopleura texana,** n. sp. 371
Transverse serial section, cardinal extremity showing tiny unusual platelets on the inner lateral margins of valves, USNM 154579, USNM locality 9045; × 2.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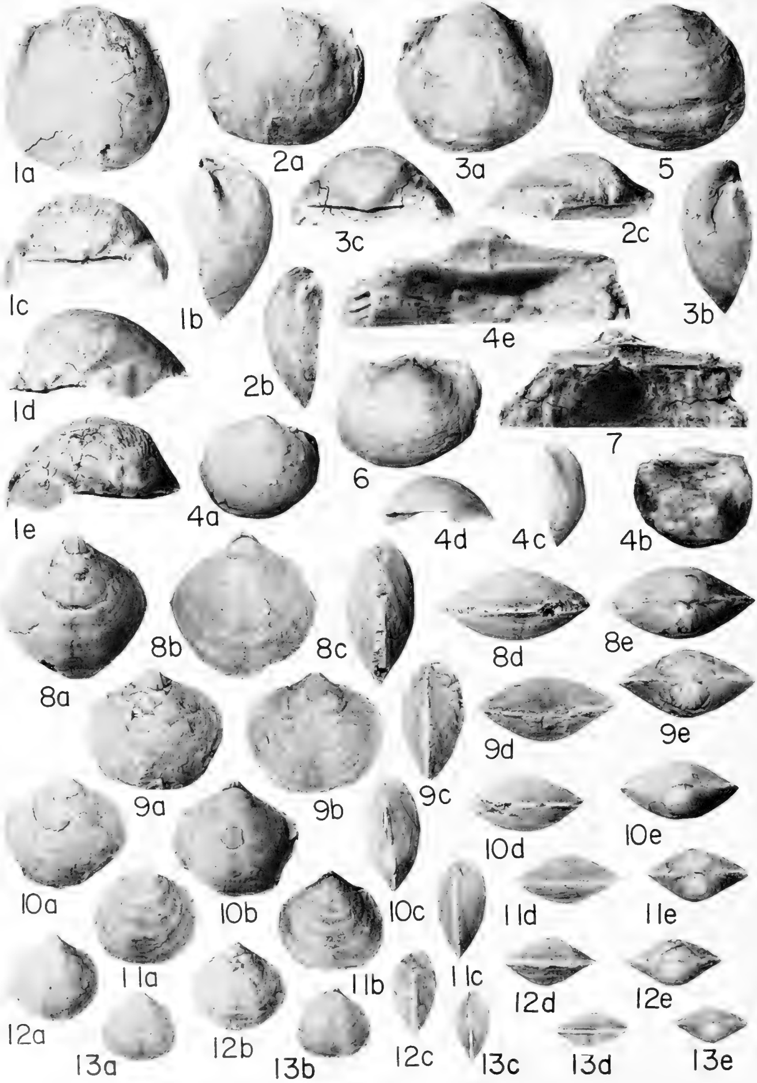
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EXPLANATION OF PLATE 16

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1a-7. **Cyphotalosia masonensis,** n. sp. 283

1a-e. Ventral, lateral, posterior, and two oblique views, calcined mold, pedicle valve interior, USNM 154580, USNM locality 9045. 2a-c. Ventral, lateral, and oblique views, spalled pedicle valve, USNM 154581, USNM locality 9045. 3a-c. Ventral, lateral, and posterior views, calcined mold, pedicle valve interior, USNM 154582, USNM locality 9045. 4a-e. Ventral, dorsal, lateral, oblique, and enlarged dorsal views, holotype, USNM 154583, USNM locality 9045. 5. Large pedicle valve, USNM 154584, USNM locality 9046. The lateral extremities are not preserved. 6. Natural mold, brachial valve exterior, USNM 154585, USNM locality 9046. 7. Enlarged view, pedicle valve interarea, USNM 154586, USNM locality 9046. All × 2 except figs. 4e and 7, × 5.

8a-13e. **Cleiothyridina tenuilineata** (Rowley) 344

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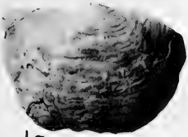
1a-8.	**Quadratia egregia,** n. sp. USNM locality 9045. 1a-e. Ventral, dorsal, anterior, posterior, and lateral views, holotype, USNM 154597. 2a-3e. Ventral, dorsal, anterior, posterior, and lateral views, two nearly complete specimens, USNM 154598-9, respectively. 4a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, USNM 154600. 5. Calcined mold, pedicle valve interior, USNM 154601. 6. Natural mold, brachial valve exterior, USNM 154602. All × 1. 7, 8. Enlargements of inter-areas of USNM 154596-154597, respectively, showing the spalled ventral beak and impressions of cardinal processes, USNM locality 9045; × 3.5.	284
9a-c.	**Marginatia** sp. Three views, natural mold, brachial valve exterior, USNM 154603, USNM locality 9045; × 1.	298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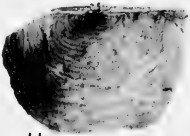
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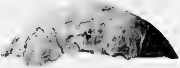
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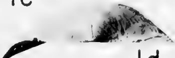
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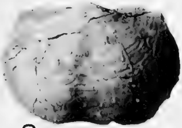
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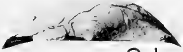
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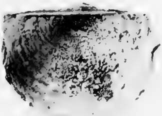
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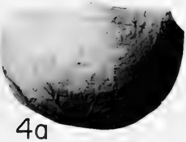
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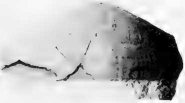
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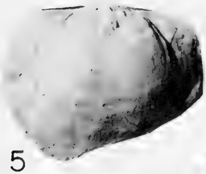
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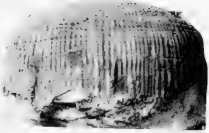
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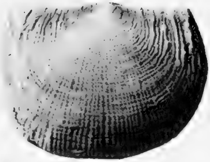
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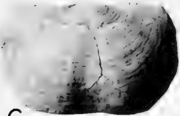
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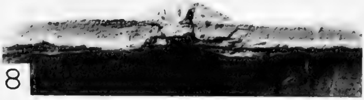
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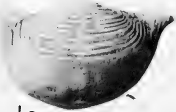
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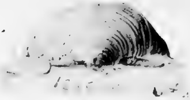
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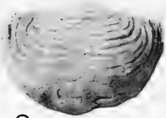
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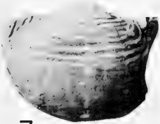
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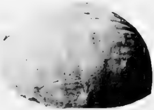
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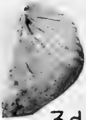
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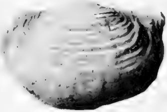
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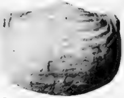
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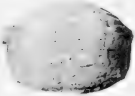
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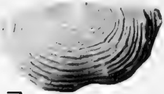
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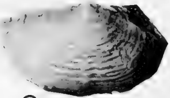
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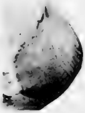
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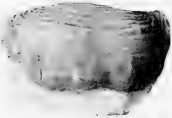
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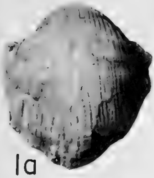
EXPLANATION OF PLATE 18

Figure		Page
1a-8d.	**Acanthoplecta inopinata,** n. sp.	287

USNM locality 9044; × 1. 1a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, holotype, USNM 123969. 2a-5d. Ventral, anterior, posterior, and lateral views, four pedicle valves, USNM 154604-7, respectively. 6a-8c. Natural molds, three brachial valve exteriors, USNM 154608-10, respectively.

EXPLANATION OF PLATE 19

Figure		Page
1a-2d.	**Productina sampsoni** (Weller)	289
	1a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, USNM 154611, USNM locality 9043. 2a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, USNM 123970b, USNM locality 9046; × 2.	
3a-4d.	**Rhytiophora** sp.	298
	3a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, USNM 154613, USNM locality 9045; × 1. 4a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, USNM 154614, USNM locality 9045.	
5a-7b.	**Avonia** ? **honeycreekensis,** n. sp.	291
	5a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, holotype, USNM 154615, USNM locality 9045; × 2. 6a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, USNM 154616, USNM locality 9046. 7a-b. Natural mold, brachial valve exterior, USNM 154617, USNM locality 9046.	
8a-d.	**Avonia** cf. **A. pustulifera** Moore	290
	Ventral, anterior, posterior, and lateral views, pedicle valve, USNM 154620, USNM locality 9048; × 2.	
9a-b.	**Rhytiophora** cf. **R. blairi** (Miller)	297
	Ventral, and lateral views, pedicle valve, USNM 154621, USNM locality 9043; × 1.	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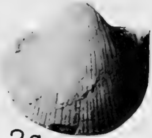
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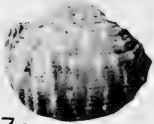
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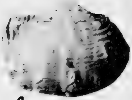
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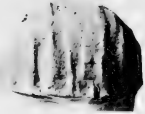
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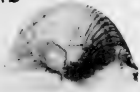
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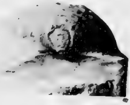
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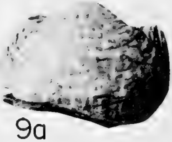
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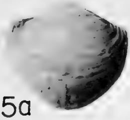
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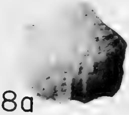
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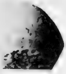
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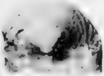
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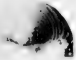
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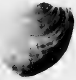
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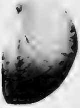
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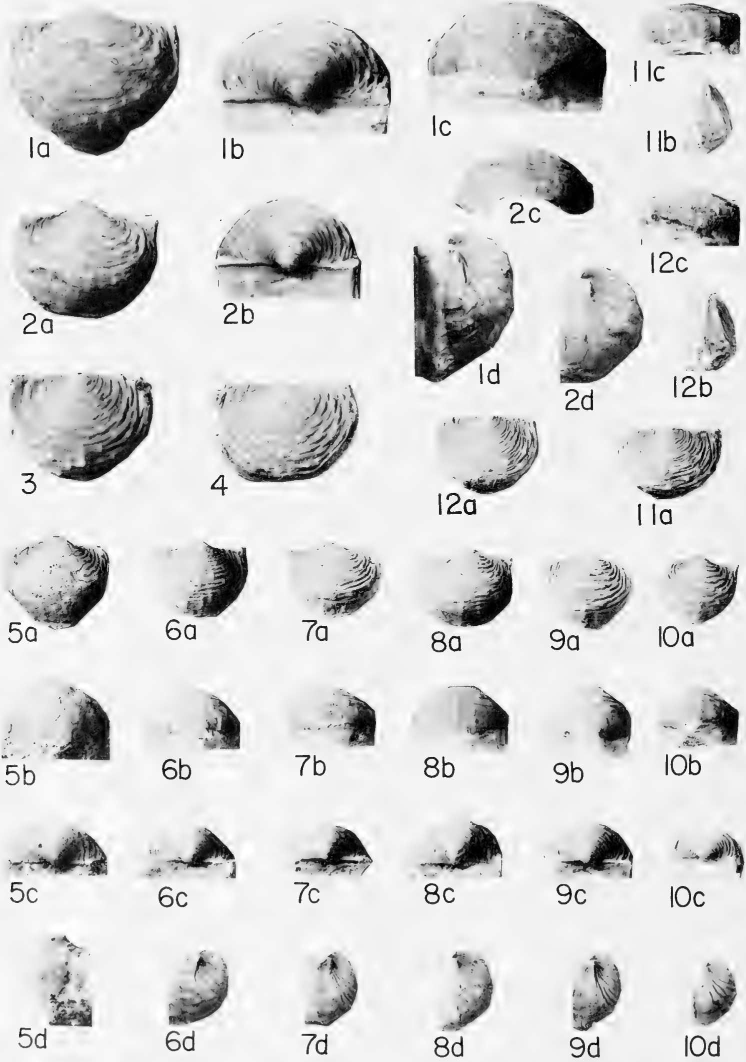
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EXPLANATION OF PLATE 20

Figure		Page
1a-12c.	**Geniculifera brevicula,** n. sp.	292

(Figs. 1a-4 × 2) (figs. 5a-12b × 1). 1a-d. Ventral, posterior, anterior, and lateral views, pedicle valve, holotype, USNM 154622. USNM locality 9044. 2a-d. Ventral, posterior, anterior, and lateral views, pedicle valve, USNM 154623, USNM locality 9044. 3, 4. Natural molds, two brachial valve exteriors, USNM 154624-5, respectively, USNM locality 9044. 5a-7d. Ventral, anterior, posterior, and lateral views, three pedicle valves, USNM 154626-8, respectively, USNM locality 9048, × 1. 8a-10d. Ventral, anterior, posterior, and lateral, views, three pedicle valves, USNM 154629-31, respectively, USNM locality 9045. 11a-12c. Natural molds, two brachial valve exteriors, USNM 154632-3, respectively, USNM locality 9045.

EXPLANATION OF PLATE 21

Figure		Page
1a-11.	**Rhytiophora calhounensis** (Moore)	294

1a-e. Ventral, dorsal, anterior, posterior, and lateral views, USNM 154634, USNM locality 9046. 2a-b. Ventral and lateral views, pedicle valve, USNM 154635, USNM locality 9046. 3a-d. Ventral, anterior, and lateral views, pedicle valve, USNM 154636, USNM locality 9046. 4. Ventral view, incomplete specimen in which much of the valves has been lost, partially revealing a natural mold of the brachial valve exterior, USNM 154637, USNM locality 9045. 5a-b. Ventral and lateral views, pedicle valve, USNM 154638, USNM locality 9045. 6a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, USNM 154639, USNM locality 9045. 7a-d. Ventral, anterior, posterior, and lateral views, pedicle valve, USNM 154640, USNM locality 9045. 8. Natural mold, brachial valve exterior, USNM 154641, USNM locality 9045. 9. Natural mold, brachial valve exterior, USNM 154642, USNM locality 9045. 10. Natural mold, brachial valve exterior, USNM 154643, USNM locality 9045. 11. Natural mold, brachial valve exterior, USNM 154644, USNM locality 9045. All × 1.


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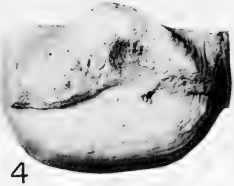
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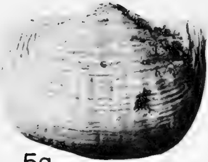
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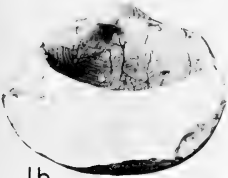
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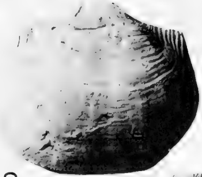
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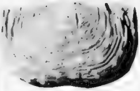
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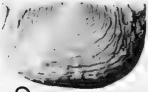
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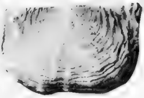
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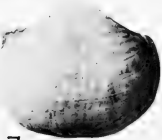
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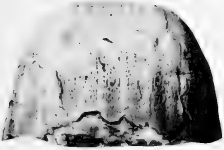
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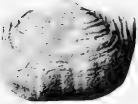
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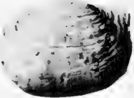
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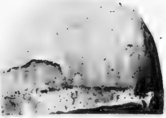
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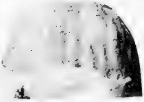
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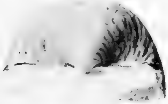
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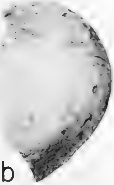
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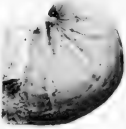
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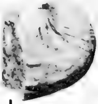
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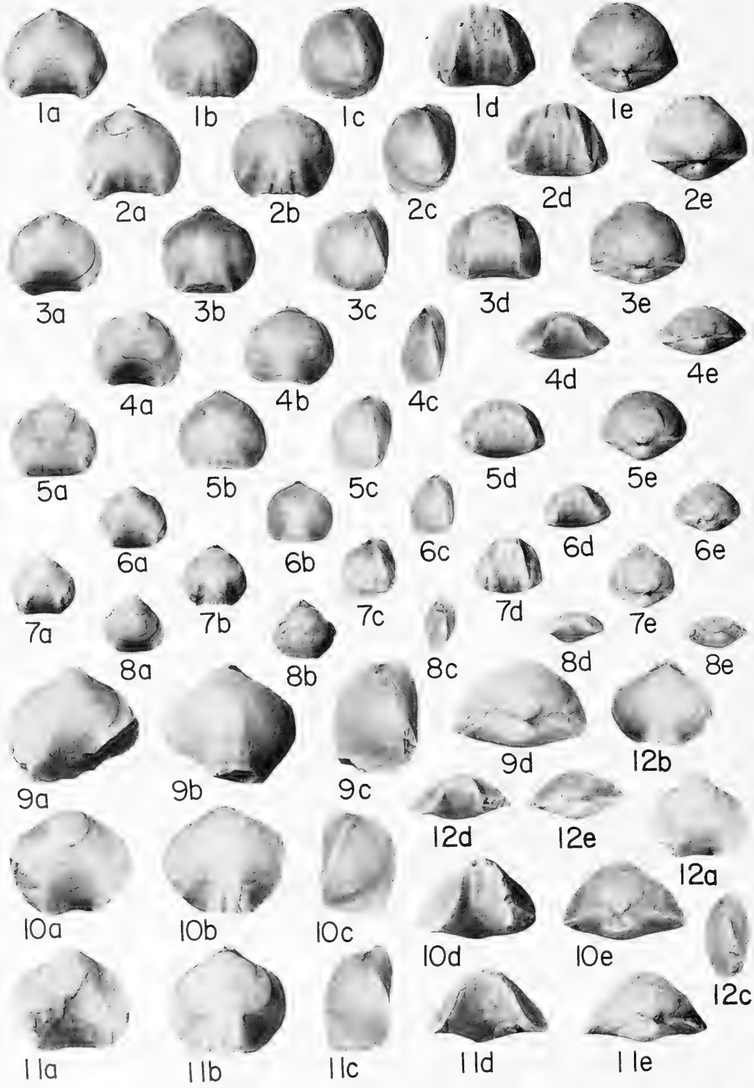
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EXPLANATION OF PLATE 22

Figure		Page
1a-8e.	**Shumardella obsolescens** Weller Ventral, dorsal, lateral, anterior, and posterior views, growth series, eight specimens, USNM 154646-53, respectively, USNM locality 9045; × 1.	301
9a-12e.	**Coledium altisulcatum,** n. sp. USNM locality 9048; × 2. 9a-d. Ventral, dorsal, lateral, and posterior views, holotype, USNM 154655. 10a-12e. Ventral, dorsal, lateral, anterior, and posterior views, three specimens, USNM 154656-8, respectively.	308

EXPLANATION OF PLATE 23

Figure Page

1a-5e. **Coledium ? costatulum,** n. sp. 312
Ventral, dorsal, lateral, anterior, and posterior views, five specimens, USNM 154660-64, respectively, including holotype (fig. 2), USNM locality 9155; × 2.

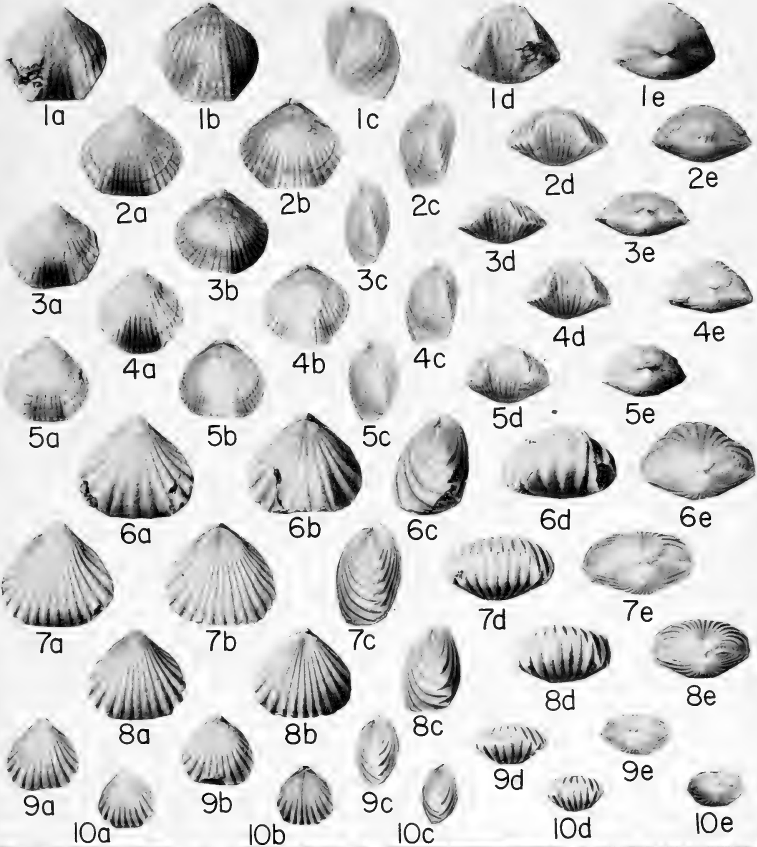
6a-10e. **Cupularostrum** ? sp. 300
Ventral, dorsal, lateral, anterior, and posterior views, growth series, five specimens, USNM 154666-70, respectively, USNM locality 9043; × 2.

11. **Fusella llanoensis,** n. sp. 386
Microporospon, exceptionally well-preserved specimen, USNM 154672, USNM locality 9042; × 10.

12. **Spirifer chappelensis,** n. sp. 377
Microprosopon, small specimen, USNM 154673, USNM locality 9045; × 10.

13. **Eomartiniopsis girtyi** (Branson) 419
Microprosopon, USNM 154674, USNM locality 9045; × 10.

14. **Crassumbo inornatus,** n. gen., n. sp. 410
Microprosopon, USNM 154675, USNM locality 9046; × 10.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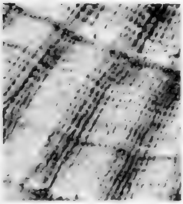
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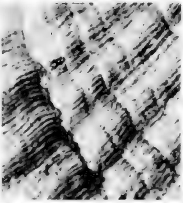
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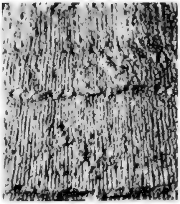
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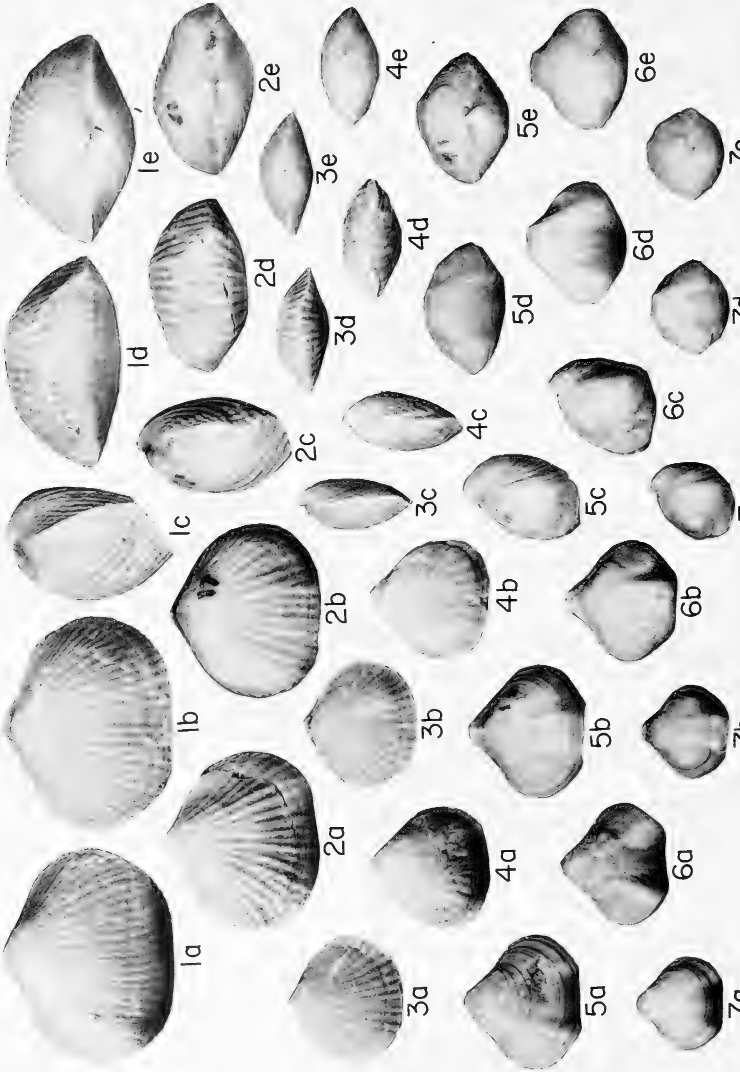
PLATE 24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EXPLANATION OF PLATE 24

Figure		Page
1a-4e.	**Sedenticellula sacra** Grant	306
	Ventral, dorsal, lateral, anterior, and posterior views, four specimens, USNM 142040, 142039, 154676, and 154677, respectively, including holotype (fig. 1), USGS locality 9367 (figs. 1, 2), USNM locality 9047 (fig. 3), and USNM locality 9155 (fig. 4); × 2.	
5a-7e.	**Coledium evexum** Grant	307
	Ventral, dorsal, lateral, anterior, and posterior views, three specimens, USNM 142147, 154678, and 154679, including holotype (fig. 5), USNM locality 9045; × 2.	

EXPLANATION OF PLATE 25

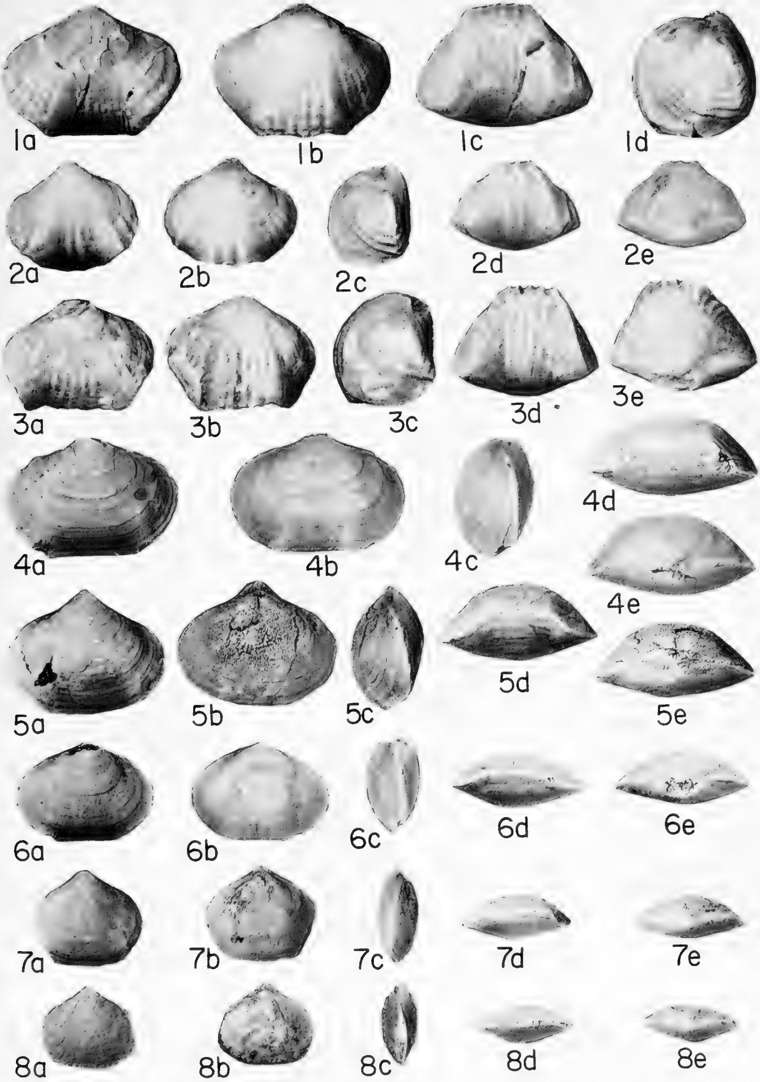
Figure Page

1a-3e. **Coledium undulatum** Grant 307

1a-d. Ventral, dorsal, anterior, and lateral views, large specimen, USNM 142502, USNM locality 9045. 2a-e. Ventral, dorsal, lateral, anterior, and posterior views, holotype, USNM 142501, USNM locality 9045. 3a-e. Ventral, dorsal, lateral, anterior, and posterior views, nearly complete specimen, USNM 154680, USNM locality 9047. All × 2.

4a-8e. **Coledium vadosulcatum,** n. sp. 310

Ventral, dorsal, lateral, anterior, and posterior views, growth series, five specimens, USNM 154681-5, respectively, including holotype (fig. 4), USNM locality 9047; × 2.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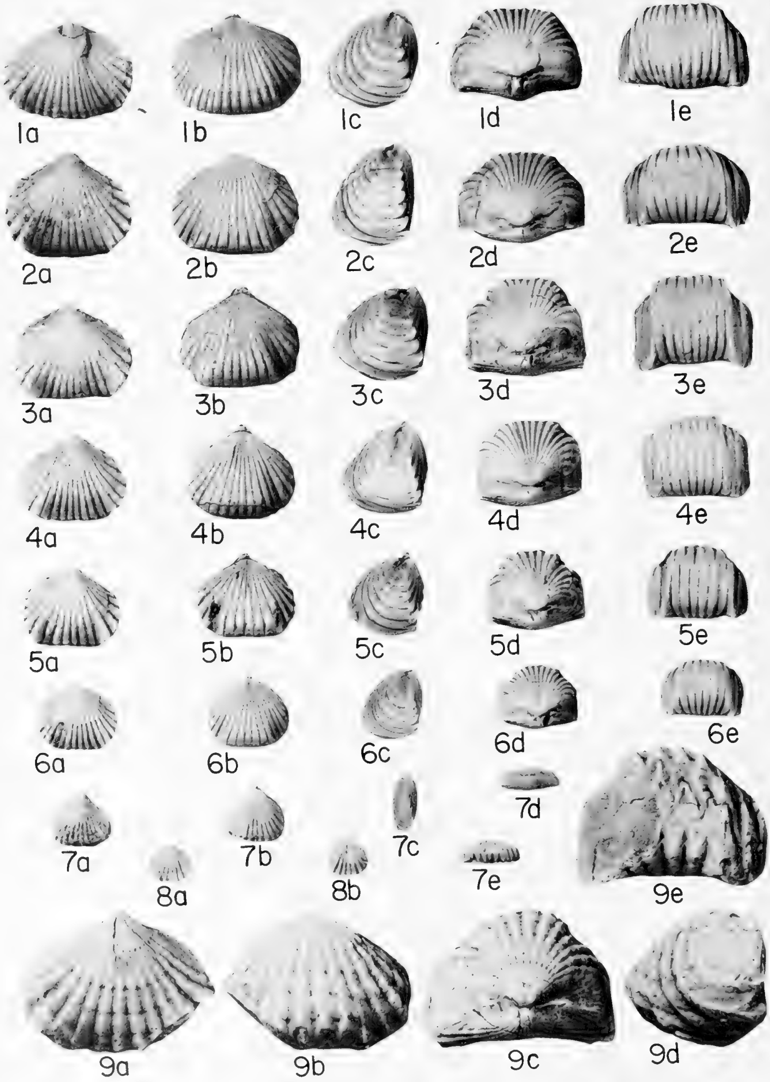
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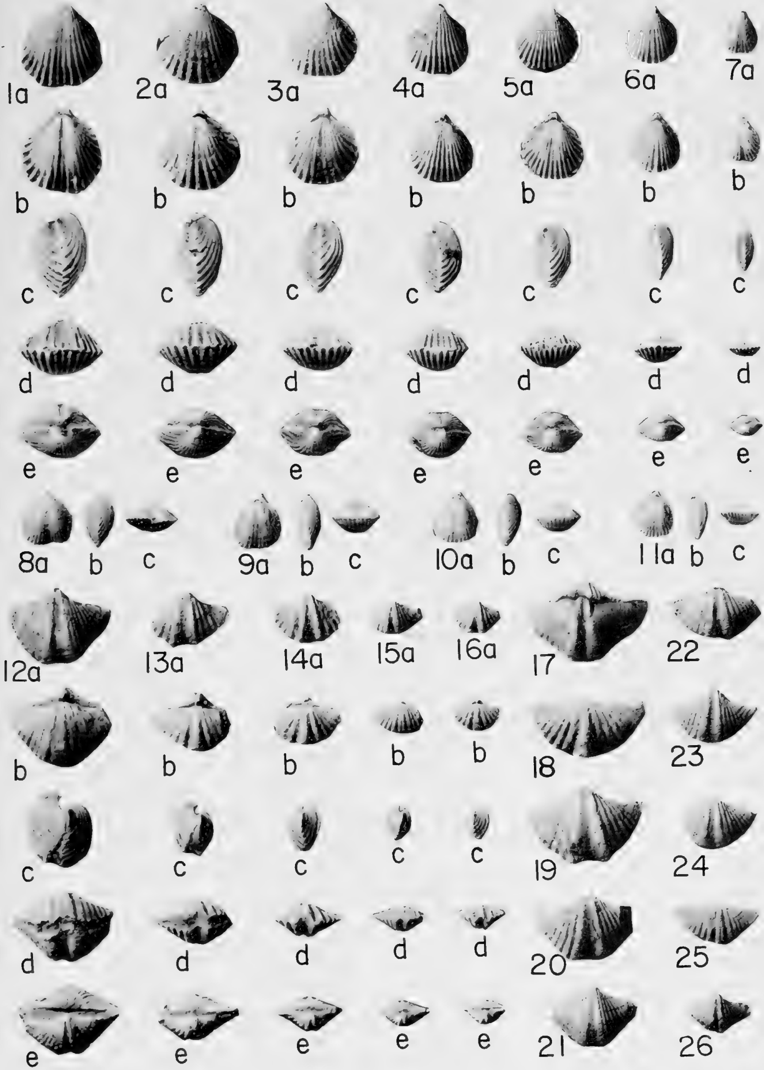
EXPLANATION OF PLATE 26

Figure		Page
1a-8b.	**Rhynchopora sansabensis,** n. sp. .... Ventral, dorsal, lateral, posterior, and anterior views (only ventral and dorsal in fig. 8), growth series, eight specimens, USNM 154687-94, respectively, including holotype (fig. 2), USNM locality 9045; × 1.	314
9a-e.	**Rotaia** sp. .... Ventral, dorsal, posterior, lateral, and anterior views, USNM 154697, USNM locality 9046; × 1.	304

EXPLANATION OF PLATE 27

Figure	Page
1a-11c. **Hustedia ? texana** Girty	319
1a-7e. Ventral, dorsal, lateral, anterior, and posterior views, growth series, seven specimens, USNM 154698-704, respectively, USNM localities 9048 (figs. 1, 3, 4) and 9045 (figs. 2, 5, 6, 7). 8a-11c. Dorsal, lateral, and anterior views, four Syntypes, USNM 121188, 121187, 121186, and 121185, respectively, USGS locality 2623. All × 2.
12a-26. **Amesopleura texana,** n. sp.	371
12a-e. Ventral, dorsal, lateral, anterior, and posterior views, holotype, USNM 154709, USNM locality 9045. 13a-16e. Ventral, dorsal, lateral, anterior, and posterior views, growth series, four specimens, USNM 154710-13, respectively, USNM localities 9045 (figs. 13, 14, 16) and 9048 (fig. 15). 17. Natural mold, brachial valve interior with portion of pedicle valve intact, USNM 154714, USNM locality 9045. 18-26. Nine free valves, USNM 154715-23, respectively, USNM localities 9045 (figs. 18, 19, 21, 26) and 9048 (figs. 20, 22, 23, 24, 25). All × 1.

PLATE 27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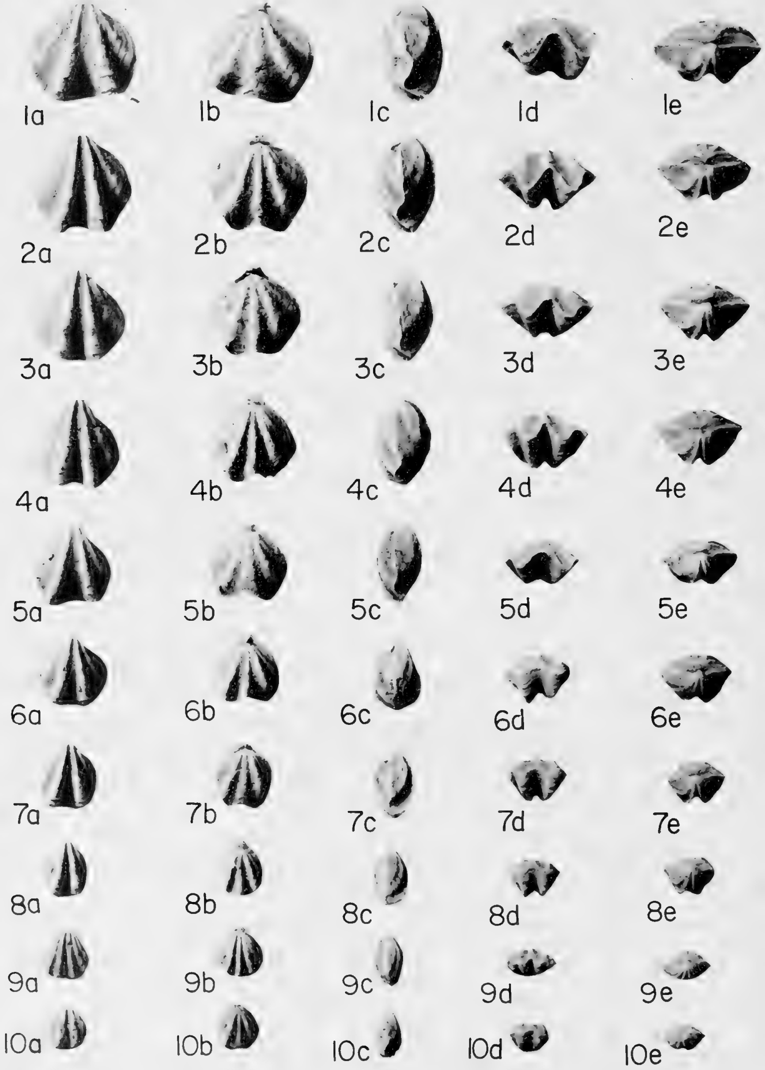
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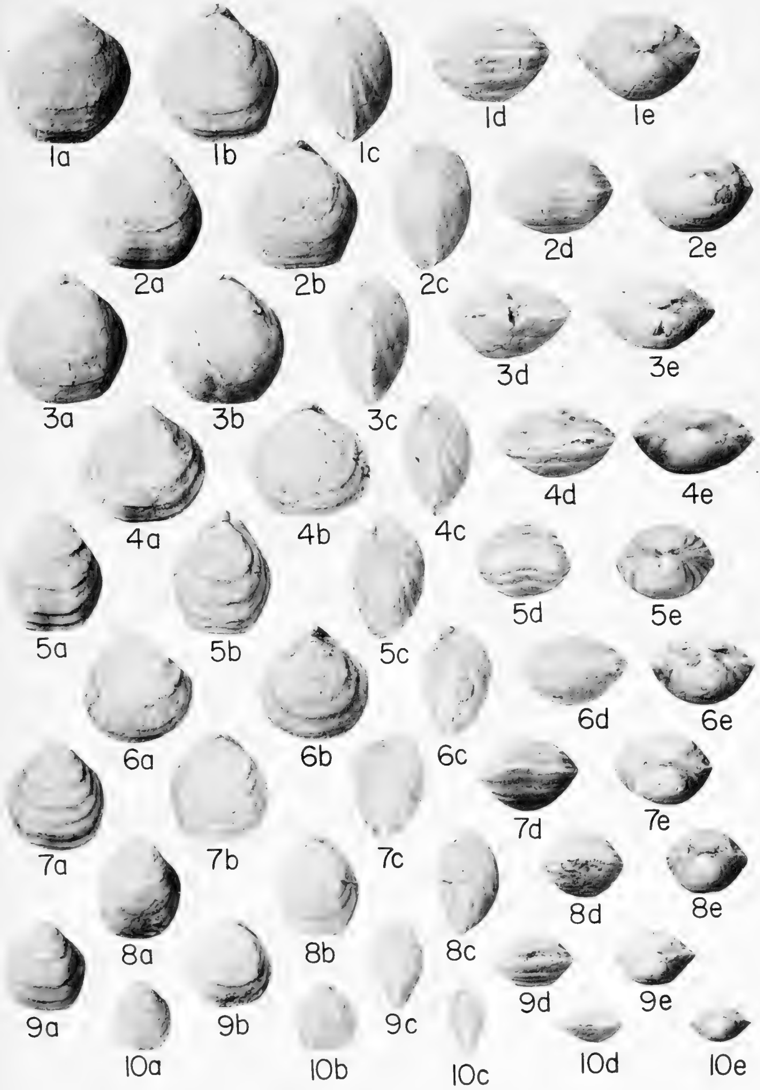
EXPLANATION OF PLATE 28

Figure		Page
1a-10e.	**Plectospira problematica** (Girty)	323

1a-9e. Ventral, dorsal, lateral, anterior, and posterior views, growth series, nine specimens, USNM 154725-33, respectively, USNM locality 9045. 10a-e. Ventral, dorsal, lateral, anterior, and posterior views, holotype, USNM 121190, USGS locality 2623. All × 2.

EXPLANATION OF PLATE 29

Figure		Page
1a-10e.	**Merista maccullochensis,** n. sp. .... Ventral, dorsal, lateral, anterior, and posterior views, growth series, ten specimens, USNM 154737-46, respectively, including holotype (fig. 2), USNM localities 9048 (figs. 1, 5, 9), 9046 (figs. 2, 4), and 9045 (figs. 3, 6, 7, 8, 10); × 3.	328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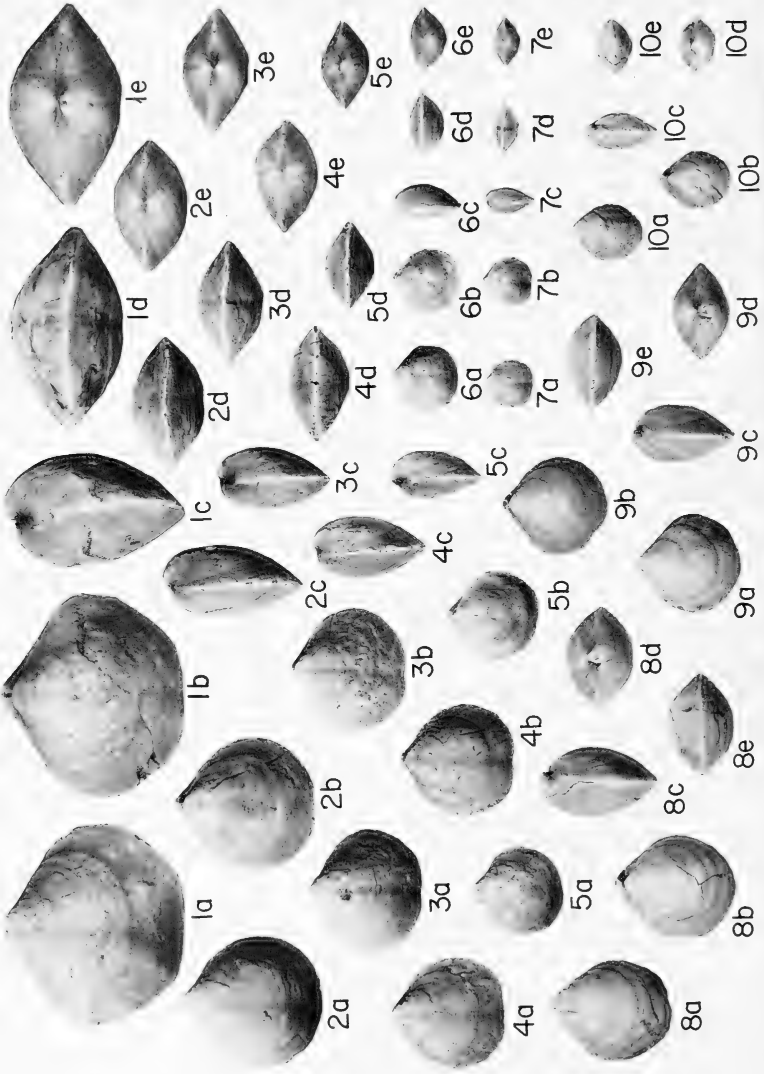
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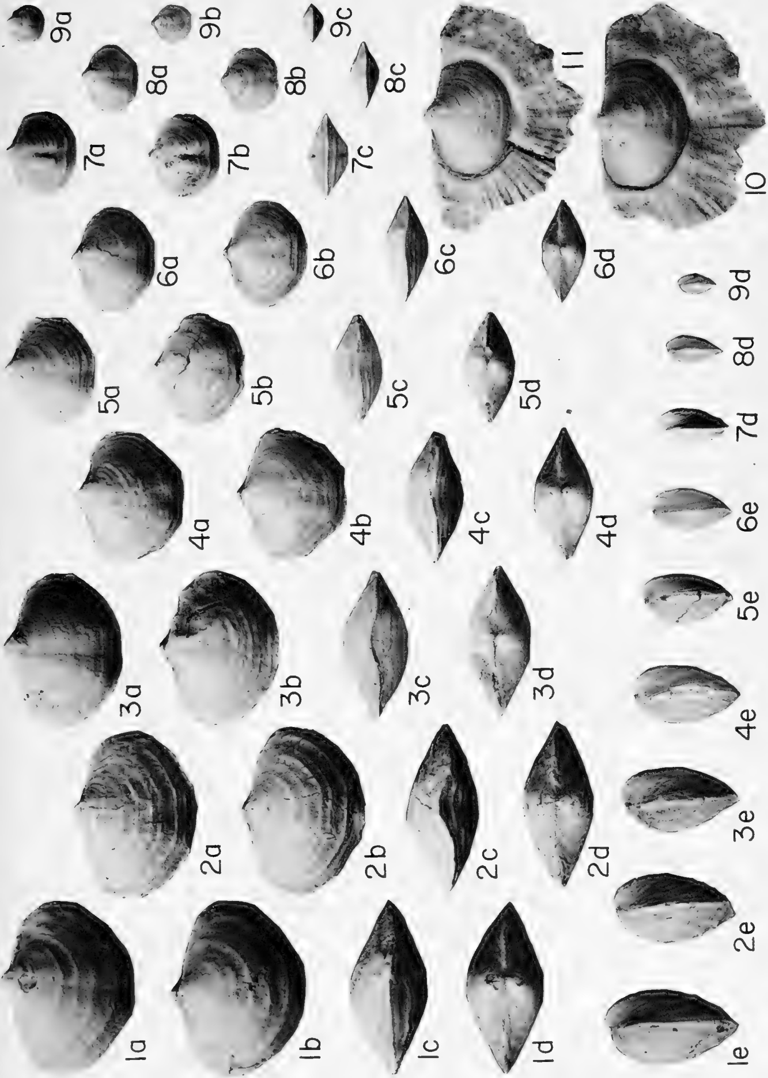
EXPLANATION OF PLATE 30

Figure		Page
1a-7e.	**Camarophorella dorsata,** n. sp. .... Ventral, dorsal, lateral, anterior, and posterior views, growth series, seven specimens, USNM 154749-55, respectively, including holotype (fig. 1), USNM localities 9045 (fig. 1), 9047 (figs. 2, 4), and 9048 (figs. 3, 5, 6, 7); × 2.	331
8a-10e.	**Cranaena** cf. **C. hannibalensis** Moore .... Ventral, dorsal, lateral, posterior, and anterior views, three specimens, USNM 154757-9, respectively, USNM locality 9045; × 1.	428

EXPLANATION OF PLATE 31

Figure		Page
1a-11.	**Athyris bradyensis,** n. sp.	336

USNM locality 9045. 1a-e. Ventral, dorsal, anterior, posterior, and lateral views, holotype, USNM 154761. 2a-6e. Ventral, dorsal, anterior, posterior, and lateral views, growth series, five specimens, USNM 154762-6, respectively. 7a-9d. Ventral, dorsal, anterior and, lateral views, three smaller specimens, USNM 154767-9, respectively. 10-11. Ventral views, two specimens, USNM 154770-1, respectively, showing the frilled lamellar extension characteristic of this genus. All × 1.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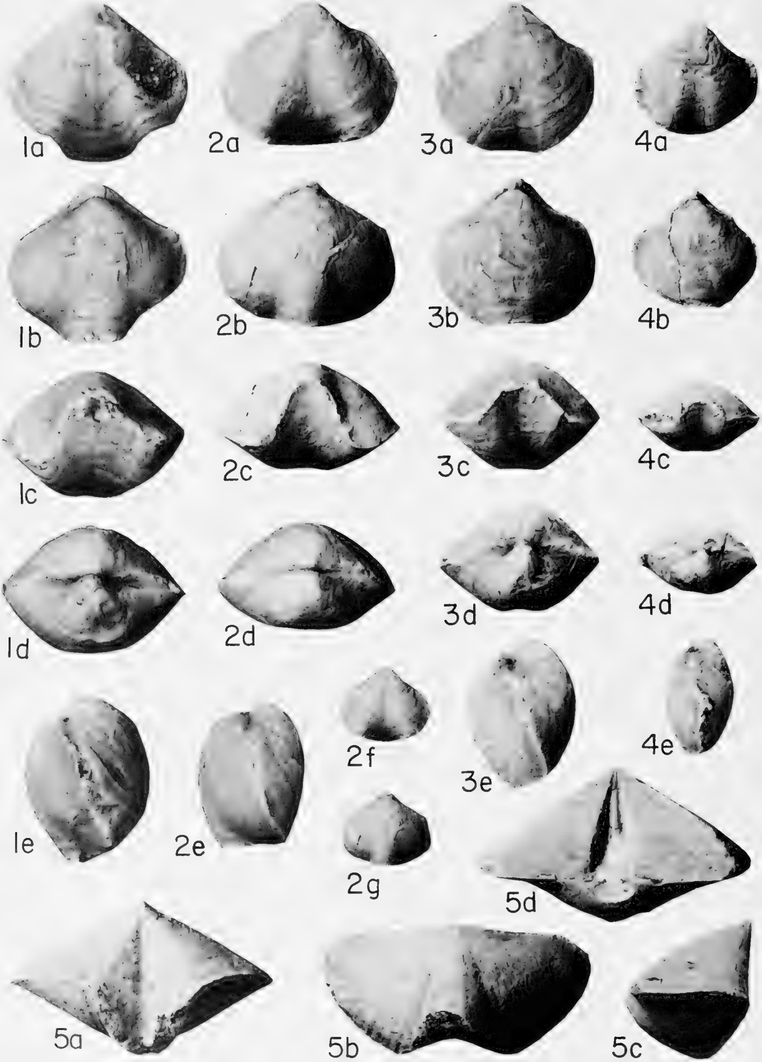
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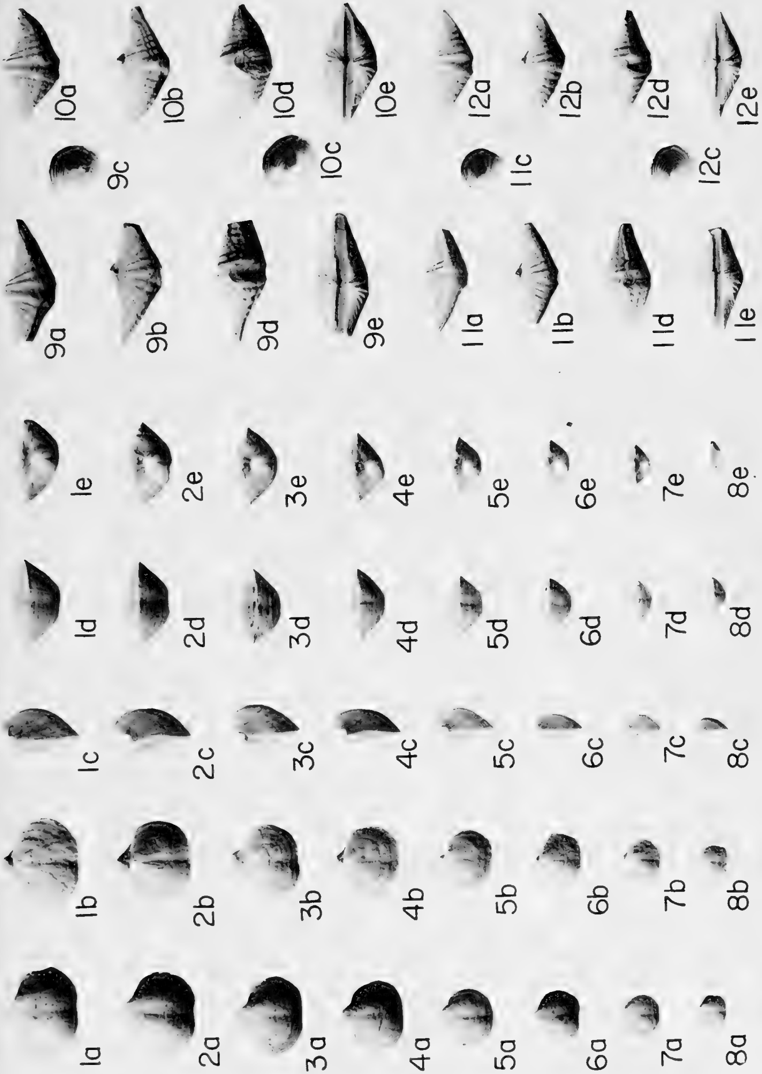
EXPLANATION OF PLATE 32

Figure		Page
1a-4e.	**Cleiothyridina** aff. **C. prouti** (Swallow) 1a-e. Ventral, dorsal, anterior, posterior, and lateral views, large specimen, USNM 154774, USNM locality 9048; × 2. 2a-4e. Ventral, dorsal, anterior, posterior, and lateral views, three specimens, USNM 154775-7, USNM locality 9045; × 2. (Figs. 2f-2g × 1).	347
5a-d.	**Syringothyris** sp. Ventral, dorsal, lateral, and posterior views, USNM 154779, USNM locality 9045; × 1.	374

EXPLANATION OF PLATE 33

Figure		Page
1a-8e.	**Crurithyris** cf. **parva** (Weller) Ventral, dorsal, lateral, anterior, and posterior views, growth series, eight specimens, USNM 154780-87, respectively, USNM locality 9045; × 2.	350
9a-12e.	**Amesopleura novamexicana** (Miller) Ventral, dorsal, lateral, anterior, and posterior views, four specimens, USNM 154791-4, respectively, USNM locality 3027A, Lake Valley Formation, near Lake Valley, New Mexico; × 1.	366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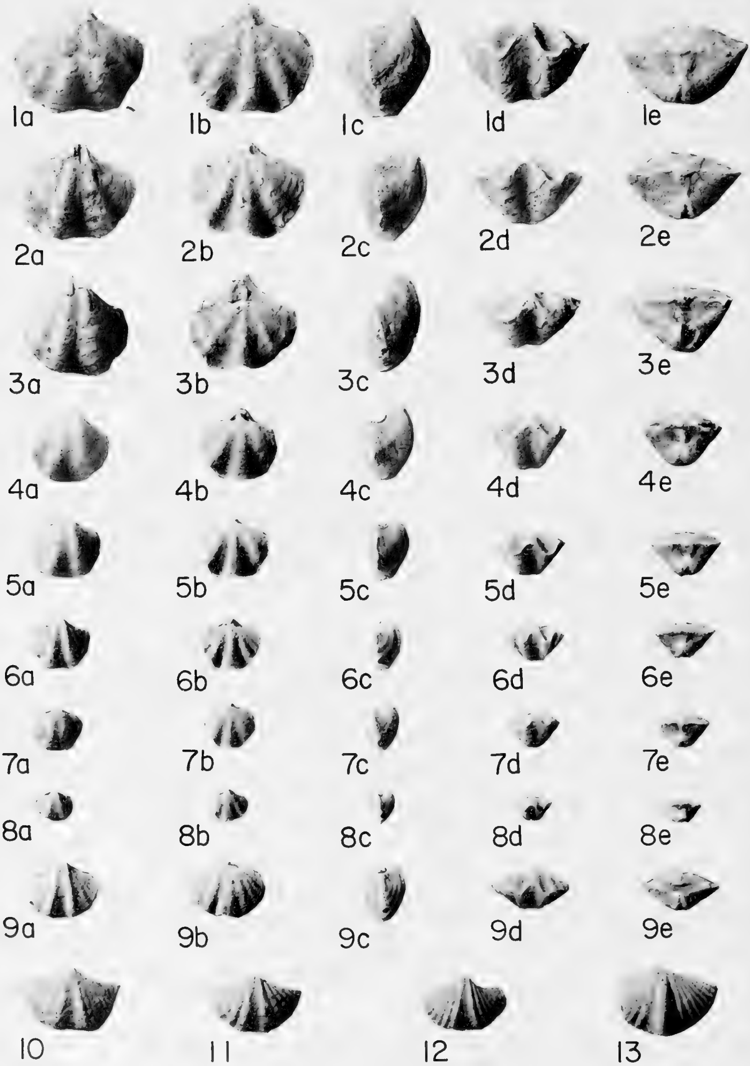
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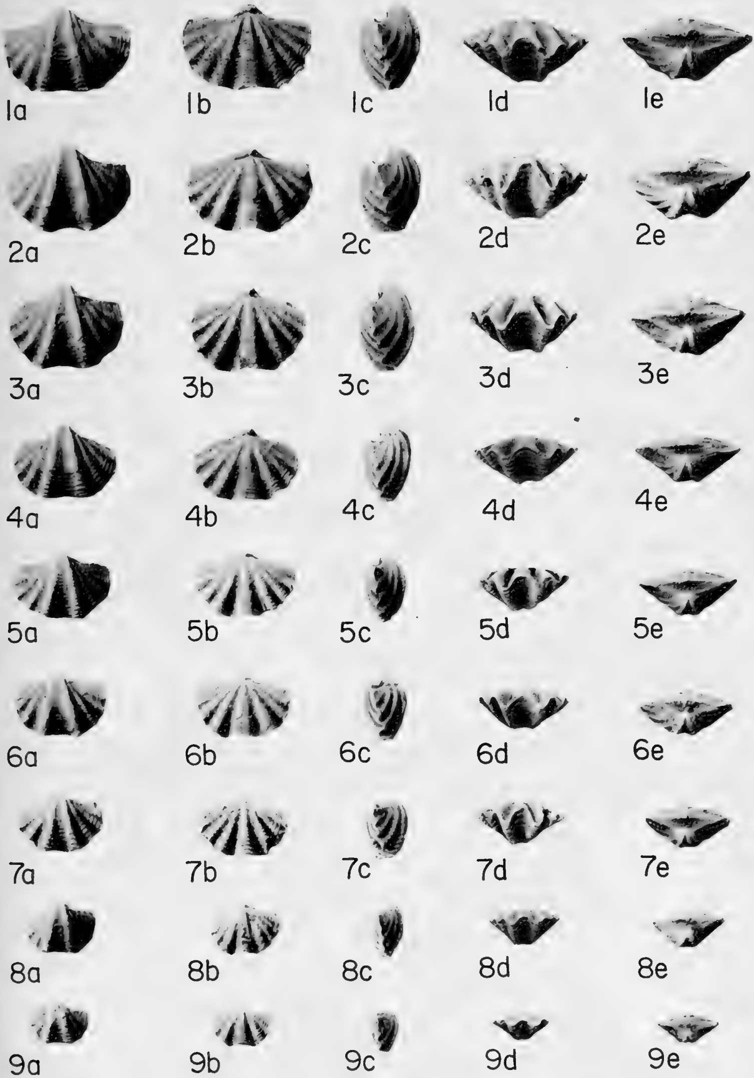
EXPLANATION OF PLATE 34

Figure		Page
1a-8e.	**Cyrtina burlingtonensis** Rowley Ventral, dorsal, lateral, anterior, and posterior views, growth series, eight specimens, USNM 154797-804, respectively, USNM localities 9045 (figs. 1, 3-8) and 9047 (fig. 2); × 2.	354
9a-e.	**Tylothyris** cf. **T. missouriensis** (Weller) Ventral, dorsal, lateral, anterior, and posterior views, USNM 154807, USNM locality 9043; × 1.	362
10-13.	**Punctospirifer** ? sp. 10-11. Two pedicle valves, USNM 154808-9, respectively, USNM locality 9045. 12. Pedicle valve, USNM 154810, USNM locality 9048. 13. Brachial valve, USNM 154811, USNM locality 9045. All × 1.	405

EXPLANATION OF PLATE 35

Figure		Page
1a-9e.	**Tylothyris brevaurita,** n. sp.	358

Ventral, dorsal, lateral, anterior, and posterior views, growth series, nine specimens, USNM 154812-20, respectively, including holotype (fig. 2), USNM localities 9045 (figs. 1, 2, 3, 4, 5, 6, 8, 9) and 9047 (fig. 7); × 2.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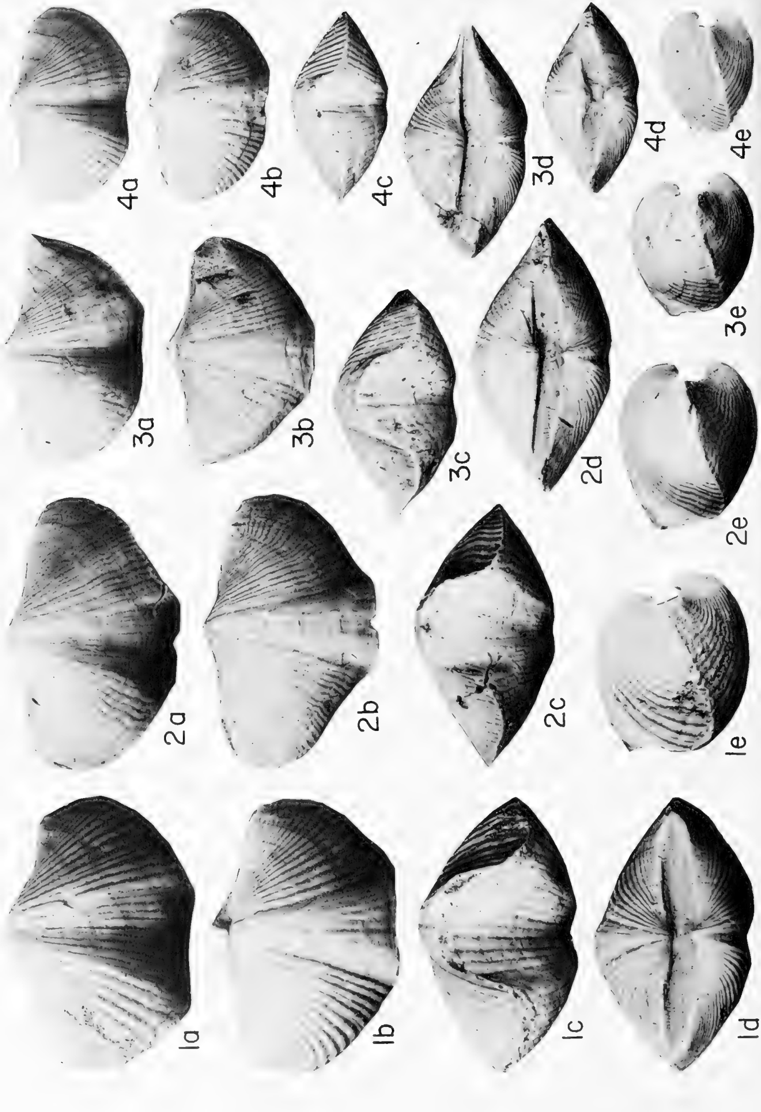
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EXPLANATION OF PLATE 36

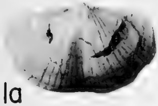
Figure Page

1a-4e. **Spirifer chappelensis,** n. sp. 377

1a-e. Ventral, dorsal, anterior, posterior, and lateral views, holotype, USNM 154823, USNM locality 9045. 2a-4e. Ventral, dorsal, anterior, posterior, and lateral views, part of growth series, USNM 154824-6, respectively, USNM localities 9045 (figs. 2, 4) and 9043 (fig. 3). (See Plate 37). All × 1.

EXPLANATION OF PLATE 37

Figure		Page
1a-4e.	**Spirifer chappelensis,** n. sp. .... Ventral, dorsal, lateral, anterior, and posterior views, part of growth series, USNM 154827-30, respectively, USNM locality 9045; × 1.	377
5a-6e.	**Ectochoristites inflatus,** n. sp. .... USNM locality 9045; × 1. 5a-e. Ventral, dorsal, lateral, anterior, and posterior views, holotype, USNM 154834. 6a-e. Ventral, dorsal, lateral, anterior, and posterior views, smaller specimen, USNM 154835.	400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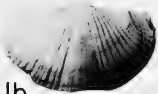
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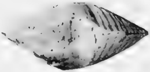
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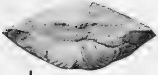
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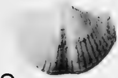
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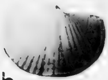
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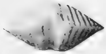
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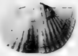
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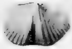
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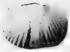
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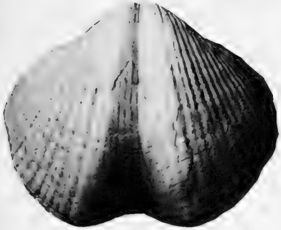
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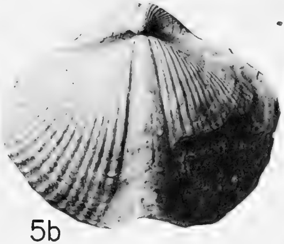
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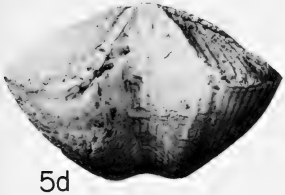
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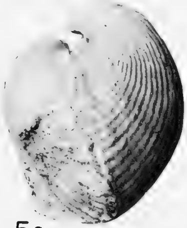
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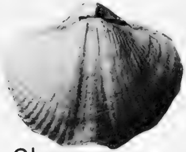
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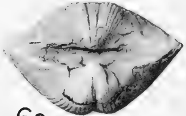
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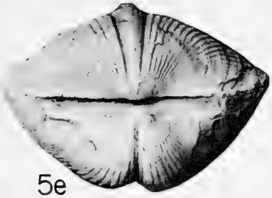
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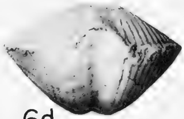
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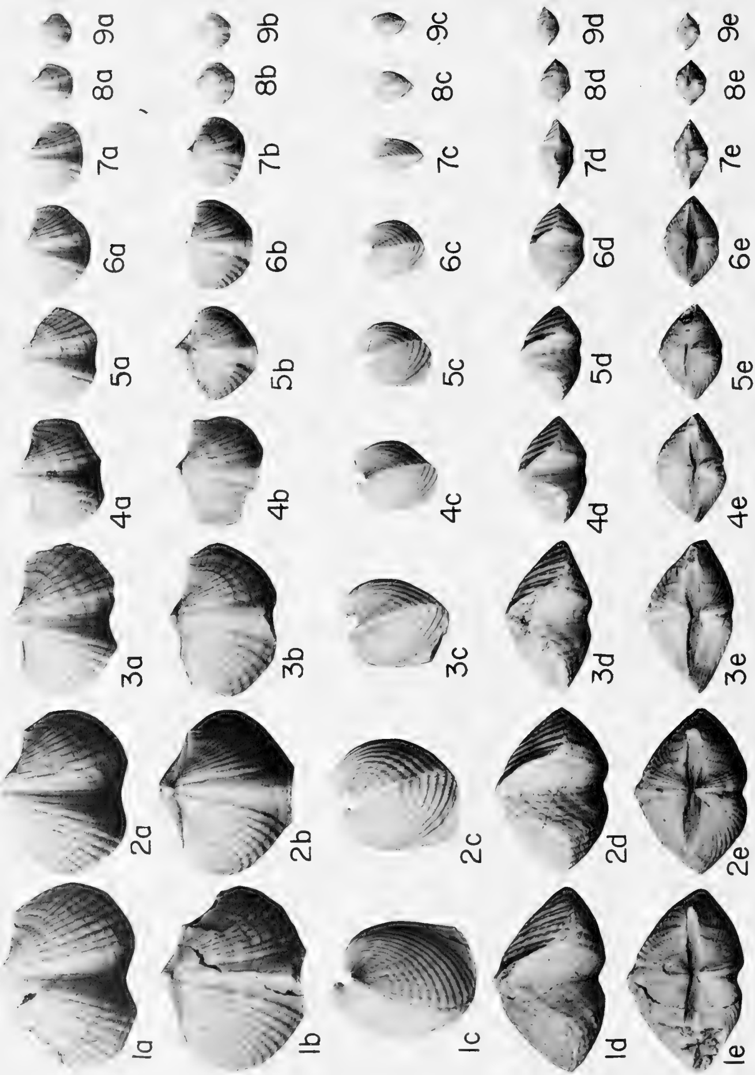
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1a-9e.	**Fusella llanoensis,** n. sp. Ventral, dorsal, lateral, anterior, and posterior views, growth series, nine specimens, USNM 154839-47, respectively, including holotype (fig. 2), USNM localities 9044 (figs. 1, 5), 9045 (figs. 3, 7, 8, 9), and 9048 (figs. 4, 6); × 1.	386

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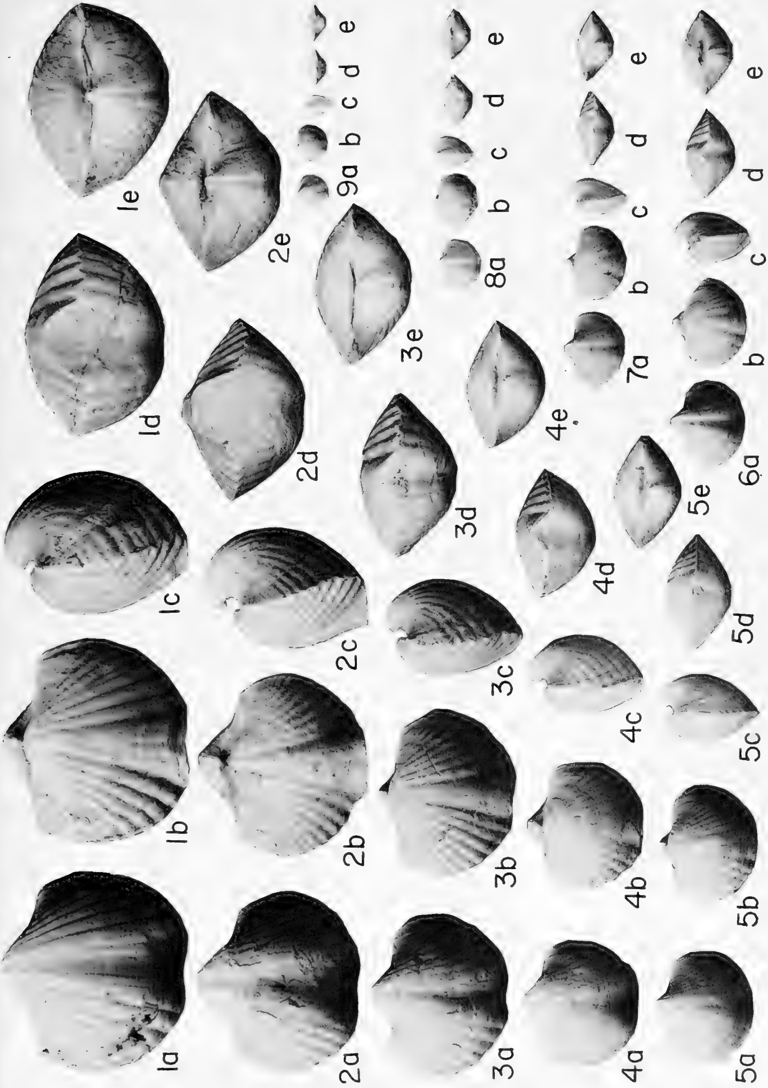
Figure		Page
1a-9e.	**Brachythyris chouteauensis** (Weller) .... Ventral, dorsal, lateral, anterior, and posterior views, growth series, nine specimens, USNM 154851-9, respectively, USNM locality 9045; × 1.	394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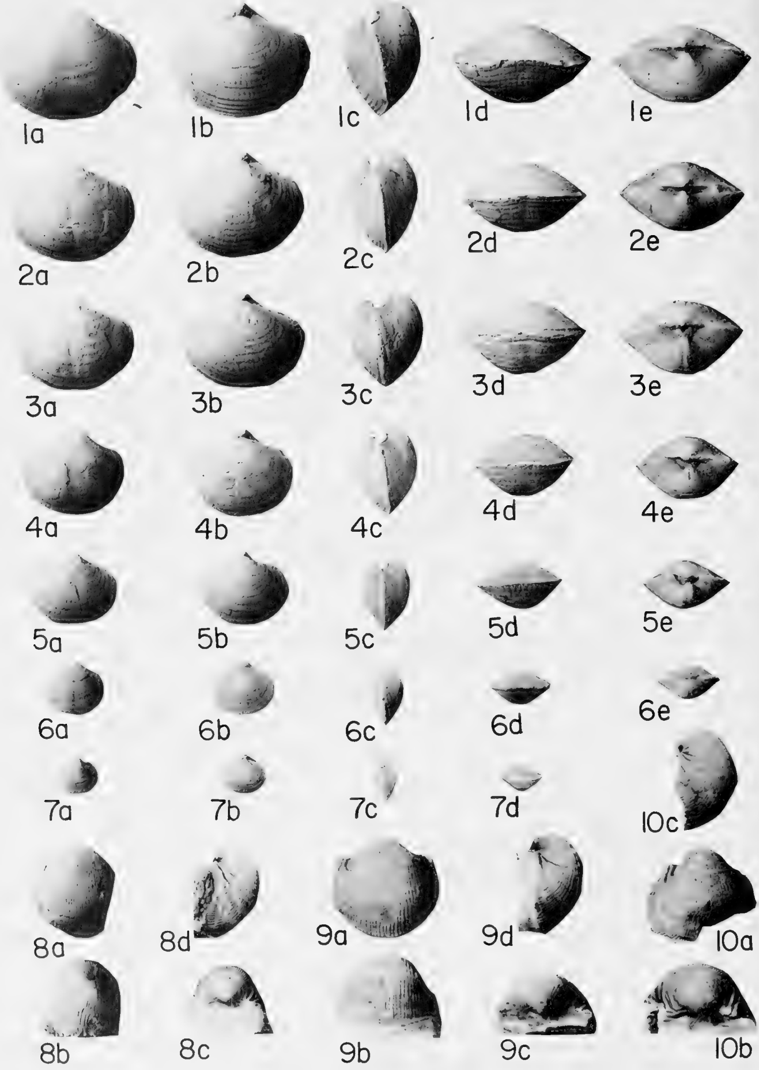
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Figure		Page
1a-7d.	**Reticularia ? cooperensis** (Swallow) Ventral, dorsal, lateral, anterior, and posterior views (fig. 7 lacks a posterior view), growth series, seven specimens, USNM 154862-8, respectively, USNM localities 9045 (figs. 1, 3-7) and 9048 (fig. 2); × 1.	405
8a-10c.	**Ovatia** sp. 8a-d. Ventral, anterior, posterior, and lateral views of pedicle valve, USNM 154870; × 1, USNM locality 9047. 9a-d. Ventral, anterior, posterior, and lateral views, small pedicle valve, USNM 154871; × 2, USNM locality 9047. 10a-c. Ventral, posterior and lateral views, large pedicle valve, USNM 154872; × 1, USNM locality 9045.	299

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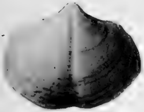
1a-12.	**Crassumbo inornatus,** n. gen., n. sp. 1a-e. Ventral, dorsal, lateral, anterior, and posterior views, holotype, USNM 154873, USNM locality 9045. 2a-6e. Ventral, dorsal, lateral, anterior, and posterior views, growth series, five specimens, USNM 154874, 154675, 154875, 154876, 154877, respectively, USNM localities 9045 (figs. 2, 4-6) and 9046 (fig. 3). 7-9. Three brachial valves, USNM 154878-80, respectively, USNM locality 9045. 10-12. Three pedicle valves, USNM 154881-3, respectively, USNM locality 9045. All × 1.	410
13.	**Spirifer cf. S. gregeri** Weller Pedicle valve, USNM 154886, USNM locality 9045; × 1.	383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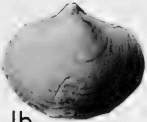
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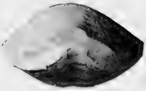
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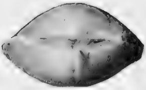
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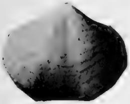
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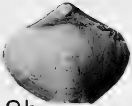
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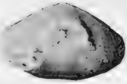
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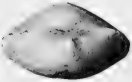
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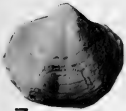
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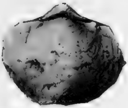
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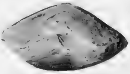
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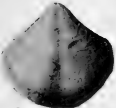
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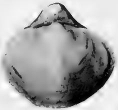
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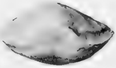
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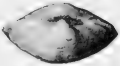
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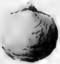
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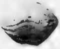
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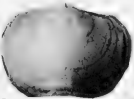
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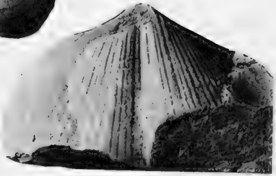
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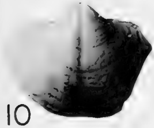
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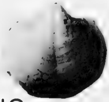
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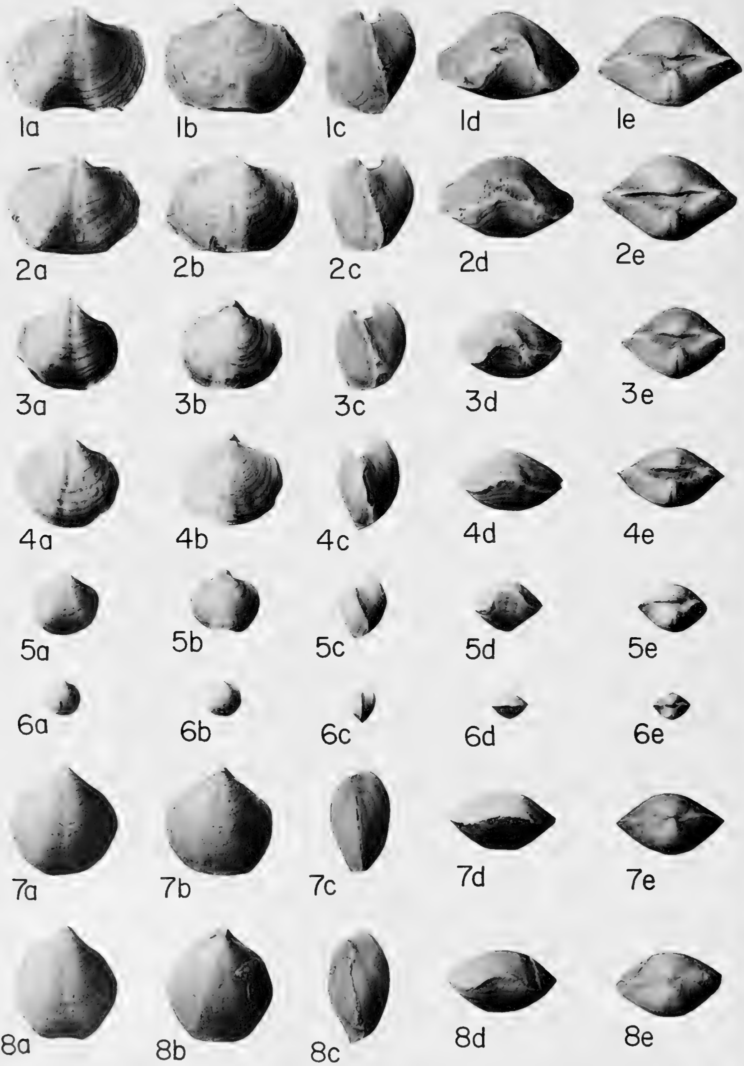
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EXPLANATION OF PLATE 42

Figure		Page
1a-6e.	**Crassumbo turgidus,** n. gen., n. sp. 1a-e. Ventral, dorsal, lateral, anterior, and posterior views, holotype, USNM 154887, USNM locality 9043. 2a-6e. Ventral, dorsal, lateral, anterior, and posterior views, growth series, five specimens, USNM 154888-92, respectively, USNM localities 9043 (figs. 2-4) and 9046 (figs. 5, 6). All × 1.	413
7a-8e.	**Actinoconchus** ? sp. Ventral, dorsal, lateral, anterior, and posterior views, two specimens, USNM 154902-3, respectively, USNM locality 9045; × 1.	341

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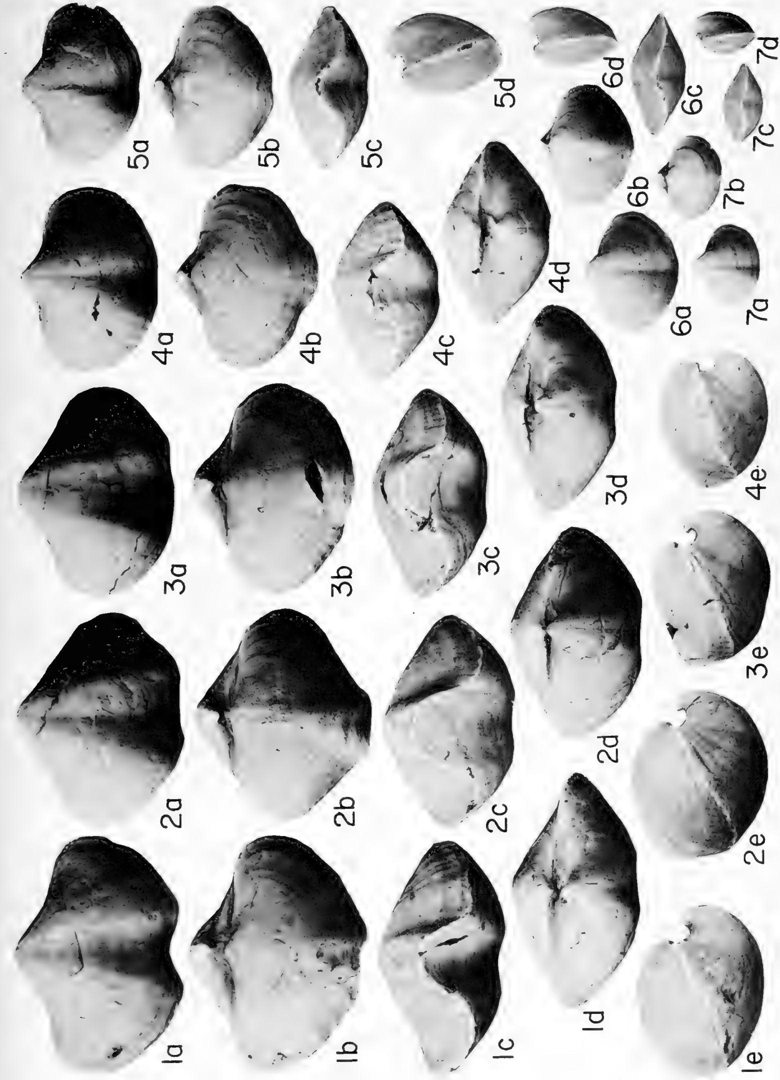
Figure		Page
1a-7d.	**Eomartiniopsis girtyi** (Branson)	419
	Ventral, dorsal, anterior, posterior, and lateral views (figs. 6, 7 lack posterior views), growth series, seven specimens, USNM 154905-11, respectively, USNM locality 9045; × 1.	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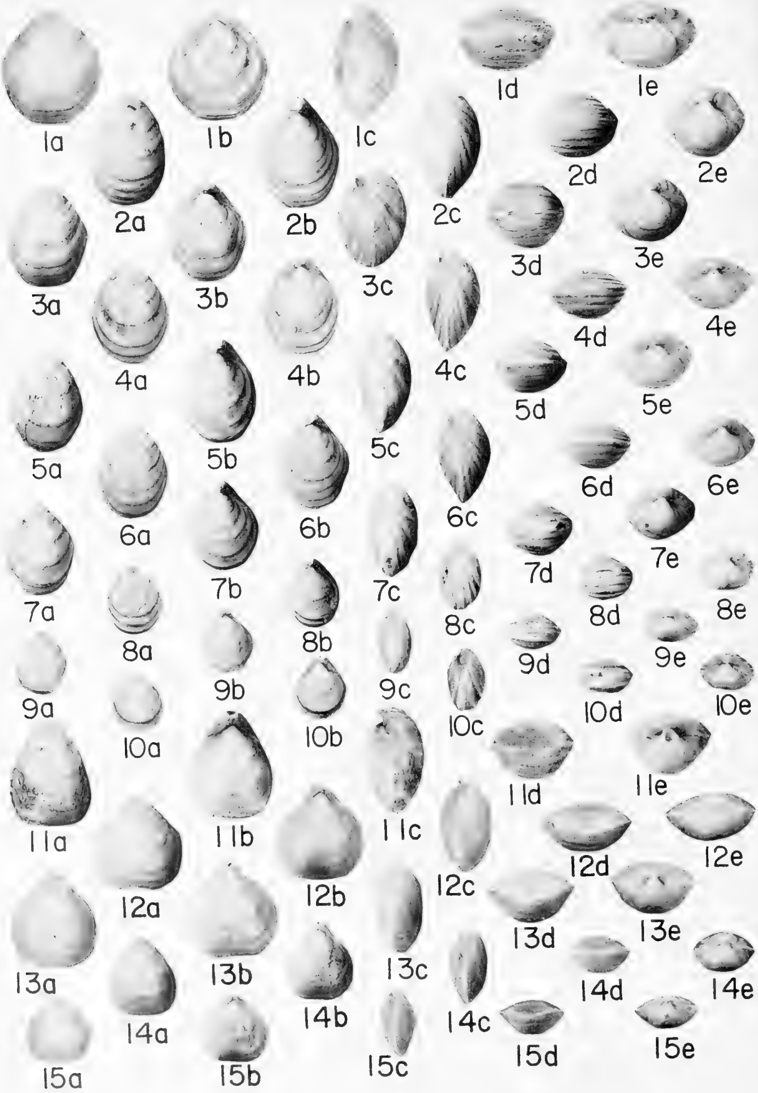
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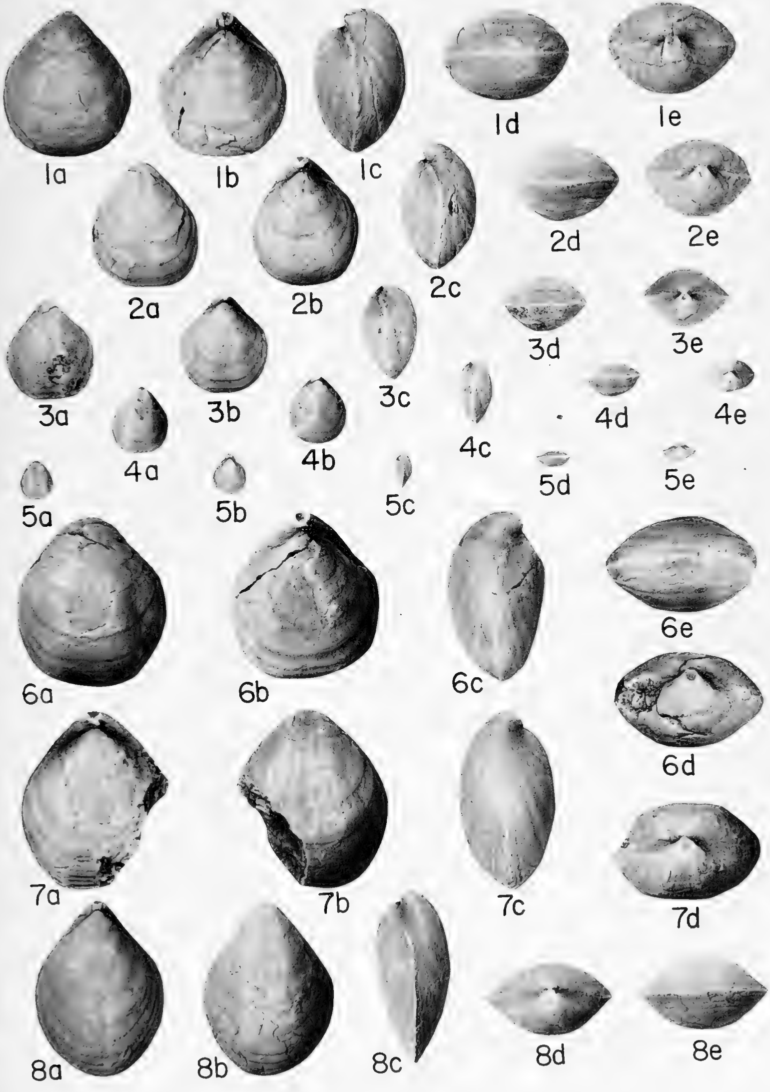
1a-10e.	**Cranaena texana,** n. sp. ...... Ventral, dorsal, lateral, anterior, and posterior views, growth series, ten specimens, USNM 154914-23, respectively, including holotype (fig. 2), USNM locality 9045; × 2.	425
11a-15e.	**Cranaena ? dorsisulcata,** n. sp. ...... Ventral, dorsal, lateral, anterior, and posterior views, five specimens, USNM locality 9047. 11a-e. Holotype, USNM 154925, × 1. 12a-15e. Four juveniles, USNM 154926-9, respectively, × 2.	430

EXPLANATION OF PLATE 45

Figure		Page
1a-5e.	**Hamburgia chappelensis,** n. sp. Ventral, dorsal, lateral, anterior, and posterior views, growth series, five specimens, USNM 154931-5, respectively, including holotype (fig. 1), USNM locality 9045; × 1.	432
6a-7d.	**Girtyella** aff. **G. cedarensis** Weller Ventral, dorsal, lateral, posterior, and anterior (fig. 6 only) views, two specimens, USNM 154939-40, respectively, USNM locality 9045; × 2.	436
8a-e.	**Beecheria chouteauensis** (Weller) Ventral, dorsal, lateral, posterior, and anterior views, exceptionally well-preserved specimen, USNM 154943, USNM locality 9045; × 1.	438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