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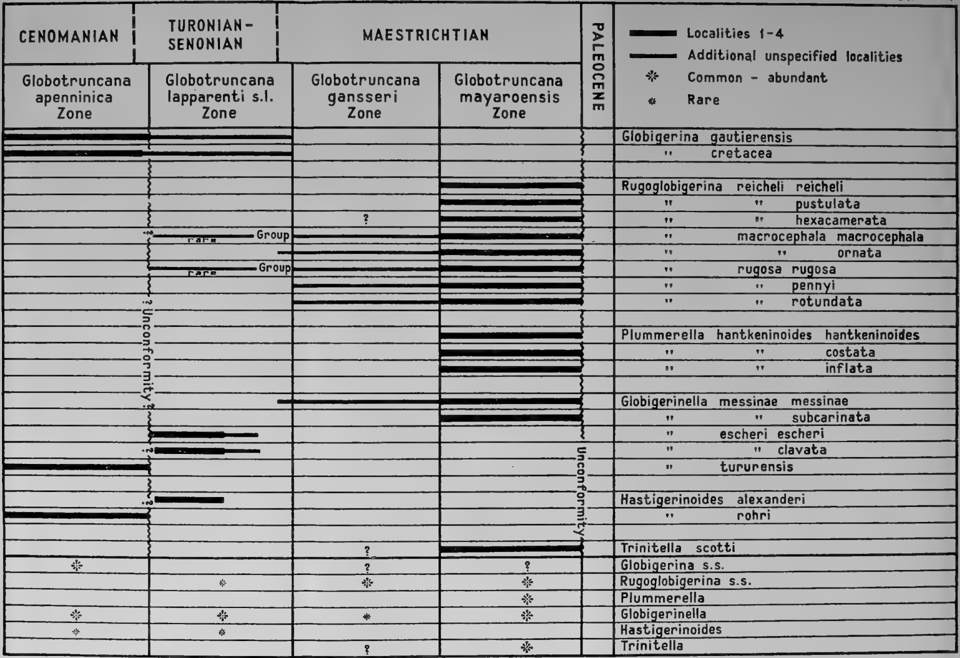

Text fig. 1. Stratigraphic distribution of Globigerinidae of the Upper Cretaceous of Trinidad.

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GLOBIGERINIDAE FROM THE UPPER CRETACEOUS (CENOMANIAN-MAESTRICHTIAN) OF TRINIDAD, B. W. I.

By

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P. Bronnimann*

INTRODUCTION

In this paper an attempt is made to describe the more prominent representatives of the Upper Cretaceous Globigerinidae of Trinidad.

Although the biostratigraphy of Trinidad's Upper Cretaceous is almost exclusively based on the life ranges of Globotruncanas (Bolli, 1951), it has, in the course of practical work, become increasingly necessary to arrive at a more detailed knowledge of the composition of the accompanying *Globigerina* assemblages. This is all the more justified because Globotruncanas are rare in the lower part of the Upper Cretaceous. The *Globotruncana* zones can be recognized also, in a general way, by the occurrence of Globigerinas, and, if found practicable, the zonation could also be based on Globigerinas. The introduction of improved methods for the disintegration of siliceous and otherwise indurated shales enabled the writer to obtain rich assemblages of Globigerinas from a small but representative number of surface and subsurface samples ranging in age from Cenomanian to Maestrichtian. The large suites of specimens, being in general fairly well preserved, permitted a rather detailed morphologic description and taxonomic treatment. Umbilical cover-plates and depressed parts of the tests are often concealed by unremovable parts of the country rock.

The proposed systematic grouping of the Upper Cretaceous Globigerinidae is based on the characteristics of the adult specimens. A few subspecific definitions, however, also take early ontogenetic features into account, as well as their changes in the course of the individual development. Bioseries have not been established on the basis of the present information, but some general remarks on the possible genetic relationship of the various forms are offered. Future evolutionary studies will have to be based to a large extent on the detailed analysis of the life ranges of the individual species and subspecies, and on embryogenetic investigations.

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The holotypes of the new species and subspecies are deposited in the Cushman Collection of the U. S. National Museum, Washington, D. C. Sets of topotypes will be deposited in the Museum of Natural History, Basle, Switzerland, and in the Paleontological Research Institution, Ithaca, New York. The original samples remain in the possession of the Geological Laboratory of Trinidad Leaseholds Ltd., at Pointe-a-Pierre, Trinidad, B. W. I.

The writer is indebted to the management of Trinidad Leaseholds Ltd. for the use of the facilities of the Geological Laboratory; to Dr. H. G. Kugler for reading the manuscript and for many valuable suggestions; and to Dr. Bolli with whom the pertinent stratigraphic points were discussed.

STRATIGRAPHIC DISTRIBUTION

The described Globigerinidae, as indicated below, originate from four localities found in the *Globotruncana mayaroensis* zone, the *Globotruncana lapparenti, s. l.* zone, and the *Globotruncana apenninica* zone (Cenomanian-Maestrichtian, see biostratigraphic zonation, Text fig. 1). The Maestrichtian *Globotruncana gansseri* zone is only represented by unreliable or poorly preserved assemblages from outcrops situated in the eastern Central Range and from subsurface sections near Pointe-a-Pierre and in the Guayaguayare area.

Surface

1. Gautier formation, outcropping in the Gautier River, near Chert Hill, Turure area, E. Central Range. *Globotruncana apenninica* zone, Cenomanian or Cenomanian-Turonian.

Subsurface

2. Guayaguayare beds, upper part, Guayaguayare area, S. E. Trinidad. *Globotruncana mayaroensis* zone, Maestrichtian.

3. Dark, indurated non- to slightly calcareous shales, Morne Diablo area, S. Trinidad. Sample near the base of the *Globotruncana lapparenti, s. l.* zone, Turonian-Senonian.

4. Dark, indurated, calcareous shales, San Fernando area, S. Trinidad. Sample in the lower part of the *Globotruncana lapparenti s. l.* zone, Turonian-Senonian.

The faunas from the above localities yielded the richest and best preserved Upper Cretaceous *Globigerina* assemblages we were able to obtain with the methods described by Layne (1950) and by Bolli (1950) for the disintegration of indurated or siliceous shales. It can be assumed that they are representative for the individual biostratigraphic zones. The vertical distribution of the various species from the four localities is recorded on the accompanying stratigraphic chart (Text fig. 1) by thick lines. Thin lines refer to information from poorly preserved additional samples, which, as a rule, did not permit more than a general determination (*Rugoglobigerina rugosa* group, *Rugoglobigerina macrocephala* group). The analysed material, however, is far from sufficient to determine the exact life ranges of the individual species. Such a compilation will have to be based on a large number of assemblages of known stratigraphic position.

The following remarks on the stratigraphic distribution may be added:

a. The species found in the *Globotruncana apenninica* zone are confined to this zone. They belong to the genera *Globigerina,* (?)*Globigerinella,* and *Hastigerinoides.* Rugoglobigerinas and Globigerinellas of the *Globigerinella escheri* group are not known from this zone, which, on the other hand, is characterized by the floodlike predominance of *Globigerina gautierensis* and *Globigerina cretacea.* It is of interest to note, that, apart from these two low trochoidal *Globigerina* species, no indisputable *Globigerina, s. s.* were recognized in the Trinidad Upper Cretaceous during the preparation of the present paper.*

The clear faunistic break between the *G. apenninica* zone and the overlying *G. lapparenti, s. l.* zone, together with geologic evidence from a subsurface section, suggests the presence of a stratigraphic break at the base of the *G. lapparenti, s. l.* zone.

b. The *Globotruncana lapparenti, s. l.* zone, at least its lower part, is characterized by common to abundant Globigerinellas of the *Globigerinella escheri* group, and by the occurrence of the stellate *Hastigerinoides alexanderi.* The representatives of *Rugoglobigerina* are rare and usually badly preserved, permitting neither a species nor a subspecies determination.

c. Poorly preserved assemblages of the *Globotruncana gansseri* zone contain numerous Rugoglobigerinas and scarce *Globigerinella messinae messinae.* A few specimens with affinities to *Rugoglobigerina reicheli hexacamerata* and to *Trinitella scotti* were recorded.

d. The *Globotruncana mayaroensis* zone is typified by the large group of abundant rugose Globigerinas, by frequent large Globigerinellas, and by the common occurrence of the peculiar genus *Trinitella.* It appears that *Plummerella* is restricted to this zone, whereas *Rugoglobigerina* and the *Globigerinella messinae* group are already known from the *Globotruncana lapparenti bulloides* and *Globotruncana lapparenti tricarinata*-bearing shales at the top of the *Globotruncana lapparenti, s. l.* zone. As regards the distribution of the Globigerinidae, the *Globotruncana lapparenti, s. l.* zone, the *Glo-*

* Information obtained after the completion of this paper has shown that *G. cretacea* and allied forms occur also, though sparsely, in the *Globotruncana lapparenti, s. l.* zone.

botruncana gansseri zone, and the *Globotruncana mayaroensis* zone show a distinct faunistic relationship.

e. The genus *Rugoglobigerina* supplies a series of excellent index fossils for the determination of the Cretaceous-Tertiary boundary in Trinidad. The same stratigraphic observation has been made in Texas where, according to Mrs. Plummer (1926, p. 39), the ornamented globigerinid species of the Navarro group do not occur in any of the Tertiary strata.

f. The genus *Globigerinella* Cushman is commonly distributed throughout the whole Upper Cretaceous with the exception of the *Globotruncana apenninica* zone where it is only questionably recorded (? *Globigerinella tururensis*). In the *Globotruncana lapparenti, s. l.* zone, Globigerinellas are occasionally the only, or at least the predominant, pelagic Foraminifera and thus of special stratigraphic significance. Tromp's observations on the occurrence of pelagic genera in the Upper Cretaceous of the Near East (1949, p. 674), namely that *Globigerinella* and *Globigerina* are almost equally represented in the Uppermost Cretaceous as *Globigerina* (?rugose group), but that *Globigerinella* is predominant in the Campanian of the Arabian facies, are confirmed by the distribution of these genera in Trinidad. A very similar distribution of Globigerinidae was observed by Nauss (1947) in the late Cretaceous Lloydminster and Lea Park shales of the Vermilion area, Alberta, inasmuch as the abundant calcareous faunas of the Lea Park shales contain only *Globigerinella aspera* (Ehrenberg) besides *Globigerina* cf. *cretacea* d'Orbigny. This assemblage occurs above the floods of *Globigerina loetterlei* and *G. cretacea* of the Lloydminster shale.

SYSTEMATIC GROUPING

Generic rank is given to the large group of strongly ornamented Globigerinas which reaches its acme in the Maestrichtian *Globotruncana mayaroensis* zone. The new genus *Rugoglobigerina*, genotype *Globigerina rugosa* Plummer 1926, is distinguished from all other Upper Cretaceous and Tertiary Globigerinas with depressed trochoidal tests by the marked and regularly arranged ornamentation and by the presence of an umbilical cover-plate in most of its species. To judge from the drawing of the umbilical side of *R. rugosa rugosa* (Plummer) (Plummer, 1926, pl. 2, fig. 10d) the cover-plate is pierced by accessory openings, thus resembling that of the following Cenomanian Globotruncanas: *Ticinella* Reichel (Reichel, 1949, pl. 16, fig. 1) and *Thalmanninella* Sigal (Reichel, pl. 16, figs. 2, 3). Due to the generally very poor preservation of the delicate umbilical features in the Trinidad material, however, it was not possible to clarify the structure of the umbilical cover-plate and to compare it with that of *Globotruncana.*

The rugose Globigerinas were first reported by Mrs. Plummer from the upper Navarro clay of Texas (1926, pp. 38-39, pl. 2, fig. 10) where *Rugoglobigerina rugosa rugosa* (Plummer) is the most frequent species of this large ornamented group. Although certain Midwayan species, such as *Globigerina pseudo-bulloides* Plummer and *G. compressa* Plummer (1926, pl. 8, figs. 9, 11), have a similar low trochoidal test, the absence of the strong, regularly arranged rugosities and of the umbilical cover-plate render them easily distinguishable from the Upper Cretaceous forms. This is also true for not yet described, small (average diameter 0.3 mm.), low trochoidal Paleocene Globigerinas from Trinidad which have a coarsely spinose and regularly ornamented surface.

The new subgenus *Plummerella* of the genus *Rugoglobigerina* comprises a small number of stellate and semi-stellate species, commonly co-existing with *Rugoglobigerina* proper. The assignment of *Plummerella* as subgenus to *Rugoglobigerina* is tentative. It is based on the fact that *Plummerella* possesses much the same rugose ornamentation as typical *Rugoglobigerina* and in addition shows transitions from the hantkeninoid to the *Globigerina*-like test.

It is noteworthy that no umbilical plate was observed in *Plummerella,* although the umbilical features of the more progressed and stronger trochoidal subspecies *inflata* suggest the presence of a cover-plate. Further investigations of this peculiar stellate and ornamented group, especially embryogenetic studies, may result in elevating *Plummerella* to generic rank.

At present the following subgenera and species are included in *Rugoglobigerina*:

Rugoglobigerina n. gen.
- *Rugoglobigerina, s. s.* n. subgen.
  - *R. reicheli reicheli* n. sp., n. subsp.
  - *R. reicheli pustulata* n. sp., n. subsp.
  - *R. reicheli hexacamerata* n. sp., n. subsp.
  - *R. macrocephala macrocephala* n. sp., n. subsp.
  - *R. macrocephala ornata* n. sp., n. subsp.
  - *R. rugosa rugosa* (Plummer) 1926
  - *R. rugosa pennyi* n. sp., n. subsp.
  - *R. rugosa rotundata* n. sp., n. subsp.
- *Plummerella* n. subgen.
  - *P. hantkeninoides hantkeninoides* n. sp., n. subsp.
  - *P. hantkeninoides costata* n. sp., n. subsp.
  - *P. hantkeninoides inflata* n. sp., n. subsp.

The new genus *Trinitella* exhibits morphologic features related to *Rugoglobigerina, s. s.* (early portion of test) and to *Globotruncana, s. l.* (single-keeled end chambers and overlapping chambers of last volution). *Trinitella* is monotypic and represented by:

T. scotti n. sp.

Low trochoidal, weakly ornamented species of the *Globotruncana apenninica* zone are referred with reservation to the genus *Globigerina* d'Orbigny. Two species are recognized:

G. gautierensis n. sp.
G. cretacea d'Orbigny 1840

which are both equally common in the dark calcareous shales of the Gautier formation.

The genus *Globigerinella* comprises the following species:

G. messinae messinae n. sp., n. subsp.
G. messinae subcarinata n. sp., n. subsp.
G. escheri escheri (Kaufmann) 1865
G. escheri clavata n. subsp.
(?) *G. tururensis* n. sp.

Rather scarce, small, stellate and planispiral *Hastigerinella*-like species of the lower part of the *Globotruncana lapparenti, s. l.* zone and of the *Globotruncana apenninica* zone are separated from the genus *Hastigerinella* Cushman 1927 by the obvious difference in the shape of the adult chambers. They are referred to the new subgenus *Hastigerinoides*, which at present contains the following species:

H. alexanderi (Cushman) 1931
H. rohri n. sp.

PHYLOGENETIC REMARKS

The present compilation includes only the more important Upper Cretaceous globigerinid species and does not claim to be complete. The more detailed faunistic investigation of Upper Cretaceous sediments and the application of yet better methods of disintegration of hard rocks will undoubtedly supply many more new, or in Trinidad not yet recorded, pelagic species. It is therefore considered to be premature to make an attempt at a phylogenetic grouping of the present incomplete inventory of globigerinid forms. Only the following very general statements are offered:

a. *Rugoglobigerina, s. s.* is the predominant group of the Maestrichtian zones. Although small globigerinid forms of the Trinidad Paleocene resemble in the depressed trochoidal test the Upper Cretaceous Rugoglobigerinas, the Paleocene and the Upper Cretaceous species are not considered to be related. At the present stage of investigation, however, the possibility that Paleocene forms might be related with Upper Cretaceous Rugoglobigerinas cannot be ruled out completely.

b. *Plummerella* and *Trinitella* become extinct at the close of the Cretaceous at least as far as Trinidad is concerned. They can not be regarded as possible ancestors of the morphologically different Tertiary Globigerinas.

c. *Globigerinella*, which is often the predominant globigerinid genus, apparently does not essentially differ in its Cretaceous and Tertiary species, and thus no bioseries can be established. It is quite possible that *Globigerinella* tests of the Tertiary have originated independently from those of the Cretaceous.

d. *Hastigerinoides*, a highly specialized group of stellate forms, seems to be related to *Globigerinella*.

e. The only ancestral forms from which modern Globigerinas could have sprung are represented by the group of low trochoidal, weakly ornamented Globigerinas of the *Globotruncana apenninica* zone. Unlike the Rugoglobigerinas, which are virtually all dextrally coiling, *Globigerina gautierensis* and *G. cretacea* are both dextrally and sinistrally coiling. This would suggest a rather undeveloped phylogenetic position (Bolli, 1951b) from which further evolution is still possible.

This phylogenetic derivation, however, appears to be rather remote in view of the fact that in Trinidad Globigerinas of the *gautierensis-cretacea* type apparently do not occur in the post-*Globotruncana lapparenti, s. l.* zones.

SYSTEMATIC DESCRIPTION

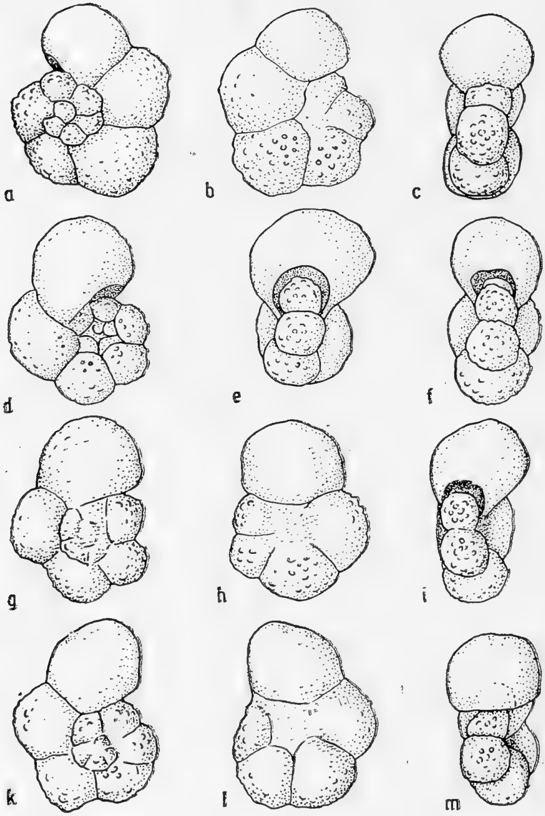
Family **GLOBIGERINIDAE** Cushman
Genus **GLOBIGERINA** d'Orbigny 1826

Globigerina gautierensis n. sp. Plate 1, figs. 1-3
Text fig. 2

Description.—The test is a low trochoidal spiral with 5 to 6 chambers in the adult. The trochoidal arrangement is so weak that the apertural aspect is almost that of *Globigerinella*. The chambers are much oppressed, subglobular and increase gradually in size. The end chamber is often strongly inflated and broad in apertural view and tends to shift toward the umbilical side. The more or less flat spiral side shows about 12 chambers arranged in 2 volutions. The deep and well-defined subcircular umbilicus is rather small compared with that of 6-chambered Rugoglobigerinas. The sutures are straight and not much depressed. The outline of the test, therefore, is only weakly lobulate. The large arcuate aperture is interiomarginal. The walls are finely perforate, and the surface is ornamented with small papillae which are stronger on the early ontogenetic chambers. The surface of the end chamber appears to be almost smooth. The species is random coiling.

Dimensions.—The maximum diameter of paratypes ranges from 0.375 mm. to 0.4 mm.

Holotype.—*Globigerina gautierensis* Bronnimann. T. L. L. Cat. Nos. 144455, 168920. Text figs. 2a-c. All appr. × 80. Plate



Text fig. 2. *Globigerina gautierensis* Bronnimann. T. L. L. Cat. Nos. 144455, 168920. *Globotruncana apenninica* zone, Gautier formation, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, spiral, umbilical and apertural views. Holotype. (g,h,i) Same specimen, spiral, umbilical and apertural views. (k,l,m) Same specimen, spiral, umbilical and apertural views. (d,e) Same specimen, spiral and apertural views; extreme form with broad end chamber. (f) Apertural view of an almost planispiral individual.

1, figs. 1-3. Maximum diameter 0.412 mm. Diameter of umbilicus 0.05 mm. End chamber: radial diameter 0.15 mm.; tangential diameter 0.175 mm.; thickness 0.177 mm. *Globotruncana apenninica* zone, Gautier formation, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—Globotruncana apenninica zone, Gautier formation, Upper Cretaceous. Abundant. Associated with *Globotruncana apenninica* O. Renz (*see* Bolli, 1951, pl. 34, figs. 1, 2, 3) and with *Globigerina cretacea* d'Orbigny. See footnote p. 7.

Remarks.—Globigerina gautierensis differs from the morphologically related, slightly compressed *G. cretacea* by the subglobular to globular, oppressed chambers, which are more numerous in the adult, and by the distinctly less lobulate outline. The low trochoid *Globigerina planispira* Tappan 1940, from the Grayson formation, Washita group, Lower Cretaceous, Denton County, Texas, differs from *G. gautierensis* by its bulbous chambers with a smooth surface. *G. portsdownensis* Williams-Mitchell 1948, from the Cenomanian, Upper Cretaceous, Portsdown No. 1 well, Hampshire, England, is much more trochoidal than any of the Globigerinas of the Gautier formation.

Nauss (1947, pp. 336-337, pl. 49, figs. 11a-c) introduced *Globigerina loetterlei* (originally misprinted *G. loetterli*) from the Upper Cretaceous Lloydminster shale, Vermilion area, Alberta, Canada. This form is associated with *Globigerina cretacea* d'Orbigny and with *Guembelina globulosa* (Ehrenberg). *G. loetterlei* resembles *G. gautierensis* in its weakly trochoidal spiral test of only slightly lobulate outline. Only ornamentation and size differentiate the 2 forms which very likely belong to the same group of Cretaceous Globigerinas. *G. loetterlei* Nauss has also been recorded from the Upper Cretaceous of Alaska (Tappan, 1951, pp. 4-5, pl. 1, figs. 19a-c). The Alaskan specimens appear to be rather small (greatest diameter 0.18-0.29 mm.) in comparison with those from Alberta (greatest diameter 0.4-0.7 mm.).

Due to the lack of information regarding the occurrence of Globotruncanas in the Upper Cretaceous of Alaska and of Canada, it is at present not possible to draw any conclusions regarding the correlation of these deposits and the Trinidad Upper Cretaceous.

The 5-chambered rugose *Globigerina* from the Upper Cretaceous White Chalk of Antigua, reported by Cushman (1931, p. 44, pl. 6, figs. 6a-c) as *G. cretacea,* apparently belongs to the genus *Rugoglobigerina.* According to Cushman's description there is frequently a thin, platelike structure across the umbilical region. The figured specimen is small for the genus (0.28 mm.) and possibly represents

Rugoglobigerina reicheli hexacamerata or a variant of this species. The figured specimen (pl. 6, figs. 5a-b) with 6 chambers in the adult and a low trochoidal spiral has to be assigned to the same species.

In this connection it should be emphasized that the White Chalk from which Cushman's Foraminifera originate is not indigenous of Antigua, but was imported as ballast from Europe during the time the water well of Cassada Gardens was being dug. Dr. H. G. Kugler, who kindly drew the writer's attention to this fact, states in a private report on the Geology of Antigua:

L. 1303—Cassada Garden.

The famous well of Cassada Garden is situated in a low undulating savannah near the golf course. Ever since Cushman has reported a Cretaceous fauna of exactly the same assemblage as known from the French Chalk of the Paris basin, there were doubts about the existence of such Cretaceous in Antigua. Senn (1940) used the reported Cretaceous to support one of his theories. Trechmann (1941) doubted the occurrence of the chalk. In 1941, the geologist Cleaves reported to the writer that Mr. Forrest, who had supplied the samples to Dr. Cushman, was in England during the deepening of the well. There is little doubt that the rock had been brought across the sea in ballast for "sweetening" the very salty water of the well.

The name of the new species is derived from the Gautier River, Eastern Central Range, Turure area.

Globigerina cretacea d'Orbigny 1840 Text fig. 3

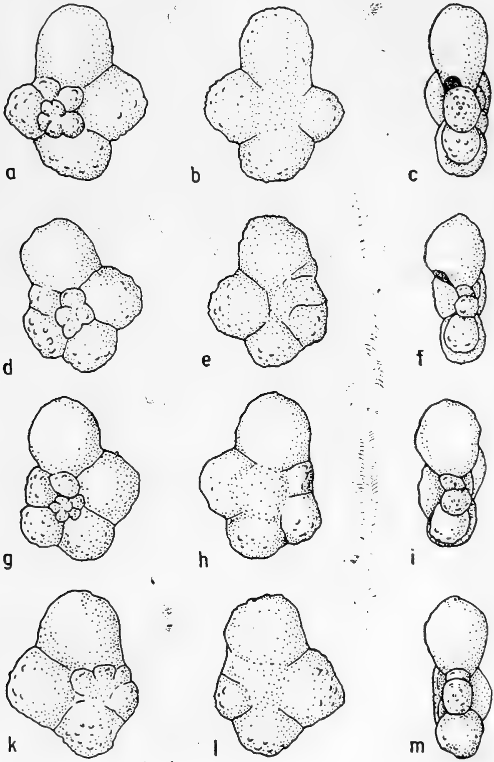
Globigerina cretacea d'Orbigny, 1840, Soc. Géol. France, Mém., 4(1): p.34, pl. 3, figs. 12-14.

Description.—The adult test is a very low trochoidal spiral with a slightly angular to lobulate outline. The distinct and rather deep umbilicus is surrounded by 5 chambers. The spiral side with 2 volutions comprises about 12 chambers gradually increasing in size. The chambers are slightly compressed, elongate-ellipsoid in frontal view, rounded to slightly subangular when seen from the spiral side. The sutures are straight and deep. The aperture could not be clearly observed and is believed to be a large arcuate opening directed toward the umbilicus. The walls are finely perforate and the surface is ornamented by minute papillae which are stronger developed in the early stage. The end chamber is not, or not much, ornamented. The pustules are not arranged in a regular pattern as in the Rugoglobigerinas. Right and left hand coiling specimens were observed, the latter seem to be predominant.

Dimensions.—The maximum diameter of the tests range from 0.275 to 0.35 mm.

Holotype.—*Globigerina cretacea* d'Orbigny. Mémoir sur les foraminifères de la Craie blanche du bassin de Paris. Soc. Géol. France, Mém., 1840, 4(1): pl. 3, figs. 12-14. Craie blanche, Cretacé, St. Germain, Bassin de Paris, France, and England.

Occurrence.—Globotruncana apenninica zone, Gautier formation, Upper Cretaceous. Abundant. See footnote p. 7.



Text fig. 3. *Globigerina cretacea* d'Orbigny. T. L. L. Cat. Nos. 144455, 168920. *Globotruncana apenninica* zone, Gautier formation, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, spiral, umbilical and apertural views. (d,e,f) Same specimen, spiral, umbilical and apertural views. (g,h,i) Same specimen, spiral, umbilical and apertural views. (k,l,m) Same specimen, spiral, umbilical and apertural views.

Remarks.—This species is clearly defined by the slightly compressed, very low trochoidal test and the distinctly lobulate sometimes subangular outline, and can easily be separated from the similarly ornamented *G. gautierensis.* The Trinidad specimens agree perfectly with d'Orbigny's figures and description (1840, p. 34, pl. 3, figs. 12-14). D'Orbigny's specimen is 5-chambered in the adult, the chambers are somewhat compressed, and the surface is ornamented with minute papillae. *Globigerina infra-cretacea* Glaessner (1937, p. 28, pl. 1, fig. 1) resembles *G. cretacea* very closely. Morrow (1934, p. 198, pl. 30, figs. 7, 10a,b) figured and described specimens of *G. cretacea* from the Upper Cretaceous Colorado group of Kansas which appear to be identical with the specimens recorded from Trinidad. *G. cretacea* (Applin, 1933) has also been reported from the Upper Cretaceous Niobrara formation and the Carlile shale of South Dakota. Albritton and Phleger (1937) encountered this species in clays of Navarro and Taylor age from Texas, associated with (?)*Globigerinella aspera* (Navarro) and with *Globigerina belli* White and (?)*Globigerinella aspera* (Taylor). It is doubtful whether the specimens reported by Young (1951, p. 65, pl. 14, figs. 1-3) from the Upper Cretaceous Frontier formation of southern Montana belong to *G. cretacea.* They are larger (0.42 to 0.45 mm.) than the Trinidad specimens and (as based on the illustrations) are rather coarsely hispid on the entire surface. No umbilical cover-plate was observed by Young, and the ornamentation does not show any sign of the meridional pattern.

Genus **RUGOGLOBIGERINA** n. gen.

Diagnosis.—Test either *Hantkenina*-like or distinctly *Globigerina*-like, almost planispiral to trochoidal. Chambers of *Hantkenina* type with axially situated spines, those of *Globigerina* type rounded peripherally, truncate toward umbilicus. Sutures straight to slightly curved in direction of coiling. Apertures large, arcuate, directed toward umbilicus, occasionally with liplike projections. Umbilicus subcircular, as a rule large, deep, with covering plate. Surface ornamented by rugosities of various size and type, either distributed irregularly or arranged in rows radiating from a central point on the surface toward the aperture (meridional pattern).

Generotype.—*Rugoglobigerina* (*Rugoglobigerina*) *rugosa rugosa* (Plummer) 1926.

Remarks.—The Upper Cretaceous genus *Rugoglobigerina* contains the hantkeninoid subgenus *Plummerella* and the *Globigerina*-like subgenus *Rugoglobigerina,* both of which carry the characteristic rugose surface, which in typical forms displays a peculiar meridional pattern. A further indication of relationship of these two subgenera is the occurrence of spines in the early stages and truncate *Globigerina* chambers in the late ontogenetic stages of some species. The covering plate across the umbilicus was not found in *Plummerella,* but from the general morphology of the tests its presence has to be expected in well-preserved specimens. The genus *Rugoglobigerina* differs from all other Cretaceous and Tertiary Globigerinas by the strongly rugose, as a rule regularly ornamented surface, by a covering plate across the umbilicus, and by the development of hantkeninoid chambers and of truncate *Globigerina* chambers, with large arcuate apertures directed toward the umbilicus.

Occurrence.—Upper Cretaceous, Trinidad, B. W. I., Eastern Venezuela, Texas, U. S. A., and Egypt.

Subgenus **RUGOGLOBIGERINA** n. subgen.

Diagnosis.—Test medium to large sized, low trochoidal throughout the ontogeny. Spiral side with about 2 whorls, initial portion depressed. Umbilicus variable in diameter, as a rule large, circular and deep, and provided with a delicate covering plate (only preserved as fragments or not observed). Chambers increasing in size as added, subglobular in early stages, those of last volution truncate toward umbilicus, rounded peripherally, occasionally elongate in direction of spiral axis. The end chamber can be larger, of the same size, or even smaller than the penultimate one and in many forms it is shifted toward the umbilical side. Early chambers of last volution with hantkeninoid points, or provided with large pustules, or irregularly rugose, or ornamented by distinct rows of rugosities radiating from a central point on the periphery toward the apertural face (meridional pattern). Plummer (1926, pp. 38-39) describes this feature as follows:

.....irregularly developed rugosities or even indistinct, discontinuous, and rugulose ridges that radiate backward over each chamber from a central point on its periphery.

The meridional arrangement of the rugosities is typically developed on all or on part of the chambers of the adult volution. Sutures are well marked, straight to slightly curved in direction of coiling. Apertures of end chambers, large, arcuate, directed into umbilicus and occasionally provided with minute liplike projections.

Subgenerotype.—*Rugoglobigerina* (*Rugoglobigerina*) *rugosa rugosa* Plummer 1926.

Remarks.—The subgenus *Rugoglobigerina* comprises 3 well-defined species, *R. reicheli, R. macrocephala,* and *R. rugosa,* each of them split into a number of closely interrelated subspecies. In spite of the development of short hantkeninoid points in early chambers of the adult volution of *R. reicheli reicheli,* it maintains its distinct *Globigeri-*

na character. *Rugoglobigerina* is separated from the hantkeninoid subgenus *Plummerella* by the distinctly *Globigerina*-like test.

Occurrence.—Upper Cretaceous Trinidad, B. W. I., Eastern Venezuela, Texas, U. S. A., Egypt.

Rugoglobigerina reicheli reicheli n. sp., n. subsp. Plate 3, figs. 10-12
Text figs. 4, 5

Description.—The last volution of the small to medium-sized low trochoidal test comprises 5 to 6 chambers. Umbilical and spiral side are well defined. About 2 whorls can be counted on the centrally slightly depressed spiral side. No details of the initial portion are discernible due to the coarsely rugose surface. The ultimate chamber can be larger or of the same size or even smaller than the penultimate one and is displaced toward the umbilical side. The first 2 or 3 chambers of the last whorl are of conic shape. The adjoining chambers are peripherally rounded and truncate at the apertural side. The umbilicus is deep, usually filled with matrix. Remains of the delicate covering plate were noted. The straight sutures are depressed, thus producing a lobulate outline. The large arcuate aperture of the end chamber with a small liplike projection opens into the umbilicus. The apertures of the preceding chambers are not known. The walls appear to be thick, and the surface is coarsely rugose. The rugosities of the inflated last chambers are arranged in meridional rows radiating from a centre on the surface toward the edges of the aperture. The investigated specimens are invariably dextrally coiling.

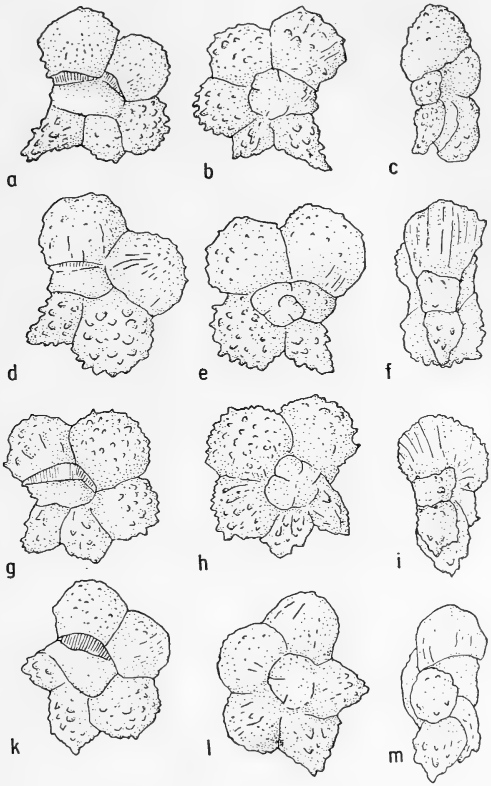
Dimensions.—The maximum diameter of the tests, including the spinelike projections, ranges from 0.325 mm. to 0.37 mm.

Holotype.—*Rugoglobigerina* (*Rugoglobigerina*) *reicheli reicheli* Bronnimann. T. L. L. Cat. Nos. 155591-155594. Plate 3, figs. 10-12. Maximum diameter 0.35 mm. End chamber: radial diameter 0.125 mm.; tangential diameter 0.15 mm.; thickness 0.15 mm. Radial diameter of first spinose chamber 0.10 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

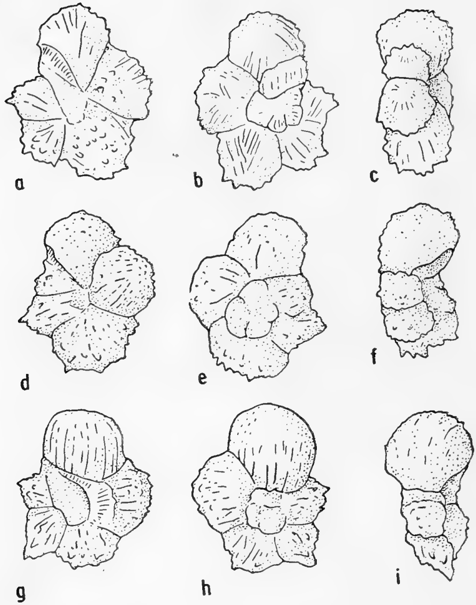
Occurrence.—*Globotruncana mayaroensis* zone. Abundant.

Remarks.—Although the adult stage is *Globigerina*-like, this subspecies still shows in the early chambers of the last volution indications of hantkeninoid features similar to those described from the subgenus *Plummerella*. It is conceivable that *R. reicheli reicheli* represents a transitional form between the two groups. The identical rugose ornamentation suggests that both subgenera are genetically related. The central type differs by the hantkeninoid early chambers from the other forms of the *reicheli* group.

This species is named after Dr. M. Reichel for his contribution to the knowledge of the Upper Cretaceous genus *Schackoina* Thalmann.



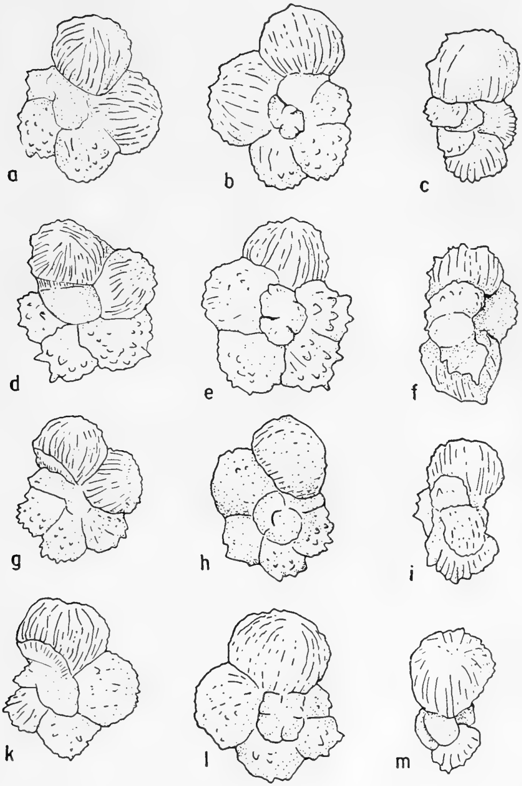
Text fig. 4. *Rugoglobigerina reicheli reicheli* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen umbilical, spiral and apertural views. (k,l,m) Same specimen umbilical, spiral and apertural views.



Text fig. 5. *Rugoglobigerina reicheli reicheli* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views.

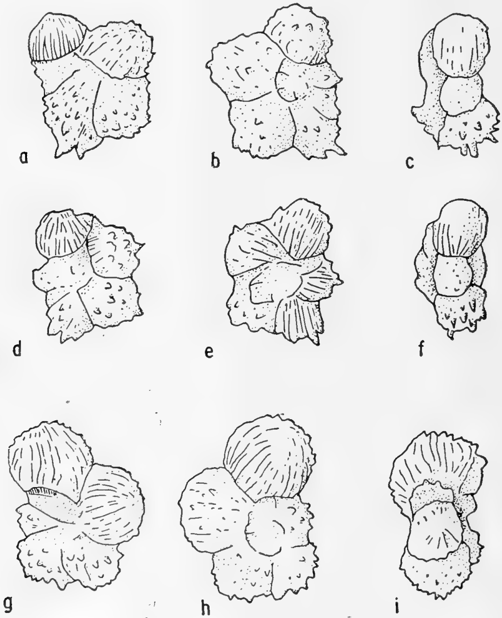
Rugoglobigerina reicheli pustulata n. sp., n. subsp. Plate 2, figs. 7-9
Text figs. 6, 7

Description.—The last whorl of the small to medium-sized low trochoidal test is 5-chambered. The centrally slightly depressed spiral side exhibits about 2 whorls. Due to the rugose surface, details of the initial stage could not be observed. The chambers are subglobular throughout the last whorl, the earlier ones occasionally provided with large spicules. The chambers increase in size as added. The end



Text fig. 6. *Rugoglobigerina reicheli pustulata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views. (k,l,m) Same specimen, umbilical, spiral and apertural views.

chamber, however, can be smaller than the penultimate one and usually is clearly displaced toward the umbilicus. Such size reduction and displacement appear to be typical features of the Rugoglobigerinas. The end chamber is distinctly truncate at the apertural side. The sutures are depressed and straight. The circular umbilicus is deep and usually filled with matrix. Remains of a covering plate were observed along the truncate edges of the chambers. The large, semicircular aperture of the end chamber opens into the umbilicus. The apertures of the preceding chambers are not known. The walls appear to be



Text fig. 7. *Rugoglobigerina reicheli pustulata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views.

thick, and the surface is coarsely rugose, especially in the early stages. The ornamentation of the last chambers exhibits the characteristic meridional pattern. All the investigated specimens are dextrally coiling.

Dimensions.—The maximum diameter of paratypes varies from 0.275 mm. to 0.375 mm.

Holotype.—*Rugoglobigerina* (*Rugoglobigerina*) *reicheli pustulata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. Plate 2, figs. 7-9. Maximum diameter 0.35 mm. End chamber: radial diameter 0.125 mm.; tangential diameter 0.175 mm.; thickness 0.20 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—*Globotruncana mayaroensis* zone. Abundant.

Remarks.—The subspecies *pustulata* is a completely *Globigerina*-like form and therefore can be distinguished without difficulty from the spinose subspecies *reicheli* and from the asteroid species of the subgenus *Plummerella*. It is separated from the related Rugoglobigerinas by the number of chambers in the last whorl, by the less developed meridional ornamentation, and by the much smaller size.

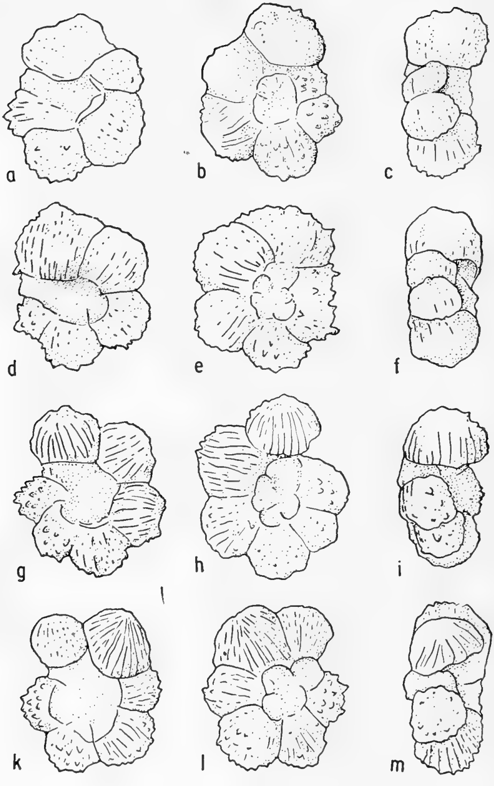
Rugoglobigerina reicheli hexacamerata n. sp., n. subsp. Plate 2, figs. 10-12
Text fig. 8

(?)*Globigerinella aspera* (Ehrenberg), Cushman, 1931, Cushman Lab. Foram. Res., Contrib., 7: pp. 44-45, pl. 6, figs. 5a-b.
(?)*Globigerina cretacea* d'Orbigny, Cushman, 1931, Cushman Lab. Foram. Res., Contrib., 7: p. 44, pl. 6, figs. 6a-c.

Description.—The small to medium-sized test is a low trochoidal spiral with 6 chambers in the adult. The umbilical side, characterized by a very large, deep, almost circular umbilicus, exhibits fragments of the covering plate along the truncate edges of the chambers. The slightly depressed spiral side shows about 2 whorls. The well-separated subglobular and truncate chambers increase rather slowly in size. The end chamber can be smaller than the penultimate one and is frequently displaced toward the umbilical side. The deep sutures are straight and occasionally slightly curved. The arcuate aperture of the end chamber is large and apparently provided with a minute liplike projection. Those of the preceding chambers are not known. The walls are thick, and the surface is coarsely rugose. The surface of about two-thirds of the chambers of the last volution shows the meridional pattern, whereas that of the earlier chambers is irregularly hispid. Only dextrally coiling individuals were counted.

Dimensions.—The maximum diameter of paratypes varies from 0.35 mm. to 0.375 mm.

Holotype.—*Rugoglobigerina reicheli hexacamerata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. Plate 2, figs. 10-12. Maximum



Text fig. 8. *Rugoglobigerina reicheli hexacamerata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views. (k,l,m) Same specimen, umbilical, spiral and apertural views.

diameter 0.375 mm. Diameter of umbilicus 0.125 mm. End chamber: radial diameter 0.115 mm.; tangential diameter 0.15 mm.; thickness 0.175 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—*Globotruncana mayaroensis* zone. Abundant. Possibly also in *Globotruncana gansseri* zone.

Remarks.—The subspecies *hexacamerata* and *pustulata* are so closely related that at first they were lumped together. The more detailed investigation proved that the two types can be separated, not only on account of the difference in the number of adult chambers but also by the large, subcircular umbilicus and by the predominant meridional ornamentation in the last whorl of *R. reicheli hexacamerata.* From the morphologically similar subspecies *pennyi* of the *rugosa* group (0.4-0.425 mm.), it is separated by the smaller size and the more delicate ornamentation.

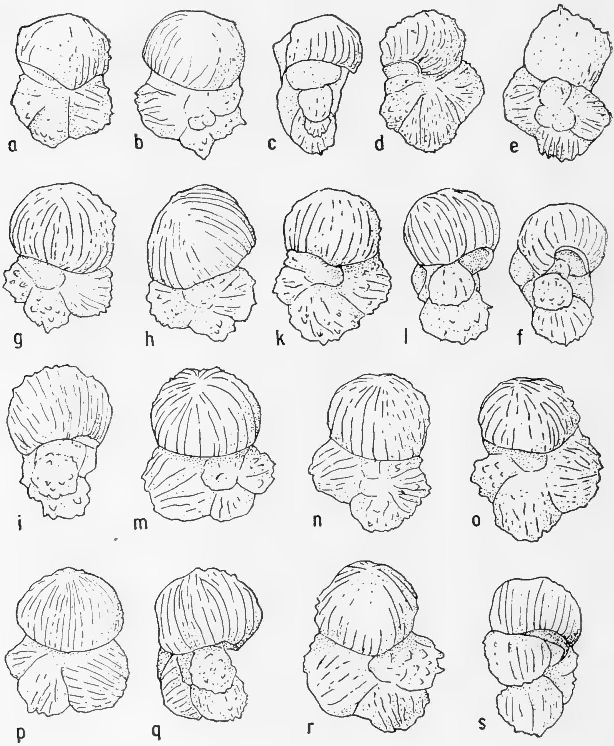
Rugoglobigerina macrocephala macrocephala n. sp., n. subsp.

Plate 2, figs. 1-3
Text fig. 9

Description.—The small to medium-sized trochoidal test is 4 to 5-chambered in the adult. The rather small and deep umbilicus is filled with matrix and no signs of a covering plate were observed. The spiral side is centrally depressed and shows in well-preserved specimens about 2 whorls. The subglobular chambers are truncate toward the umbilicus and increase rapidly in size as added. The peripherally somewhat flattened end chamber is much larger than the penultimate one, and in many individuals equals the whole preceding spiral in size. The straight sutures are well developed in the adult stage. The large semicircular aperture of the end chamber is provided with a minute liplike border and opens into the umbilicus. The apertures of the preceding chambers are not visible. The walls are thick and the surface is rugose. The ornamentation of the early chambers is irregular and coarsely hispid whereas the 2 last-formed chambers show the meridional pattern. The rugosities are delicate and composed of numerous fine continuous and discontinuous ridges. All the investigated individuals are dextrally coiling.

Dimensions.—The maximum diameter of paratypes ranges from 0.275 mm. to 0.35 mm.

Holotype. — *Rugoglobigerina* (*Rugoglobigerina*) *macrocephala macrocephala* Bronnimann. T. L. L. Cat. Nos. 155591-155594. Plate 2, figs. 1-3. Maximum diameter 0.325 mm. Diameter of aperture 0.1 mm. End chambers: radial diameter 0.175 mm.; tangential diameter 0.25 mm.; thickness 0.225 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.



Text fig. 9. *Rugoglobigerina macrocephala macrocephala* Bronnimann. T.L.L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views. (k,l,m) Same specimen, umbilical, spiral and apertural views. (n-s) Views of 6 different specimens.

Occurrence.— *Globotruncana mayaroensis* zone. Abundant. *Globotruncana lapparenti, s. l.* zone. Rare.

Remarks.—This subspecies is the central form of the *macrocephala* group, typified by the large-sized end chamber. It is distinguished from the subspecies *ornata* by the relatively small test and by the coarsely and irregularly ornamented early chambers of the last volution. Only the 2 last chambers carry the meridional pattern.

Rugoglobigerina macrocephala ornata n. sp., n. subsp. Plate 2, figs. 4-6
Text fig. 10

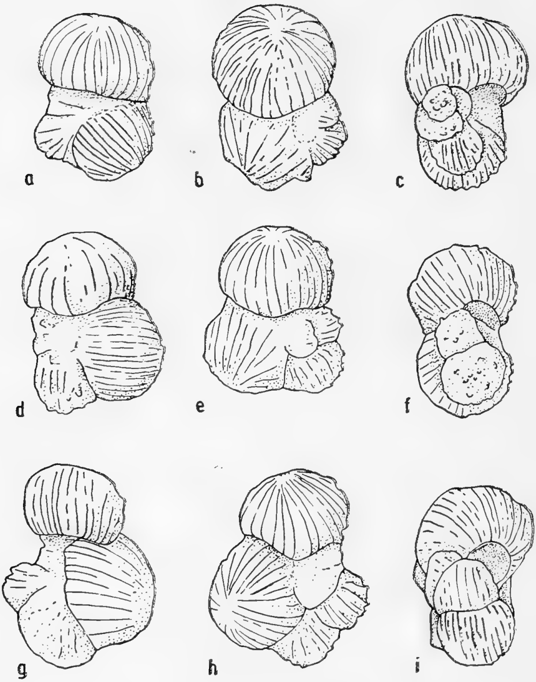
Description.—The relatively large trochoidal test is, as a rule, 4-chambered in the adult. The deep and small umbilicus is invariably filled with matrix and only remains of the covering plate were observed. The slightly depressed spiral side exhibits about 2 whorls. The truncate and peripherally rounded chambers increase rapidly in size. The end chamber is occasionally smaller than the penultimate one (compare the descriptions of the *reicheli* group). The sutures between the chambers of the adult are deep and straight, those of the initial portion indistinct. The large, semicircular aperture of the end chamber is provided with minute liplike borders and opens into the umbilicus. The walls are thick. The irregular arrangement of the rugosities is confined to the innermost chambers. The 4 last chambers show in general the meridional pattern. The specimens are invariably dextrally coiling.

Dimensions.—The maximum diameter of paratypes measures from 0.325 mm. to 0.4 mm.

Holotype.—*Rugoglobigerina* (*Rugoglobigerina*) *macrocephala ornata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. Plate 2, figs. 4-6. Maximum diameter 0.35 mm. End chambers: radial diameter 0.15 mm.; tangential diameter 0.25 mm.; thickness 0.225 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—*Globotruncana mayaroensis* zone. Abundant. *Globotruncana lapparenti, s. l.* zone. Rare.

Remarks.—The subspecies *ornata* is similar to *macrocephala,* but rather constant differences in size and development of the meridional pattern justify separate subspecies. The test of *ornata* is larger than that of *macrocephala,* and in addition shows a more pronounced meridional pattern in the adult. It occupies an intermediate position between the *macrocephala* and the *rugosa* groups.



Text fig. 10. *Rugoglobigerina macrocephala ornata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views.

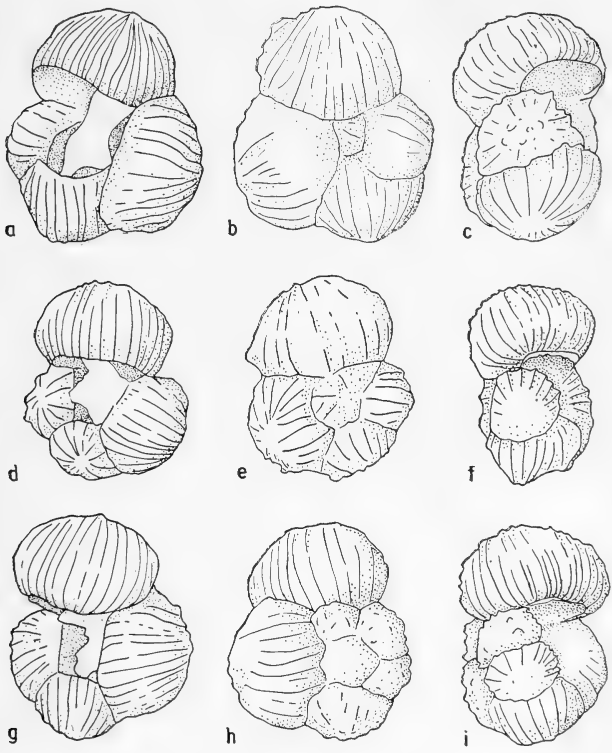
Rugoglobigerina rugosa rugosa (Plummer) 1926 Text figs. 11, 12, 13

Globigerina rugosa Plummer, 1926, Univ. Texas, Bull. 2644, pp. 38-39, pl. 2, figs 10a-d; Loetterle, 1937, Nebraska Geol. Survey, Bull. 12.

(?) *Globigerina cretacea* d'Orbigny, Young, 1951, Jour. Paleont., 25(1): pp. 65-66, pl. 14, figs. 1-3.

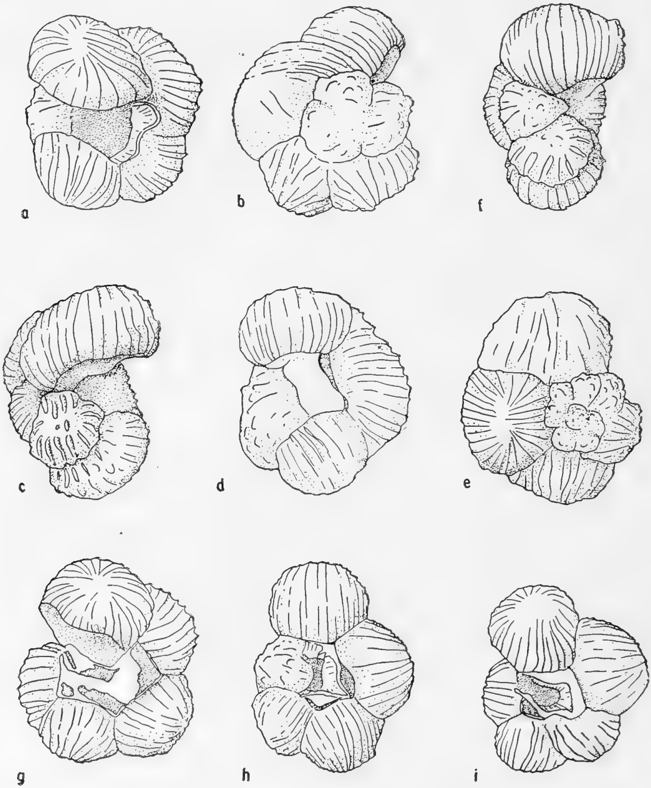
(?) *Globigerina cretacea* d'Orbigny var. *esnehensis* Nakkady, 1950, ibid., 24(6): p. 689, pl. 90, figs. 14-16.

Description.—The large low trochoidal test is 4-, 5-, and 6-chambered in the adult. The chambers of the last volution are truncate toward the aperture, rounded at the peripheral side, and increase moderately in size as added. The end chamber is displaced toward

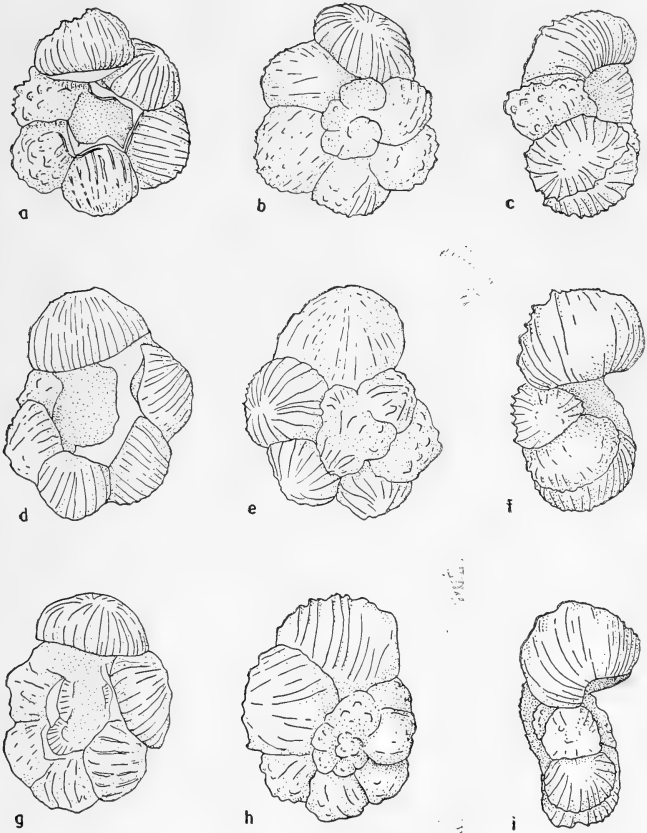


Text fig. 11 (all 4, 5-chambered specimens). *Rugoglobigerina rugosa rugosa* (Plummer). T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views.

the umbilical side and occasionally smaller in size than the penultimate one. The spiral side shows about 2 whorls. Due to the coarse rugosities no information can be given regarding the arrangement



Text fig. 12 (5-chambered specimens). *Rugoglobigerina rugosa rugosa* (Plummer). T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 65. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g-i) Umbilical views 3 different specimens.



Text fig. 13 (6-chambered specimens). *Rugoglobigerina rugosa rugosa* (Plummer). T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 65. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views.

of the innermost portion which is occasionally slightly depressed. The subcircular umbilicus is large and deep, and in well-preserved individuals is covered by a delicate plate with irregular openings. As a rule, only fragments of this covering plate are preserved. The sutures are deep, well marked, straight on the umbilical side, and straight to curved on the spiral side. The large, semicircular apertures are provided with minute liplike projections. The apertures are directed into the umbilicus. The surface of the adult chambers is ornamented by coarse rugosities, arranged in the meridional pattern. The early ontogenetic chambers are irregularly rugose. The meridionally arranged ridges and spines are much coarser than in the *macrocephala* and *reicheli* groups. Only dextrally coiling individuals were counted.

Dimensions.—The maximum diameter of the tests ranges from 0.4 mm. to 0.575 mm.

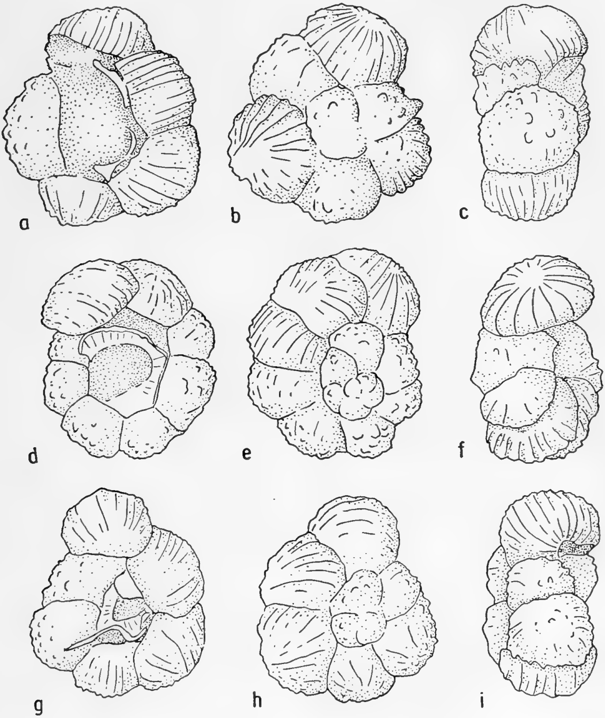
Lectotype (here designated).—*Globigerina rugosa* Plummer 1926 Univ. Texas, Bull. 2644, pl. 2, fig. 10a, Navarro clay, Walker Creek, Cameron, Milam Co., Texas.

Occurrence. — *Globotruncana mayaroënsis* zone. Abundant. *Globotruncana lapparenti, s. l.* zone. Rare.

Remarks.—The central type and the related subspecies of the *rugosa* group can readily be distinguished from the similar 5- and 6-chambered forms of the *reicheli* group by the larger tests and the stronger rugosities. The 4-chambered tests display affinities to the likewise 4-chambered *R. macrocephala ornata,* and it appears that the smaller and not so coarsely rugose *macrocephala* group is related to the large and strongly ornamented *rugosa* group. The subspecies *rugosa* is separated from *rotundata* by the difference in the development of the adult chambers, the large, subcircular umbilicus, and the less spherical test. The 6-chambered forms differ from the related *pennyi* by the larger test and stronger increase in size of the chambers.

Mrs. H. J. Plummer figured and described specimens of *R. rugosa rugosa* (1926, pp. 38-39, pl. 2, figs. 10a-d) from the Upper Cretaceous Navarro clay, bank of Walker Creek, 6 miles N. 15° E. of Cameron, Milam Co., Texas, about 5 feet below Midway greensand, which perfectly agree in size and ornamentation with the specimens described from the Trinidad Cretaceous.

It is also possible that Nakkady's new variety of *G. cretacea* (1950, p. 689, pl. 90, figs. 14-16) from the "top shale" and Lower Eocene samples of Abu Durba, the Lower Eocene of Wadi Danili, and from a "lower zone" and the Lower Eocene of Gebel Duwi has to be assigned to the genus *Rugoglobigerina.* Nakkady's description and figures unfortunately are not adequate, and the original material will have to be checked in order to decide the validity of Nakkady's determination.



Text fig. 14. *Rugoglobigerina rugosa pennyi* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views.

Rugoglobigerina rugosa pennyi n. sp., n. subsp. Plate 4, figs. 1-3
Text fig. 14

Description.—The test is of intermediate size, between the forms of the *reicheli* group and the typical representatives of *rugosa*. The chambers are arranged in a low trochoidal spire of about 2 whorls. The spiral side is slightly depressed. The last volution comprises 6 to 7 chambers, which do not, or only very slowly, increase in size. The chambers are truncate at the apertural side and rounded peripherally. The subcircular umbilicus is large and deep, and covered with a frail plate, usually only preserved in fragments along the apertural edges. The large, arcuate apertures open into the umbilicus and seem to be provided with minute liplike borders. The sutures are well defined and fairly deep on the umbilical side. The surface shows strong rugosities which in the last volution are arranged in the meridional pattern.

Dimensions.—The maximum diameter of the paratypes ranges from 0.4 mm. to 0.425 mm.

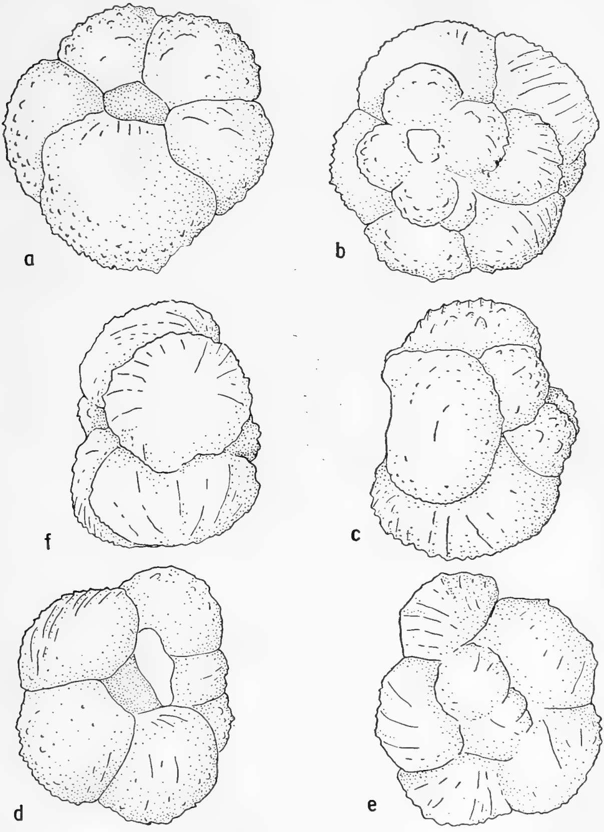
Holotype.—*Rugoglobigerina* (*Rugoglobigerina*) *rugosa pennyi* Bronnimann. T. L. L. Cat. Nos. 155591-155594. Plate 4, figs. 1-3. Maximum diameter 0.4 mm. Diameter of umbilicus 0.15 mm. End chamber: radial diameter 0.125 mm.; tangential diameter 0.175 mm.; thickness 0.125 mm. *Globotruncana mayaroensis* zone. Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—*Globotruncana mayaroensis* zone. Common.

Remarks.—This subspecies is related to the 4 to 6-chambered *rugosa,* but can be separated on account of the smaller average size (0.4-0.425 mm. against 0.4-0.57 mm.), the 6 to 7 chambers of the last volution, their less marked increase in size, and the much larger umbilicus. It is named for F. W. Penny who extensively developed the use of Foraminifera in correlation and in mapping the marine Tertiary clays of the southern part of Trinidad in the early Twenties.

Rugoglobigerina rugosa rotundata n. sp., n. subsp. Plate 4, figs. 7-9
Text figs. 15, 16

Description.—The large, occasionally subspherical test starts with a low, trochoidal spiral which is followed in the adult by a somewhat higher volution with 5 to 6 chambers increasing little in size. The chambers of the last whorl are truncate at the apertural side, rounded at the periphery and much elongated in axial direction. The spiral side with about 2 whorls is usually slightly depressed. The aperture, as seen in the end chamber, is large, arcuate, and opens into the deep and narrow umbilicus. The covering plate seems to be absent. The deep sutures are straight on the umbilical side, and straight to slightly curved on the spiral side. The surface is ornamented by numerous coarse pustules and small ridges arranged in an indistinct meridional



Text fig. 15. *Rugoglobigerina rugosa rotundata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views.

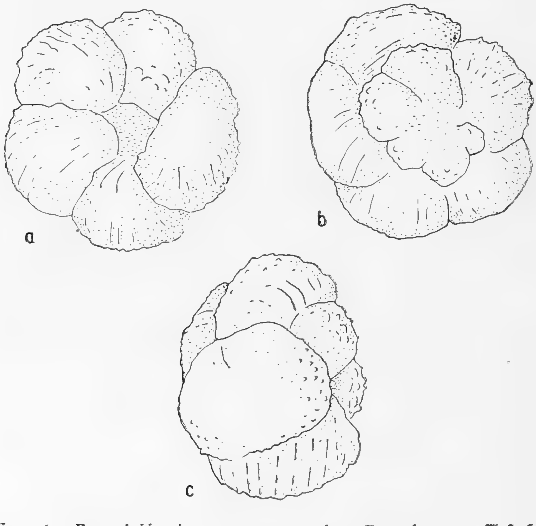
pattern. All the investigated specimens are dextrally coiling.

Dimensions.—The maximum diameter of the paratypes is from 0.5 mm. to 0.55 mm.

Holotype.—*Rugoglobigerina* (*Rugoglobigerina*) *rugosa rotundata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. Plate 4, figs. 7-9. Maximum diameter 0.5 mm. End chamber: radial diameter 0.175 mm.; tangential diameter 0.275 mm.; thickness 0.375 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection U. S. National Museum, Washington, D. C.

Occurrence.—*Globotruncana mayaroensis* zone. Common.

Remarks.—The rather irregular, occasionally almost subglobular test with the large, axially elongated chambers of the last volution, and the deep and small umbilicus, differentiate this subspecies from other Rugoglobigerinas. In addition, the ornamentation is not so clearly developed in a meridional pattern as observed in typical representatives of the *rugosa* group. It is believed that *R. rugosa rotundata* is an offshoot of the *rugosa* group.



Text fig. 16. *Rugoglobigerina rugosa rotundata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views.

Subgenus **PLUMMERELLA** n. subgen.

Diagnosis.—Test small, *Hantkenina*-like, almost planispiral to distinctly trochoidal, generally only last whorl visible. Chambers increasing in size as added, compressed in early portion of last volution, slightly to much inflated in the adult. Spines in axial position of the chambers, present throughout the last whorl or restricted to early chambers. Sutures straight, shallow, but clearly marked. Umbilicus developed in trochoidal species, probably with covering plate. Aperture unknown, in analogy to the related forms probably rounded and large, leading into the umbilicus. Wall thick and surface ornamented by minute spines and ridges, either irregularly distributed or arranged in rows radiating from a central point on the surface toward the apertural face (meridional pattern).

Subgenerotype.—*Rugoglobigerina* (*Plummerella*) *hantkeninoides hantkeninoides* Bronnimann. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I.

Remarks.—This remarkable subgenus of *Rugoglobigerina* consists at present of one species split into 3 well-defined and easily distinguishable but closely related subspecies; *P. hantkeninoides hantkeninoides* (subgenerotype), *P. hantkeninoides costata*, and *P. hantkeninoides inflata*. *Plummerella* differs from the Tertiary genus *Hantkenina* Cushman 1924, to which it displays certain similarities, by the slightly to distinctly trochoidal adult stage and by the rugose surface showing a radiating structure at least in the more trochoidal representatives. From the Upper Cretaceous hantkeninoid genus, *Schackoina* Thalmann 1932, the new subgenus differs by the general form of the test, which in *Schackoina* is almost planispiral and involute in the adult, by the development of the spines, and by the ornamentation. (Cushman, 1946; Reichel, 1947.)

The subgenus is named after the late Mrs. Helen Jeanne Plummer who for the first time drew the attention of micropaleontologists to the ornate Upper Cretaceous Globigerinas.

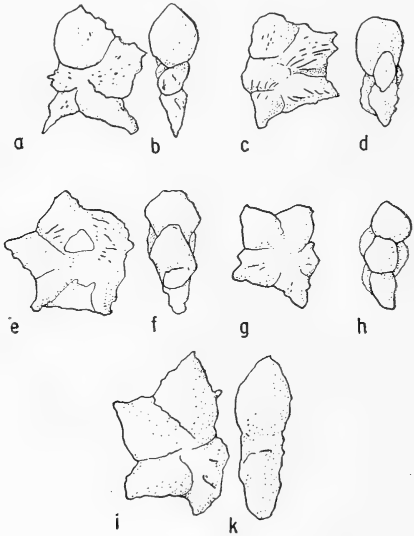
Occurrence.—*Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I.

Plummerella hantkeninoides hantkeninoides n. sp., n. subsp.

Plate 3, figs. 1-3
Text fig. 17

Description.—The delicate asteroid test resembles the Middle Eocene *Hantkenina* (*Aragonella*) *mexicana* Cushman 1925. Only the last 5-chambered volution is visible. The chambers are arranged in an indistinct trochoidal spiral. The peripherally well-separated chambers are compressed, except the end chamber which in some individuals is slightly inflate. The chambers are radially elongate and possess throughout the last whorl axially situated spines. The angles between the spines measure on the average 70°-80°. In general the spines of the last chambers are smaller than those of the earlier ones. It is possible that this feature becomes obsolete in the course of the ontogenetic development. The umbilicus is indistinct, and the central areas are, on both sides masked by matrix. The sutures are straight, shallow, but clearly defined. The aperture is not known. The walls appear to be thick. The surface is rugose, and, in a few specimens, even a kind of linear pattern can be observed. Due to the indistinct trochoidal spiral the direction of coiling can not be determined.

Dimensions.—The maximum diameter of the tests, including the spines, varies from 0.25 mm. to 0.35 mm.



Text fig. 17. *Plummerella hantkeninoides hantkeninoides* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone. Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b) Same specimen, lateral and apertural views. Holotype. (c,d) Same specimen, lateral and apertural views. (e,f) Same specimen, lateral and apertural views. (g,h) Same specimen, lateral and apertural views. (i,k) Same specimen, lateral and apertural views.

Holotype.—Rugoglobigerina (*Plummerella*) *hantkeninoides hantkeninoides* Bronnimann. T. L. L. Cat. Nos. 155591-155594. Text fig. 17a,b. All appr. × 80. Plate 3, figs. 1-3. Maximum diameter 0.370 mm. Radial diameter of spinose chambers 0.1-0.125 mm. Thickness of end chamber 0.085 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—Only found in the *Globotruncana mayaroensis* zone. Scarce.

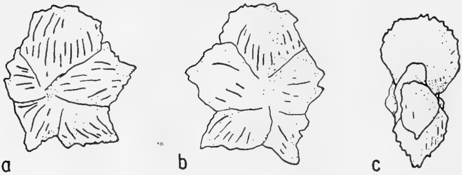
Remarks.—This species is named after its *Hantkenina*-like outline. It differs from the related forms by the faint trochoidal test, by the 5 laterally compressed spinose chambers, and by the only slightly inflated end chamber.

Plummerella hantkeninoides costata n. sp., n. subsp. Plate 3, figs. 4-6
Text fig. 18

Description.—The test is stellate in outline and comprises in the last volution 5 chambers arranged in a depressed trochoidal spiral. The early chambers are slightly, the end chambers strongly, inflated to subglobular. The trochoidal structure is clearly visible from the frontal side. The peripherally well-separated chambers, except the end chamber, are elongate in radial direction into roughly axially situated points, which correspond to the spines of the central type *hantkeninoides hantkeninoides*. The end chamber does not possess a spine, thus indicating that this feature disappears in the course of the ontogeny (see remarks on the occurrence in spines in *P. hantkeninoides hantkeninoides*). The spines are separated by angles of 70°-80°. The rather shallow umbilicus is not well defined and is filled with matrix. No details are visible on the spiral side. The straight sutures are deep and clearly marked. The aperture is large, semicircular and opens into the umbilicus. The walls seem to be thick and the surface is strongly rugose; the individual ridges and spines—at least of the end chambers—radiate from a central point on the surface. The strong ornamentation of the early chambers of the last volution is irregular. The only well-preserved specimen is coiling to the right hand side.

Holotype.—Rugoglobigerina (*Plummerella*) *hantkeninoides costata* Bronnimann, T. L. L. Cat. Nos. 155591-155594. Text figs. 18a,b,c. Plate 3, figs. 4-6. Maximum diameter 0.35 mm. Radial diameter of first spinose chambers 0.15 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—Globotruncana mayaroensis zone. Rare.



Text fig. 18. *Plummerella hantkeninoides costata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. Holotype.

Remarks.—This subspecies is transitional between the central type *hantkeninoides* and the 3-spined, strongly trochoid subspecies *inflata.* It differs from the typical form by the distinct trochoidal tests, by the stronger inflated chambers, and by the complete reduction of the spine of the end chamber. It can be separated from *inflata* by the reduction of the number of spinose chambers to 2 or 3, and by the less inflated end chambers.

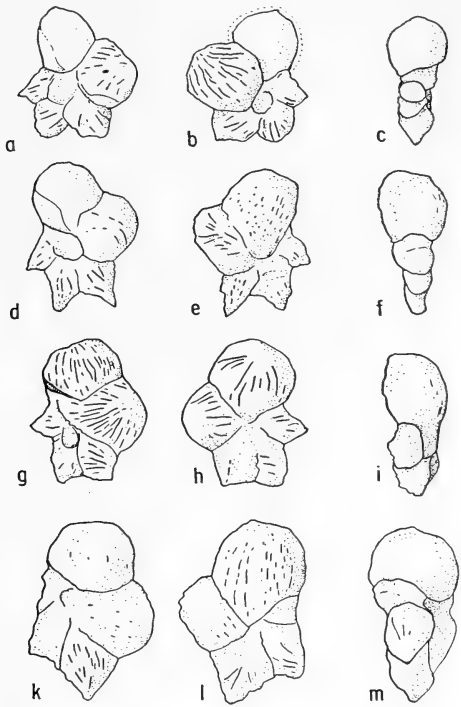
Plummerella hantkeninoides inflata n. sp., n. subsp. Plate 3, figs. 7-9 Text fig. 19

Description.—The small 5-chambered trochoidal test is stellate in its early stage. The spineless adult approaches the *Globigerina* type as represented by the *Rugoglobigerina macrocephala* group. The first 3 chambers are laterally compressed, but not as strongly as in the subspecies *hantkeninoides,* and are provided axially with pointed, occasionally spinelike prolongations. The 2 last-formed chambers are spineless and strongly inflate. The axis of the early spinelike chambers are separated by angles of 50°-60°. The subcircular umbilicus is well defined and generally filled with matrix. No indication of a covering plate was found, but from the general morphology of the test its presence can be expected. The spiral side is masked by matrix. The aperture is arcuate and opens into the umbilicus. The straight sutures are well defined throughout the last whorl. The walls appear to be thick, and the surface is strongly rugose. The ornamentation of the last-formed chambers shows a distinct meridional pattern, radiating from a peripheral pole toward the apertural face. The coarse surface of the spinose chambers is less regular. All the investigated specimens are dextrally coiling.

Dimensions.—The maximum diameter of the paratypes, including the spines, is from 0.275 mm. to 0.375 mm.

Holotype.—*Rugoglobigerina* (*Plummerella*) *hantkeninoides in-*

flata Bronnimann. T. L. L. Cat. Nos. 155591-155594. Text figs. 19d,e,f. All appr. × 80. Plate 3, figs. 7-9. Maximum diameter 0.30 mm. End chambers: radial diameter 0.125 mm.; tangential diameter 0.175 mm.; thickness 0.125 mm. Radial diameter of first spinose chamber 0.10 mm. *Globotruncana mayaroensis* zone, Guayaguayare



Text fig. 19. *Plummerella hantkeninoides inflata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. (d,e,f) Same specimen, umbilical, spiral and apertural views. Holotype. (g,h,i) Same specimen, umbilical, spiral and apertural views. (k,l,m) Same specimen, umbilical, spiral and apertural views.

beds, Maestrichtian, Upper Cretaceous, Trinidad; B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—*Globotruncana mayaroensis* zone. Common.

Remarks.—This distinctly trochoid and strongest inflated subspecies of the *hantkeninoides* group shows only 3 spinose chambers. The new feature, *i. e.*, the subglobular, regularly patterned *Globigerina*-like chamber, becomes the predominant characteristic of the adult test. Although no stratigraphic proof can be offered, it can be assumed that the hantkeninoid chambers are a more primitive feature, superseded in the course of ontogeny by the spineless *Globigerina* chambers. This subspecies, therefore, seems to be more progressive than the others. The subspecies *inflata* can easily be distinguished by the reduced hantkeninoid portion and by the 2 characteristic subglobular end chambers. In addition, the test is considerably more trochoidal. It is of interest to note that the angles between the axis of the *hantkeninoides* chambers are smaller than in the related forms.

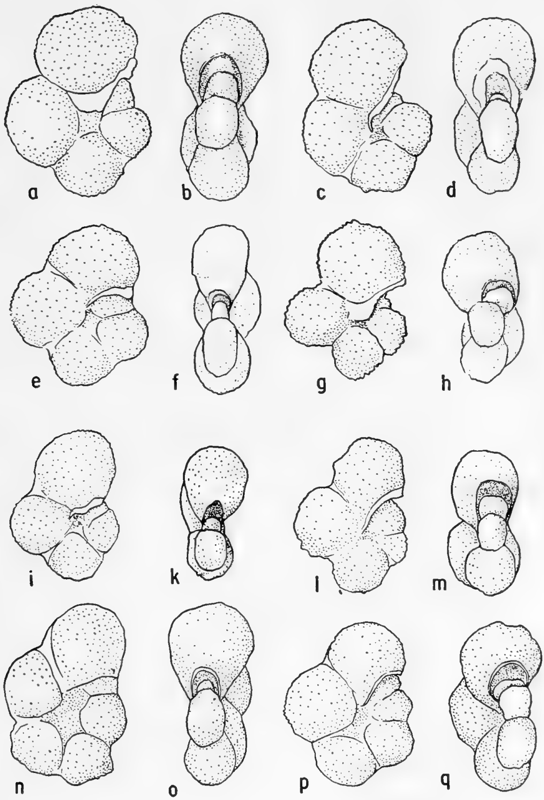
Genus **GLOBIGERINELLA** Cushman 1927

The following, in the adult planispiral Globigerinas, have been assigned to the genus *Globigerinella,* although a few individuals develop occasionally a faint trochoidal arrangement.

Globigerinella messinae messinae n. sp., n. subsp. **Plate 1, figs. 6, 7**
Text fig. 20

Description.—The small and compressed test with its more or less lobate outline is semi-involute and planispiral in the adult though occasionally developing a tendency toward a weak trochoidal spiral. The test throughout is closely coiled. The adult volution comprises 5, rarely 6, chambers. They are peripherally rounded and laterally somewhat compressed, and increase in size rapidly. The outline of the chambers is elongate-ellipsoid in apertural view, and subcircular in umbilical view. The shallow umbilici are partly covered with the prolongations of the delicate liplike projections of the apertural border. In well-preserved individuals they exhibit portions of the early ontogenetic volutions. No details of shape and arrangement of the innermost chambers are recognizable. The straight sutures are deep and well marked. The large arcuate aperture is situated equatorially at the base of the end chamber. The aperture is surrounded with delicate liplike projections extending into the umbilici. The walls appear to be thin and finely perforate. Minute papillae are evenly distributed over the surface. Early chambers are more strongly ornamented.

Dimensions.—The maximum diameter of the paratypes ranges from 0.31 mm. to 0.4 mm.



Text fig. 20. *Globigerinella messinae messinae* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b) Same specimen, umbilical and apertural views. Holotype. (c,d) Same specimen, umbilical and apertural views. (c,f) Same specimen, umbilical and apertural views. (g,h) Same specimen, umbilical and apertural views. (i,k) Same specimen, umbilical and apertural views. (l,m) Same specimen, umbilical and apertural views. (n,o) Same specimen, umbilical and apertural views. (p,q) Same specimen, umbilical and apertural views.

Holotype.—Globigerinella messinae messinae Bronnimann. T. L. L. Cat. Nos. 155591-155594. Text figs. 20a,b. All appr. × 80. Plate 1, figs. 6, 7. Maximum diameter 0.4 mm. End chamber: radial diameter 0.2 mm.; tangential diameter 0.2 mm.; thickness 0.175 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.— Globotruncana mayaroensis zone. Abundant. *Globtruncana lapparenti, s. l.* zone. Rare.

Remarks.—This subspecies is named after Miss A. Messina, co-author of the Catalogue of Foraminifera. It differs from the related forms by the rounded periphery of the chambers. From *Globigerinella voluta* (White), originally described from the Mendez shale and from the base of the Velasco shale, Tampico Embayment area, Mexico (White, M. P., 1928, pp. 197-198, pl. 28, figs. 5a-b) it is distinguished by the much smaller size, the distinctly laterally compressed, finely ornamented chambers, and by the large arcuate aperture with liplike projection, which in *Globigerinella voluta* is "a thin lunate opening in the suture on the margin of the last chamber."

Globigerinella messinae subcarinata n. sp., n. subsp. Plate 1, figs. 10, 11
Text fig. 21

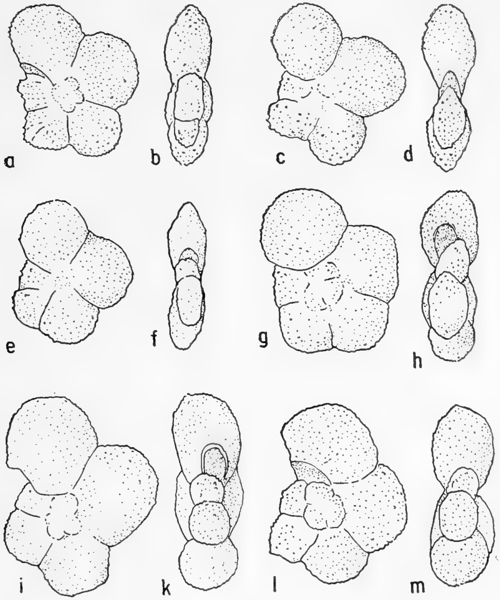
Description.—The small, compressed and planispiral test has a lobate outline. The adult volution is composed of 5, rarely 6, much compressed, subcarinate chambers. The last whorl is semi-involute, exposing in the shallow umbilici parts of the earlier chambers. The chambers are separated by rather deep and straight sutures. The end chamber is occasionally not larger or even smaller than the penultimate one. The outline of the individual chambers is elongate-ellipsoid in apertural and subcircular in lateral view. Early ontogenetic chambers are rounded peripherally, similar to those of the subspecies *messinae.* The large arcuate aperture is situated equatorially at the base of the end chamber and is provided with a delicate, indistinct liplike projection. The walls appear to be thin and finely perforate. Minute papillae are evenly distributed over the surface. The ornamentation is stronger in the early stage of the last volution.

Dimensions.—The maximum diameter of the paratypes varies from 0.3 mm. to 0.4 mm.

Holotype.— Globigerinella messinae subcarinata Bronnimann. T. L. L. Cat. Nos. 155591-155594. Text figs. 21a,b. All appr. × 80. Plate 1, figs. 10, 11. Maximum diameter 0.35 mm. End chamber: radial diameter 0.15 mm.; tangential diameter 0.15 mm.; thickness 0.10 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—Globotruncana mayaroensis zone. Rather scarce.

Remarks.—The subspecies *subcarinata* is closely related to *messinae* and transitional forms are difficult to assign. Most of the tests however can be classified without difficulty. As a rule, *subcarinata* is more compressed, coarser ornamented and stronger evolute than the non-carinate central type. In addition the liplike projection is better developed in *messinae* than in *subcarinata*. Early ontogenetic stages of the 2 subspecies are almost identical.



Text fig. 21. *Globigerinella messinae subcarinata* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b) Same specimen, umbilical and apertural views. Holotype. (c,d) Same specimen, umbilical and apertural views. (e,f) Same specimen, umbilical and apertural views. (g,h) Same specimen, umbilical and apertural views. (i,k) Same specimen, umbilical and apertural views. (l,m) Same specimen, umbilical and apertural views.

Globigerinella escheri escheri (Kaufmann) 1865 Text figs. 22, 23

Nonionina escheri Kaufmann, 1865, in Heer, Die Urwelt der Schweiz, p. 198, text fig. 110a.
Globigerina aspera (Ehrenberg), Franke, 1928, Preuss. geol. Landesanst., Abh., n. f., Heft 111, p. 192, pl. 18, figs. 10a-c.
Globigerinella aspera (Ehrenberg), Carman, 1929, Jour. Paleont., 3(3): p. 315, pl. 34, fig. 6.

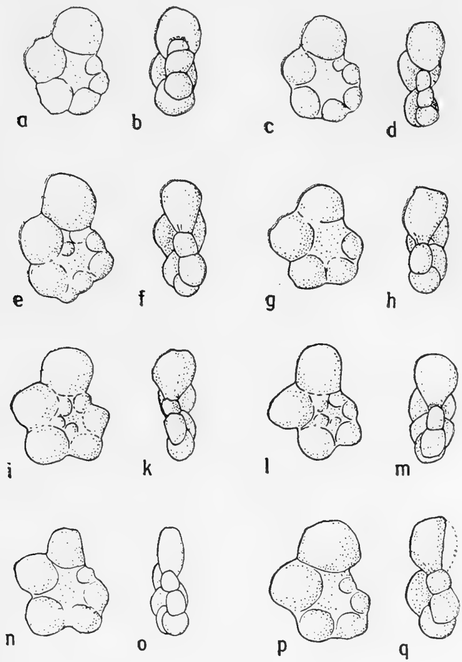
Description.—The relatively small, more or less lobulate and slightly compressed test is planispiral in the adult. It is possible that the early ontogenetic chambers are arranged in a weak trochoidal spiral. The adult spiral is semi-involute to almost evolute. The last volution is 6-chambered as a rule, but specimens with 5 and 7 chambers were also recorded. The chambers are subglobular in early stages, later laterally compressed, and increase slowly in size as added. The end chamber is larger than the penultimate one, but not predominant in size, and somewhat elongate. The outlines of the chambers are elongate-ellipsoid in apertural view, and subcircular in lateral view. The umbilici are shallow, and, due to adhering matrix, details of the early portion of the test can be seen only exceptionally. The sutures are straight, broad and deep. The low-arcuate apertures of the end chambers are basal and equatorial. No lips or liplike projections were observed. The walls are thin and finely perforate. The surface is smooth.

Dimensions.—The maximum diameter of the test ranges from 0.225 mm. to 0.275 mm.

Lectotype (*here designated*).—*Nonionina escheri* Kaufmann. 1865, *in* Heer, O., Die Urwelt der Schweiz, p. 108, text fig. 110a, F. Schulthess, Zurich. Upper Cretaceous.

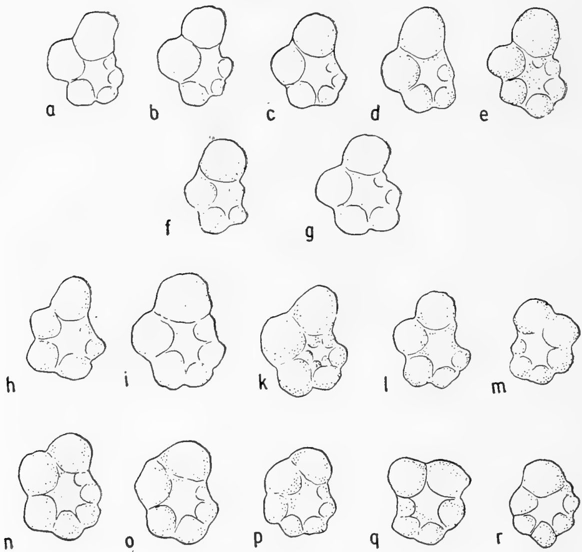
Occurrence.—*Globotruncana lapparenti, s. l.* zone. Common to abundant.

Remarks.—*Nonionina escheri* Kaufmann, 1865, was originally reported from the Upper Cretaceous Seewerkalk of Switzerland (Seewen and Gersau) and from the White Chalk of England. According to Bolli (1944, p. 275-277) the Seewerkalk comprises at the locality of Seewen top Cenomanian and Turonian-Senonian, characterized by *Globotruncana apenninica, Globotruncana stefani, Globotruncana o. renzi* (Cenomanian-Lower Turonian) and by *Globotruncana helvetica, Globotruncana lapparenti inflata, Globotruncana lapparenti lapparenti, Globotruncana lapparenti bulloides, Globotruncana lapparenti tricarinata, Globotruncana lapparenti coronata,* and *Globotruncana globigerinoides* (Turonian-Senonian). Although the specimens described and figured by Kaufmann are slightly smaller than the average individuals from the Upper Cretaceous of Trinidad, their characteristics agree perfectly. The 5 to 6-sided "first chamber" of Kaufmann obviously represents the umbilical area which also in the Trinidad specimens is 5 to 6-sided. The much larger *Globigerinella*



Text fig. 22. *Globigerinella escheri escheri* (Kaufmann). T. L. L. Cat. Nos. 167518, 167519. *Globotruncana lapparenti, s. l.* zone, Upper Cretaceous. All appr. × 80. (a,b) Same specimen, umbilical and apertural views. (c,d) Same specimen, umbilical and apertural views. (e,f) Same specimen, umbilical and apertural views. (g,h) Same specimen, umbilical and apertural views. (i,k) Same specimen, umbilical and apertural views. (l,m) Same specimen, in umbilical and apertural views. (n,o) Same specimen, umbilical and apertural views. (p,q) Same specimen, umbilical and apertural views.

voluta (White, 1928, p. 197, pl. 28, figs. 5a,b) with almost globular chambers is considered to represent a different species. This however should be checked with the original material. *Globigerinella messinae messinae* and the subspecies *subcarinata* differ from *Globigerinella escheri escheri* by the larger size, by the more involute and compressed test, and by the high arcuate basal aperture with liplike projections.



Text fig. 23. *Globigerinella escheri escheri* (Kaufmann). T. L. L. Cat. Nos. 167518, 167519. *Globotruncana lapparenti* s. l. zone, Upper Cretaceous. All appr. × 80. 17 different individuals in umbilical view.

Globigerinella escheri escheri is closely related to the subspecies *clavata*. Transitional forms between the two subspecies are common. Typical representatives of the much scarcer *clavata* with its peculiar prolongation of the end chamber, however, can be determined without difficulty.

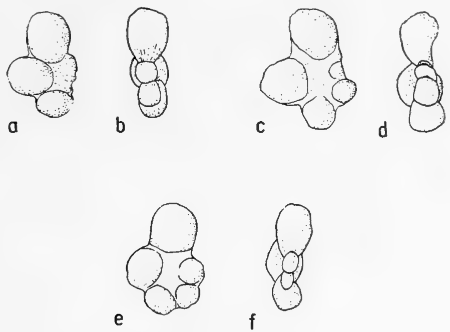
Rotalia aspera Ehrenberg (1854, figs. 28, 42, 44, 57, 58) may in part possibly represent species of Upper Cretaceous Globigerinellas. Ehrenberg's description and figures, however, are considered to be inadequate, and the name *aspera*, therefore, should not be used, unless Ehrenberg's material has been revised and a lectotype has been designated. *Globigerinella aspera* (Carman, 1929, p. 315, pl. 34, fig. 6) from the Niobrara formation of Wyoming, belongs to *Globigerinella escheri escheri*. Also *Globigerina aspera* (Ehrenberg), reported by Franke (1928, p. 192, pl. 18, figs. 10a-c) from various Turonian-

Senonian localities of Germany, appears to be identical with Kaufmann's species.

Globigerinella aspera (Ehrenberg) from the Upper Cretaceous White Chalk found as imported material in Antigua (Cushman, 1931, pp. 44-45, pl. 6, figs. 5a-b) may be a low trochoidal *Rugoglobigerina* (*see* p. 13 of the present paper).

Globigerinella escheri clavata n. subsp. Plate 1, figs. 12, 13
Text figs. 24, 25, 26

Description.—The test is similar to that of *Globigerinella escheri escheri*, except that the end chamber, occasionally also the penultimate one, is distinctly prolonged in radial direction, thus producing in lateral view a broad ellipsoid, non-tapering outline. Text figure 26 shows a specimen with extremely long and compressed end chamber determined here as *Globigerinella* aff. *escheri clavata.*



Text fig. 24. *Globigerinella escheri clavata* Bronnimann. T. L. L. Cat. Nos. 167518, 167519. *Globotruncana lapparenti, s. l.* zone, Upper Cretaceous. All appr. × 80. (a,b) Same specimen, umbilical and apertural views. (c,d) Same specimen, umbilical and apertural views. (e,f) Same specimen, umbilical and apertural views. **Holotype.** T. L. L. Cat. No. 167518.

Dimensions.—The maximum diameter of the paratypes is from 0.225 mm. to 0.275 mm.

Holotype.—*Globigerinella escheri clavata* Bronnimann. T. L. L. Cat. No. 167518. Text fig. 24e,f. All appr. × 80. Plate 1, figs. 12, 13. Maximum diameter 0.238 mm. End chamber: radial diameter 0.11

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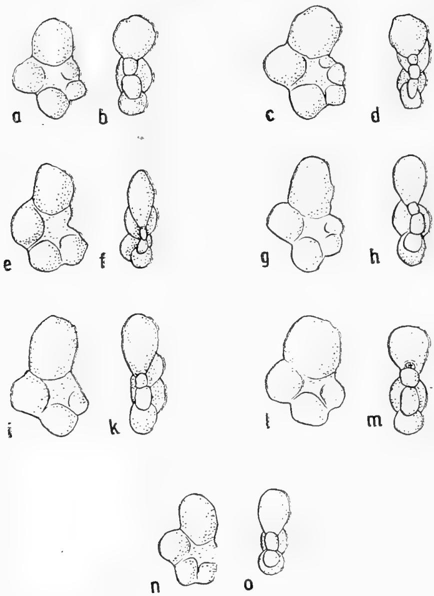
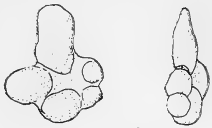


Text fig. 25. *Globigerinella escheri clavata* Bronnimann. T. L. L. Cat. Nos. 167518, 167519. *Globotruncana lapparenti, s. l.* zone, Upper Cretaceous. All appr. × 80. (a,b) Same specimen, umbilical and apertural views. (c,d) Same specimen, umbilical and apertural views. (e,f) Same specimen, umbilical and apertural views. (g,h) Same specimen, umbilical and apertural views. (i,k) Same specimen, in umbilical and apertural views. (l,m) Same specimen, umbilical and apertural views. (n,o) Same specimen, umbilical and apertural views.

mm.; tangential diameter 0.1 mm.; thickness 0.075 mm. Thickness of first chamber of last volution 0.050 mm. *Globotruncana lapparenti, s. l.* zone, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—Globotruncana lapparenti, s. l. zone. Scarce.

Remarks.—The subspecies differs from the central type by the prolongation of the end chamber and by the non-tapering outline in lateral view. *Globigerina subdigitata* (Carman, 1929, p. 315, pl. 34,



a b

Text fig. 26. *Globigerinella* aff. *escheri clavata* Bronnimann. T. L. L. Cat. No. 167518. *Globotruncana lapparenti s. l.* zone, Upper Cretaceous. All appr. × 80. (a) Umbilical; (b) apertural view of same specimen with extremely long end chamber.

fig. 5, non fig. 4), from the Niobrara formation of Wyoming displays affinities to the subspecies *clavata*. The Trinidad specimens, however, have radially and not obliquely arranged chambers.

(?) Globigerinella tururensis n. sp. Plate 1, figs. 4, 5
Text fig. 27

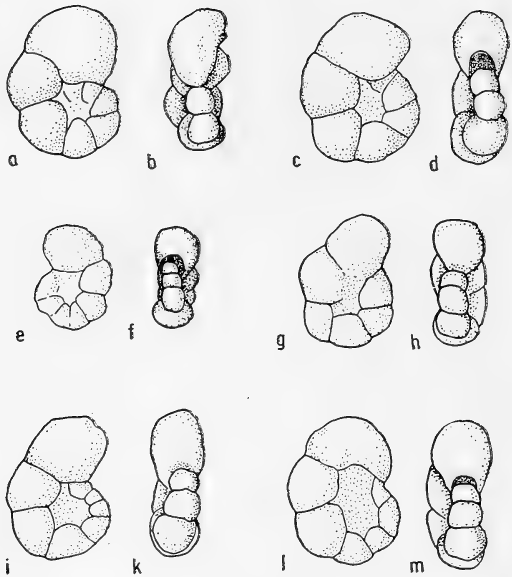
Description.—The general outline of the only slightly compressed and not very lobulate test is ellipsoid. The semi-involute last volution comprises 6 to 7 appressed chambers which are subglobular at first then become distinctly laterally compressed. The chambers increase gradually in size, and the end chamber usually is considerably larger and more compressed than the penultimate one. The large subcircular umbilici are filled with matrix. The distinct sutures are straight but their direction is oblique. The large, low arcuate aperture is apparently situated in the equatorial plane at the base of the end chamber. The walls are thin, finely perforate, and the surface is smooth.

Dimensions.—The maximum diameter of the paratypes is from 0.225 mm. to 0.35 mm.

Holotype.—(?) *Globigerinella tururensis* Bronnimann. T. L. L. Cat. Nos. 144455, 168920. Text figs. 27a,b. All appr. × 80. Plate 1, figs. 4, 5. Maximum diameter 0.325 mm. Diameter of umbilicus 0.075 mm. End chamber: radial diameter 0.16 mm.; tangential diameter 0.20 mm.; thickness 0.125 mm. *Globotruncana apenninica* zone, Gautier formation, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—*Globotruncana apenninica* zone, Gautier formation, Upper Cretaceous. Common.

Remarks.—The generic position of this species is not clear. For the time being it is assigned to *Globigerinella*. At first glance it could be taken as a deformed and compressed *Globigerina gautierensis*, which, however, is ornamented with small pustules, especially on the early



Text fig. 27. (?) *Globigerinella tururensis* Bronnimann. T.L.L. Cat. Nos. 144455, 168920. *Globotruncana apenninica* zone, Gautier formation, Upper Cretaceous. All appr. × 80. (a,b) Same specimen, umbilical and apertural views. Holotype. (c,d) Same specimen, umbilical and apertural views. (e,f) Same specimen, umbilical and apertural views. (g,h) Same specimen, umbilical and apertural views. (i,k) Same specimen, umbilical and apertural views. (l,m) Same specimen, umbilical and apertural views.

chambers of the last volution.

The species is named after the Turure area, E. Central Range where the type locality of the Gautier formation is situated.

Genus **HASTIGERINELLA** Cushman 1927
Subgenus **HASTIGERINOIDES** n. subgen.

Diagnosis.—Test stellate, planispiral in the adult, possibly trochoidal in young stages. Chambers of adult subglobular to subglobular-elongate, broadly rounded at the base, gradually tapering into pointed outer ends. Aperture at base of end chamber, in equatorial plane.

Subgenerotype.—Hastigerinoides alexanderi (Cushman), 1931, Cushman Lab. Foram. Res., Contrib., 7: p. 87, pl. 11, figs. 6-9. Holotype, figures 6a, 6b, and 6c. Road cut between two railroad underpasses near the northern edge of the Town of Howe, Grayson County, Texas. Yellowish, calcareous clay of Austin age, Upper Cretaceous.

Remarks.—The new subgenus *Hastigerinoides* displays affinities to the Middle Eocene genus *Hantkenina* (*Aragonella*), and to the Cretaceous—Recent genus *Hastigerinella.* It differs from the stellate subgenus *Aragonella* by the elongate chambers which are subglobular at the base and uniformly tapering toward pointed outer ends. Spines of *Hantkenina* type, which are separated from the chambers proper, are not developed in *Hastigerinoides. Hastigerinella* Cushman (1948, p. 324) is defined by elongate, club-shaped adult chambers, with spines limited to the outer ends. The adult chambers of *Hastigerinoides*, on the other hand, are pointed, not club-shaped, at the outer end. The difference in the shape of the adult chambers is considered to justify the splitting of the genus *Hastigerinella* Cushman into *Hastigerinella, s. s.,* with club-shaped adult chambers, and *Hastigerinoides* n. subgen. with pointed adult chambers.

Occurrence.—Upper Cretaceous, Trinidad, B. W. I. Upper Cretaceous, Austin chalk, Texas.

Hastigerinoides alexanderi (Cushman) 1931 Text fig. 28

Hastigerinella alexanderi Cushman, 1931, Cushman Lab. Foram. Res., Contrib., 7: p. 87, pl. 11, figs. 6-9.

Description.—The fairly large stellate test is planispiral in the adult and almost involute. The last whorl consists of 5 to 6 chambers which are subglobular at the base (bulbose), elongate, and tapering gradually into pointed ends which as a rule are broken off. The chamber lumina become canal-like toward the outer ends. Spines of the *Hantkenina* type are not developed. In some individuals the early chambers of the last whorl appear to be subglobular. The end chambers are much elongate and laterally slightly compressed. The shallow umbilici are generally concealed by matrix. The straight sutures are well defined and slightly depressed. The aperture is a low arched slit at the base of the end chamber, according to Cushman's description (1931, p. 87) with a very slight lip. The walls appear to be thin and finely perforate. The surface is smooth.

Dimensions.—The maximum diameter of well-preserved tests is from 0.325 mm. to 0.4 mm.

Occurrence.—Globotruncana lapparenti, s. l. zone. Scarce.

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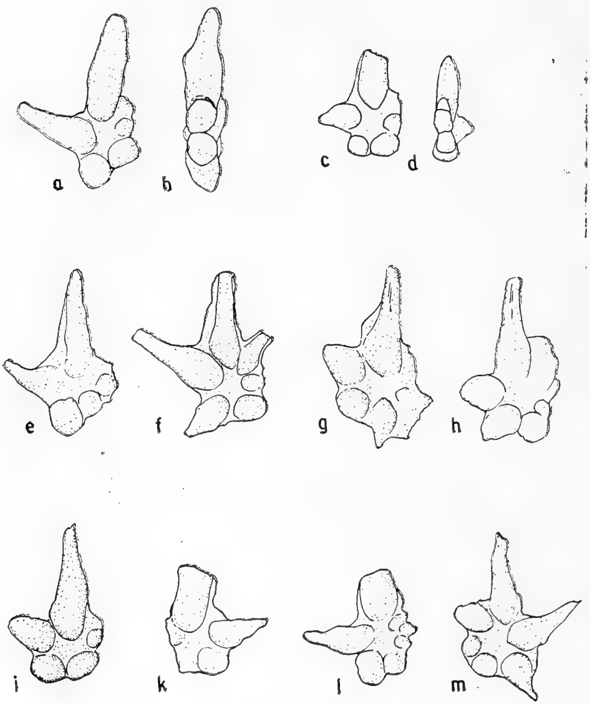
Remarks.—The Trinidad specimens are slightly smaller, but otherwise agree completely with those described by Cushman from the Austin chalk of Texas.



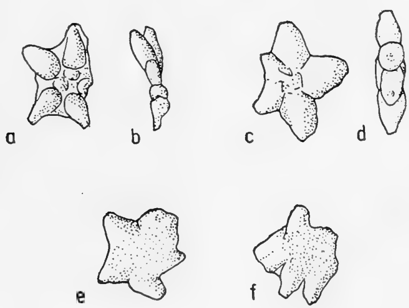
Text fig. 28. *Hastigerinoides alexanderi* (Cushman). T. L. L. Cat. No. 167518. *Globotruncana lapparenti, s. l.* zone, Upper Cretaceous. All appr. × 80. (a,b) Same specimen, umbilical and apertural views. (c,d) Same specimen, umbilical and apertural views. (e-m) 8 different specimens in umbilical view.

Hastigerinoides rohri n. sp. Plate 1, figs. 8, 9
Text fig. 29

Description.—The small and regularly stellate test is planispiral and semi-involute in the adult. It is possible that the early chambers are arranged in a weak trochoidal spiral. The 5 elongate chambers of the adult only slightly increase in size during growth, and not much difference exists between the dimensions of the first and the last chamber of the final volution. The chambers are bulbose at the base and tapering more or less gradually into pointed ends, which as a rule are broken off. The regular stellate arrangement of the adult is a remarkable feature of this species. Deformations of the test are rather common. The shallow umbilici are usually filled with matrix. Traces of subglobular earlier chambers can occasionally be seen. The straight sutures are well defined and not much depressed. The aperture was not clearly seen; it appears to be a low arcuate opening at the base of the end chamber. The walls are thin and finely perforate. The surface is smooth.

Dimensions.—The maximum diameter of the paratypes including the elongate chambers varies from 0.2 mm. to 0.25 mm.

Holotype.—*Hastigerinoides rohri* Bronnimann. T. L. L. Cat. Nos. 144455, 168920. Plate 1, figs. 8, 9. Maximum diameter 0.275 mm. Basal thickness of end chamber 0.075 mm. Thickness of spine 0.030 mm. Radial length of average chamber 0.075 mm. *Globotruncana apenninica* zone, Gautier formation, Upper Cretaceous, Trinidad, B. W. I. Deposited in Cushman Collection, U. S.



Text fig. 29. *Hastigerinoides rohri* Bronnimann. T. L. L. Cat. Nos. 144455, 168920. *Globotruncana apenninica* zone, Gautier formation, Upper Cretaceous. All appr. × 80. (a,b) Same specimen, umbilical and apertural views. (c,d) Same specimen, umbilical and apertural views. (e,f) 2 different specimens in umbilical view.

National Museum, Washington, D. C.

Occurrence.—*Globotruncana apenninica* zone, Gautier formation, Upper Cretaceous. Rare.

Remarks.—This delicate species apparently is a forerunner of *Hastigerinoides alexanderi* (Cushman), from which it differs by the smaller test and by the regular stellate arrangement of the more or less equal-sized and less elongate adult chambers.

This species is named for Dr. K. Rohr in recognition of his outstanding contributions to the geology of Trinidad.

Genus **TRINITELLA** n. gen.

Diagnosis.—Test trochoidal, elongate in direction of end chamber. Chambers truncate at apertural side, increasing in size as added (end chamber about twice the size of the penultimate one), subglobular in major portion of adult whorl, flattened at the spiral side and peripherally keeled in the end stage. Chambers arranged in about 2 whorls, those of the last volution overlapped by the preceding ones. Sutures on the spiral side curved in direction of coiling, those on the umbilical side more or less straight to slightly curved backward. Umbilicus large, subcircular, with fragments of covering plate along truncate edges of chambers. Aperture large, elongate-arcuate, with minute liplike projection leading into the umbilicus. Wall apparently thick, surface coarsely rugose, especially in earlier chambers. Ornamentation suggesting a variant of the meridional pattern of *Rugoglobigerina.*

Generotype.—*Trinitella scotti* Bronnimann. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I.

Remarks.—The new genus *Trinitella* is monotypic and named after Trinidad, B. W. I. It shows affinities to *Rugoglobigerina* through the early *Globigerina*-like portion of the test and to *Globotruncana* through the keeled end chamber, flattened at the spiral side. *Trinitella*, however, does not appear to be directly connected with the highly evolved Globotruncanas of the *Globotruncana mayaroensis* zone (Bolli, 1951) and thus is tentatively regarded to represent an offshoot from *Rugoglobigerina.* The flattened and keeled end stage and the overlapping chambers of the last volution easily distinguish *Trinitella* from *Rugoglobigerina.*

Occurrence.—*Globotruncana mayaroensis* zone. Common. Possibly also *Globotruncana gansseri* zone. Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I.

Trinitella scotti n. sp. Plate 4, figs. 4-6
Text fig. 30

Description.—The trochoidal test is small to medium-sized and elongate in direction of the end chamber. The 5 to 6 chambers of the adult volution are subglobular at first. They then become flattened at the spiral side, forming a keel. These new features pertain to the end chamber, occasionally also to the 2 last ones. The end chamber is about twice as large as the penultimate one and elongate in radial direction. About 2 whorls can be recognized on the spiral side. The slightly depressed initial portion is not clearly exposed, and no information regarding the arrangement of the early chambers can be obtained due to the coarse rugosities or adhering matrix. The umbilicus is large, deep, subcircular, and probably provided with a delicate covering plate. Only fragments of this plate are preserved along the border of the umbilicus. The chambers are truncate toward the apertural side and increase in size as added. Seen from the spiral side, each adult chamber overlaps the next one. The sutures on the spiral side, therefore, are strongly curved in the direction of coiling. Those on the umbilical side are deep and relatively straight to slightly curved backward.

The arcuate apertures open into the umbilicus. The walls seem to be thick, and the surface, especially of the inner chambers, is strongly rugose. The ornamentation appears to be of the meridional pattern, although no central point was noted on the surface of the end chamber.

The counted individuals are invariably dextrally coiling.

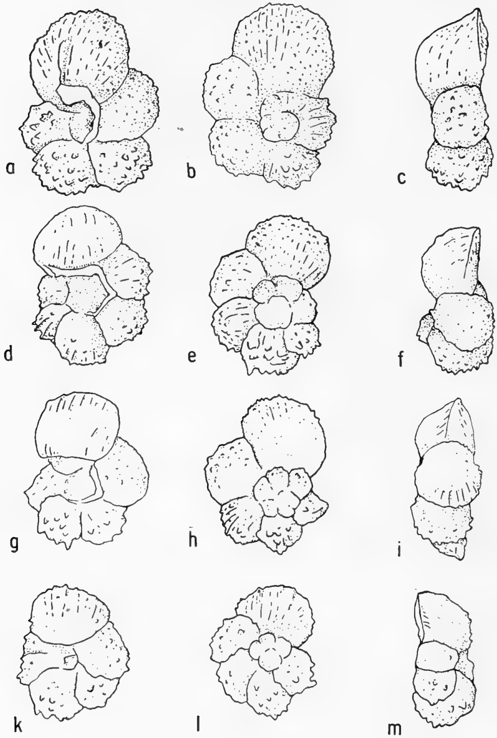
Dimensions.—The longer diameter of the paratypes measures from 0.27 mm. to 0.425 mm.

Holotype.—*Trinitella scotti* Bronnimann. T. L. L. Cat. Nos. 155591-155594. Text fig. 30a,b,c. All appr. × 80. Plate 4, figs. 4-6. Maximum diameter 0.4 mm. Diameter of umbilicus 0.075 mm. End chamber: radial diameter 0.2 mm., tangential diameter 0.225 mm. Diameter of aperture 0.75 mm. *Globotruncana mayaroensis* zone, Guayaguayare beds, Maestrichtian, Upper Cretaceous, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, D. C.

Occurrence.—*Globotruncana mayaroensis* zone. Frequent. Possibly also *Globotruncana gansseri* zone.

Remarks.—The initial portion of this form seems to be identical with that of typical representatives of the *rugosa-reicheli* groups of *Rugoglobigerina.*

It is named after E. Cooper Scott, former Chief Geologist of Trinidad Leaseholds Ltd.



Text fig. 30. *Trinitella scotti* Bronnimann. T. L. L. Cat. Nos. 155591-155594. *Globotruncana mayaroensis* zone, Guayaguayare beds, Upper Cretaceous. All appr. × 80. (a,b,c) Same specimen, umbilical, spiral and apertural views. Holotype. (d,e,f) Same specimen, umbilical, spiral and apertural views. (g,h,i) Same specimen, umbilical, spiral and apertural views. (k,l,m) Same specimen, umbilical, spiral and apertural views.

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PLATES

PLATE I (1)

Explanation of Plate 1 (1)

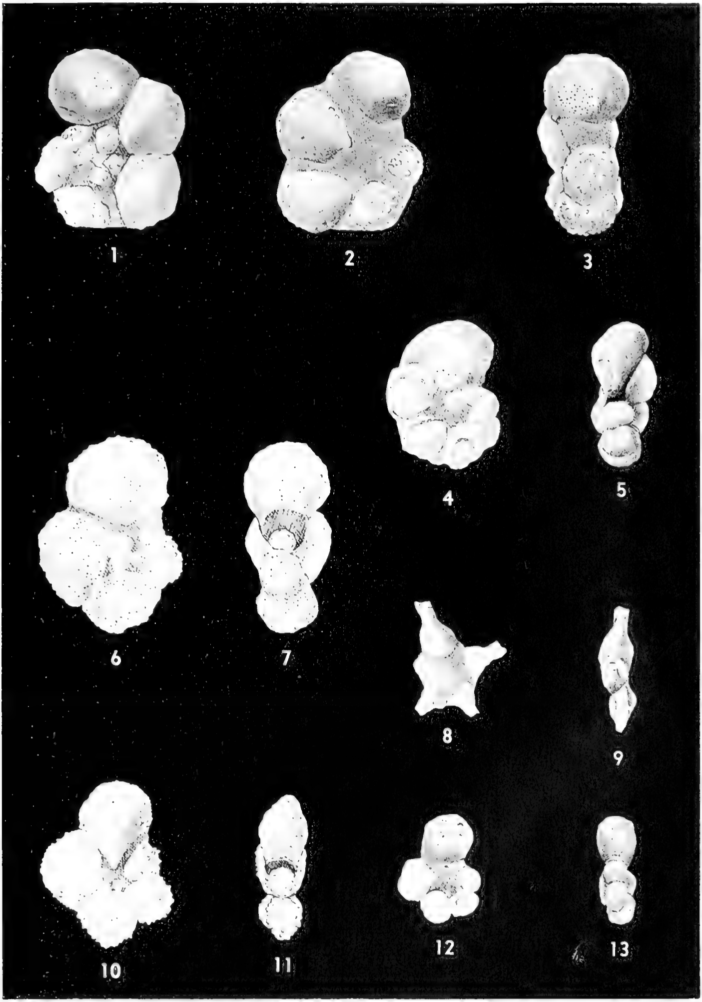
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PLATE 2 (2)

Explanation of Plate 2 (2)

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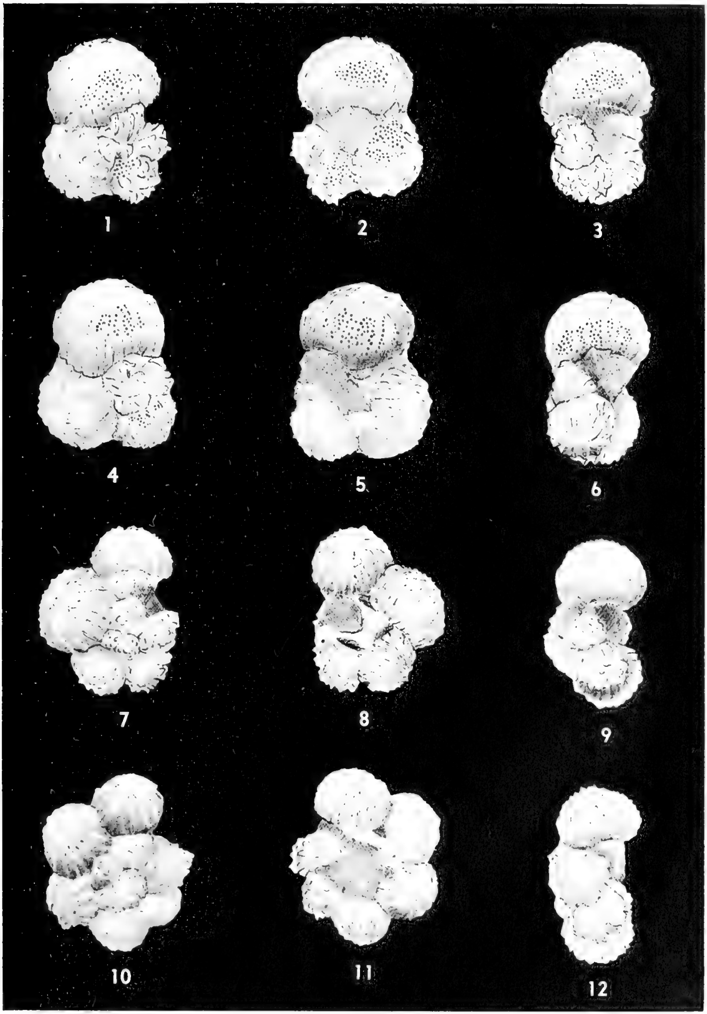
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Explanation of Plate 3 (3)

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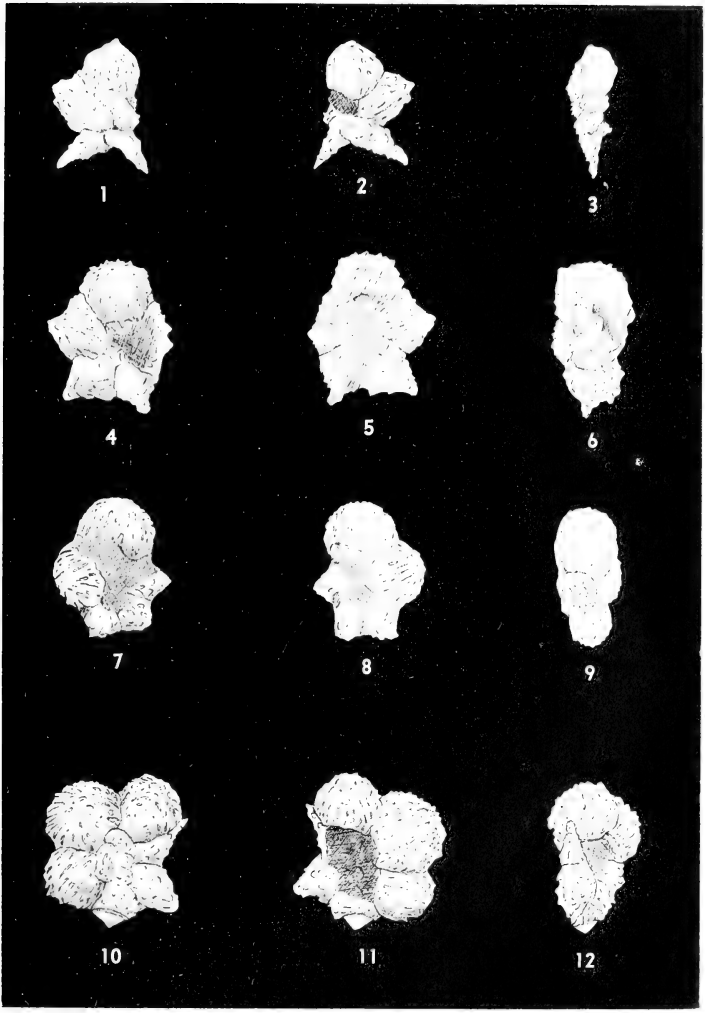
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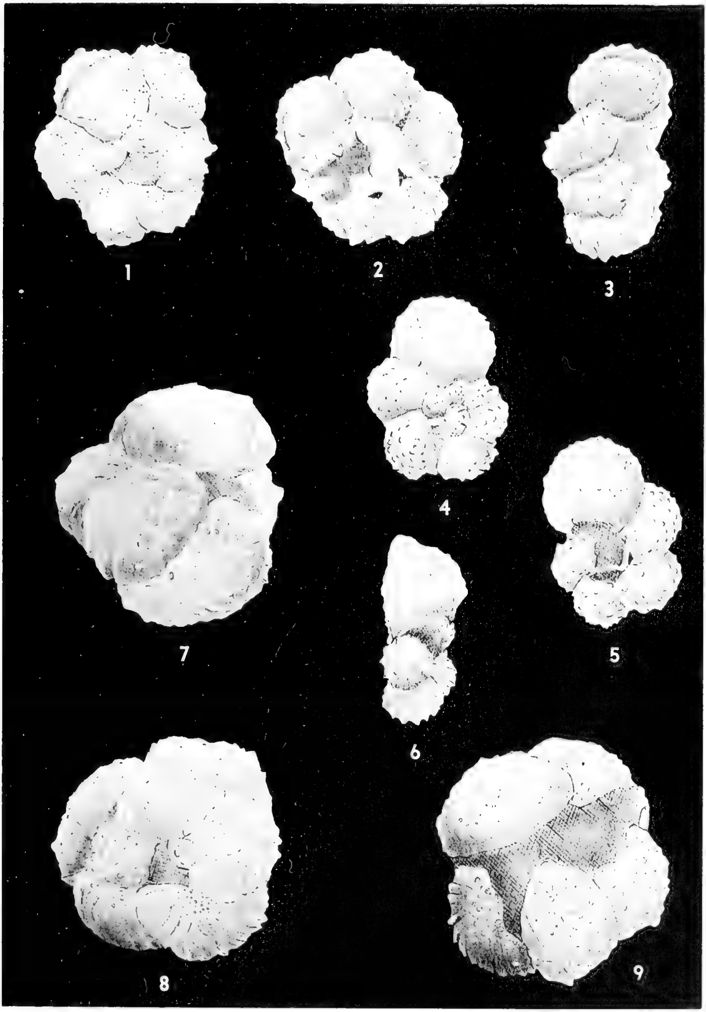
PLATE 4 (4)

Explanation of Plate 4 (4)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CONCERNING ENOPLOURA OF THE UPPER ORDOVICIAN AND ITS RELATION TO OTHER CARPOID ECHINODERMATA

By

Kenneth E. Caster
University of Cincinnati

August 4, 1952

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ABSTRACT

An essentially complete calyx of the problematical carpoid echinoderm, *Enoploura* Wetherby, from the Upper Ordovician of the Cincinnati, Ohio, area, proves the genus to be valid and illustrates a new pattern of mitrate carpoid organization. The genus is redefined, the species reviewed, and three new species described (*E. popei, E. meeki,* and *E. wetherbyi*). In connection with a reorganization of the Carpoidea Mitrata, on the basis of the implications in the morphology of *Enoploura,* one new genus (*Basslerocystis*), one new family (*Placocystidae*), six new sub-families (*Placocystinae, Enoplourinae, Placocystellinae, Basslerocystinae* and *Lagynocystinae*) and four new sub-orders (*Mitrocystida, Lagnocystida, Anomalocystida* and *Placocystida*) are proposed.

INTRODUCTION

In the spring of 1951 two specimens of the rare echinoderm, usually referred to the species described by Meek (1872) as *Anomalocystites* (*Ateleocystites?*) *balanoides*, were discovered near Cincinnati, Ohio. They came from the Corryville member of the Maysville subseries. This is in the Cincinnatian series, or Upper Ordovician. No specimens of this species have been reported in print since 1879 when Wetherby reviewed the species and described the genus *Enoploura* for it. The new material, in preserving a nearly complete set of thecal plates and a pair of rigid brachia, greatly supplements knowledge of the genus. It also reveals structures which confirm Wetherby's observations on the morphology of the extraordinary peduncle[1] (despite his mistaken interpretation of it). It develops from

[1] The term "peduncle" is preferable to "stem" or "column" in referring to the posterior appendage of the carpoids. Despite Jaekel's (1900, 1918) and Bather's (1900) impressions and interpretations, this echinoderm group seems to have been eleutherozoic throughout its history; certainly during its fossil record. The peduncle is, like the rest of the body, a bilateral structure and does not appear to have served either in ontogeny or phylogeny as a stem for fixation; it may have been a counterbalance or even have had a locomotor function (Kirk, 1911).

these new data that the *Enoploura* organization requires the recognition of a new sub-family of Carpoidea.

The first-discovered specimen is an incomplete calyx (Plate 1, figs. 4-6) which preserves the articulated peduncle and its structures very well. Mr. Stanley Schweinfurth, geology student at the University of Cincinnati, found it at Tower Lake, an artificial pond on the north side of Harrison Avenue, near Dent, Ohio. This is on the outskirts of Cheviot, a Cincinnati suburb. The second specimen is truly remarkable; it preserves the calyx nearly intact, thus for the first time showing the arrangement of the thecal plates in the genus; moreover, the pedunculate structures are amazingly well preserved. It was found by Mr. John K. Pope, geology student at Harvard University and assiduous "Dry Dredger" in Cincinnati. It comes from the middle Corryville beds in Stonelick Creek, Clermont County, Ohio. A new species, based on this specimen (Plate 1, figs. 1-3), is named in Pope's honor. Both specimens are deposited in the University of Cincinnati Museum. Four additional specimens pertaining to the genus have been borrowed for study from the U. S. National Museum.

Enoploura balanoides has remained since 1879 one of the least known and more enigmatic fossils of the Cincinnatian. The original description (Meek, 1873) was based on two crushed fragments (Plate 2, figs. 7-9) collected by the amateur geologist, G. W. Harper, from the "upper part of the hills at Cincinnati." Wetherby (1879) identified this horizon as "350 feet above the low water of the Ohio River." Bassler (1906, p. 8) and Lucy Braun (1916, opp. p. 42) gave the "low water" level of the Ohio in the pre-dam period as 432 ft. A. T. According to their figures, the McMillan formation (upper Maysville) occupies the zone between 460 ft. and 375 ft. This formation is divided into the Mt. Auburn beds which outcrop (hill tops, Cincinnati) between 425 ft. and 460 ft. above "low water"; the Corryville member from 390 to 425 ft.; and the Bellevue beds from 375 to 390 ft. The Fairview formation (lower Maysville) comes between 375 ft. and 280 ft. The upper member of the Fairview, the Fairmount or "Hill Quarry" beds occupies the interval from 325 to 375 ft.; the Mt. Hope member from 280 to 325 ft. Thus it is difficult to understand how Bassler in 1915 (p. 88) arrived at the stratigraphic designation of this species as "Maysville (Corryville), Cincinnati, Ohio and vicinity," when his own (1906) figures indicate that the 350 foot level could be no higher than the Fairmount member ("Hill Quarry Beds"). This level comes at about the middle of the Fairmount member. Bassler's age-assignment is the more curious when the published history of all the previously known specimens of *"Enoploura balanoides"* is reviewed.

The only specimen, other than the holotype, which came from what may rightfully be called the "vicinity of Cincinnati" is one attributed by Dr. Wetherby (1879) to George Vallandingham, another amateur collector. This one came, according to Wetherby from "about 400 feet above the river," a figure which would place it in the McMillan formation, certainly, and probably in the Corryville member. Unfortunately, nothing is known of the morphology of this specimen, which would be of particular interest in view of the two new Corryville specimens which are the motivation of this paper.

But Wetherby (1879, 1879A) was chiefly concerned with new Richmondian specimens. These he referred to Meek's *balanoides*, but it was the additional data furnished by this material that led him to create a new generic assignment for the species. All of these materials were found at a considerable distance (30-40 miles) from Cincinnati and in horizons indisputably high in the Richmond. He credits A. J. Newton, a collector of Richmond, Indiana, with a specimen from that city, found in "the upper part of the Hudson River Group," *i. e.,* uppermost Ordovician. This was probably from the Whitewater (perhaps Saluda member) or Elkhorn formation. This is the specimen (or Wetherby's illustration of it, 1879A, figs. 1d, 1e, 1f) which Bather (1900) (see below) used as the basis for Haeckel's (1896) species *Placocystis crustacea* (Plate 2, figs. 3-5).

W. J. Patterson of Oxford, Ohio, contributed another Richmondian specimen (Wetherby, 1879A, fig. 1g) which Haeckel (and Bather) questioningly attributed to *crustacea* (Plate 2, fig. 6). Most remarkable, however, of all hitherto described material, and the real basis for Wetherby's creation of the genus *Enoploura,* was a unique example (Plate 2, figs. 10-12) found by Wetherby himself (*Enoploura wetherbyi* Caster, n. sp.) which Haeckel also referred to his new species, but which Bather (1900) referred back to *E. balanoides.* This came from Osgood, Indiana. He judged the horizon to be about the same as that of the specimen found by Newton in Richmond, Indiana. The Osgood specimen (Wetherby, 1879A, figs. 1, 1a, 1b) preserved most of the peduncle and revealed a structure so unexpected and non-cystidian that Wetherby was convinced Meek had been mistaken in assigning his species to the echinoderms. Consequently, *Enoploura* was proposed as a new genus of the Crustacea, based on Meek's species[2]. Woodward (1880), representing the "professionals," reacted vigorously to this idea. It was not so much the idea, as the place of its origin that seemed to incense them. Although Woodward denied this pro-professional attitude, one can still read its

[2] The status of the rules of zoological nomenclature and insight into the taxonomic ethics of that time are nicely revealed by Wetherby's (1879, p. 164) admitted generosity: "While the removal of this fossil from the Cystidea to the Crustacea, under a new class and genus, would be found sufficient excuse by many writers, under cover of which to plunder this eminent author of his species, I shall retain his expressive name, and leave the species to his credit."

presence in his personal advice to Dr. Wetherby[3]. To the Eastern Seaboard geologists and paleontologists the names of the Cincinnati school of publishing amateurs were anathema, and it is most likely that Dr. Woodward's censorious remarks and aspersions were much enjoyed in Albany, Boston, New Haven and New York, if, indeed, they were not inspired there.

The subsequent neglect of *Enoploura* was no doubt materially conditioned by this attack on its author by the eminent Woodward. It now develops that the aspersions cast on Wetherby's powers of observation, and the suggestion (Woodward, p. 201) that the peduncular structures which he described were not in life-association with the "cystoid" calyx, were quite unwarranted. Wetherby seems to have been the first to call attention to the anomalous structure now known, on the basis of later European discoveries, as the styloid process or stylocone. (Note, for example, the complete absence of any mention of this structure in Haeckel, 1896.) He was also probably the first to express dissatisfaction with the customary inclusion of the bilateral "cystoid" echinoderms in the Cystidea, although he went too far and removed them from the echinoderms completely. The physiological implications inherent in the structures he observed certainly did not fit into any concept of the cystidean Echinodermata then current. In all probability the Carpoidea did live in a manner much more analogous to the vagrant Crustacea than to static Pelmatozoa.

In retrospect, Wetherby's really remarkable acuity merits admira-

[3] Writing (1880, pp. 200, 201) of Wetherby's allocating his new genus to the Crustacea instead of the Cystidea Woodward said: "Every point about *Ateleocystites* (=*Enoploura*) agrees with the known characters of this singular cystidean family (Anomalocystidae), and no one who has studied them attentively can doubt the propriety of the determinations of MM. James Hall, E. Billings, De Koninck, and F. B. Meek, as regards the zoological position in which they should be placed. Professors James Hall, De Koninck and myself have had the good fortune to see and study more perfect specimens than those which were placed in the hands of Messrs. Meek and Billings, but it is all the greater honour to these latter savans that they rightly interpreted the fragmentary remains which came under their notice for description.

"I am the last person who would insist merely upon the dictum of recognized scientific authority, and I beg to assure Prof. Wetherby (whom I have not the pleasure personally to know) that I have no desire to detract from his work by any word of mine; but I may be permitted to suggest that hasty publication, with a view to obtaining "priority," may have caused him in this instance to overlook the importance of first becoming thoroughly acquainted with the subject before him. None but those who have spent their lives in scientific research know the piles of "chaff" which every careful worker has to winnow away before he can arrive at the substratum of really good "grain" beneath.

"If Prof. Wetherby desires his work to stand, he must be prepared not only to hunt up carefully the bibliography of his subject, but also to understand more thoroughly the class characters of these difficult Paleozoic forms before attempting, on very imperfect materials, to correct older and more experienced labourers in Paleontology."

tion. Moreover, considering the taxonomic vicissitudes of the carpoids at the hands of the "professionals" in the last seventy years, Wetherby's crustacean theory now seems less impressively fantastic, clearly wrong though he was. Following Wetherby's lead, Haeckel (1896) made a strong point of the crustaceous aspect of the "Anomocystida," both in appearance and probable habits.

SYSTEMATICS

The new categories of classification shown below, prior to the listing of the genus *Enoploura,* are defined under the ensuing discussion of the genus.

Class **CARPOIDEA** Jaekel, 1900

Order **MITRATA** Jaekel, 1918

Sub-order **PLACOCYSTIDA** Caster, n. sub-order

Family **PLACOCYSTIDAE** Caster, n. family

Sub-family **ENOPLOURINAE** Caster, n. sub-family

Genus **ENOPLOURA** Wetherby, 1879, emend.

Type species.—*Anomalocystites* (*Ateleocystites?*) *balanoides* Meek. Based on two specimens from the vicinity of Cincinnati, Ohio. The stratigraphic horizon, as explained in the Introduction, is judged to be in the Fairmount member ("Hill Quarry beds") of the Fairview formation (Maysville sub-series); Upper Ordovician (Cincinnatian series). (See Plate 2, figs. 7-9, the holotype.)

Anomalocystites Hall, Meek, F. B., 1872, Amer. Jour. Sci. and Arts, 3(3): p. 423; 1873, Ohio Geol. Survey, Paleont. Ohio, 1, pt. 2: p. 41; Miller, S. A., 1889. North Amer. Geol. and Paleont., p. 224 (*pars*).
Enoploura Wetherby, A. G., 1879, Cincinnati Soc. Nat. Hist., Jour., 1, No. 4, p. 163; 1879, *Idem.*, 2, No. 1: pl. 7, figs. 1, 1a-g; Jaekel, O., 1900, Deut. Geol. Gesell., Zeits., 52: p. 668; Bather, F. A., 1900, Treatise on Zoology, pt. 3, p. 51.
Ateleocystites Billings, Woodward, H., 1880, Geol. Mag., 7 (dec. 2): p. 194 (*pars*); Bassler, R. S., 1915, U. S. Nat. Mus., Bull., no. 92, p. 88 (*pars*).
Placocystis de Koninck, Haeckel, E., 1896, Festschr. z. Siebenzigsten Geburtstage v. C. Gegenbaur, Bd. 1, pp. 39-40, Leipzig (*pars*).

Generic analysis.—A composite generic analysis follows. This is largely based on new material from the Corryville formation of the Cincinnati area which shows for the first time the details of the distal calicinal plates, a clue as to the nature of the distal appendages, and substantiates Wetherby's description of the structure of the peduncle.

General anomalocystid traits.—Pleuronect, pedunculate eleutherozoic echinoderms; characteristically carpoid, *i. e.*, non-radial, compressed, and of grossly bilateral symmetry. Calyx subrectangular, longer than wide; compressed dorso-ventrally[4] (morphologically left-right); dorsal carapace (right) convex; plastron (left) concave; sides axially arcuate and nearly vertical, making almost a right-angle with the carapace, but less than this with the plastron, due to its concavity. Peduncle segmented, proximally swollen, and inserted in a deep emargination of the calyx.

Two delicate, apparently unsegmented, spines or "arms" articulate at the anterior plastron corners.

The calyx is comprised principally of 28 large plates, and two tiny interbasals (*ib*); the disposition of the plates is shown in text Figure 1. There are six ponderous lateral marginals (*alm*, *mlm*, *plm*); these cover a large marginal area of the plastron and geniculate to form the pleural walls, against the dorsal edges of which the lateral carapace plates abut. The largest plates of the dorsal carapace are three adcolumnals (basals) which may cover nearly half the dorsal area. The lateral adcolumnals (*lac*) are joined to the large median adcolumnal (*mac*) by anteriorly divergent sutures. An arcuate median row of four epicentral plates lies in front of the adcolumnals; the lateral plates of this series (*m*1 and *m*4) meet the lateral adcolumnals at the suture between the posterior lateral marginals (*plm*) and the median lateral marginals (*mlm*). Usually the median adcolumnal extends forward of this position, excavately to meet the epibasals or median plates (*m*2 and *m*3). Anterior to the median row is found an arcuate row of plates comprised of a lateral pair of anterior marginal somatics (*lam*), and three adtegmenal marginals (*atm*), the central one of which is apparently the correlate of the "M" plate of Bather's (1900, p. 50) plate nomenclature. An additional pair of large adtegmenal plates, the axillaries or sub-brachials (*ax*), cover the anterior corners of the carapace and at their outer corners participate in the articulatory facet of the spinous brachioles.

The ventral plastron is excavated toward the center from the angular peripheral geniculation of the lateral marginal plates; more so toward the front where the surfaces are truly convexo-concave;

[4] Some confusion exists in the literature with respect to "dorsal" and "ventral" in the heterosteles. This is understandable, since the two sides so distinguished are technically, apparently, *right* and *left* by comparative morphology (Bather, 1900). In this paper the terms "*carapace*," for the convex side, and "*plastron*," for the concave, are preferred. Moreover, the up-side in life was apparently the convex one, and hence "dorsal" in terms of commonplace terminology; the down-side the concave one, and hence "ventral." Hall (1859), and the older writers in general, often used "anteal" and "posteal" for the concave and convex sides, respectively, of the "anomalocystids,"based, no doubt, on a different concept as to the morphologic direction of the calicinal flattening. Furthermore, the habitus (*vs.* phylogenetic) "right" and "left" have often been confused in describing the carpoids. Since the flat or concave side was down in life, and was functionally the venter, the right side of the venter lies on the left side of the customarily oriented views of the ventral surface. The irregularity in the somatic plates of the mitrates lies on the *right*, not the left, side.

adjacent to the peduncle the basal ventral plates rise to a low axial convexity. Corresponding in position to two anteriorly converging carinae on the internal surfaces of the ventral medial plates, a conspicuous furrowing occurs on the ventral surface from the posterior lateral angles to about the mid-point of the large central (hypocentral) plate. This delimits a very characteristic depressed isosceles triangular area in this genus and certain other mitrate carpoids. The posterior ventral margin is deeply and arcuately emarginate for the peduncle insertion. This margin of the plastron is strengthened by a raised flange.

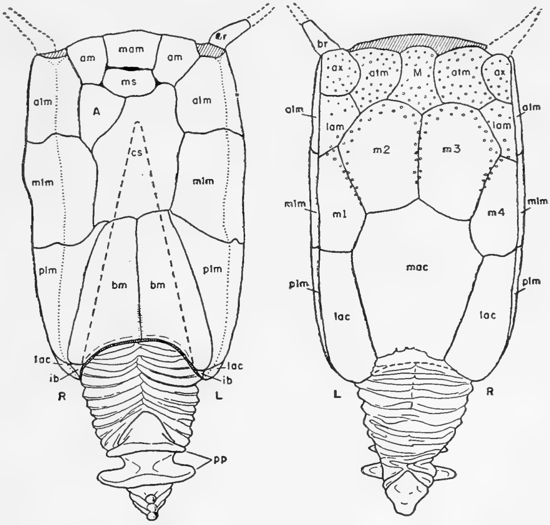


Fig. 1. Two views of the holotype of *Enoploura popei* Caster, n. sp., demonstrating the nomenclature of the carapace plates. Left figure represents the concave side or plastron; right figure the convex side, or carapace. The broken lines show the position of the anteriorly converging carinae on the inner surface of the plastron. *A*, irregular hypocentral ("anomalocystid") plate; *alm*, anterior lateral marginals; *am*, right and left adtegmenals; *ax*, axillaries, or sub-brachials; *bm*, medial adcolumnals or basal median plates; *br*, brachiole; *cs*, hypocentral, epibasal or central somatic plate; *ib*, interbasal plates; *L*, left side; *lac*, lateral adcolumnals; *lam*, lateral anterior marginal somatics; *M*, dorsal median adtegmenal plate; *m1*, *m2*, *m3*, *m4*, dorsal epibasals, or median somatic (epicentral) plates; *mac*, median adcolumnals; *mam*, median adtegmenal plates; *mlm*, median lateral marginals; *ms*, median somatic or hypocentral plate; *plm*, posterior lateral marginals; *pp*, peduncular or styloid process (stylocone); *R*, right side. Drawings by Anneliese S. Caster.

About one-third of the venter is shielded by the plastron surface of the lateral marginal plates; the posterior pair (*plm*) are sub-equal in size and form wedges at the adcolumnar angles. Their surface is gently rounded, and they are generally securely and obscurely sutured to the pair of median basal plates (*bm*) or true adcolumnals. The median lateral marginals (*mlm*) are also subequal and descend at about a 45° angle from the margins to meet the nearly flat-lying hypocentral, epibasal, or central somatic plate (*cs*), with which they are loosely sutured. Their ventral surface is almost a plane. The anterior lateral marginals (*alm*) are unequal in size, due to the intercalation of the irregular hypocentral (*A*) plate ("anomalocystid plate") between the right marginal and the central plate.

A pair of large basal marginal or adcolumnal plates (*bm*) occupy on the venter about the same area as the median basal plate on the dorsum. These together form a basally emarginate trapezoid. The obscure sutures between these plates and the posterior lateral marginals lie laterad of the convergent furrows, which are always conspicuous on these forms and easily mistaken for the lateral sutures. The median suture is usually obscure, also, and the greatest (albeit low) convexity of the central plastron lies along it. On the front margin are found three adtegmenal plates (*am, mam*).

The so-called "somatic plates" or hypocentral plates are three: a large central plate (*cs*) is quite the most conspicuous plate of the plastron, both for its size and anterior asymmetry; the latter is due either to the crowding in of the irregular plate (*A*), or the absorption, without visible sign, of a complement to the *A* plate at the front left of the central plate. The irregular plate (*A*) is a conservative characteristic of many mitrate genera, whereas the second hypocentral, which is the third, or median, somatic plate (*ms*), and lies in axial series with the median adtegmenal plate (*mam*), is apparently a primitive plate. It is commonly lost in the more advanced carpoids. The sutures around the median somatic plate are unusually crinkled and open, suggesting that there may have been actual (ostial?) penetration to the interior cavity around this plate.

Two deltoid interbasal (*ib*) plates fit between the plastron and carapace plates at the basal angles of the plastron side. These plates have hitherto been reported only in the Bohemian *Mitrocystella* (Chauvel, 1941). In view of the generally primitive nature of both genera possessing these small intercalated plates in the basal series, it is probable that a hexabasal plan is to be accounted for in all carpoids, instead of the tetrabasal scheme which Jaekel (1918) originally postulated. The interbasals are often inconspicuous, and easily misconstrued as a sutural wrinkle.

The brachioles were paired and apparently of the spinous, rigid *Placocystis* type, as suggested by the proximal portion of the only one known. The base of the brachiole fragment is slightly expanded, and the facet of attachment is at the junction of the antero-lateral marginal plates (*alm*), the anterior adtegmenals (*am*) and the axillary plates (*ax*) of the carapace. They seem to have been ventral in functional position, however.

The tegmenal area is arcuate and rather restricted due to close approximation of carapace and plastron anteriorly; tegmenal cover unknown, but one specimen from the Indiana Ordovician (Plate 2, figs. 1, 2) shows many small polygonal plates scattered about this region, suggesting the nature of the cover. Possibly the *M* plate (dorsal median adtegmenal) or an adjacent tegmenal, served as an operculum. The "*M*" plate appears to have borne axial furrows on its inner anterior surface in the *Mitrocystis* manner, as suggested by the same Indiana specimen cited above (Plate 2, fig. 2). Neither the mouth nor the anus is known, but since there are no calicinal perforations which might serve these functions, they were presumably both tegmenal in position. If not, then the anus (or mouth, Chauvel, 1941) may have been posteriorly located, although this is viewed as unlikely. With respect to the latter possibility, although no apertures can be seen, one might be concealed: a) at the ventral median contact of carapace and peduncle (where Haeckel, 1896, imagined it in *E. crustacea*); and (b) proximad of the "anchor structure" (stylocone process) on the median peduncle venter. There may have been no functional anus in adulthood (Jaekel, 1918).

The calicinal prosopon consists in *E. popei* and most other species of a general finely granular surface and delicate microscopic porelike structures. The latter are easily seen in the Pope specimen due to pyrite fillings. They are abundant and generally distributed. The granular surface is coarser on the concave plastron, but this may be due to erosion on the higher parts of the carapace. The pleurae of the posterior lateral marginal plates and the contiguous adcolumnals (*lac*) of the carapace carry the transverse undulatory grooves and ridges seen in *Ateleocystites* and most other carpoids. However, these do not appear to extend onto the median adcolumnal plate (*mac*). Where this ornament exists, the fine porelike structures are aligned in the grooves between the ridges. All of the carapace plates in front of the median series (*m*1-4) are conspicuously and coarsely pitted. The circular pits are apparently not cystoid pores or pore-wells, nor do they contain pores or connect with canals penetrating the crystalline calcite of the plates. No pitting of this nature has been observed on the ventral surface, although being more coarsely granular than the dorsal surface, the pitting may be thereby concealed. Or again, absence of granulation and/or coarse pitting on the most convex area of the carapace may be due to abrasion. In one of the paratypes of *E. popei*, (Pl. 1, figs. 4-6) the ornamental traits of other species are much exaggerated, despite the smaller size of the specimen. Here as can be seen on Plate 3, figures 4-6, the pitting takes on a labyrinthine character which is most reminiscent of the ornament on the bony plates of the primitive armoured fishes of the Paleozoic, such as the antiarch *Bothriolepis,* for example.

The peduncle is gross, about half the length of the carapace; it is compressed ovate in proximal section, distally tapering, and dorsally sharply recurved; the tail end, apparently short and held aloft, seems to have been directed forward in life. The proximal part of the peduncle is made up of serial annular laminations, each of which is derived from the fusion of what appear to be four elements (tetrameres rather than dimeres as postulated in other carpoids). There are two dorsal and two ventral elements with sutures in the mid-dorsum, mid-pleurae, and mid-venter. The dorsal and lateral sutures represent end-on fusion of the tetramere elements, whereas most of the ventral elements overlap in alternate series, forming a zigzag suture. The lateral suture is fused at the lateral angles. The paired ventral laminae of the expanded peduncle recurve anteriorly to overlap on the median line and form a series of chevrons of which the anterior "V"s, however, are made by en-echelon overlap; similar angular recurving of the peduncular elements occurs on the pleurae, though less pronouncedly and without overlap and alternation. From the mid-venter through the pleural angles the elements are sharply carinate and apparently tightly fused. The dorsal elements are rounded and ringlike. The first impression is that of a series of axially overlapping and articulating somites, arranged much as in the rhachis of a trilobite. In life, the proximal peduncle was presumably flexible. The crest of each ventral lamella continues as a rounded thickening on the dorsum; the dorsal correlates of the angular inter-annular spaces of the venter are largely filled with transversely wrinkled calcareous material, which, despite its low relief on the surface, is much the thickest portion of each calcareous ring. The wrinkling is deepest adjacent to the mid-dorsal suture. Thus the proximal peduncle cover was in no sense a fragile structure; instead, it was a heavily armoured body area.

The most characteristic generic and probably familous trait of the group is a curious bifoliate peduncular "process," or exaggerated stylocone plate, which is inserted on the mid-ventral suture distad of the swollen portion of the peduncle. This styloid structure forces the paired ventral peduncle plates apart, and crowds them and the dorsals to a restricted dorsal position. Apparently the main "process" is comprised of the indistinguishably fused elements of two serial ventral median insertions. They are an extraneous element in the peduncle and do not originate by the fusion of the paired ventral peduncular elements, and may be a relic of a fifth element which once participated in the formation of the peduncle. If so, this is a unique relic in the carpoids of a pentaradial condition. From a massive, anteriorly projecting and axially striated arcuate platform, which passes beneath the ventral plates, two very prominent, ploughsharelike, transverse blades protrude ventrad and laterad. Where the plates protrude the process is massively calcareous and appears to fill completely the whole axis of the peduncle, but a restricted lumen may pass dorsally over the stylocone. The anterior blade, which is somewhat anchor-shaped, is peripherally, and especially ventrally, recurved toward the front. It is medially subacuminate, and its posterior median section is strengthened by an inconspicuous axial thickening. The second transverse blade emerges without any detected suture; it is lower and more transverse, and less anchorlike in form. It descends nearly vertically and is less acuminate medially; its edge is granular. Behind these two "process" blades, analogous, but non-transverse, ventral insertions continue serially, possibly (though doubtfully) to the end of the peduncle. Five such are known. These may be mid-ventrally keeled (*E. crustacea*) or terminate in a simple mid-ventral spine (*E. popei*), depending apparently on the species. They are, however, separated from the "process" and from each other by sutures, and decrease in size distally. Behind the bifoliate "process" the peduncle is sharply recurved dorsally; thus the ventral median insertions assume a radiate arrangement. The distal dorsal elements of the peduncle become much reduced and abortive. Apparently the actual distal termination has never been seen. The lumen of the proximal part of the peduncle is very large.

Generic attributes would seem to comprise the number and arrangement of the plates of the calyx, rigid arms, general plan of the peduncle, and especially the bifoliate arrangement of the styloid process and presence of median peduncular insertions distad of the process itself. The granular and labyrinthine surface ornament, in addition to the general carpoid rugosities, is also, presumably, a generic characteristic.

Specific traits may be either of a general or of a restricted nature. Relative sizes of the calyx plates, ornamental details, relative convexities and concavities of the theca, dimensions, etc., are specific variables. Likewise details of the peduncle. Unfortunately, due to the incomplete nature of the usual fossil materials of the genus, the proximal morphology has grown to have maximum value for specific differentiation. How far these restricted details are to be relied upon can be determined only when further discoveries of the distal structures of both calyx and peduncle have been made. Most current species, in fact, are based on materials which do not preserve any vestige of the highly important peduncle.

The genus *Enoploura* is represented by five species, two of which are described as new in this paper. These appear not to overlap in range, with the possible exception of two previously described from near the top of the Richmond series, the precise formation not yet having been established.

Range.—So far the genus has been positively identified only in the Upper Ordovician deposits exposed on the crest of the Cincinnati Arch in the states of Ohio and Indiana. The stratigraphic distribution of the species is as follows:

Richmond subseries	
Whitewater formation (incl. Saluda)	*E. crustacea* (Haeckel)
	and
Elkhorn formation	*E. wetherbyi* Caster, n. sp.
Liberty formation	
Waynesville formation	*E. meeki* Caster, n. sp.
Arnheim formation	
Maysville subseries	
Mt. Auburn formation	
Corryville formation	*E. popei* Caster, n. sp.
Bellevue formation	
Fairmount formation	*E. balanoides* (Meek), type

Discussion

Comparisons.—The above data substantially alter all previous ideas on the organization of the genus *Enoploura*. So long as the distal theca was unknown and the peduncular details, first demonstrated by Wetherby (1879), were discredited (Woodward, 1880), such a fanciful illustration as Haeckel's (1896, p. 40, figs. 1, 2) of *Placocystis* (=*Enoploura*) *crustacea* was tacitly accepted. Haeckel had been misled, of course, by the flexible brachia of *Pleurocystis* which he considered to be related to the group now known as carpoids; thus he assumed that such arms prevailed. It is not clear, however, just what genus served as inspiration for his distal restoration of the thecal plates. At any rate, his historic predictions are now proven false.

Enoploura, as now understood, conforms to the broad characterization of the family Anomalocystidae as used by Bather (1900, p. 49) which was elevated to ordinal rank as the Mitrata by Jaekel (1918). Of ordinal importance is the possession of a flattened calyx, one side of which is concave and the opposite convex; both being framed by common lateral marginal plates. As in other genera of the class, the plastron plates are fewer in number than those of the carapace. The so-called "somatic plates" (within the border) of the plastron are asymmetrically disposed, whereas the carapace is almost bilaterally symmetrical in plate arrangement. The plastron is much the more conservative side in the carpoids, thus deviations from the norm on this side would seem to have higher categorical significance than those of the carapace. All of the "anomalocystid" genera of any immediate bearing on *Enoploura* are represented in Figure 2.

Most American writers since Wetherby's day have referred his genus to *Ateleocystites* Billings (1858), based on a Middle Ordovician type species (Fig. 2, A,B). This and the genus *Mitrocystella* Jaekel (1918) of the Lower Ordovician of Bohemia appear to be the only carpoids exhibiting three (and only three) hypocentral (somatic) plates on the plastron. Presumably the larger the number of somatic plates, the more primitive the organizational condition of the carpoids. Likewise bilateral symmetry of these plastron plates would appear to reflect more archaic conditions than asymmetry. The enlargement of the principal somatic plate (*cs*) appears to have been by complete amalgamate fusion of contiguous plates (*e. g., "Placocystis" bohemicus* (Barrande), Chauvel, 1941, p. 216) which were originally symmetrically arranged. The left-handed asymmetry would seem to derive from the pressure of the diagonal gut against the inner ventral surface in its passage from the anterior left corner toward the posterior right of the thecal cavity. Though just why such a state should effect the already closed sutures of the ventral plates is not readily clear. The commoner condition among the Mitrata is seen in the plastron of *Placocystis* de Koninck (1869) which has two somatic plates, (Fig. 2, C,D). *Mitrocystis* Barrande (1887) from the same horizon as *Mitrocystella* exhibits from four to six somatic plates, always in irregular arrangement; likewise *Basslerocystis* of the Lower Devonian appears to possess five somatic plates, (Fig. 2, E,F). Among the arm-possessing Mitrata, *Enoploura* is one of the most primitive in plastron plan.

In keeping with the general primitiveness of the *Enoploura* plastron, the interbasal pair of plates (*ib*), otherwise known only in the Bohemian mitrocystids (*e.g.*, Chauvel, 1941, *Mitrocystella,* p. 158, fig . 56, 57), is preserved. So far, apparently, these plates have not been observed in any other carpoids.

Continuing with the comparison between *Enoploura* and *Ateleocystites*, the assumption of any close relationship hinges on the likelihood that the latter genus possessed the placocystid type of brachia. This is counter to what has previously been written about *Ateleocystites*, *s. s.*, although Haeckel (1896) did assume that the genus had *segmented* brachioles of the same sort he postulated for all *"anomalocystida,"* and such as Schuchert (1904) has found in the type species of *Anomalocystites.* Careful scrutiny of the photographs of Billings' types given by Miss Alice Wilson (1946, pl. 2, figs. 1b,2) reveals suggestions of spinous arm-bases at the distal corners of the carapace of *Ateleocystites.* Hence the restoration of the genus as shown in Text Figure 2, A,B.

Both Billings and Miss Wilson show a transverse tegmenal plate in the *Ateleocystites* types; it is a lenticular, massive plate which stretches across the whole tegmenal area, and bears on the surface exposed on the ventral side many axial grooves. These recall the groovings on the median adtegmenal plate of one specimen of *Enoploura* which was discussed above. A median plate, though never so large, occurs in several carpoid genera; it is usually correlated with the "M" plate in *Mitrocystis* (*e.g.,* Bather, 1900, fig. xii). Confronted by this furrowed plate, and not having observed the arm-bases on the type material, Miss Wilson suggested that a transverse row of short preservable tentacles may have existed in *Ateleocystites.* This may well have been the case, for certainly the rigid spine-like arms were in all probability mere props and had no food-gathering or subvective function. The grooved plate in all these genera may correspond to the tegmenal opercular plate which Kirk (1911) described in the type species of *Basslerocystis* (new genus). It is quite conceivable that the carpoids in general lived in much the same manner of modern holothurids, as Jaekel (1918) has suggested. They may even have had no functional anus in accordance with Jaekel's idea, the single aperture serving in the coelenterate manner as the only intestinal ostium, and the gut functioning as a pump. Soft tentacles might quite logically surround such an aperture, and their number be reflected on a hinged opercular plate against which they pressed when extruded. Such soft structures could, however, hardly be expected to be preserved.

The peduncle of *Ateleocystites* is imperfectly known, but Miss Wilson's photographs of the type specimens show a tri-partite peduncle of the Mitrata sort instead of a simple column such as Billings drew and Woodward (1880) copied. One of the type specimens (Canadian Geol. Survey No. 1392a) shows a transverse styloid process, but of much less prominent proportions than the huge bifoliate structure in *Enoploura.* The two genera appear to be allied in calyx details, and, on the assumption of the possession of the same type of arms, are thought to belong to the same family and subfamily. However, it seems that Miss Wilson was quite right in concluding that *Ateleocystites* is represented in America (and presumably, so far, in the world) only by the type species, *A. huxleyi* Billings. *Anomalocystites bohemicus* Barrande (*e.g., Placocystis bohemicus* (B.), Chauvel, 1941, pl. 8 fig. 8) may prove to be an ateleocystid.

Placocystis de Koninck (1869) (Fig. 2, C,D) of the Upper Silurian of Great Britain (and questionably elsewhere) is the prototype of the rigid-arm-bearing carpoids. This organization is so fundamentally different from the armless mitrocystids and supposedly flexible-arm-possessing anomalocystids, *s.s.,* that it has seemed desirable to point up this distinctness by the creation of a new sub-order, the *Placocystida,* below, which is for the present, at least, thought of as co-extensive with the new family *Placocystidae.* There appears to be little more than general familous similarity between *Enoploura* and the many-plated forms on one hand, or the symmetrically plated on the other. With respect to the latter condition, there exist so far only the South African Lower Devonian (Bokkeveld beds) species *Placocystis africanus* Reed (1925) and an undescribed species from the equivalent horizon (Ponta Grossa beds), now in the writer's hands for description, from the State of Paranà, Brazil. Both are placocystoids, but no satisfactory genus has yet been described for either (new genera now in manuscript, Caster, 1952). In these the plastron plates appear to be nearly symmetrically arranged, and no sign of the "placocystid" odd somatic plate is in evidence. Curiously, this was supposedly the state of affairs in the genus *Placocystella* Rennie (1936), based on the species *P. capensis* Rennie, but supposed to accomodate Reed's species also. Careful scrutiny of Rennie's photographs of his holotype and paratype specimens reveals what appear to be odd somatic plates on each, thus contradicting Rennie's diagnosis in this respect. (This situation will be treated in greater detail in another place in connection with the description of the first carpoid echinoderms from South America.) A symmetrical arrangement of the plastron plates of carpoids has not so far been recorded in the northern world. *"Placocystis" bohemicus* (Barrande) Chauvel (1941) of the Bohemian Upper Ordovician may show signs of the sutures between the plates elsewhere fused to make the large hypocentral of the Mitrata. While this latter would serve as a prototype (archetype) for the carpoids having two asymmetrically disposed somatic plates, it is already advanced beyond the *Enoploura* condition (and *Ateleocystites?*) where the median hypocentral (*ms*) is retained. *Placocystella* appears (in Reed's restoration (1925) of *Placocystis africanus*) to have a median plate distad of its paired series of somatic plates; however, Rennie (1936) shows no such plate in his representation of the holotype.*

In *Rhenocystis* Dehm (1933) of the Bundenbach Lower Devonian (Germany), *Placocystis* finds its closest similarity; both exhibit the mid-dorsal "placocystid" plate, and a large number of carapace somatic plates (9 in the latter, 13 in the former, as against 6 in *Enoploura*); the German form shows five series of carapace plates, and *Placocystis* four. The remarkably simple carapace of *Enoploura*, in comparison, seems to indicate a separate and early line of carapace specialization. Apparently the large median plates in this genus represent the fusion of the more common numerous carapace plates of the other placocystids.

The carapace plate arrangement in *Enoploura* is truly unique, and can only be homologized uncertainly with that of the other Placo-

* While the present paper was in press, an excellent photograph of Reed's holotype was furnished by Dr. A. Brighton, Curator of the Sedgwick Museum, Cambridge. The nature of the preservation of this enigmatic fossil is such as to suggest still other representations of the plates than those already given by students of the South African specimen. The photograph and further interpretation will appear in the forthcoming study of the Paranà Devonian material.

cystida. It represents the acme of the placocystids in reduction of the number of plates and in the proportional large sizes of such plates as it retains. If the second series of plates in *Enoploura* (Fig. 1, *m*1-4) corresponds to the second series in *Rhenocystis*, as appears quite possible, then the Ordovician genus would seem to have undergone specialization by loss of distal carapace plates; *Placocystis* likewise, but to a lesser degree. This may be one important direction of Mitrata evolution, but apparently a recurrent, or latent recessive tendency which was not restricted to a single generic lineage. In *Ateleocystites* such facts as can be deduced from the poorly preserved carapaces of the types (Wilson, 1946, pl. 2, figs. 1-3) indicate (Fig. 2, A,B) a carapace plan significantly different from *Enoploura*. The median basal plate (*mac*) appears not to reach the peduncle, thus recalling the status of *Placocystis* and *Rhenocystis*; the marginal plates overlap widely on the carapace, instead of being mere vertical abutments against the plates as in *Enoploura*; and at least eight somatic plates, in addition to the basal median plate, appear to be indicated inside the frame of the marginals. The unique disposition of the *Ateleocystites* carapace plates alone is enough to establish the generic distinctness of these two.

With *Anomalocystites* Hall (1859), *s.s.*, (type species: *A. cornutus* Hall) of the Lower Devonian (Helderbergian) of eastern America, and the carpoid species *A. disparilis* Hall from the Oriskanian, described at the same time (see *Basslerocystis*, below) *Enoploura* shares really very little, except a general carpoid organization and gross form. The two species are unique in possessing swollen egglike thecae. Two very different genera are involved in these inflated Devonian species. Since both were used by Hall in his definition of the genus *Anomalocystites*, it is not surprising that there has been some uncertainty ever since as to precisely what constitute the morphologic traits of the genus. Thus one is always perplexed by the adjective "anomalocystid," especially when employed as a synonym for "carpoid." As Figure 2, E,F,G,H will bring out, not only are these species extraordinary, but in detail they are quite dissimilar; they occupy what appear to be homeomorphic extremes in carpoid evolution, if, indeed, both are really carpoids! Schuchert (1904) and Kirk (1911) have somewhat clarified the confusion concerning Hall's genus through their reexamination of the two species involved in its description.

As will be seen by an examination of the restorations on Figure 2, in the Helderbergian species *cornutus*[5], the type species, six

[5] It is interesting to note in passing that Haeckel (1896) in his great monograph on the Phylogeny of the Echinoderms was mistaken as to the relative stratigraphic horizons of *Anomalocystites* and of *Ateleocystites* (lower Middle Ordovician). He reversed them; thus some of his phylogenetic thinking with respect to the two is peculiar.

transverse series of carapace plates are well defined; they do not fall readily into vertical tiers, and the bilateral symmetry is somewhat imperfect. Most characteristic, and apparently unique among the carpoids, as now understood, is the presence of a pair of segmented brachia with ambulacral extensions upon them. These were described in detail by Schuchert (1904). (The brachia are amazingly similar to his representation of the terminal peduncle, one should note.) This character alone should make the true anomalocystids suspect members of both the Carpoidea and the Mitrata. (It is extremely inappropriate and misleading to continue the custom of using "anomalocystid" as a substitute for "carpoid.") Although Bather (1900) hesitantly referred *A. cornutus* to *Ateleocystites*, it really now seems to have nothing generic or even of a family nature in common with that Ordovician genus. An added matter for speculation is the apparent complete lack of a stylocone or its correlate in *Anomalocystites.* Schuchert (1904) gave a quite unequivocal restoration of the two-part peduncle (see Fig. 2, H). In this respect the assignment of the genus to the Mitrata again becomes suspect, for the genera pertaining to this order seem always to have a styloid. Because of the exceptional morphology of the genus a new sub-order, *Anomalocystida,* has been created for it below. The Anomalocystida may eventually prove to be a distinct order (of the Carpoidea?).

When more data are available, *Anomalocystites, s.s.,* may prove to be a terminal expression of the *Rhipidocystis* Jaekel line, redefined by Hecker (1940), from the Baltic Black River equivalents in the Ordovician (B-3 through D-1). In this genus (now completely dissociated from Jaekel's fantastic ideas on the organization of the genus, as shown in Hecker, fig. 1, p. 9) there are also exothecal ambulacral extensions on many (up to 10) segmented brachia or "fingers," as Hecker calls them. The food-grooves are covered by imbricate, wedge-shaped plates. Hecker proposed the new carpoid order Digitata for *Rhipidocystis.* Although the number of plates in the theca is apparently constant, and the plates themselves differentiable into marginal and somatic, the details of arrangement are not especially carpoid; moreover the ornament is granular and not of the carpoid type. The peduncle is degenerate, not differentiable into two zones, and apparently without any trace of a styloid process. The two faces of the *Rhipidocystis* theca are flat and subparallel, and both depressed below the thick plates of the marginal flange. This contrasts with the much-inflated theca of the Lower Devonian genus.

Hall's other species, *Anomalocystites disparilis,* is a true mitrate carpoid in every respect, albeit a very conservative one. So far it is known only from the American Oriskanian (Lower Devonian), and may represent the highest stratigraphic occurrence of the class. As even casual comparison of the drawings in Figure 2 will show, Hall's two species share very few generic traits—if any. The plate number and arrangement of *A. disparilis* are distinctive, and especially so the inflexible placocystid brachia. A new genus is created below for this species. The generic name is intended to honor Dr. Ray S. Bassler.

Genus **BASSLEROCYSTIS** Caster, n. genus

Type species.—Anomalocystites disparilis Hall. Based on a single incomplete specimen. Oriskany sandstone (Lower Devonian), eastern United States.

Anomalocystites Hall, J., 1858, Amer. Jour. Sci. and Arts, 25(2): p. 279; 1858, Paleontology of New York, 3: p. 132 (*pars*); Meek, F. B., 1873, Ohio Geol. Survey, Paleont. Ohio, 1, pt. 2: p. 43 (*pars*); Woodward, H., 1880, Geol. Mag., 7 (dec. 2): pp. 193, 199 (*pars*); Schuchert, C., 1904, Smithsonian Misc. Coll., 47, pt. 2: p. 204 (*pars*); Kirk, E., 1911, U. S. Nat. Mus., Proc., 41: pp. 21-26 (*pars*).

Anomocystis Haeckel, E., 1896, Fest. z. Siebenzigsten Geburtstage v. C. Gegenbaur, Bd. 1, p. 41 (*pars*).

Placocystis de Koninck (aff.), Bather, F. A., 1900, Treatise on Zoology, pt. 3, p. 51.

Non Anomalocystis (and *Anomalocystites*) Barrande, J., 1887, Syst. Silur. Centre Bohême, 7, pt. 1: p. 89; Jaekel, O., 1900, Deut. Geol. Gesell., Zeits., 52: p. 668.

This is one of the most elusive and enigmatic carpoids, due both to the rarity of specimens and the unsatisfactory preservation of such as are known. There are fundamental discrepancies among the three printed accounts of the morphology of the type species such as argue for the possibility of involvement of more than one species. However, Schuchert (1904) and Kirk (1911), who appear to have handled in the main the same specimens, still came up with quite different plats of plate arrangement in the species. The diagram shown in Figure 2, 1,F, is an attempt to harmonize the divergent representations (especially Schuchert's and Kirk's) in the light of the apparent morphologic probabilities judged on the basis of other carpoids. Hall's somewhat restored illustration of the holotype shows considerably fewer carapace plates than either Schuchert or Kirk represent from suites of better preserved topotype specimens. The essential characteristics of the species, and those of generic importance, seem not to be in dispute. Should more than one species be found to be masquerading under this designation, all appear to pertain to the new genus *Basslerocystis*, the analysis of which follows:

Carpoid, flattened egg-shaped theca; possessing inflexible brachia (Schuchert, 1904) attached in the placocystoid manner (Kirk, 1911); tegmenal area a quadrate, transverse opening (Schuchert, 1904) which is closed by a single, hinged, opercular plate (Kirk, 1911) which bears longitudinal internal furrows (Schuchert. 1904). No mouth or anus openings known; both probably confined to the quadrate tegmenal zone (Kirk, 1911). Plastron slightly concave, with subangular lateral carinæ; carapace much inflated, and proximally rolled under (as shown by Kirk, 1911, pl. 3, fig. 11). The plastron shows two "somatic plates," in characteristic conservative carpoid (and also "anomalocystid") pattern; however, a narrow transverse median plate, possibly comprised of fused tegmenal (or adtegmenal) plates, lies distad of the usual anterior ventral bounding plates (Kirk, 1911); also two lateral bounding plates, chiefly ventral in position, lie at the extremities of this transverse median plate and form the lateral boundary of the tegmenal (apertural) quadrangle (Kirk, 1911, pl. 3, fig. 9).

The carapace appears to be symmetrical in plate number (Schuchert, 1904, Kirk, 1911), if not in arrangement (Schuchert, 1904), thus apparently making Hall's species name, *disparilis,* somewhat inappropriate. Hall showed an odd number of carapace plates, a number smaller than that noted by either of the revisers. The number and arrangement represented on Figure 2, F, seems to conform in essentials to the Schuchert and Kirk analysis. However, Schuchert, following Hall's restored basal pattern, showed three basal (adpeduncular) plates, whereas Kirk found an additional row of plates between those supposed basals and the peduncle on the underturned carapace surface. These basal marginals are shown in broken line on Figure 2, F. Schuchert (1904, fig. 22) suggested the presence of such an intercalated basal series on the left side of his diagram A. Kirk denied the existence of either an anal aperture or special anal plate in the proximal carapace such as Schuchert suggested. Hall had restored a tiny, more or less placocystid, mid-carapace plate in the position selected by Schuchert for the anal area.

Comparisons of Genus Basslerocystis.—Bather (1900) indicated the affinities of this genus when he referred the type species to *Placocystis* rather than Hall's genus. One can infer in the writings of both Schuchert and Kirk that they were open-minded on the assignment of the species to some genus other than Hall's. Clearly, both in the plate dissimilarities and the differences in the nature of the distal appendages of the calyx, the two Hall species have very little in common. These differences are most clearly brought out in Figure 2, by comparing drawings E,F with G,H.

What appear to be the homologues of the *Enoploura* axillary plates (*ax*) have been represented by Kirk (1911) in *A. disparilis;* this is the only other occurrence so far reported of these plates. The transverse median adtegmenal plate of the *Basslerocystis* plastron has no counterpart in the carpoids; it may be a fused series of adtegmenal plates, although the prototype of such is unknown so far in the class.

On the dorsal surface *Basslerocystis* preserved the largest number of carapace plates so far known in the Mitrata, showing fused, rather than imbricate (Mitrocystida), dorsal plates. It is not possible now to correlate these plates with those of other genera, except in a general way. Most distinctive and different is the existence of an extra series of basals (sub-basals) on the underturned surface of the carapace in *Basslerocystis*, as shown by Kirk (1911).

It would apparently require a considerable lineage of genera to connect *Basslerocystis* with any other mitrate form.

Both *Anomalocystites, s.s.,* and *Basslerocystis* would seem to illustrate the retention of a very primitive carapace plan, more primitive in scheme even than *Rhenocystis* (Fig. 2, I,J). The inflated thecae would seem to be more archaic than the flattened forms common among carpoids. They would appear to preserve on the dorsum the generalized archetype in plate pattern that *Placocystella* of the Austral Lower Devonian preserves in its symmetrical venter. Perhaps one might project backward from these terminal "anachronisms," the kind of prototype to be expected in the early Ordovician from which the Placocystida (new sub-order, below) developed.

By way of contrast, *Kirkocystis* Bassler (1950), from the Oklahoma Middle Ordovician, and *Anatiferocystis* Chauvel (1941), of about the same age in Brittany, are probably the most specialized carpoids known. They have inflated anomalocystoid thecae but the carapace plates have been chiefly reduced to two large (marginal?) ones which meet on the mid-dorsal line. In *Kirkocystis* there are possibly several small basal plates on the carapace; the plastron bears two such basal plates, but the main area of the flat plastron is covered by the ventral extensions of the two large carapace plates; between them on the venter are an elongate somatic plate and a small epicentric plate. This curious arrangement is foreshadowed by several European Ordovician genera (see, for example, Chauvel, 1941) from which the unknown, but probably asymmetric, appendicular details of *Kirkocystis* may be inferred. *Anatiferocystis* Chauvel (1941) is dicotyledonoid with only two thecal plates retained; these meet on the mid-dorsum and mid-venter. The thecal form is still kirkocystoid.

The higher category Carpoidea (=Heterostelea) has not yet found its natural level in the classification of the echinoderms. Although listed as a class on a previous page, it may with equal propriety be elevated to the rank of sub-phylum, alongside Pelmatozoa and Eleutherozoa. Whitehouse (1941) proposed the sub-phylum Homalozoa to include the classes Carpoidea and Machaeridia (Withers, 1926), however the elimination of Withers' "class" from the Echinodermata by Wolburg (1938) and others leaves the Carpoidea alone to represent the sub-phylum.

Such elevation is incompatible with the still current concept of the carpoids as derived pelmatozoans, like the rest of the "cystoids." Inherent in this long-standing classification, which Bather (1900) was largely instrumental in advancing, is the idea that all echinoderms are derived from a sessile archetype, through whose fixation radial symmetry was attained; and that both free-moving and non-radial echinoderms can be homologized with such a forebear.

In the paper cited above, Whitehouse (1941) described Middle Cambrian vagrant echinoderms which he interpreted as the fulfillment of the historic prediction from the Biogenetic Law of the eventual discovery of fossil correlates of the free swimming larval stages of existing echinoderms. The previous absence of such fossil data had been the basis for the development of the current ideas outlined above. On the basis of the new Cambrian remains, Whitehouse resuscitated the dormant idea that echinoderm radial symmetry may stem with as much orthodoxy from a free-swimming existence as from sessility. Indeed, the most perfect degree of radial symmetry throughout the Animal Kingdom pertains to eleutherozoic organisms. Whitehouse's discovery, if his material has been properly interpreted (see Regnéll, 1948 and Gislén, 1947), is a fundamental challenge to the pelmatozoan theory. He proposed the new sub-phylum Haplozoa for the new Cambrian eleutherozoic echinoderms.

Two new classes were recognized for the Haplozoa: the class Cycloidea, based on the radially symmetrical genus *Cymbionites,* and the class Cyamoidea, based on the bilaterally symmetrical genus *Peridionites.* Thus in this sub-phylum the fundamental cleavage between bilateral and radial organization was established in the Echinodermata. Whitehouse postulated a dipleurula-like, segmented and coelomate archetype of the phylum, as most echinoderm specialists have done, but passes directly therefrom, without either radial symmetry or fixation, into the cyamoid Haplozoa. A direct projection of this lineage became the Carpoidea (=Homalozoa, restricted); thus there could have been no radial symmetry or sessility in this line. By further evolution at the Haplozoa grade of organization, Whitehouse would have the radially symmetrical, but still eleutherozoic, cycloids differentiated. Apparently a basic cleavage of the Cycloidea resulted in the sessility and concomitant modifications of the sub-phylum Pelmatozoa on the one hand, whereas on the other, perseverence of the radial organization and motility of the cycloids accompanied the evolution into a more complex organization seen in the sub-phylum Eleutherozoa. According to the Whitehouse scheme, this last sub-phylum did not pass through a pelmatozoan intermediate stage, and any larval fixation that occurs in the sub-phylum is purely coincidental and non-recapitulatory. The adaptive form which represents the average habitus for each sub-phylum seems to have been independently attained in homeomorphic lines within each of the other sub-phyla; witness: the eleutherozoic Pelmatozoa, pelmatozoic Eleutherozoa, pore-bearers of carpoid form, etc.

The following synopsis will summarize the relations between these genera, and other mitrate genera, and *Enoploura*. It will also serve as an instrument for emending Jaekel's (1900, 1918) higher category classification of the Mitrata.

Order MITRATA Jaekel, 1918

Carpoidea (Heterostelea) having convexo-planate or convexi-concave calices; both surfaces are covered by relatively large plates: there are many fewer plates on the plastron ordinarily than on the carapace. Lateral marginal plates are common to both surfaces; four to six adpeduncular basal plates present; these usually exhibit characteristic striations or laminations. Peduncle tri-partite: the proximal section is swollen, with a large lumen, and is comprised of fused annulations each formed of two dimeres sutured on the mid-dorsum and mid-venter (the "heterostele" character) (in *Enoploura* each peduncular "dimere" bears a lateral suture, thus creating a tetramerous condition which possibly represents the archaic condition of the peduncle in the whole order); the middle section of the peduncle bears a large ventrally-inserted toothed or bladed ossicle, the "process," styloid or stylocone; distal portion of peduncle narrow, cylindrical column of flexibly united columnals. These are presumably also made up of fused dimeres (tetrameres?). Terminal section of peduncle is often much reduced and frequently coiled in repose.

The principal morphologic differentia and the taxonomic categories so far based thereon are shown in the following key.

Key to the Genera, Families and Sub-families of the Mitrata

I. Carapace plates imbricate; no brachia or other distal exothecal appendages ....
Sub-order *Mitrocystida* n. sub-order; Family *Mitrocystidae* Jaekel, 1900.
- A. Three somatic plates on plastron ....
Genus *Mitrocystella* Jaekel, 1918; Lower Ordovician, Bohemia.
- B. Four, five or six somatic (hypocentric) plates on the plastron ......
Genus *Mitrocystis* Barrande, 1887, Lower Ordovician, Bohemia.

II. Carapace of fused, non-imbricate plates; distal appendage or appendages present.
- A. Only one distal arm or process present ....
Sub-order *Lagynocystida* n. sub-order; Family *Lagynocystidae* Jaekel, 1918.
  - 1. Plastron comprised wholly of marginal plates; carapace with many small central plates; much elongated calyx ....
Sub-family *Laynocystinae* n. sub-family; Genus *Lagynocystis* Jaekel, 1918, Middle Ordovician, Bohemia.
  - 2. Plastron or carapace, or both, reduced to two plates ....
Sub-family *Kirkocystinae* n. sub-family.
    - a. Carapace comprised wholly or essentially of two marginal plates; surface tubercular.

(1) Plastron largely covered by two marginal plates, but contains two or more narrow somatic plates ....
Genus *Kirkocystis* Bassler, 1950, Middle Ordovician, Oklahoma.

(2) Plastron bearing several (about 11) plates ....
Genus *Balanocystis* Barrande, 1887, Middle Ordovician, Bohemia.
Allied new genus, not described, Lower Devonian, Brazil.

b. Calyx comprised of two large plates only; these meet on mid-venter and mid-dorsum; apparently no basal plates ....
Genus *Anatiferocystis* Chauvel, 1941, Middle Ordovician, Brittany.

B. Two exothecal arms or brachia present.

1. Brachia segmented, bearing exothecal ambulacra (Schuchert, 1904).
Sub-order *Anomalocystida*[6] n. sub-order; Family *Anomalocystitidae* Meek, 1872, emend., restr.; Genus *Anomalocystites* Hall, 1858, *s.s.*; Lower Devonian, United States.

2. Brachia rod-like, unsegmented, articulated at base, non-subvective..
Sub-order *Placocystida*[6], (Haeckel, 1896) emend., n. sub-order; Family *Placocystidae* n. family.

a. Symmetrically arranged plates on both carapace and plastron.
Genus *Placocystella* Rennie, 1936, Lower Devonian, South Africa and Brazil (allied form).

b. Asymmetrically arranged plastron plates; carapace symmetrical.

(1) Less than three somatic plates on the plastron ....
Sub-family *Placocystinae* n. sub-family.

(a) Two somatic plates on the plastron; carapace with "placocystid" plate.

(i) Elongate calyx; five series of carapace plates.
Genus *Rhenocystis* Dehm, 1933, Lower Devonian, Germany.

(ii) Ovate calyx; four series of carapace plates ....
Genus *Placocystis* de Koninck, 1869, Upper Silurian, Great Britain.

(2) Three somatic plates on the plastron; no "placocystid" plate .... Sub-family *Enoplourinae* n. sub-family

(a) Six somatic plates on the carapace; prominent stylocone..
Genus *Enoploura* Wetherby, 1879, Upper Ordovician, United States.

(b) More than six somatic (epicentral) plates on the carapace; stylocone not prominent; broad grooved tegmenal plate ....
Genus *Ateleocystites* Billings, 1838, Middle Ordovician, Canada.

(3) Five somatic plates on the plastron; large number of non-imbricate carapace plates; operculate tegmenal area ....
Sub-family *Basslerocystinae* n. sub-family; Genus *Basslerocystis* n. genus, Lower Devonian, United States.

[6] Haeckel (1896) used the term "Anomocystida" (=Anomalocystida) for a *family* of the Amphoridea. He credited Woodward (1880) with the family (Anomalocystidae), the spelling of which he arbitrarily modified; however, the family Anomalocystidae was first proposed by Meek (1872). That family is now employed in a restricted sense in this paper under the emended spelling *Anomalocystitidae*, to agree with the orthography of Hall's genus. The term "Placocystida" was also employed by Haeckel for a *family* designation (=Placocystidae), but in a sense more nearly corresponding to the *order* here indicated.

It is quite likely that each of the above proposed sub-families will in time be elevated to family status. The morphologic differences involved appear to be of higher taxonomic value than the rank here assigned. It would seem to require unduly long generic phylogeny to connect the various "sub-families" of the Placocystidae of this synopsis, for example. There does not seem to be any sound basis for the current assumption that these organisms exhibited any markedly greater plasticity in the arrangement of thecal plates than did other echinoderms of comparably high organization. In the study of this group there is still too much carry-over in the mode of thinking about them from the days when they were assigned to the Cystidea. The morphologic evidence now at hand strongly suggests that a truly grand array of genera yet await discovery before the evolutionary links between many of the known carpoid genera (and families) now known can be ranged with any confidence into phylogenetic series.

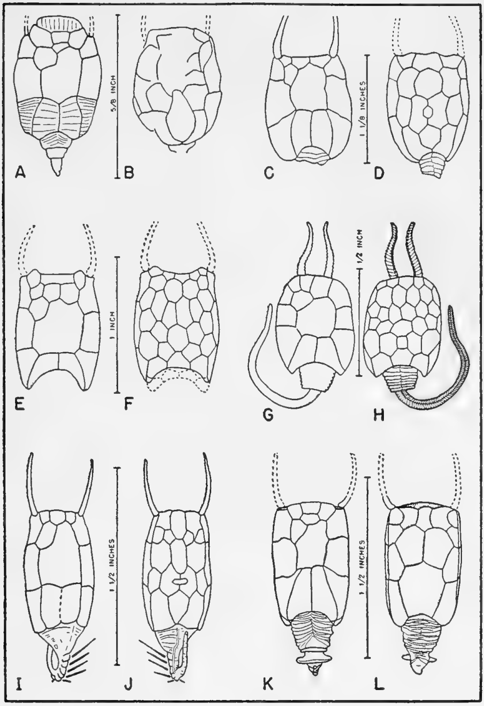
SPECIES OF ENOPLOURA

Enoploura balanoides (Meek) Plate 2, figs. 7-9

Anomalocystites (*Ateleocystites?*) *balanoides* Meek, F. B., 1872, Amer. Jour. Sci. and Arts, 3(3): p. 423; 1873, Ohio Geol. Survey, Paleont. Ohio, 1, pt. 2: p. 41, pl. 3 *bis*, figs. 6 a-c.
Enoploura balanoides (Meek), Wetherby, A. G., 1879, Cincinnati Soc. Nat. Hist., Jour., 1: p. 163 (*pars*).
Ateleocystites balanoides (Meek), Woodward, H., 1880, Geol. Mag., 7 (dec. 2): p. 198 (*pars*), pl. 6, figs. 6-8.
Anomalocystites balanoides Meek, Miller, S. A., 1889, North Amer. Geol. and Paleont., p. 224, fig. 247.
Placocystis balanoides (Meek), Haeckel, E., 1896, Festschr. z. Siebenzigsten Geburtstage v. C. Gegenbaur, Bd. 1, pl. 2, figs. 5-7.
Placocystis crustacea Haeckel E., 1896, *Idem.*, p. 39 (*pars*).

No new facts concerning the type species, *s.s.*, have been discovered since Meek's original analysis, which was based on a specimen collected by G. W. Harper (*fide* Wetherby, 1879) from the Cincinnati hills. His illustrations are copied on Plate 2, figs. 7-9. Apparently no new specimens showing the traits of the holotype nor any other specimen from the horizon of the holotype have so far turned up.

The exceptionally large size of the holotype calyx fragment, the narrow basal carapace plate (*mac*), breadth of the proximal calyx, markedly arcuate basal plastron plates (*bm*), and very deep reentrant in these plates at the base of the plastron for the attachment of the peduncle, all mark this specimen as very different from any others representing the genus. Since it is clearly from a distinct geologic



SPECIES OF ENOPLOURA

Fig. 2. Type species of characteristic mitrate echinoderms. A and succeeding alternate letters are plastron views; B and succeeding alternate letters are corresponding carapaces. A,B, *Ateleocystites huxleyi* Billings. Middle Ordovician, Canada. Included here on the assumption that rigid, placocystid arms are present; this appear to be true of the type specimens. Based on the Billings types shown by Alice Wilson, 1946. C,D, *Placocystis forbesiana* de Koninck. Upper Silurian (Wenlock), Great Britain. Based on Bather's restoration, 1900, from type material. E,F, *Basslerocystis disparilis* (Hall) Caster, n. genus. Lower Devonian (Oriskanian), United States. Composite restoration based on Hall, 1859, Schuchert, 1904, and Kirk, 1911, from type and topotype material. G,H, *Anomalocystites cornutus* Hall. Lower Devonian (Helderbergian), United States. Questionably a carpoid. Drawn from Hall, 1859, and Schuchert, 1904, based on type and topotype material, I,J, *Rhenocystis latipedunculata* Dehm. Lower Devonian (Bundenbach), Germany. Somewhat restored from Dehm, 1933. K,L, *Enoploura popei* Caster, n. species. Upper Ordovician (Maysville, Cincinnatian), United States. Drawn by Anneliese S. Caster.

horizon, from which no competing specimens have so far been recovered, and because there now appears to be some degree of specific differentiation discernible in the various formational occurrences of the genus, it seems best to restrict the Meek species to the original holotype. Clearly the only other Maysville species known, *E. popei*, n. sp., to be described below, from the Corryville formation, is morphologically different from the type species in every comparable detail.

Occurrence.—As explained in the introduction, the type horizon of the Harper species must lie in the Fairmount member ("Hill Quarry beds"), upper Fairview formation, basal Maysville subseries of the Cincinnatian series (Upper Ordovician). It was recovered from the hills at Cincinnati[7].

Enoploura crustacea (Haeckel) Plate 2, figs. 1?, 2?, 3-5, 6?

Enoploura balanoides (Meek), Wetherby, A. G., 1879, Cincinnati Soc. Nat. Hist., Jour., 1: p. 163 (*pars*); 1879A, 2: pl. 7, fig. 1d-g.
Ateleocystites balanoides (Meek), Woodward, H., 1880, Geol. Mag., 7 (dec. 2): p. 198 (*pars*), pl. 6, figs. 12-15.
Placocystis crustacea Haeckel, E., 1896, Festschr. z. Siebenzigsten Geburtstage v. C. Gegenbaur, Bd. 1, p. 39, fig. 1,2 (imaginative restoration), (*pars*).
Enoploura crustacea (Haeckel), Bather, F. A., 1900, Treatise on Zoology, pt. 3, p. 51.
Ateleocystites balanoides (Meek), Bassler, R. S., 1915, U. S. Nat. Mus., Bull. 92, p. 88 (*pars*).

Ever since the discovery of the first enoplourid, the arthropodous aspect of the group has been manifest. Witness the type species name *balanoides*, above. The basal thecal plates do recall the plates of barnacles; likewise the flattened theca and the flexible peduncle. However, the nature of the peduncle was unknown when Wetherby discovered the truly amazing, stylocone-bearing structure which he reported in 1879, along with two new thecal fragments. The new material only increased the similarity to the Crustacea; so much so, in fact, that Wetherby courageously removed his new genus *Enoploura*,

[7] There is a rather marked difference in fauna and facies between the calcarenaceous Fairmount beds and the overlying argillaceous McMillan formation, so it would not be especially strange should different species characterize genera common to the two formations. In the past there has been too little species discrimination between the formations of the Maysville subseries. Recent restudies, such as Flower's (1946) on the Cincinnatian cephalopods and Van Fossen (1951, M. S. Thesis, U. C.) on the rafinesquinid brachiopods, point up rather forcefully the need for closer specific distinctions among even the commoner Cincinnatian faunal elements. Many of these new, and morphologically sound, species derived from closer scrutiny of old broad "species" have quite restricted stratigraphic ranges.

based on the original Meek fragment, his two new comparable fragments, and especially the new peduncle-bearing specimen, from the Echinodermata. Wetherby's new material came from near the top of the Richmond subseries, considerably higher than Meek's types, hence it is not surprising that they are somewhat different morphologically.

From his broad world-perspective of the echinoderms, Haeckel (1896) recognized that these structural differences between Meek's primary types and Wetherby's supposed hypotypes were of a specific nature. The name *crustacea* was proposed for the Richmond fossils, although the Wetherby genus was suppressed as a synonym of *Placocystis*. The new name was an especially felicitous one, as a glance at Plate 2, figures 10-12 will show. These are three views of Wetherby's specimen showing the attached peduncle and remarkably crustaceous appearance of the fossil. One specimen of Wetherby's other material (Plate 2, figs. 3-5) bears the attached peduncle, without the "process"; but the calices of all his specimens are incomplete to about the same degree as Meek's material.

A comparison of the dimensions and plate arrangements in the three new specimens illustrated by Wetherby (1879, pl. 7, figs. 1, 1a-g) shows differences which may well represent contemporaneous speciation, and are here so evaluated. Bather (1900, p. 51, footnote) noted this when, in the process of recognizing Wetherby's genus anew, he restricted Haeckel's name *crustacea* to only part of the Wetherby suite (1879, p. 7, figs. 1d,e,f, g). He does not indicate his intentions with respect to Wetherby's other specimen (figs. 1, 1a-c), but it is to be supposed that he wished it referred back to Meek's original species, which was the only other one then known in the genus. However, it now appears that this specimen cannot be referred to either Meek's Maysville species (*balanoides*) or the Richmondian *crustacea* of Haeckel, as delimited by Bather. Hence the new species *E. wetherbyi*, below. The result of Bather's action was to eliminate from the species *crustacea* Wetherby's most crustaceous-appearing type, and the one which probably most influenced Haeckel in choosing the species name. Bather's action indirectly made the specimen illustrated by Wetherby on his plate 7, figs. 1d-f, the holotype of *E. crustacea* (Haeckel), and there seems to be no good reason to contest this designation now. Especially so, in view of the fact that all members of the genus, in which the peduncular detail is well preserved, have a remarkably crustaceous appearance.

All the characteristics of *E. crustacea* now knowable are shown by the copies of Wetherby's illustrations (1879, pl. 7, fig. 1d-g) given on Plate 2. The prominent triangular depression of the posterior plastron surface, corresponding in its delimitation to the internal converging buttresses (Fig. 1), marks *crustacea* as a highly distinctive form. Apparently the basal angles of the buttress triangle have specific value. A specimen from Madison, Indiana, (Plate 2, fig. 1) appears to belong to this species, on the basis of similar triangular areas. It represents the nearly complete interior of a plastron surface, and is therefore the second specimen to be discovered which reveals the outline of the whole *Enoploura* calyx. At the anterior end of this specimen are many scattered polygonal plates. They are suggestive of a tegmen covering. The inner edge of a large (median?) plate (presumably the *mam* plate) is bordered by a channeled flange (Fig. 2) in a manner remotely suggestive of the "M" plate furrowings in the carapace of *Mitrocystis.* Possibly this plate performed an opercular function in *Enoploura.*

This species differs from *E. popei*, below, in its narrower calyx, and more pronouncedly depressed triangular area of the plastron. It differs from the type species in the same characters, and especially in its lesser proportional width, shallower peduncular emargination of the plastron, and less arcuate basal plastron plates. Although no stylocone process is preserved in the original collection, the massive structure is present, but badly fractured, in the Madison specimen. No comparison with either *Enoploura popei* or *E. wetherbyi* can be made in this respect, however.

Occurrence.—The holotype (Newton specimen) came, according to Wetherby (1879), from the "upper part of the Hudson River group at Richmond, Indiana." This is in the upper part of the Richmond subseries of the Cincinnatian series in modern stratigraphy. The exact formation is unknown, but it is probably the Whitewater or Saluda formation. The Madison hypotype is poorly documented. The only data on the University of Cincinnati label (U. C. No. 25708) are "Madison, Indiana." The entire stratigraphic section from the upper Maysville to the top of the Ordovician is exposed in the Ohio River bluffs at Madison, but the more likely fossil horizons would be in the Richmond. The only indentifiable fossils in the matrix of this specimen are shells of the brachiopod *Zygospira* which is, unfortunately, not an adequate stratigraphic marker.

Enoploura wetherbyi Caster, n. sp. Plate 2, figs. 10-12

Enoploura balanoides (Meek), Wetherby, A. G., 1879, Cincinnati Soc. Nat. Hist., Jour., 1: p. 163 (*pars*); 1879A, 2: pl. 7, fig. 1, 1a-b; Woodward H., 1880, Geol. Mag., 1896, 7 (dec. 2): pl. 6, fig. 9-11.
Placocystis crustacea Haeckel, E., 1896, Festschr. z. Siebenzigsten Geburtstage v. C. Gegenbaur, Bd. 1, p. 39 (*pars*).

This species is based on the original specimen collected by Dr. Wetherby which preserved the curious peduncular "process" (stylocone) and ventral peduncular styloid insertions. It was this specimen which led him astray in assigning the species to the Crustacea and brought down Woodward's (1880) censure upon him. It also furnished the basis for Haeckel's keen comparison of the carpoids with crustaceans. Since no additional material of the species has subsequently come to light, Wetherby's published diagnosis (complicated by his mistakenly employed crustaceous nomenclature) and excellent illustrations (copied on Plate 2) are the complete documentation. This species is characterized by its angular posterior calicinal angles, and especially by the construction of the peduncle. In contrast with *Enoploura popei*, below, the peduncle of *E. wetherbyi* is narrower and more tapering and less conspicuously dorsally recurved. The stylocone is less produced either ventrally or laterally, and the post-process mid-ventral insertions are less aborted, in keeping with the suaver dorsal curvature of the peduncle. The distal styloid insertions are foliaceous, keeled and imbricate, rather than closely fused structures bearing blunt vestigial bosses or spines as they are in *E. popei*[8].

Occurrence.—From the "upper part of the Hudson River Group" at Osgood, Indiana, and according to Wetherby's statement, it was found at about the same horizon as the Newton specimen (*E. crustacea*) from Richmond, Indiana. This is probably from the Whitewater formation, and may have come from the Saluda layer, in which other cystoids are relatively common.

[8] Although Wetherby's description and excellent illustrations of this curious specimen certainly offered no basis for doubting the authenticity of the organization he described, Woodward (1880) was loathe to accept it as a fact. In making a footnote-suggestion that the ventral insertions might be, in reality, adventitious plates of a *Turrilepas*, he planted the germ which fifty years later was to grow into a veritable epidemic: "Is it possible," he wrote, "that the associated plates ... which Prof. Wetherby considers to be the "abdominal appendages" are the plates of *Turrilepas?* If this were the case, and their association not merely fortuitous, it might prove, not that *Ateleocystites* was a Crustacean, but that *Turrilepas* was possibly the peduncle of an anomalous Cystidean! We recommend this to Prof. Wetherby's consideration." It appears that this was the beginning of the thought which eventually led to Withers' (1926) presentation of *Turrilepas* and its kind as a new echinoderm class, the "Machaeridea." Despite considerable current acceptance on the Continent, Wolburg's (1938) arguments against this "class" have never been successfully met, as Regnéll (1945) points out. Wolburg's strongest argument was that, except for *Lepidocoleus*, a doubtful "machaerid", the representatives of Withers' "class" do not possess the crystalline calcite skeletal structure universally known in the Echinodermata. The entire skeleton of *Enoploura* is of the true echinoderm nature; dissociated peduncles appear never to have been discovered so far, thus they have not been confused with any "machaerid" genus in paleontologic writings. If they do turn up, and the original skeletal structure is preserved, there is little chance of confusion. Moreover, the styloid process has apparently no analogue in the turrilepid organization, and so far as known, the characteristic sculpturing of the leaves in the machaerid strobilii does not occur on the peduncle plates of any carpoid.

Enoploura popei Caster, n. sp. Plate 1, figs. 1-6; Plate 3, figs. 1-6; Plate 4, figs. 4-8, Text fig. 1

The holotype and three paratypes are the basis for the following specific analysis. The former is the first specimen of the genus to show the preservation of all carapace and plastron plates; likewise it is unique in demonstrating the presence of a pair of articulated rigid arm-spines at the distal corners of the calyx. The preservation of the peduncle is also exceptional. The first paratype (USNM No. 180483) retains more of the calicinal plates than any specimen discovered prior to the holotype, and shows an exceptionally fine preservation of the surface ornamentation.

The plate arrangement and sizes are shown by the photographs and Figure 1. The absence of any angularity at the basal angles of the calyx is very characteristic of these Corryville forms of the genus (see, for example, the contrasting condition in *E. meeki*, n. sp., from the Waynesville, below). Although the holotype is exceedingly important for an understanding of the plate arrangement of the genus, each of the paratypes contributes certain details which the holotype does not show, or deviations which help toward an understanding of the range of variation to be encountered in the species. Each specimen of the type suite is therefore separately considered below.

Holotype.—The holotype (Univ. Cincinnati Museum No. 25993) is illustrated in Figure 1 and Plate 1. It is conspicuously devoid of striking ornament, except for the coarsely pitted condition of the distal carapace plates, represented on Figure 1. The rest of the test is finely punctose only, with pyrite filling the delicate vertical pores. Even the characteristic carpoid rugae of the posterior (proximal) lateral areas are obscure on the holotype (Plate 1, fig. 3). It seems hardly possible that this specimen, the best articulated yet recovered, could have suffered enough abrasion to account for the low grade of ornament now preserved. Were it not that the three paratypes represent a progressive ornamental sequence from the inconspicuous prosopon of the holotype to the strikingly rugose and labyrinthine, ostracoderm-like condition in the first paratype (described below), one might consider the holotype as specifically distinct from the remainder of the type suite.

The most characteristic specific traits of *E. popei* appear to belong to the peduncle. On the dorsal (*i.e.,* carapace) side, 14 peduncular somites proximad of the styloid "process" can be distinguished. Two of these, however, which would normally not emerge from beneath the posterior calyx shield, are revealed here by abrasion.

Each peduncular somite (ring) is comprised of four elements which meet at sutures on the mid-dorsum, mid-pleurae and mid-venter. Thus the proximal peduncle is made up of four-part (tetramere) fusion, rather than the two-part (dimere) fusion customarily postulated for the carpoids (erroneously?). Of the 14 somites distinguishable on the dorsum of the proximal peduncle, the comprising elements meet end-on at the mid-dorsal suture; those comprising the dorsal surface of the 4 somites adjacent to the process meet in zigzag. On the pleurae, 8 somites are revealed distad of the calyx plates; the corresponding dorsal and ventral elements of each of the 8 somites recurve toward the calyx at the mid-pleural line to form a characteristic series of proximally-directed pleural chevrons; the elements of each somite meet end-to-end, however, on the pleural suture. On the venter, the proximal 3 somites meet end-on; 8 are en-echelon along the zigzag ventral sutural line, but touch one another. The distal two fail to meet due to the insertion of the ventral "process." The latter is inserted between the 12th, 13th (aborted) and 14th segments, as counted on the dorsal side.

The "process" has the form to be seen in the photographs. The foliaceous margins, however, were considerably extended both ventrally and laterally, and were slightly pustulose on the very edge; *i.e.*, they show no signs of abrasion. The shape of the process is probably a specific trait; likewise the nature of the post-process mid-ventral insertions. In *E. popei* these distal styloid insertions, like the "process," are massive crystalline calcite. They appear to have been solidly fused together and to the "process," although the sutures are discernible. On the ventral surface each insertion carries a blunt spine or boss. One such spine is shown intact in Plate 1, figure 3. The peduncle is sharply recurved dorso-anteriorly distad of the last preserved insertion on the holotype, and, judging from the area of fracture and apparent size of the peduncular lumen here, the recurved portion may have been very short and stubby.

The dimensions of the holotype are as follows:

Median length plastron	23. mm.
Median length carapace	23.8 mm.
Carapace width (max.)	16. mm.
Depth plastron concavity	2.8 mm.
Depth distal emargination of plastron (peduncle insertion)	2.5 mm.
Width first blade of stylocone	5.3 mm.
Width second blade of stylocone	7. mm.
Distance between blades	3. mm.

Occurrence.—Discovered by Mr. John K. Pope from the middle part of the Corryville member of the Maysville group on Stonelick Creek, Clermont County, Ohio. The specimen was found on a calcarenite slab which had fallen from the middle section of the cut-bank of the creek about 200 yds. downstream from the highway bridge on Ohio Route No. 131. This is at the first stream ford below the highway.

Paratype No. 1.—The first paratype (U. S. Nat. Mus. No. 114798), illustrated on Plate 3, figures 4-6, is subequal in dimensions to the holotype. It is second only in the number of calyx plates preserved, and shows the most remarkable ornamental detail of any specimen of the genus so far discovered. Only the distal thecal plates and distal peduncle are missing. All of the somatic plates of the carapace are preserved, most of the central somatic and the "anomalocystid" plate of the plastron. Only the proximal part of the stylocone cylinder is preserved, however.

By comparing the photographs it will be seen that the general shape and arrangement of the plates are the same in the two specimens. However, the basal marginals (*bm*) of the holotype are slightly longer and narrower, and their lateral margins converge distally more rapidly. The proximal median emargination of the plastron for the peduncle insertion is slightly deeper in the paratype. The median lateral marginal plates (*mlm*) of the holotype are subequal in size and symmetrically placed, whereas in this paratype the left plate is apparently considerably longer than the right (plastron view), and consequently the suture between the median lateral marginals and the anterior lateral marginals (*alm*) is considerably distad of the proximal acute angle of the "anomalocystid" plate. They are on approximately the same level in the holotype. The median somatic plates (*m2*, *m3*) of the carapace are longer and narrower in the paratype. On figure 4 the deltoidal interbasal (*ib*) plates show very distinctly.

The most conspicuous trait of the paratype is the labyrinthine external ornament of all the calyx plates. As figure 6 shows, the transverse undulatory rugae, so characteristic of most carpoids, are prominent on the basal lateral regions of the lateral adcolumnals (*lac*), but over the remainder of the test a pebbled-leather effect, which grades into labyrinthine pitting distally, is unique. The effect is amazingly similar to that exhibited by many early placoderm and ostracoderm fishes[9] (*e.g., Bothriolepis* of the Devonian in Patten, 1912, fig. 247, 248, etc.). The labyrinthine ornament becomes a series of parallel ridges or rugae on the suture between the median plates (*bm*) and the posterior lateral marginals (*plm*). The deep circular pits on the distal carapace plates of the holotype may be derived from the kind of ornament seen in this paratype, where, too, the excavations in the labyrinth appear to be deepest adjacent to the sutures of the median somatic plates (*m*1-4). The peduncle of the paratype shows longitudinal ridges on all the tetramere elements; they are especially conspicuous on the carapace (dorsal) side. The basal portion of the stylocone is deeply pitted. In the holotype no peduncular ornament was observed.

Occurrence. — The paratype was discovered by Mr. Joseph Stocker behind the Seminole Apartments, on Ravine Street, Cincinnati. The horizon is in the middle part of the Corryville formation (Maysville subseries).

Paratype No. 2.—The second paratype (Univ. of Cincinnati Mus. No. 25257) is a much smaller specimen than either of the previous ones. Only the basal series of plates is adequately preserved for study. Plate 3, figure 1-3 and Plate 4, figure 8 show the plate details and proportions. The peduncular emargination of the carapace is extraordinarily deep in this specimen, and the median adcolumnal (*mac*) much more scutelliform than in the preceding specimens. Figure 2 shows the undeformed basal profile of the specimen. Despite the smaller size of the specimen, the proximal peduncle appears to

[9] This similarity in ornament between the enoplourid carpoids and the earliest fishes may be more than mere coincidence. Indeed, it is difficult to imagine such a close similarity arising completely independently. Gislén (1930) developed the thesis that the carpoids were closely allied to the enterocoelic radicle whence came the early chordates, and, indeed, may actually be more closely allied to the chordates than to the echinoderms. His arguments were largely based on similarities, real or inferred, in the pore system of certain carpoids (*Cothurnocystites*) and gill apertures in *Amphioxous.* Gregory (1935, 1951) has pointed out a certain similarity in the arrangement of the plates of the carpoid calyx (especially in *Placocystites* and *Mitrocystella*) and the armour plates of the Devonian ostracoderm *Drepanaspis.* Certainly from the earliest record of "fishes" in the Upper (?) Ordovician (*Astraspis* and *Eriptychius*), persistently through most of their Paleozoic history, the armoured chordates repeatedly bore plate ornament very similar to that here illustrated for *Enoploura.* Thus one more morphologic trait appears to link these "atypical" echinoderms with the earliest preserved fish. In view of the fact that the ranges of the first fish and the carpoids overlap, one would presumably need to project the separate lineages backward for an immense time before they could possibly converge to the point of identity. The fact that the earliest fishes were apparently dwellers in fresh waters, and the carpoids, like all echinoderms, wholly marine, would support the contention that an immense amount of time and concomitant evolution intervene in the morphologic hiatus between the point of departure and the coëval records of carpoids and the first fishes.

show the same number of elements as in the larger types. The four sutures between the peduncular elements show very well.

Occurrence.—Collected by Mr. Stanley Schweinfurth about 8 feet below the base of the Mt. Auburn formation, in the upper part of the Corryville beds at Tower Lake, on the outskirts of Cheviot, near Dent, Ohio. This is in the western hills of Cincinnati.

Paratype No. 3.—The fourth specimen of *E. popei* (Plate 4, figs. 4-7) is only slightly better preserved than the foregoing paratype. The proportions of the basal plates are slightly different from any of the other types. Of particular interest in this specimen is the preservation in the peduncle (fig. 4) of clear evidence of the metameric nature of the styloid process. Beneath the exfoliation of the sutureless exterior of the two process blades, only the base of the first blade is retained in the specimen, a sutural surface is exposed. This bears a median keel. It seems to correspond in position to the junction between the two process blades and would thus indicate that the two blades of the stylocone are but modified and externally fused isomeres of a series.

In this specimen the ornament is intermediate in stage of development between the holotype and the first paratype, with a low-relief labyrinth well developed.

Occurrence.—From the A. F. Foerste Collection in the U. S. National Museum (No. 93345) from "Maysville (Corryville), Cincinnati, Ohio." It was identified as Meek's species *Enoploura balanoides*, and presumably was the basis for the restriction of the species to the Corryville formation in Bassler's (1914) Bibliographic Index.

Comparisons.—The present species differs from the Wetherby specimen from the Upper Richmond of Osgood, Indiana (described above as *E. wetherbyi*) (Plate 2, figs. 10-12), in being considerably less produced at the posterior angles of the calyx, in having a more transverse and more ponderous peduncular "process," and especially in possessing spinous, post-process, mid-ventral, styloid peduncle insertions, rather than keeled foliaceous plates. The basal carapace plate (*mac*) in *E. popei* is considerably broader and longer proportionally than in *E. wetherbyi*. Wetherby's specimen was the only one previously discovered which shows the peduncular "process" and was the first record of the styloid structure in paleontologic literature. The Newton specimen (Plate 2, figs. 3-5) from the Upper Richmond also (Richmond, Indiana) preserved the proximal peduncular plates, but no "process." This species has a narrower and apparently longer calyx, with a very conspicuous triangular depression in the posterior plastron floor, corresponding to the area delimited by the converging internal buttresses (Plate 2, fig. 1). It is possible that the plastron interior of a nearly complete calyx shown on Plate 2, figures 1, 2, pertains to Haeckel's species. The type species *Enoploura balanoides*, (Plate 2, figs. 7-9), which comes from the lower Maysville, apparently, is a considerably larger organism than *E. popei*, and is characterized by the narrowness of the posterior carapace plate (*mac*), the arcuate outer sutures of the posterior plastron plates (*bm*), and the conspicuously deep basal invagination of the plastron for the peduncle insertion. Nothing is known of the peduncle itself in this specimen.

Enoploura meeki Caster, n. sp. Plate 4, figs. 1-3

This species is known from a single specimen in the U. S. National Museum collection (No. 93346). Although only the proximal thecal plates of the calyx are known, and naught of the peduncle, the fragment seems clearly to belong to a distinct species. As can be seen by the photographs, the lateral adcolumnal plates of the carapace are subtrigonal in outline, and the median adcolumnal narrows to a remarkable degree toward the peduncle emargination. On the plastron, the basal median plates are extremely long and narrow, and perhaps the most conspicuous feature of the species is the strongly recurved flange of these plates around the peduncle emargination. Also of a highly characteristic nature are the subangular basal angles of the theca, well seen in figure 2. In contrast with typical *Enoploura popei*, where the basal margin fits snugly and without an angle to the peduncle, here the base of the calyx is produced. The surface of the plates is finely labyrinthine to pustulose. The dimensions are essentially those of the holotype of *E. popei*, insofar as the present fragment will permit comparison.

Occurrence.—In the Ulrich Collection of the U. S. National Museum. The label indicates that the specimen came from the Blanchester division of the Waynesville beds, 3 ft. below the *Rhynchotrema dentata* Hall horizon at Clarksville, Ohio. A notation on the cover of the box in Dr. Ulrich's handwriting indicates that he had spotted this as a distinct species.

GENERALIZATIONS

Stratigraphic value.—From the little now known of the species distribution of *Enoploura* the genus appears to have evolved with sufficient rapidity in Cincinnatian time to give the various species significant stratigraphic index value. Unfortunately, the rarity of articulated specimens makes them poor workaday tools; probably closer scrutiny of the triturated coquinites of the Upper Ordovician would reveal dissociated *Enoploura* plates. However, many of these appear to be specifically identifiable.

Paleoecology.—It appears that most of the *Enoploura* specimens so far recovered have come from coquinites and calcarenites. These sandy matrix deposits of broken shell fragments, pieces of Bryozoa and echinoderm skeletons probably help to account for the rarity of articulated thecae of the local carpoids. The Cincinnatian calcarenites are shallow neritic deposits which were sufficiently stirred by surface waves and bottom currents to be washed free of mud and most silt-size particles. The Pope specimen from the Corryville formation was found on the top surface of a calcarenite or coquinite layer which was 1-2 inches thick. Probably the exceptional preservation of that specimen is attributable to the fact that it is embedded in the silt-size and mud-size material immediately overlying the fragmental limestone bed. These are quiescent, thinly laminated deposits. Hence the specimen came into the sedimentary setting at a time propitious for preservation, whereas most other specimens were broken or disarticulated by the shifting sands. Probably the occurrence of Wetherby's articulated specimen was of this same siltstone sort.

Habitus.—Like all the bilateral carpoid echinoderms, *Enoploura* was apparently completely eleutherozoic, though just how it (and the other carpoids as well) achieved locomotion is something of a mystery. Possibly it did less free crawling than mere direction shifting so as to maintain an optimum con-current orientation of its mouth. In the absence of any evidence of an external subvective system, and with no evident capacity for agility of movement, it seems probable that *Enoploura* (as well as all Mitrata) was a microphage. Whether or no it possessed any soft circum-oral appendages is problematical; just as likely is the possibility that it sucked in its provender from the bottom currents by a contractile anterior gut, or oesophagus.

Kirk (1911) and Jaekel (1918) have suggested that the brachia or spines of the carpoids served as props for elevating the distal theca and ventrally oriented mouth off the sea-floor for more expeditious feeding. The peduncle "tail" is frequently carried aloft, and commonly in a planospiral curl, enrolled toward the distal end of the theca. It has a prehensile aspect, so that quite logically it has often been suggested that the carpoids pulled themselves along the sea-bottom by means of it. Almost certainly it did serve the function of a temporary anchor, in the manner of a crinoid cirrus; but how a closely, although flexibly, joined series of annuli could achieve any contractile function—such as locomotion would require—is not clear. Furthermore, the distal tail is often very fragile, and in several genera seems to have been atrophied, as it may have been in *Enoploura.* It is too fragile in most genera of Mitrata to have had much wriggling locomotor function when the relatively large size of the theca is considered. Perhaps the terminal peduncle, where it was of any significant size, was held aloft as a kind of rudder to help keep the animal properly oriented in the bottom currents.

The peduncular somites appear to have been connected by flexible integument, hence a certain amount of movement between the proximal peduncular rings was possible. The gliding surfaces of overlap between these scleritic rings suggests limited, but easy, movement between them in any direction, but perhaps freest dorsoventrally. The styloid process is deeply inserted in the venter, and considerable gliding movement on its inserted, external proximal and distal axial surfaces by the adjacent somites appears certain. Apparently the junction of the peduncle to the calyx at the proximal line was integumentary; possibly the large chevron-shaped buttress on the plastron interior represents the seat of attachment of peduncular muscles to the calyx. The capacious lumen in the proximal part of the peduncle suggests large muscles; these in turn strongly suggest that the peduncle played a very significant role in the enoplourid economy. Chauvel (1941) maintains that he has evidence of two ganglia in the adpeduncular corners of the *Mitrocystella* theca and postulates a large nerve mass in the lumen of the proximal peduncle. This localization of nerve centers, if Chauvel is correct, may well correlate with the zone of maximum muscular activity in the organism.

The massive proximal peduncle and stylocone of *Enoploura* would appear to be subequal to the whole theca in weight, and may well have served as a counterbalance to the latter. Thus in a motile benthonic organism temporary stability on the bottom would be achieved. The stylocone plate and associated structures would appear to have been a ventral anchor which increased the efficiency of the peduncle as a counterbalance. The gross development of the styloid in *Enoploura* may have permitted a more stable existence in swifter bottom currents than would have been otherwise possible; the broad lateral expansions of the process blades would have served excellently to keep the organism from swinging sidewise in a stream of water. Moreover, the different directions of curvature of the two stylocone blades in *Enoploura* may well have served to keep the carpoid anchored in an oscillatory current setting, such as a tidal reversal on shallow bottom. It is well known that such currents existed over the crest of the Cincinnati Arch during the Eden and Maysville accumulation (Bucher, 1919), and many of the calcarenites and coquinites still preserve the oscillatory ripple bedding planes within them; more often they preserve surface undulations due to destructional rather than constructional work of the oscillating currents on the sea-floor (megaripples). The anterior blade, with its proximal curvature and blunt ploughshare median prominence, would have served as a most effective stabilizer in a bottom current proceeding from the peduncle toward the brachia; the second blade would have been most effective for opposing a counter movement of a current.

It may be that the styloid served a kind of ratchet function in "backward" locomotion when a definite need for a shift of scene was indicated. This would be possible only if the theca and peduncle were flexibly united, as they always seem to have been. The proximal overhang of the basal angles of most carpoid thecae would have made any great lateral movements impossible. On the other hand, the median emarginations of the carapace and plastron bespeak considerable dorso-ventral mobility. The deeper emargination of the plastron than of the carapace seems to indicate that the animal flexed upward on the peduncle-thecal junction to a greater degree than could the theca be raised distally from the same junction. The shallowness of the proximal emargination of the carapace may correlate with the relatively slight amount of distal elevation of the theca to be expected from the prop function of the delicate and short brachial spines, if they actually functioned thus.

Following this reasoning, it may have been possible for the animal to shift position and even have achieved a kind of hitching locomotion along the seafloor by a succession of up-flexings at the proximal point of the body. Such locomotion might be visualized as embracing these stages: a) with the stylocone anchor set in the seafloor sediments, the proximal point was upflexed, thus giving a slight proximad movement of the theca; b) by dorsally recurving the distal peduncle toward the theca, the stylocone would be released from the sediment, and the proximal line come to lie again flat on the bottom, thus completing the axial progression of this hitch; c) by relaxation of dorsal peduncle muscle tension, and ventral muscle contraction, the ventral stylocone would be once more emplaced; probably concomitant with the process emplacement the proximal upflexion took place.

Such inching along the seafloor need not have been any slower or more painful than the progression of a terrestrial "measuring worm" insect larva. In the same beds with the *Enoploura* remains, and especially abundantly so in the Corryville formation of the Cincinnati area, segmented "worm trails" are found of proper proportions to have fitted the carpoid body and styloid process.

The axial progression of the enoplourid, as for all carpoids, seemingly, may have been in part directed toward shifting scene in accordance with the shifting of bottom currents, in which the animal fed impassively on the fine particles washed over it by the moving waters. It is conceivable also that the repeated stylocone emplacement served a harrowing function, stirring the bottom and releasing additional potential food particles for microphagic consumption.

It is premature as yet to define the direction of axial progress in *Enoploura*, or any other carpoid; there is no general consensus as to which was fore and aft in body orientation. Certainly there is a great deal of evidence to support the general zoological concept of cephalization deriving from the advantage inherent in extra-sensitivity acquirement at the buccal, counter-current, end of a motile aquatic creature. Whether the enoplourid (general carpoid) organization and habitus have any bearing on the evolutionary history of cephalized creatures must yet be ascertained.

Of course, if Chauvel (1941) is correct in his interpretation of the orientation of the alimentary tract in *Mitrocystella*, then the peduncle end of the calyx would be the buccal end, and the nerve centers presumably anterior. Under this scheme the carpoid locomotion outlined above would have been in a "forward" direction after all.

In the customary orientation of the Mitrata both mouth and anus are located in the tegmenal area, between the brachia; the gut is imagined as making a loop as in Pelmatozoic echinoderms. *Enoploura* reveals no opening in the basal theca; nor do most carpoids, apparently. Jaekel (1918) accounted for the absence of an anal aperture in the Mitrata by suggesting that in adulthood the alimentary tract became a blind caecum and that a single aperture in the inter-brachial tegmenal area served both subvective and excretory function through periodic pulsation of the gut. *Enoploura* affords no answer to the problem; so far no apertures are known, although the arcuate tegmenal area is large enough to accommodate a variety of ostia. In *E. popei* it was noted that the second somatic plate is very loosely set among the other plastron plates, and that the open sutures are irregular and suggestive of openings into the interior of the theca. This may be purely an accidental condition. It seems soundest still to assume that *Enoploura* was organized in much the manner of the type species of *Basslerocystis*, according to Kirk's (1911) plan. Such a scheme may well apply to all the brachia-possessing Mitrata.

ACKNOWLEDGMENTS

Every stage of the investigation of *Enoploura*, since Meek's original description of the species *balanoides*, has been based on material discovered by and made available to science through the generosity of amateur fossil-hunters. Very few specimens referable to this genus have been found by professional geologists or paleontologists.

The debt of Paleontology to the amateur collector is very great indeed, and especially so for the materials on which knowledge of the rich Cincinnatian fauna has been acquired during the last century.

Aware of the traditionally important role of the amateur in paleontology, a large group of Cincinnatians have organized themselves during the last decade into a society of fossil-hunters, the "Dry Dredgers," dedicated to the furtherance of earth science. The Department of Geology at the University of Cincinnati is proud to have served as sponsor of the society, and is happy to acknowledge the substantial additions to its scientific collections that this group has

made over the years. Not a single paper treating of the local fossil fauna has appeared since the society was organized that Dry Dredger material has not figured prominently in it. Several times, indeed, such material has initiated an investigation as in the present instance.

Four specimens of *Enoploura* from the Cincinnati area were loaned for comparisons by the United States National Museum through the courtesy of Dr. G. Arthur Cooper, Curator of Paleontology and Paleobotany. Dr. Ray S. Bassler furnished data on rare publications. Several papers inaccessible in Cincinnati were loaned by Dr. G. Winston Sinclair of the University of Michigan who also loaned important comparative materials of Middle Ordovician carpoids from Canada.

The careful, microscopic preparation of the holotype of *E. popei* was largely done by Mr. John K. Pope, discoverer, and generous donor to the University of Cincinnati Museum. The drawings for the text figures were made by my wife, Anneliese S. Caster, who also helped in the preparation of the manuscript. The photographs were made by Mr. William B. Macke. The excellence of the technical contributions of each of these is self-evident.

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PLATES

PLATE I (5)

The cost of the plates was met by the Faber Fund for Paleontology of the University of Cincinnati Museum.

EXPLANATION OF PLATE 1 (5)

Figure		Page
1-3.	**Enoploura popei** Caster, n. sp.	34

Three views of holotype. Fig. 1 plastron (concave) view; fig. 2, carapace (convex) side; fig. 3 "left" side, plastron side down. Line between figs. 1 and 2 represents natural median length. Corryville formation (Upper Ordovician: Maysville), Stonelick Creek, Clermont Co., Ohio. Univ. Cincinnati Mus. No. 25993.

4-6.	**Enoploura popei** Caster, n. sp.	37

Three views of paratype, No. 2. Fig. 4 carapace side; fig. 5, plastron; fig. 6, lateral view. The line between figs. 4 and 5 represents natural median length of the fragment. Corryville formation, Tower Lake quarry, near Dent, Ohio, outskirts of Cincinnati, Ohio. Univ. Cincinnati Mus. No. 25257.

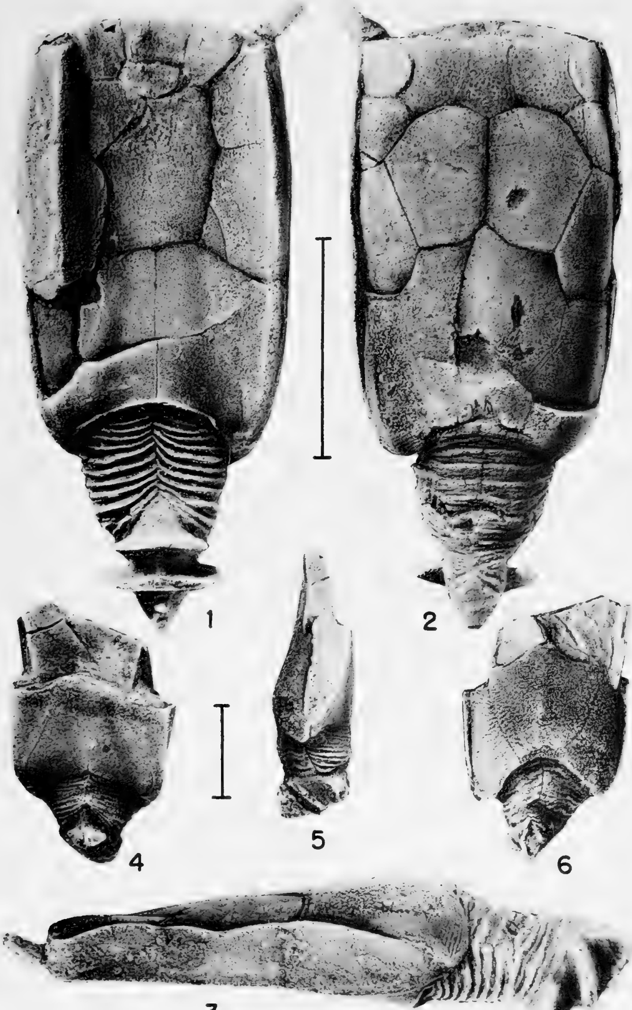
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PLATE 2 (6)

EXPLANATION OF PLATE 2 (6)

Figure		Page
1, 2.	**Enoploura**, sp.	30

Possibly referable to E. crustacea (Haeckel). Fig. 1 shows interior view of the plastron and is noteworthy for the preservation of the anteriorly converging carinae. Many flattened polygonal plates at the anterior end probably represent portions of the original tegmen. Fig. 2 is an amplification of the anterior region to show the crenulations on an adtegmenal plate (possibly the "M" plate). Horizon unknown but presumably Upper Richmond, from Madison, Indiana. Univ. Cincinnati Mus. No. 25708. Line represents median natural length of the calyx.

3-6.	**Enoploura crustacea** (Haeckel)	30

Fig. 3-5 are drawings of the Newton specimen illustrated by Wetherbyi 1879A, pl. 7, fig. 1d,e,f from the Upper Richmond subseries, Richmond, Indiana. This is the holotype of Haeckel's (1896) species. Fig. 6 appears to be conspecific but was referred to his species with doubt by Haeckel. This is the Patterson specimen, from the Upper Richmond, at Oxford, Ohio, which Wetherby (1879A) illustrated as fig. 1g. Natural size.

7-9.	**Enoploura balanoides** (Meek)	28

Three views of the type species. This is the Harper specimen and only example known of the species, *s.s.*, and only carpoid so far recovered from the type horizon. Illustrations from Meek, 1873, pl. 6 bis.. fig. 6a-c. From an elevation above mean low water of the Ohio River at Cincinnati, Ohio (Wetherby 1879), which corresponds to the Fairmount formation (Maysville). Natural size.

10-12.	**Enoploura wetherbyi** Caster, n. sp.	32

Three views of the holotype which is Wetherby's specimen from the Upper Richmond at Osgood, Indiana. From Wetherby (1879A, pl. 7, fig. 1, 1a,b). Natural size.

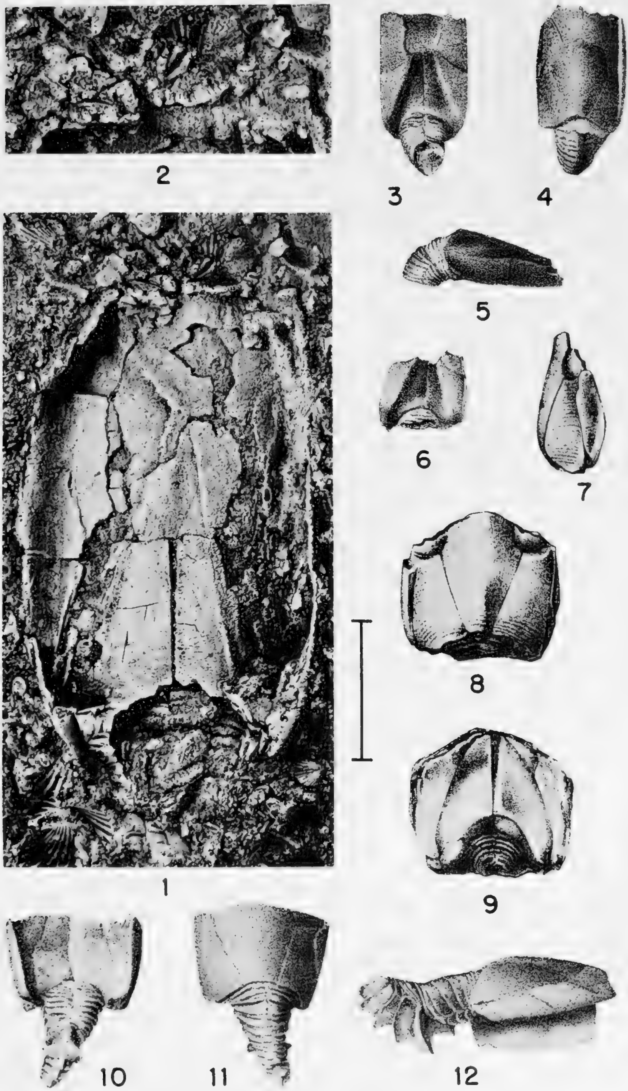
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PLATE 3 (7)

EXPLANATION OF PLATE 3 (7)

Figure		Page
1-3.	**Enoploura popei** Caster, n. sp.	37
	Three views of paratype No. 2. See also Plate 1, fig. 4-6. Univ. Cincinnati Mus. No. 25257.	
4-6.	**Enoploura popei** Caster, n. sp.	36
	Three views of paratype, No. 1. From the Corryville formation on Ravine Street, Cincinnati, Ohio. Collector: Joseph Stocker. U. S. Nat. Mus., No. 114798. Length indicated by line to right.	

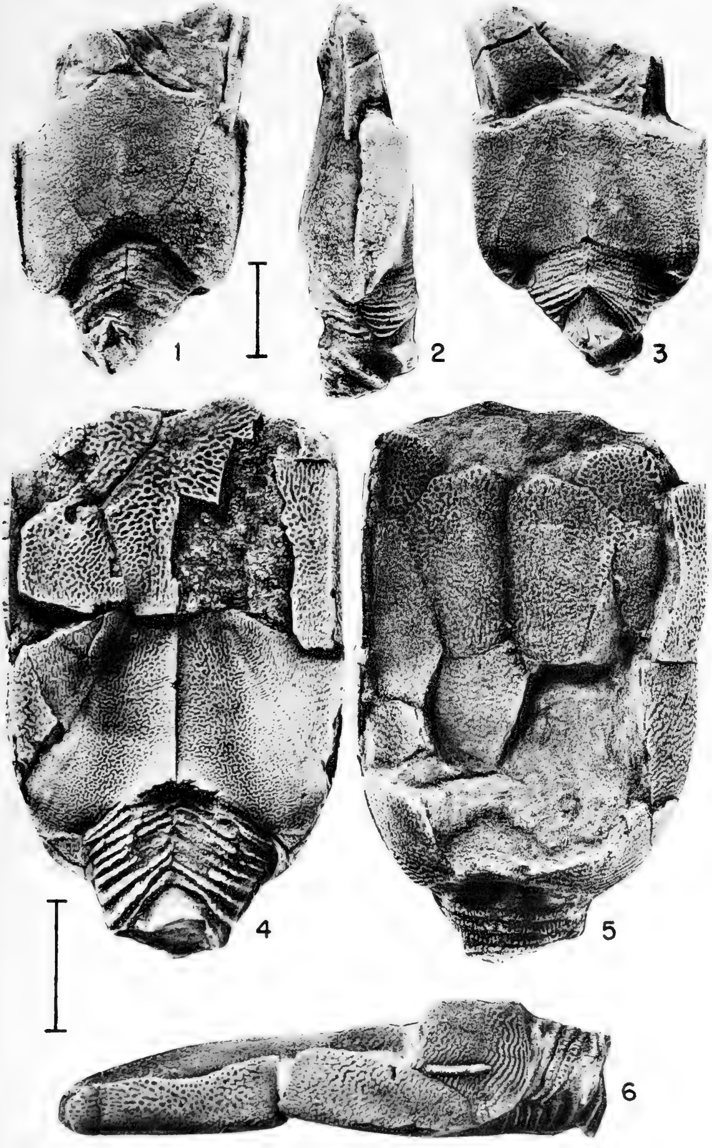
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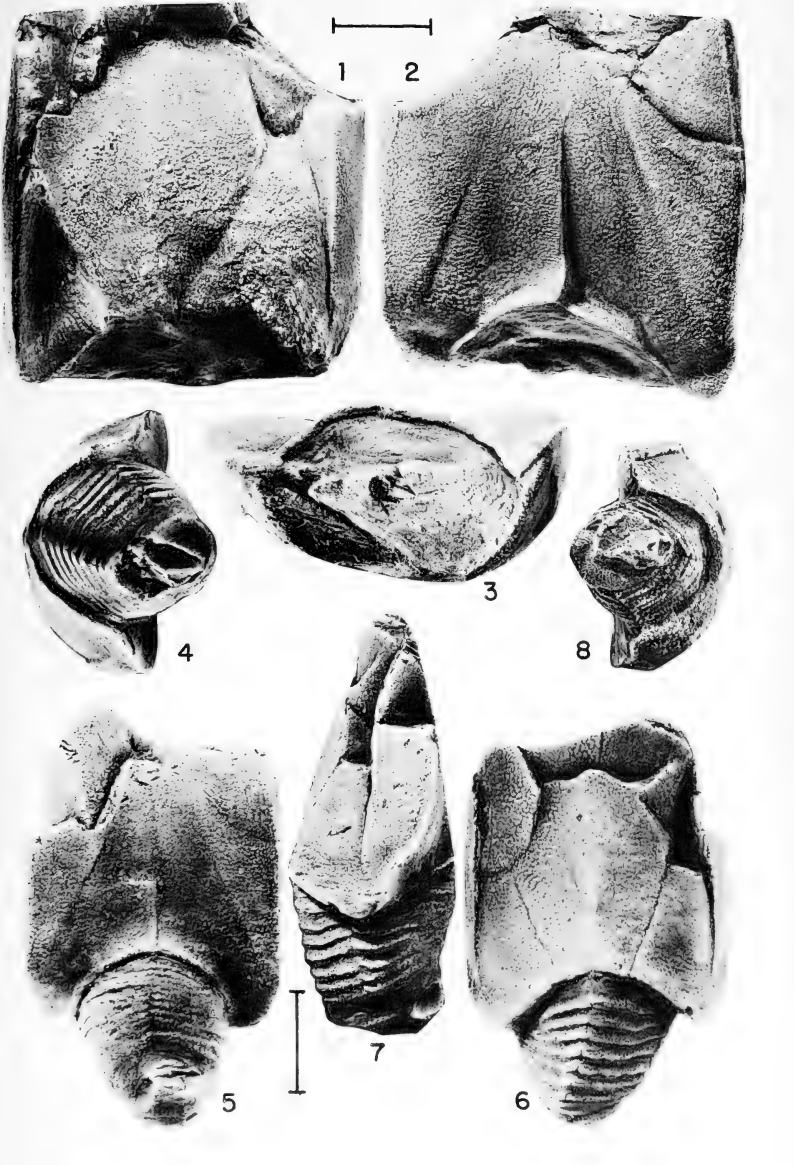
Plate 4 (8)

EXPLANATION OF PLATE 4 (8)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NEW OSTRACODA FROM THE MIDDLE SILURIAN NEWSOM SHALE OF TENNESSEE

By

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NEW OSTRACODA FROM THE MIDDLE SILURIAN NEWSOM SHALE OF TENNESSEE

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ABSTRACT

Seven new species of Ostracoda belonging to six genera are described from the Middle Silurian Newsom shale of Tennessee. *Thlipsuroides, Hemiaechminoides, Newsomites, Spinobairdia,* and *Pseudocyproides* are new genera The definition of *Daleiella* is expanded to include a new species, the first known from North America.

INTRODUCTION

The Silurian Ostracoda of the Appalachian Province of the United States are well known from the work of Ulrich and Bassler (1923) and of Swartz (1933). Coryell and Williamson (1936) have described a fauna from the Waldron shale of Indiana, and a few other papers describing one or two species each have been published. With these few exceptions the Silurian Ostracoda of most of the United States remain practically a virgin field of study. The authors originally planned to describe the entire ostracod fauna of the Newsom shale, but it soon became apparent that this would be impractical without access to a large number of European publications, many of them published in journals which can be consulted in only a few of our largest libraries. For this reason only a few of the more conspicuous elements of the fauna are described in the present paper. It is hoped that circumstances will permit publication of the remainder of the fauna at a later date.

The Newsom shale, as exposed in the vicinity of its type section at Newsom, Tennessee, is a soft calcareous shale which upon weathering soon breaks down into a yellowish clay. It contains an abundant fauna of megafossils which is closely related to that of the Waldron shale of Indiana. Only a small minority of the megafossils of the two formations are not common to both, and the exceptions are usually the rarer species. To the casual collector the only noticeable differences in the faunas are the somewhat greater abundance of corals and pelecypods in the Newsom shale and the greater predominance of brachiopods in the Western shale. In addition, the rather common but inconspicuous *Hyolithes newsomensis* appears to be restricted to the Newsom shale.

In view of this similarity of the megafossils of the two formations, it was with considerable surprise that we found only one Waldron ostracod species occurring commonly in the Newsom, although extensive search eventually yielded representatives of six others. The following species described from the Waldron shale have been found in the Newsom, but, with the exception of *"Leperditia" faba,* they are extremely rare and are represented in our Newsom collections by only one or two specimens:

Aechminaria robusta Coryell and Williamson
?*Bairdia planoconvexa* Coryell and Williamson
Beyrichia waldronensis Ulrich and Bassler
Bythocypris? sinuosa Coryell and Williamson
Euprimitia elongata Coryell and Williamson
"Leperditia" faba Hall
Paraechmina indianensis Coryell and Williamson

ACKNOWLEDGMENTS

We regret that space does not allow us to thank individually everyone who has contributed to this paper, but the two persons in whose honor we have named *Spinobairdia kellettae* and *Spinobairdia shideleri* have made especially significant contributions.

Mrs. E. H. Nadeau (Betty Kellett) formerly of Washington University, St. Louis, Missouri, made many valuable suggestions regarding the relationships of several of the new genera and gave freely of her time at all stages of the preparation of the manuscript. Any merit which this paper may possess is due in large measure to her constructive criticism.

Dr. W. H. Shideler of Miami University, Oxford, Ohio, originally suggested the problem and has continued to give the authors the benefit of his advice and encouragement.

LOCALITY

All of the Ostracoda described in this paper were taken from a single exposure of the Newsom shale in a small abandoned quarry in the side of a hill overlooking Newsom, Tennessee, from the north-northwest. The hill lies just west of the road entering Newsom from the north and just south of the railroad track, in the south-west quadrant of their intersection.

ILLUSTRATIONS

All illustrations are camera lucida drawings by the junior author. They have been independently checked for accuracy by Mrs. Betty Kellett Nadeau and the senior author.

SYSTEMATIC DESCRIPTIONS

Family **APARCHITIDAE** Jones, 1901

Genus **HEMIAECHMINOIDES** Morris and Hill, n. gen.

Type species.—Hemiaechminoides monospinus Morris and Hill, n. sp.

Description. — Carapace subovate; hinge line long, straight, slightly less than greatest length; right valve overlaps left on all free margins; left valve expanded upward and outward dorsally into a dorsally flattened expansion which is produced into an upward, outward, and backward pointing spine; right valve bears neither dorsal expansion nor spine. Hingement unknown.

The left valve of *Hemiaechminoides,* if found alone, would probably be assigned to the genus *Aechmina,* but the lack of a spine on the right valve and the presence of overlap demonstrate a complete lack of relationship to that genus. The unornamented right valve might easily be confused with *Leperditia* if found alone, but no other described genus is likely to be confused with *Hemiaechminoides* if complete carapaces are available.

Range.—Middle Silurian, known only from the Newsom shale of Tennessee.

Aechmina inaequalis Roth (1929) may be related to *Hemiaechminoides*, although it certainly is not congeneric with the type species. Its more recent assignment to *Phanassymetria*[1] (Warthin, 1945) may be correct, but the fact that Roth did not include it in *Phanassymetria* when he described the genus, even though *A. inaequalis* was described in the same paper, shows that he did not consider it typical of *Phanassymetria.* The present authors have been unable to examine the types. The presence of the large normal pore canals of *Phanassymetria* would indicate probable affinities with that genus, whereas their absence would indicate that it is probably a new genus related to *Hemiaechminoides.*

Hemiaechminoides monospinus Morris and Hill, n. sp. Plate 2, figs. 2 a-c; Text fig. 1 h-j

Description.—Carapace subovate in lateral view; hinge line straight, about three-quarters greatest length; ventral margin convex; ends rounded, meeting hinge line at obtuse cardinal angles; greatest length slightly above midheight; greatest height at about middle of posterior half; right valve larger than left, overlapping it rather evenly on all free edges; overlap is slightly greater at ends; left valve expanded dorsally above and beyond hinge line; expansion is produced into an upward, outward, and backward pointing spine; base of spine is not well defined but grades into convexity of dorsal expansion; spine thins rapidly, probably terminating in a thin sharp point in specimens where it is well preserved. Lenticular in dorsal view; ends narrowly rounded, sides evenly convex. Surface smooth. Hingement unknown.

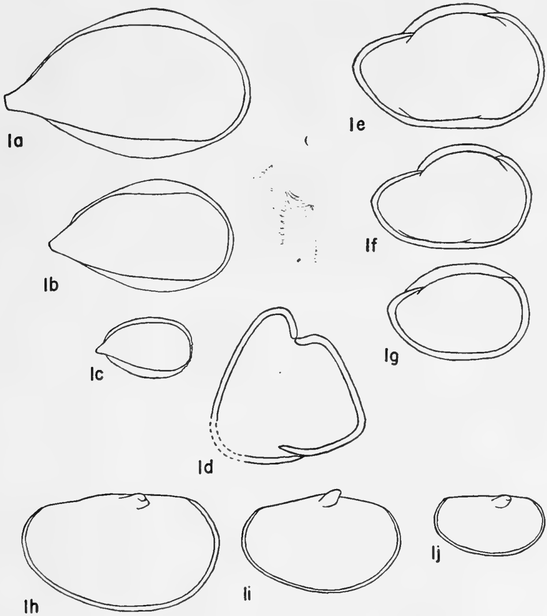
As seems to be true in most Ostracoda, the posterior "fills out" during ontogeny; the posterior of young specimens is, therefore, narrower than that of adults. In addition there is slight variation in the length-height ratio; this seems to be due to individual variation

[1] Since the above was written the senior author has had the opportunity to examine topotypes of the type species of *Phanassymetria* Roth, 1929, and of *Pachydomella* Ulrich, 1891. The two species seem to be congeneric, which would make *Phanassymetria* a subjective junior synonym of *Pachydomella.* Both are thick shelled and possess coarse normal pore canals similar to those of *Tubulibairdia,* from which they differ in the presence of a conspicuous dorsal groove. In general outline of lateral and dorsal aspects the two species are similar to each other, as well as to the type species of *Tubulibairdia.* Apparently both *Pachydomella* (*Phanassymetria*) and *Tubulibairdia* belong in the Bairdiidae. The tendency toward development of a dorsal groove in the Bairdiidae may be seen in an undescribed species of "*Bairdia*" from the Permian of Texas. (See Kellett, 1943, *Permian Ostracodes,* Jour. Paleont., vol. 17, p. 621).

rather than dimorphism, as intermediate stages have been found between the extremes.

Measurements.—Holotype: length, 0.86 mm.; height, 0.55 mm.; paratypes: length, 0.94 mm., 0.74 mm., and 0.52 mm.; height, 0.52 mm., 0.48 mm., and 0.28 mm.

Repository.—Holotype and figured paratypes: United States National Museum, Nos. 123223 and 123224a-c. Unfigured para-



Text figure.—1a-d. *Daleiella americana* Morris and Hill, n. sp.: a. The holotype, a mature individual. b, c. Two paratypes. c is the smallest individual found. d. Thin section of an adult individual through the approximate position of greatest height. 1e-g. *Newsomites monospinus* Morris and Hill, n. sp. The holotype (largest specimen) and two paratypes showing increase of dorsal inflation and relatively rapid development of posterior with increasing age. 1h-j. *Hemiaechminoides monospinus* Morris and Hill, n. sp. Three paratypes showing ontogeny. Note "filling out" of posterior with increasing age. Varying appearance of dorsal spines is due to preservation. All figures ×38.4.

types: American Museum of Natural History; Paleontological Research Institution; Paleontologisk Museum, University of Oslo, Oslo, Norway; Senckenberg Museum, Frankfort-am-Main, Germany.

This species is common at Newsom.

Family **THLIPSURIDAE** Ulrich, 1894

Genus **THLIPSUROIDES** Morris and Hill, n. gen.

Type species.—Thlipsuroides thlipsuroides Morris and Hill, n. sp.

Description.—Carapace subreniform; left valve narrowly overlaps right. Surface of each valve bears two elongate subparallel grooves which may be bordered posteriorly by a poorly defined ridge. The presence of large pits at bottom of the grooves may also be a character of generic importance. Hingement unknown.

Thlipsuroides resembles the Middle Devonian genus *Bairdites* but differs in having two elongate grooves in place of the large posterior depression of that genus. In addition the overlap is much less pronounced.

Range.—Middle Silurian to Lower Devonian, Newsom shale of Tennessee and Haragan marl of Oklahoma. An undescribed species has been noted by the senior author in the Middle Silurian Bainbridge formation of Missouri.

Although *Thlipsuroides* resembles certain Bairdiidae in shape and in the possession of a somewhat pointed posterior, it is believed that the ornament more strongly indicates affinity with the Thlipsuridae. *Bairdites,* placed in the Bairdiidae by the original authors, may be more closely allied with the Thlipsuridae. Until the types can be restudied with this possibility in mind it is tentatively left in the Bairdiidae.

Previously described species belonging in *Thlipsuroides* are *Thlipsura striatopunctata* Roth and *Thlipsura parallela* Roth, both from the Lower Devonian Haragan marl of Oklahoma.

Thlipsuroides thlipsuroides Morris and Hill, n. sp. Plate 2, fig. 1 a, b

Description. — Carapace subreniform; dorsal margin evenly rounded; anterior margin narrowly rounded; ventral margin sinuate, concave slightly anterior of midlength, convex at ends; central area of valves flattened, with surface sloping sharply downward to free edges; greatest length well below midheight; greatest height at or somewhat posterior to midlength; left valve larger than right, overlapping it except for part of postdorsal slope; overlap is more pronounced along anterodorsal slope and in concave portion of ventral margin; at posterior left valve projects backward and above narrowly rounded right valve, forming a bluntly pointed posterior. Each valve is ornamented by two subparallel longitudinal furrows which extend along central portion of valve for slightly more than half its length; ventral furrow is nearly straight, but shows tendency to curve upward at ends; dorsal furrow is convex upward; furrows of irregular depth, deeper pitlike depressions appear at irregular intervals along their length; furrows bordered at posterior by a conspicuous but poorly defined ridge. In dorsal view sides are flattened, curving evenly inward at anterior; at posterior the flattened sides break sharply inward at posterior ridge and become slightly concave as they approach posterior extremity. Surface smooth. Hingement unknown.

Measurements.—Holotype: length, 1.88 mm.; height, 0.95 mm.

Repository.—Holotype: United States National Museum, No. 123225. Unfigured paratypes: American Museum of Natural History; Paleontological Research Institution; Paleontologisk Museum, University of Oslo, Oslo, Norway; Senckenberg Museum, Frankfort-am-Main, Germany.

Thlipsuroides thlipsuroides differs from *T. striatopunctata* (Roth) in its greater size, its proportionately greater length, and in the flatness of its sides. From *T. parallela* (Roth) it differs in the possession of a more conspicuous posterior ridge and its proportionately greater length. The species is rather common.

Family **BAIRDIIDAE** Sars, 1887

Genus **SPINOBAIRDIA** Morris and Hill, n. gen.

Type species.—Spinobairdia kellettae Morris and Hill, n. sp.

Description.—Carapace small, elongate, *Bairdia*-like in side view; posterior acuminate; anterior narrowly rounded to acuminate; left valve larger than right, overlapping on all free edges; overlap strongest at dorsum. A large spine projects outward just behind midlength of each valve. Ventral surface tends to be flattened.

Range.—Middle Silurian, known only from the Newsom shale of Tennessee.

The relationships of *Spinobairdia* to *Bairdia* and related genera are not clear. The shape of the carapace is more like a typical Carboniferous *Bairdia* than are most early Paleozoic species assigned to that genus; indeed, if it were not for their possession of a large spine on each valve, neither of the two known species of *Spinobairdia* would look out of place in a Carboniferous fauna.

Spinobairdia kellettae Morris and Hill, n. sp. Plate 1, figs. 2 a-c

Description.—Carapace small, elongate; hinge line straight, slightly more than one-third greatest length; dorsal slopes long and straight; anterior narrowly rounded; anteroventral margin straight, meeting straight ventral margin proper at a rounded obtuse angle; ventral margin curves gently upward to bluntly acuminate posterior; greatest height at about middle of anterior half; greatest length well below midheight. Left valve narrowly overlaps right on all free margins, most conspicuously, although still narrowly, on ventral margin anterior of midlength, forming a slight ventral lip; left valve extends dorsally beyond straight hinge line to give gently convex dorsal outline. Somewhat spindlelike in dorsal view; anterior sharply pointed, posterior somewhat less so. A conspicuous spine extends outward and slightly upward just behind midlength of each valve at about midheight; spine circular in section, broadens rapidly at base to merge with convexity of valve. Surface smooth.

Measurements.—Holotype: length, 0.99 mm.; height, 0.44 mm.

Repository.—Holotype: United States National Museum, No. 123226.

Spinobairdia kellettae is rare at Newsom.

Spinobairdia shideleri Morris and Hill, n. sp. Plate 1, figs. 3 a, b

Description.—Carapace small, elongate; hinge line straight or nearly so; dorsal margin broadly convex, straightens somewhat as it enters the anterior and posterior slopes; ventral margin nearly straight, curves upward to the subequal bluntly pointed ends; greatest height at about middle of anterior half; greatest length slightly below midheight. Left valve larger than right, overlapping it on all margins; overlap conspicuous at dorsum and along postdorsal slope, elsewhere less pronounced. In dorsal view valves are evenly convex; anterior sharply pointed; posterior somewhat blunter; greatest thickness at about midlength. Ventral surface flattened. A conspicuous spine extends outward and backward from each valve, originating slightly behind midlength at about midheight. Surface smooth.

Measurements.—Holotype: length, 0.74 mm.; height, 0.33 mm.

Repository.—Holotype: United States National Museum, No. 123227. Unfigured paratypes: American Museum of Natural History; Paleontological Research Institution.

Spinobairdia shideleri differs most conspicuously from *S. kellettae* in the definite backward inclination of the spines. In addition the adult of *S. shideleri* is somewhat smaller and the dorsal overlap is more pronounced. *S. shideleri* is rare at Newsom.

Genus **DALEIELLA** Boucek, 1937

Daleiella Bouček, 1937, Soc. Roy. Bohême, Mém. for 1936, No. 2, p. 7, fig. 5.

Type species.—*Cythere corbuloides* Jones and Holl, 1869.

Bouček's original diagnosis of *Daleiella* is as follows:

> Carapace strongly inequivalved; smaller valve rather strongly convex, larger typically triangular (in cross section) with a flat middle portion. The carapace, seen from above, is somewhat pointed anteriorly and very thick. (*Translation.*)

The American species described below seems to be congeneric with the type species of *Daleiella,* although a redefinition of the genus is neccessary to accommodate it. The definitely acuminate posterior of the new species suggests that Bouček's orientation should be reversed, making the left valve the larger. *Daleiella,* as expanded, may be described as follows:

Description.—Carapace strongly inequivalved with left valve the larger; subtriangular in section, with broad flattened venter; left valve flattened laterally; right valve either flattened laterally or convex, may be acuminate posteriorly. Hinge line slightly to strongly impressed. Hingement unknown.

Range.—Middle Silurian, Newsom shale of Tennessee, Wenlock of England, and Silurian (e-a) of Bohemia.

Certain species of *Daleiella* bear some resemblance to *Phanassymetria* Roth or *Tubulibairdia* Swartz, but the American species, at least, lacks the thick shell and the coarse normal pores of those genera.

Daleiella americana Morris and Hill, n. sp. Plate 1, figs. 1 a, b; Text figs. 1 a-d

Description.—Carapace tumid; hinge line straight, depressed, slightly more than one-third length of carapace; dorsal margin convex, broadly rounded posteriorly, somewhat truncate anteriorly; anterior margin evenly convex; posterior acuminate; greatest height near middle of anterior half; greatest length well below midheight; left valve much larger than right, overlapping it on all edges; overlap strongest at dorsum and at middle of flattened venter, narrower at anterior. Posterior of right valve produced into a laterally flattened spine which projects beyond the bluntly pointed posterior of larger right valve. Valves strongly tumid ventrally, breaking sharply inward so that venter is nearly flat; greatest thickness slightly in front of midlength near venter. Surface smooth. Hingement unknown.

Measurements—Holotype: length, 1.15 mm.; height, .64 mm.; paratypes: lengths, 0.85 mm. and 0.43 mm., heights, 0.53 mm. and 0.29 mm.

Repository.—Holotype and figured paratypes: United States National Museum, Nos. 123228 and 123229 a, b. Unfigured paratypes (young specimens): American Museum of Natural History, Paleontological Research Institution.

Daleiella americana differs from *D. corbuloides* and other known species of *Daleiella* in the presence of the posterior spine of the right valve and in the central flattening of the right valve. *D. americana* is the only known species of *Daleiella* from North America. The species is not uncommon at Newsom, but most specimens found are young individuals. Adults are very rare.

Genus **NEWSOMITES** Morris and Hill, n. gen.

Type species.—*Newsomites pertumidus* Morris and Hill, n. sp.

Description.—Carapace very tumid, with thickness nearly equal to length; shell thick; one valve overlaps the other except along hinge line; valves strongly inflated, expanded dorsally; hinge line short, straight, depressed; posterior margin narrowly rounded; posterior relatively compressed. In dorsal view posterior is pointed. Surface smooth. Hingement unknown.

This genus was at first oriented with the most strongly inflated portion at the venter, as is the case with *Brachycythere* and other similar post-Paleozoic genera, but thin sections have shown the presence of hingement proving that the orientation here adopted is correct, at least with respect to top and bottom.

The extreme tumidity and expanded dorsum distinguish *Newsomites* from most other genera. It bears some resemblance to *Tubulibairdia* but lacks the coarse normal pore canals of that genus.

Range.—Middle Silurian. Known only from the Newsom shale of Tennessee.

Newsomites pertumidus Morris and Hill, n. sp. Plate 2, figs. 3 a-c; Text figs. 1 e-g

Description.—Carapace small, very tumid; hinge line straight, depressed; dorsum strongly inflated, convex; anterior margin evenly rounded; ventral margin slightly convex to nearly straight, bends upward posteriorly into truncate postventral margin; posterior margin narrowly rounded, acute, relatively compressed; left valve usually overlaps right on all free margins, but overlap may be reversed; greatest length slightly above midheight; greatest height and thickness at about midlength. In dorsal view posterior is pointed, sides strongly and rather evenly convex; thickness only slightly less than length. Surface is faintly pitted, but this is probably due to weathering.

Measurements.—Holotype: length, 0.89 mm.; height, 0.62 mm. Paratypes: lengths, 0.77 mm. and 0.64 mm.; heights, 0.50 mm. and 0.48 mm. Paratype with reversed overlap: length, 0.90 mm.; height, 0.65 mm.

Repository.—Holotype and figured paratypes: United States National Museum, Nos. 123231 and 123232 a-c. Unfigured paratypes: American Museum of Natural History, Paleontological Research Institution; Paleontologisk Museum, University of Oslo, Oslo, Norway; Senckenberg Museum, Frankfort-am-Main, Germany.

Genus **PSEUDOCYPROIDES** Morris and Hill, n. gen.

Type species.—*Pseudocyproides alatus* Morris and Hill, n. sp.

Description.—Carapace small, *Bairdia*-like in side view; ventral surface nearly flat with the edges extending outward to form a thin alate expansion which in dorsal view resembles a frame around the vaulted carapace; left valve overlaps right in dorsal, anterior, and posterior margins. Surface smooth. Hingement unknown.

Range.—Middle Silurian, known only from Newsom shale of Tennessee.

In general appearance *Pseudocyproides* strongly resembles the Recent genus *Pseudocypris* Daday (see Sars, 1924 and 1924a), but it differs from that genus in the much smaller size of the adult and in the possession of a definite overlap. *Pseudocypris* is known only from freshwater in Africa, whereas *Pseudocyproides* occurs in undoubted marine sediments. *Pseudocypris*, on the incontravertable evidence of the soft parts, is assigned to the family Cypridae. Because of the overlap and bairdian shape of *Pseudocyproides* it is here tentatively placed in the Bairdiidae. It is believed that the strong resemblance of the two genera is a striking example of homeomorphy rather than a demonstration of true relationship. The great time interval between the occurrences of the two genera seems to strengthen this belief.

Pseudocyproides alatus Morris and Hill, n. sp. Plate 1, figs. 4 a-c

Description.—Carapace small, *Bairdia*-like in side view; dorsum convex, arched; anterior margin narrowly rounded; posterior subacuminate; ventral margin sinuate, with anterior extremity extending slightly below plane of ventral face; greatest length just above ventral margin; greatest height at midlength; left valve larger than right, overlapping most conspicuously along dorsal margin, somewhat less along anterior and posterior slopes. Venter is flattened, extends laterally into alate expansion without break. In dorsal view this thin alate expansion may be seen to encompass the posterior three quarters of the carapace, resembling a flattened frame around the vaulted carapace; widest portion of expansion just posterior of midlength; anteriorly it curves gently inward to merge with the outline of the carapace proper at a point about one quarter of the length from the anterior extremity; posteriorly it curves backward, roughly paralleling outline of carapace, curving inward at posterior extremity. Surface smooth.

Measurements.—Holotype: length, 0.53 mm.; height, 0.25 mm.

Repository.—Holotype: United States National Museum, No. 123230.

P. alatus resembles most species of the living genus *Pseudocypris* but is easily distinguished from them by its much smaller size and its possession of overlap. Known species of *Pseudocypris* display sexual dimorphism, whereas available material of *Pseulocyproides* shows no dimorphism.

This species is very rare at Newsom.

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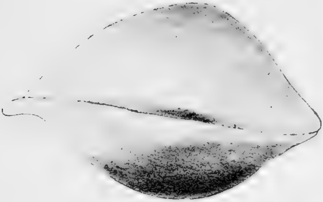
PLATES

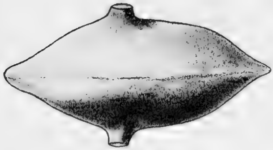
PLATE I (9)

EXPLANATION OF PLATE 1 (9)

All figures ×45



1a



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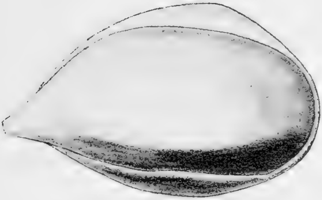

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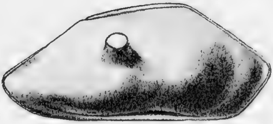

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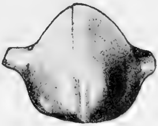

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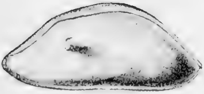

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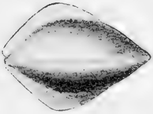

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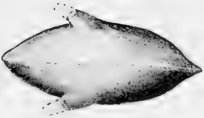

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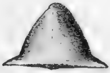

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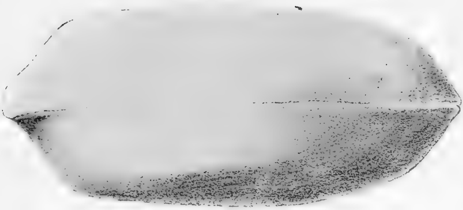

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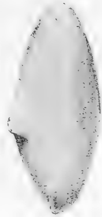

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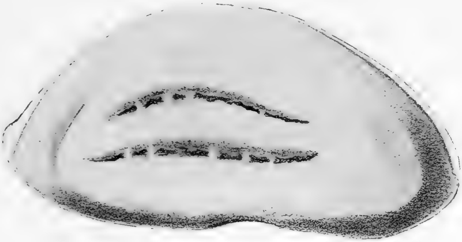

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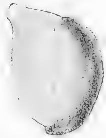

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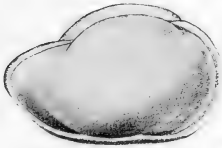

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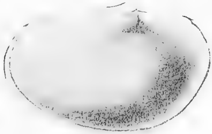

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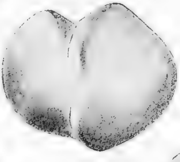

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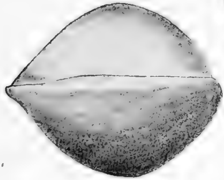

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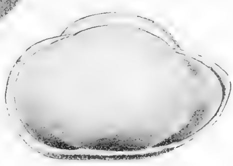

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Ithaca, New York
U. S. A.

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TRINIDAD PALEOCENE AND LOWER EOCENE GLOBIGERINIDAE

By

P. Bronnimann

December 29, 1952

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

CONTENTS

TRINIDAD PALEOCENE AND LOWER EOCENE GLOBIGERINIDAE

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Pointe-a-Pierre, Trinidad, B. W. I.

INTRODUCTION

The investigation of Trinidad Globigerinidae (Bronnimann, 1952) is continued in the present paper by the description of 12 of the more prominent *Globigerina* and of one *Globorotali*a species. The Foraminifera originate from the type locality assemblages of the Paleocene Soldado and Lizard Springs formations and from the lower Eocene Ramdat marl of the Navet formation, as well as from a heterogeneous mudflow fauna encountered in the Kapur Ridge-Stone River area, southeastern Trinidad. Some of the pelagic species, excluding the Globigerinae, have been reported on by Cushman and Renz (1942, 1946, 1948), who also supplied data on locality, age, and lithology of the type samples. The observation and catalogue numbers mentioned in the following refer to samples collected at the type localities mainly by H. G. Kugler and H. H. Renz. The mudflow sample Sh. 100, T.L.L. Cat. No. 143838, was collected by M. F. Shepherd. The figures on Plates 1-3 are Abbé Mirror drawings by the author.

STRATIGRAPHIC DISTRIBUTION

The type locality samples were analyzed in detail and the following species determined or named as new species:

[1] Now with the Cuban Gulf Oil Company, Habana, Cuba.

Globigerina finlayi Bronnimann, n. sp. Globigerina hornibrooki Bronnimann, n. sp. Globigerina linaperta Finlay, 1939 Globigerina pseudo-bulloides Plummer, 1926 Globigerina stainforthi Bronnimann, n. sp. Globigerina taroubaensis Bronnimann, n. sp. Globigerina triloculinoides Plummer, 1926 Globigerina turgida Finlay, 1939	smooth species
Globigerina collactea (Finlay), 1939 Globigerina gravelli Bronnimann, n. sp. Globigerina primitiva (Finlay), 1947 Globigerina soldadoensis Bronnimann, n. sp.	spinose species
Globorotalia compressa (Plummer), 1926	

The occurrence of these forms in the type locality samples is compiled in Table 1. Samples included by Cushman and Renz (1946, p. 7) in the list of type samples of the upper zone of the Lizard Springs formation, but now considered of doubtful stratigraphic position, as well as the allochthonous sample Sh. 100, from the mudflow in the Kapur Ridge-Stone River area, have been omitted.

1. The distribution of the *Globigerina* species confirms the biostratigraphic subdivision of the Lizard Springs formation into two zones proposed by Cushman and Renz on the different life ranges of *Rzehakina epigona* (Rzehak) var.[2] *lata* Cushman and Jarvis, and var. *minima* Cushman and Renz and other benthonic species. *G. pseudo-bulloides, G. taroubaensis, G. turgida,* and *G. collactea* occur in the upper zone, whereas *G. triloculinoides* and *Globorotalia compressa* appear to be confined to the lower zone of the Lizard Springs formation. The *Globigerina* distribution furthermore shows that the upper zone of the Lizard Springs formation is faunistically closely related with that of the lower Eocene Ramdat marl of the Navet formation. With the exception of *Globigerina,* n. sp. (see p. 21 of this paper) all the *Globigerina* species of the Ramdat marl also occur

[2] The original terminology of "var." is adopted in this paper but the term should be replaced by subspecies. See also under species descriptions.

Species	Lower zone of Lizard Springs formation						Upper zone of Lizard Springs formation					Soldado formation						Navet fmn. Ramdat marl
	50316	50505	50506	50507	50509	50510	50504	50511	50512	50514	50515	6912 b,c	7299	110019	48143	5801 5802 5803	5845a 5847 5847a	59892
Globigerina finlayi			X		X						X							
Globigerina hornibrooki	O	O	●	X	●	●	O		X	X		X		X	X	X	X	O
Globigerina linaperta	●	●	O	●	●	●	O	O	O	●	X	O	X	X	O	O	●	O
Globigerina pseudo-bulloides							●	X	●	●	●	X			X			●
Globigerina stainforthi		X			X				X									
Globigerina taroubaensis								O	X									O
Globigerina triloculi-noides					O	X												
Globigerina turgida										X	X							O
Globigerina collactea									O	O		X		X	O	X	X	O
Globigerina gravelli		X			X	X	X	X	O	X	X							X
Globigerina primitiva	X	X	O	O	X	X	X		O	X	X			X	X			
Globigerina soldadoensis	●	●	●	X	O	X	●	●	●	●	●	X		X	O	O	●	●
Globorotalia compressa					X													

Table 1: Occurrence of some Paleocene-Lower Eocene Globigerinas and Globorotalias in the type localities of the Lizard Springs formation, Soldado formation, and Ramdat marl, Navet formation.
X = Rare O = Common ● = Abundant

in the upper zone of the Lizard Springs formation. Despite a possible ambiguity in the tectonical interpretation of the type locality one must place the upper zone of the Lizard Springs formation between the lower zone of the Lizard Springs formation and the Ramdat marl. On the other hand, *G. finlayi, G. stainforthi,* and *G. primitiva* have not been found in the Ramdat marl.

2. Based on the simultaneous occurrence of the zonal marker *Globorotalia wilcoxensis* var. *acuta* and *Globorotalia crassata* var. *aequa* (Bolli, 1950) in the neritic Soldado formation (Vaughan and Cole, 1941) and in the deeper water facies of the lower zone of the Lizard Springs formation, this lower zone must be considered the time equivalent of the Soldado formation. Nevertheless it must be pointed out that the *Globigerina* assemblages of the two facies are slightly different. Rare specimens of *G. pseudo-bulloides* and *G. collactea,* both absent in the lower zone of the Lizard Springs formation, have been recorded from the Soldado type locality. Furthermore, *G. finlayi, G. stainforthi, G. triloculinoides, G. gravelli,* and *Globorotalia compressa* have been found in the lower zone of the Lizard Springs formation but not in the Soldado formation. From the distribution of these planktonic forms it could be concluded that the type samples of the Soldado formation are stratigraphically higher than those of the lower zone of the Lizard Springs formation, but they would still be within the zone of *Globorotalia wilcoxensis* var. *acuta.*

3. The faunistic break between the Upper Cretaceous *Globotruncana mayaroensis* zone and the lower Tertiary *Globorotalia wilcoxensis* var. *acuta* zone is reflected by the stratigraphic distribution of the Globigerinidae. Excepting for some very rare and reworked specimens, none of the Upper Cretaceous species of the *Rugoglobigerina - Plummerita* (=*Plummerella*)[3] group (Bronnimann, 1952) have been found in the Paleocene Lizard Springs, Chaudiere, and Soldado formations and none of the Paleocene Globigerinae here described are known from the Maestrichtian formations. It is difficult to find in Trinidad the precursors of the simply structured Paleocene

[3] *Plummerita* Bronnimann, Cont. Cushman Found. Foram. Res., vol. III, pts. 3, 4, 1952, p. 146 new name for *Plummerella* Bronnimann, 1952, not De Long, 1942.

Globigerinae amongst any of the Upper Cretaceous representatives, which in ornamentation, apertural and umbilical features are so highly differentiated. The only group of Cretaceous Globigerinae from which the Paleocene forms could have sprung is represented by *G. cretacea* and allied species. The morphology of the *G. cretacea* group, especially the features of the aperture, is not yet sufficiently well known. This, and the fact that Globigerinae of the *G. cretacea* group have not yet been encountered in the post-*Globotruncana lapparenti* zones of the Trinidad Upper Cretaceous, renders this possibility of derivation rather speculative. It is of interest to note that of all the trochoid Upper Cretaceous Globigerinae only the representatives of the *G. cretacea* group are coiling in both directions thus indicating phylogenetic youth. The Rugoglobigerinae invariably coil predominately dextrally. The Paleocene Globigerinae on the other hand, coil in both directions and are, therefore, not yet specialized. The number of available specimens was too small to investigate this feature statistically, and the preference for dextral or for sinistral coiling as observed in *G. soldadoensis, G. collactea,* and *G. triloculinoides* may be purely accidental. Should this preference for one particular direction be confirmed then the earlier evolutionary stages of these species characterized by random coiling would have to be looked for in pre-*Globorotalia wilcoxensis* var. *acuta* and post-*Globotruncana mayaroensis* zones which by the unconformable overlap of the Paleocene formations on the Upper Cretaceous are cut out in the uplift areas of Trinidad. The fossiliferous Bontour sandstone and the Corax glauconite, both of Maestrichtian age, are remnants of such Upper Cretaceous formations not yet found in their stratigraphic position.

ACKNOWLEDGMENTS

The author is indebted to the Management of Trinidad Leaseholds Ltd. for the use of the facilities of the Geological Laboratory at Pointe-a-Pierre, Trinidad, B.W.I.; to H. G. Kugler, Trinidad, for reading the manuscript and for many valuable suggestions; to H. E. Thalmann, Stanford University, California, for the loan of holotypes of species described by L. T. Martin from the Lodo formation, California; to L. T. Martin, Bakersfield, California, for topotypes

of *Globigerina decepta* Martin, *Globigerina nitida* Martin, and *Globigerina marksi* Martin; to N. de B. Hornibrook, Wellington, New Zealand, for topotypes of *Globigerina primitiva* (Finlay), *Globigerina collactea* (Finlay), *Globigerina linaperta* Finlay, and *Globigerina turgida* Finlay; to Ruth Todd, United States National Museum, Washington, D. C., for specimens of *Globorotalia compressa* (Plummer), *Globigerina pseudo-bulloides* Plummer, and *Globigerina triloculinoides* Plummer from U.S.G.S. locality, No. 5647, Naheola formation, Alabama; and to C. D. Ovey, British Museum (Natural History), London, for Globorotalias and Globigerinas from the Velasco formation of Mexico, determined by T. F. Grimsdale.

SYSTEMATIC DESCRIPTIONS

Family **GLOBIGERINIDAE**

Genus **GLOBIGERINA**

Globigerina soldadoensis Bronnimann, n. sp. Plate 1, figs. 1-9

The low trochoid test is composed of about two volutions. The four-chambered, occasionally five-chambered adult is lobulate in typical specimens. The spiral side is centrally more or less elevated, the umbilical side is convex. The umbilicus is large and deep showing the arcuate apertures of the later formed chambers. The subglobular chambers increase gradually in size. They are rounded to slightly flattened peripherally and distinctly elongate in the direction of the axis of the test. At the umbilical side the chambers tend to become somewhat pointed. The end chamber can be smaller than the penultimate one or even rudimentary. Except for the indistinct sutures of the early ontogenetic stage, those of the spiral side are deep and curved in the direction of coiling, or they are oblique giving the impression of an overlapping arrangement of the chambers. The sutures of the umbilical side are straight throughout. The large arcuate apertures of the last formed chambers are provided with minute liplike borders. The walls are perforate and rather thick. The surface is covered with irregularly distributed papillae which are stronger and more prominent on the early chambers of the adult whorl; they are absent or weakly developed near the aperture of the end chamber. The species is predominantly coiled sinistrally.

Holotype.—Globigerina soldadoensis Bronnimann, n. sp., Plate 1, figures 4-6. Rz. 287; T. L. L., Cat. No. 50506. Coiling: sinistral. Dimensions: maximum diameter of test, 0.35 mm.; end chamber, radial diameter, 0.125 mm.; tangential diameter, 0.23 mm.; height, 0.25 mm.

Remarks.—At first, an attempt was made to differentiate three types on account of the number of chambers and rudimentary chambers, on the degree of peripheral flattening of the chambers, and on the general outline of the adult test. It was found, however, that this subdivision could not be maintained in a consistent way and, therefore, the three types, which are illustrated on Plate 1, figures 1-9, were united in the same species. The greatest diameters of the figured specimens are 0.3 mm., 0.35 mm. and 0.425 mm. The radial diameter of the end chamber varies from 0.1 mm. to 0.15 mm. and the height of the end chamber from 0.25 mm. to 0.32 mm. The diameter of the aperture is from 0.05 mm. to 0.1 mm. *G. soldadoensis* differs from *Globigerina primitiva* (Finlay), 1947 by the ellipsoid-lobulate outline, by the obliquely arranged chambers and their rounded margins, and by the less pointed umbilical portions of the chambers.

G. soldadoensis is one of the most characteristic Globigerinae of the Trinidad Paleocene. It seems to be related to the spinose *Globigerina decepta* Martin, 1943 and *Globigerina nitida* Martin, 1943 both described from the Eocene Lodo formation of California. The comparison of the Trinidad forms with the holotypes of those species proved that *G. soldadoensis* is different from those forms. *G. decepta* Martin (holotype, Stanford University Collection, No. 7399, Lodo formation, L.S.J.U. loc. M-74, Sample, No. S-7-119, Lodo Gulch, Panoche Quad., Fresno Co., California, Coll. R. T. White) resembles *G. soldadoensis* in the granular surface, but it is clearly separated from *G. soldadoensis* by the much more pronounced planoconvex test, the oppressed chambers with distinct umbilical points, the rather rounded outline, the almost closed umbilicus and the small arcuate aperture. *Globigerina nitida* Martin (holotype, Stanford University Collection, No. 7400, L.S.J.U. Loc. M-74, Sample, No. S-7-47, Lodo Gulch, Panoche Quad., Fresno Co., California, Coll. R. T. White) is affined to *G. decepta*. The margin of *G. decepta* is more rounded and the chambers are more oppressed than in *G. nitida,* otherwise the two species are similar and possibly could be synonymous. This, however, can only be decided by the investigation of complete assemblages. The holotype of *G. nitida* is coiled dextrally, that of *G. decepta* sinistrally. Six out of eight topotypes of *G. decepta* and three out of eight topotypes of *G. nitida* are coiled to the right. Although these Californian forms and *G. soldadoensis* are separate species, they belong to a closely related group of Eocene Globigerinas with granulate surface.

Occurrence.—Both zones of the Lizard Springs formation, rare to abundant; Soldado formation, rare to common; Ramdat marl, abundant.

Globigerina primitiva (Finlay), 1947 Plate 1, figs. 10-12

Globoquadrina primitiva Finlay, 1947, New Zealand Jour. Sci. Tech., Wellington, vol. 28, No. 5, p. 291, pl. 8, figs. 129-134.

The low trochoid subquadrate test is composed of about two volutions, the last of which is four chambered. The spiral side is almost plane to slightly elevated; the umbilical side is convex. The chambers gradually increase in size and are flattened peripherally. They are subangular at the margin and elongate in the direction of the axis of the test; the umbilical portions are pointed. The chambers are almost perpendicular to each other and descend in the course of growth thus producing an overlapping arrangement. The sutures of the final stage are well defined, oblique to curved in the direction of coiling at the spiral side, and straight to slightly curved umbilically. The umbilicus is deep but rather small showing the large arcuate apertures of the end chamber and occasionally also of the penultimate chamber. The apertural face is flattened and makes an angle with the outer wall of the chamber. The walls are finely perforate. The surface is covered with minute papillae which are stronger on the umbilical points of the chambers and virtually absent in the neighborhood of the apertures. The species is represented by left and right hand coiled specimens.

Holotype.—*Globoquadrina primitiva* Finlay, 1947, New Zealand Jour. Sci. Tech., Wellington, vol. 28, p. 291, pl. 8, fig. 133. Loc. F. 5179B, North Otago, Hampden Beach Section, upper blue micaceous clays, $1\frac{1}{4}$ mile N. of Kakaho Creek, New Zealand, lower Bortonian, middle Eocene.

Remarks.—Finlay assigned this spinose species to the genus *Globoquadrina* Finlay, 1947, type species *Globorotalia dehiscens* Chapman, Parr and Collins, 1934, from the Oligocene (Bakombian) at Kackeraboite Creek, Port Philip area, Victoria, Australia. According to Finlay (p. 290) *Globoquadrina* "combines the open umbilicus, terminal face and apertural flaps of *Globotruncana*, the angular ventrally pointed chambers of *Globorotalia*, and the general compact shape of *Globigerina*, and plainly should not be referred to any one of these." It is doubted, however, whether the features of *Globorotalia dehiscens* really warrant the erection of a new genus differing from *Globigerina*. The aperture of *Globoquadrina primitiva* is clearly that of a *Globigerina* to which genus this species is here referred.

Six out of 10 specimens of *G. primitiva* are coiled dextrally. The maximum diameter of Trinidad specimens ranges from 0.2 mm. to 0.375 mm., the average is about 0.3 mm. The end chamber of a specimen with 0.3 mm. greatest diameter, measures 0.225 mm. in tangential direction and also in height. Topotypes from Finlay's locality F. 5179B are identical with the Trinidad specimens. The greatest diameter of topotypes ranges from 0.2 mm. to 0.3 mm. The end chamber of a specimen with maximum diameter of 0.3 mm. measures 0.25 mm. in tangential direction and also in height. Eight out of 11 topotypes coil to the left.

Occurrence.—Both zones of the Lizard Springs formation, rare to common; Soldado formation, rare.

In New Zealand, this species is recorded from the Danian to the middle Eocene. Obscure specimens were found according to Finlay in the Upper Cretaceous (?Teurian).

Globigerina gravelli Bronnimann, n. sp. Plate 1, figs. 16-18

The large spinose, low trochoid test is composed of about two volutions, the final one with five to six oppressed chambers. The outline is ellipsoid and only slightly lobulate. The spiral side is more or less convex. The subcircular umbilicus is large and deep, exposing the arcuate apertures of the last formed chambers. The chambers are subglobular, flattened peripherally, elongate in direction of the axis of the test and somewhat pointed at the umbilical side. The sutures are curved in the direction of coiling and well marked except those of the early stage. The large arcuate apertures with minute liplike borders open directly into the umbilicus. The walls of the early chambers are more coarsely perforate and pitted than those of the final chambers. The surface is covered with papillae. Those at the umbilical points are strongly developed. At the apertural faces they are absent or rare. The species is coiled in both directions.

Holotype.—Globigerina gravelli Bronnimann, n. sp. Plate 1, figures 16-18. Rz. 287; T. L. L., Cat. No. 50506. Lower zone of Lizard Springs formation, Guayaguayare area, south Trinidad. Coiling: dextral. Dimensions: maximum diameter of test, 0.425 mm., end chamber, radial diameter, 0.125 mm., tangential diameter, 0.2 mm., height, 0.25 mm. Diameter of umbilicus, ±0.125 mm.

Remarks.—The spinose surface refers this species to the characteristic group of spinose Globigerinae represented in the Trinidad Paleocene by *G. soldadoensis, G. primitiva,* and *G. collactea.* It differs from these forms by the large size, greater number of the closely oppressed chambers in the last whorl, and the large, subcircular umbilicus. The four to five-chambered *G. collactea* which resembles closely in its general form *G. gravelli*, is much smaller. The species is named for the late D. W. Gravell in recognition of his contributions to the knowledge of orbitoidal Foraminifera.

Occurrence.—Both zones of the Lizard Springs formation, rare to common; Ramdat marl, rare.

Globigerina collactea (Finlay), 1939 Plate 1, figs. 13-15

Globorotalia collactea Finlay, 1939, Roy. Soc. New Zealand, Trans. Proc., vol. 69, p. 37, pl. 29, figs. 164-165.

The outline of the rather small and low trochoid test is ellipsoid and not much lobulate. About $2\frac{1}{2}$ volutions composed of small, oppressed chambers were counted. The final whorl is four to five chambered. The spiral side is elevated across the initial portion. The umbilicus is variable in size but as a rule large enough to expose the apertures of the three to four later chambers. The well-defined sutures are straight to slightly curved in the direction of coiling. The oppressed subglobular chambers increase gradually in size, the end chamber, however, can be equal to or even smaller than the penultimate one. The chambers are peripherally flattened, elongate in the direction of the axis of the test and pointed umbilically. The aperture of the end chamber is arcuate and leads directly into the umbilicus. A minute liplike border was noticed. The walls are perforate and the surface is covered with papillae which are stronger on the umbilical points than on the outer chamber walls. The species is coiled in both directions, with preference for the right.

Holotype.—Globorotalia collactea Finlay, 1931, Roy. Soc. New Zealand, Trans. Proc., vol. 69, p. 327, pl. 29, fig. 164. From locality F. 5540, Hampden Beach section, North Otago, New Zealand, Heretaungan, lower Eocene.

Remarks.—On account of the position of the arcuate apertures, which are distinctly umbilical, this small spinose species belongs to *Globigerina*, although the low trochoid spiral and the convex spiral side suggest a *Globorotalia.* The dimensions of the figured specimen (Pl. 1, figs. 13-15) are: maximum diameter, 0.275 mm.; end chamber, radial diameter, 0.1 mm.; tangential diameter, 0.15 mm., and height, 0.15 mm. Coiling: sinistral. The maximum diameter of other specimens is from 0.25 mm. to 0.35 mm. with an average of about 0.175 mm. Twelve out of 15 specimens coil to the right. The Trinidad material agrees with topotypes from New Zealand which, like the Trinidad specimens, vary greatly in the development of the umbilicus. The elevation of the spiral side is also rather variable. The maximum diameter of topotypes ranges from 0.25 mm. to 0.3 mm., the average is about 0.275 mm. Nine out of 11 topotypes are coiled to the right.

Occurrence.—Upper zone of the Lizard Springs formation, common; Soldado formation, rare to common; Ramdat marl, common.

Globigerina, sp. aff. **G. triloculinoides** Plummer, 1926 Plate 2, figs. 1-3

The broad oval outline of the small trochoid test is slightly lobulate. About two volutions are developed, the last of which is four chambered. The spiral side is slightly convex. The umbilicus is shallow. The subglobular, peripherally flattened chambers rapidly increase. The distinct sutures are curved in the direction of coiling. The small arcuate aperture is opened into the center of the umbilicus and is provided with a prominent lip. The walls are perforate and the surface is finely pitted. The maximum diameter is 0.275 mm., the end chamber measures in tangential direction 0.186 mm., in radial direction 0.16 mm., and in height 0.175 mm. The diameter of the aperture is ±0.05 mm. The test is coiled sinistrally.

The description refers to a single specimen found in locality Rz. 287, T. L. L., Cat. No. 50506, lower zone of the Lizard Springs formation. It shows affinities to *G. triloculinoides* Plummer with which it is associated.

Occurrence.—Lower zone of Lizard Springs formaton, very rare.

Globigerina hornibrooki Bronnimann, n. sp. Plate 2, figs. 4-6

The medium-sized test is a trochoid spiral of about $2\frac{1}{2}$ volutions of which the final one is four chambered. The rounded outline is weakly lobulate. The subglobular chambers are rapidly increasing in size with the exception of the end chamber which is smaller than the penultimate one, peripherally flattened, and elongate in the direction of the axis of the test. The small umbilicus is deep enough to expose the apertures of earlier chambers. The well-defined sutures are straight in the end stage but curved in the direction of coiling in the early portion of the test. The large arcuate aperture is umbilically situated, elongate and provided with a minute liplike border. The walls are finely perforate. The surface is pitted. The species is coiled to both sides.

Holotype.—Globigerina hornibrooki Bronnimann, n. sp., Plate 2, figures 4-6. Rz. 287; T. L. L., Cat. No. 50506. Lower zone of Lizard Springs formation, Guayaguayare area, south Trinidad. Coiling: dextral. Dimensions: maximum diameter, 0.28 mm.; end chamber, radial diameter, 0.045 mm.; tangential diameter, 0.145 mm.; height, 0.175 mm.

Remarks.—G. hornibrooki differs from *G. linaperta* and *G. finlayi* essentially in the arrangement of the chambers (*finlayi*) and in the development of the end chamber (*linaperta*). In perforation and pitting, *G. hornibrooki* is very similar to these species. The greatest diameter ranges from 0.22 mm. to 0.3 mm., the average is about 0.28 mm. Five out of eight specimens are coiled to the right. The species is named for N. de B. Hornibrook, Wellington, New Zealand.

Occurrence.—Both zones of the Lizard Springs formation, rare to abundant; Soldado formation, rare; Ramdat marl, common.

Globigerina sp. aff. **G. hornibrooki** Bronnimann, n. sp. Plate 2, figs. 13-15

The subglobular trochoid test is composed of about 12 chambers arranged in $2\frac{1}{2}$ volutions. The final volution is four chambered. The subglobular chambers increase in size rapidly with the exception of the final chamber, which is strongly flattened peripherally and elongate in the direction of the axis of the test. The end chamber, as a rule, is not larger or even smaller than the penultimate one. No umbilical points are developed. The umbilicus is small but deep and shows apertures of earlier chambers. The depressed sutures are straight in the end stage but slightly curved in the direction of coiling in the early spiral. The large elongate aperture is umbilically situated and almost hidden under the overlapping end chamber. The apertural face forms an obtuse angle with the outer chamber wall. The walls are perforate and thin. The surface is pitted, and no papillae have been found at the umbilical side. The species is coiled to both sides.

The figured specimen (Plate 2, figures 13-15) originated from locality Rz. 286; T. L. L., Cat. No. 50505, lower zone of Lizard Springs formation, Guayaguayare, south Trinidad. Coiling: dextral. Dimensions: maximum diameter, 0.35 mm.; end chamber, radial diameter, 0.135 mm.; tangential diameter, 0.275 mm.; height, 0.3 mm.

Remarks.—This rather scarce species differs from the likewise four-chambered *Globigerina hornibrooki* by the much larger subglobular test, the deep, umbilical aperture, and the strongly flattened end chamber. It is possible that transitional forms occur between this subglobular type and *G. hornibrooki.* The maximum diameter of additional specimens measures from 0.3 to 0.4 mm., the average lies around 0.32 mm. The direction of coiling appears to be undetermined: three out of six specimens coil to the right.

Occurrence.—Lower zone of Lizard Springs formation, rare.

Globigerina linaperta Finlay, 1939 Plate 2, figs. 7-9

Globigerina linaperta Finlay, 1939, Roy. Soc. New Zealand, Trans. Proc., Wellington, vol. 69, p. 125, pl. 13, figs. 54-57.

The low trochoid test with its predominant end chamber is composed of about two volutions, the last of which is four chambered. The spiral side is slightly convex, occasionally plane. The shallow umbilicus shows the apertures of the two later formed chambers. The subglobular chambers are flattened peripherally occasionally somewhat pointed umbilically and elongate in direction of the axis of the test. The chambers are almost at right angles; they increase rapidly in size and the end chamber is equal to or even larger than the whole preceding spiral. The straight sutures are well defined, with the exception of those of the early stage. The large arcuate aperture of the end chamber is directed into the umbilicus and surrounded by a minute liplike border. The walls are perforate and the surface is pitted. The early chambers are rather coarsely pitted and their umbilical portions are distinctly papillate. The species has random coiling.

Holotype.—Globigerina linaperta Finlay, 1939, Roy. Soc. New Zealand, Trans. Proc., Wellington, vol. 69, p. 125, pl. 13, fig. 56. From locality F. 5179A, beach, 1 mile N. Kakaho Creek, Hampden, New Zealand. Bortonian, middle Eocene.

Remarks.—This species was described in a general way by Finlay so that a more detailed description is justified. *G. linaperta*, a dominant species of the Trinidad Paleocene, shows considerable variability in the pitting of the surface and in the development of the end chamber which can be smaller or of equal size or even larger than the preceding spiral. The degree of peripheral flattening of the chambers of the final whorl is also rather variable. Associated forms, related to *G. linaperta* in their general appearance and in the texture of the surface but with different arrangement of the chambers of the final whorl and different development of the end chamber, are described in this paper as *G. finlayi* and *G. hornibrooki.* The maximum diameter of the figured specimen is 0.332 mm., the end chamber has a radial diameter of 0.2 mm., a tangential diameter of 0.26 mm. and a height of 0.26 mm. The specimen coils to the left. The greatest diameter of other Trinidad specimens ranges from 0.25 mm. to 0.35 mm. Six out of 10 specimens coil to the left.

G. linaperta is in the general features related to *G. triloculinoides,* which, however, can be separated by the fine perforation and by the flaring lip covering most of the aperture. Globigerinae closely resembling *G. linaperta* are known from the younger Tertiary of Trinidad. The possible relationship of these forms with those from the Paleocene is yet to be investigated.

Topotypes of *G. linaperta* were compared with the Trinidad specimens which completely agree with the latter. The greatest diameter of the topotypes varies from 0.275 mm. to 0.427 mm., the average is about 0.35 mm. The direction of coiling appears to be undetermined as 7 out of 13 specimens are coiled sinistrally.

Occurrence.—Both zones of the Lizard Springs formation, rare to abundant; Soldado formation, rare to abundant; Ramdat marl, common.

Globigerina finlayi Bronnimann, n. sp. Plate 2, figs. 10-12

This species resembles *Globigerina linaperta* Finlay from which it differs by the arrangement of the chambers. The final whorl is composed of only three chambers and the fairly large arcuate aperture lies centrally at the intersections of the umbilical sutures. The end chamber is situated across two preceding chambers, whereas in *G. linaperta* it is situated across three chambers. The umbilicus is shallow and in well-preserved specimens exposes also the aperture of the penultimate chamber. The species coils in both directions.

Holotype.—Globigerina finlayi Bronnimann, n. sp., Plate 2, figures 10-12. Rz. 287; T. L. L., Cat. No. 50506. Lower zone of Lizard Springs formation, Guayaguayare area, south Trinidad. Coiling: dextral. Dimensions: maximum diameter, 0.312 mm.; end chamber, radial diameter, 0.15 mm. tangential diameter, 0.24 mm. height, 0.245 mm.

Remarks.—This rare and conspicuous species is clearly defined by the arrangement of the chambers of the final whorl and by the central positon of the aperture. Two other specimens of locality Rz. 287 have a maximum diameter of 0.275 mm. and of 0.3 mm.; one of the specimens is coiled dextrally, the other sinistrally.

G. finlayi comes close to *Globigerina eocaenica* Terquem, 1882 which, however, has the aperture located asymmetrically, at the base of the apertural face and to one side of the center of the last chamber (Terquem, 1882, pl. 9, fig. 4; Bandy, 1919, p. 120, pl. 23, figs. 2a-c). Another three-chambered species similar to *G. finlayi* with a central aperture, but belonging to *Globigerinoides,* is also known from Oligocene of Trinidad. The species is named for the late H. J. Finlay.

Occurrence.—Both zones of the Lizard Springs formation, rare.

Globigerina taroubaensis Bronnimann, n. sp. Plate 2, figs. 16-18

The relatively small subglobular test is characterized by an accessory chamber across the umbilicus. The trochoid spiral of about two volutions contains four chambers in the last whorl. The oppressed subglobular and peripherally somewhat flattened chambers increase rapidly in size. The radial sutures are shallow and indistinct throughout. The small umbilicus is almost completely covered by the accessory chamber, the aperture of which is very small. Apertures of earlier chambers are not visible. The walls are coarsely perforate. The surface, including that of the accessory chamber, is roughly pitted. The species is coiled in both directions.

Holotype.—Globigerina taroubaensis Bronnimann, n. sp., Plate 2, figures 16-18. Rz. 413; T. L. L. Cat. No. 59892. Ramdat marl, lower Eocene, near San Fernando, south Trinidad. Coiling: dextral. Dimensions: maximum diameter, 0.25 mm.

Remarks.—G. taroubaensis Bronnimann, n. sp. differs by the small subglobular test with roughly pitted surface and by the relatively large accessory chamber across the umbilicus from all other nonspinose Globigerinae described in this paper. It can easily be distinguished from the lobulate and highly trochoid *G. turgida* which also carries an accessory chamber. The maximum diameter ranges from 0.22 mm. to 0.28 mm., average about 0.25 mm. Six out of 12 specimens are coiled to the right. The species is named after the Tarouba River near San Fernando, Trinidad.

Occurrence.—Upper zone of Lizard Springs formation, rare to common; Ramdat marl, common.

Globigerina turgida Finlay, 1939 Plate 3, figs. 1-3

Globigerina linaperta var. *turgida* Finlay, 1939, Roy. Soc. New Zealand, Trans. Proc., vol. 69, p. 125 (no figures).

The large lobulate test is a high trochoid spiral of about two volutions, the last of which is composed of four chambers. The subglobular chambers increase rapidly in size. They are peripherially slightly flattened and separated by deep and straight sutures. In about half of the investigated specimens, a small subglobular chamber is added across the umbilicus. This accessory chamber, with its smooth surface and minute perforations, is situated perpendicularly to the much larger end chamber of the final whorl. The large arcuate aperture of the accessory chamber is surrounded by a broad liplike border. The walls of the normal chambers appear to be thick, and compared with the accessory chamber, coarsely perforate. The surface is pitted and no spines are developed. The species is coiled to both sides.

Holotype.—Globigerina linaperta Finlay var. *turgida* Finlay, 1939. Locality F. 3310, Pahi marl, upper Bortonian, New Zealand,

Remarks.—G. turgida from the middle Eocene Bortonian of

New Zealand, was introduced as a variety[1] of *G. linaperta*. *G. turgida*, however, differs from *G. linaperta* in the arrangement of the chambers to such an extent, that it has to be considered as a distinct new species. In addition *G. turgida* in the adult develops a small accessory chamber across the umbilicus which has never been seen in *G. linaperta*. A similar form has been described by Glaessner (1937, p. 29, pl. 1, figs. 1a,b) as *G. bulloides* d'Orbigny var. *cryptomphala* Glaessner, from the upper middle Eocene (rare) and the upper Eocene (abundant) of the northern Caucasus, Russia. It differs from the Trinidad and New Zealand species by the more lobulate test and by the deviating arrangement of the accessory chamber which is formed over the aperture of the end chamber, *i.e.* parallel and not perpendicular to the end chamber. Glaessner's form is probably a new species and not a variety of *G. bulloides*. Bandy (1940, p. 119, pl. 22, figs. 2a-c) figured as *G. dissimilis* Cushman and Bermudez from the Jackson Eocene of Alabama, a species which could be synonymous with Glaessner's *G. cryptomphala*. It differs from the typically Oligocene *G. dissimilis* which has a bridgelike accessory chamber with two openings across the umbilicus. *G. ouachitaensis* Howe and Wallace var. *senilis* Bandy (p. 121, pl. 22, figs. 5a-c), from the Jackson Eocene of Alabama, appears to be closely related to the species reported by Bandy as *G. dissimilis* and most probably represents the stage without accessory chamber. The relationship between the forms described by Bandy and Glaessner's *G. cryptomphala* should be investigated by means of study of the original material.

The greatest diameter of the figured specimen (Plate 3, figures 1-3) is 0.475 mm.; the end chamber measuring in tangential direction, 0.175 mm. and in radial direction, 0.15 mm. The species coils dextrally. The greatest diameter of additional Trinidad specimens measures from 0.35 to 0.53 mm., the average is around 0.47 mm. Topotypes from Finlay's locality F. 3310, marl, 1 mile NW. of Pahi, Paparoa, Matakohe S. D., North Auckland, New Zealand, middle Eocene Pahi marl, Bortonian, are identical with the Trinidad specimens. The maximum diameter of the topotypes varies from

[1] Variety in this paper has been used in the original terminology but the term "variety" should be replaced by subspecies. See also footnote 2.

0.45 mm. to 0.58 mm., with an average of about 0.5 mm. Eight out of 15 topotypes are coiled dextrally.

Occurrence.—Ramdat marl, common; upper zone of Lizard Springs formation, rare.

Globigerina, n. sp. Plate 3, figs. 4-6

The highly trochoid test is composed of $2\frac{1}{2}$ to 3 volutions, the last of which is five chambered. The outline is subcircular, lobulate. The subglobular chambers increase gradually in size and the dimensions of those of the final whorl do not differ much from each other. The umbilicus is filled with matrix. The aperture is not known. The indistinct sutures are straight in the adult stage, those of the early whorls curved in direction of coiling. The initial portion is similar to that of *G. pseudo-bulloides*. The walls are finely perforate. The surface is smooth. Two specimens coil to the left.

Remarks.—Only two specimens were encountered, the larger of which is illustrated on Plate 3, figures 4-6. They differ from all other Paleocene - lower Eocene Globigerinae, and it was not possible to refer them to any of the known species recorded in the Catalogue of Foraminifera. They probably belong to a new species, the available material, however, is inadequate to establish a new species. The maximum diameter of the figured specimen is 0.45 mm. and the height, 0.425 mm.

Occurrence.—Ramdat marl, very rare.

Globigerina pseudo-bulloides Plummer, 1926 Plate 3, figs. 7-9

Globigerina pseudo-bulloides Plummer, 1926, Univ. Texas, Bull., No. 2644, pp. 133-134, pl. 8, figs. 9a-c; Plummer, 1937, Pub. Lab. Pal., Univ. Moscow, Prob. Pal., vols. 2-3, pl. 4, figs. 31 a-c; Plummer, 1942, Cushman Lab. Foram. Research, Contr., vol. 18, pl. 8, figs. 3, 4.

The outline of the five, rarely six-chambered adult is lobulate. The spiral side of the trochoid test is either elevated in the center, showing the small initial spire composed of minute chambers, or it is almost plane, rarely depressed. The umbilicus is rather small. The subglobular chambers increase rapidly in size as added. In apertural view they are rather high and peripherally flattened. The sutures of the adult stage are deep and straight, those of the early chambers distinctly curved. The small arcuate aperture of the end chamber opens into the umbilicus and is bordered by a lip which varies considerably in width from specimen to specimen. The walls are perforate. The surface is pitted and the umbilical portions of the early chambers of the adult whorl are covered with minute papillae. Left and right hand coiled specimens were observed.

Holotype.—Globigerina pseudo-bulloides Plummer, 1926, University of Texas, Bull., No. 2644, pl. 8, fig. 9a. Plummer figured (1926, pl. 8) three different specimens, and the first specimen is taken to represent the dorsal view of the holotype. From Station 23, shallow ditch at road corner southeast of new Corsicana reservoir, on the road to Mildred, Texas, upper Midway.

Remarks.—G. pseudo-bulloides is a characteristic and well-defined species with relatively constant features of the upper zone of the Lizard Springs formation and of the Ramdat marl. Six-chambered specimens were rare in Plummer's material (p. 133) and in the Trinidad assemblages. The greatest diameter ranges from 0.2 mm. to 0.4 mm. that of the specimens from the Midway formation goes up to 0.4 mm. Twenty-eight out of 44 specimens coil to the right. Three specimens from the Naheola formation, U. S. G. S. locality, No. 5647, measure 0.275 mm., 0.3 mm., and 0.325 mm. The two larger specimens are typical for the species, with thin and transparent walls, broader liplike borders and slightly less elevated spiral side than the average Trinidad specimens; they coil to the left. The smaller specimen is not typical, almost plane, less lobulate, and coils to the right. The comparison of *G. pseudo-bulloides* with *G. cretacea* d'Orbigny from the Upper Cretaceous of Trinidad shows that the two species are in number, arrangement and size of chambers in the adult, and also in the greatest diameter of the test (maximum diameter of four specimens 0.325 mm. to 0.4 mm) similar. The multiple apertures mentioned by Plummer (1926, p. 133) as diagnostic for *G. cretacea* may also be found in *G. pseudo-bulloides* and in all Globigerinas with large umbilicus. Where the umbilicus is small or virtually closed, only the aperture of the end chamber is visible, but where the umbilicus is large, the apertures of two or three or more of the later formed chambers can be seen. It appears that apart from stratigraphic differences, certain morphologic differences exist between *G. pseudo-bulloides* and *G. cretacea.* The sutures of *G. cretacea* are always straight and radial whereas those of *G. pseudo-bulloides* are distinctly curved to oblique in the early ontogenetic stage. Further, the spiral side of *G. cretacea* is, as a rule, more or less plane or even depressed across the initial portion, the early chambers are larger and the surface of the chambers is, perhaps with the exception of the end chamber, provided with well-spaced minute pustules. These differences between *G. pseudo-bulloides* and *G. cretacea* are small and often difficult to ascertain. It is of interest to note that left and right hand coiled specimens occur in both species.

Occurrence.—Soldado formation, rare; upper zone of the Lizard Springs formation, common to abundant; Ramdat marl, abundant.

The quantitative differences in the distribution of this species are striking and appear to be useful for the biostratigraphic subdivision of the Paleocene deposits.

Globigerina stainforthi Bronnimann, n. sp. Plate 3, figs. 10-12

The medium-sized trochoid test of about two volutions is lobulate in its general outline. The last volution is invariably composed of four chambers. The spiral side is elevated and the central spire clearly shows the trochoid arrangement of the minute early chambers. The small umbilicus is shallow. The subglobular chambers increase gradually in size. The end chamber, however, is equal to or smaller than the penultimate one. The arcuate aperture with its large liplike border is opening into the umbilicus. The well-defined sutures are oblique in the early and straight in the final stage. The walls are finely perforate. The surface is pitted, more coarsely on the early than on the final chambers. The species is coiled to the right and to the left.

Holotype.—Globigerina stainforthi Bronnimann, n. sp., Sh. 100, 30 feet augerhole, T. L. L. Cat. No. 143838, Kapur Stone area, Guayaguayare, south Trinidad. Coiling: sinistral. Dimensions: maximum diameter, 0.287 mm.; end chamber, radial diameter, 0.125 mm.; tangential diameter, 0.175 mm.

Remarks.—The elevated spiral side and the arrangement of the sutures brings this species in relationship to *G. pseudo-bulloides* from which it differs by the four adult subglobular chambers and the large arcuate aperture with broad liplike border. The maximum diameter ranges from 0.15 mm. to 0.3 mm., the average is about 0.175 mm. Eight out of 14 specimens are coiled to the right. The species is named after R. M. Stainforth for his contributions to the micropaleontology of Trinidad.

Occurrence.—Both zones of the Lizard Springs formation, rare. Sh. 100, 30 feet augerhole, T. L. L., Cat. No. 143838, Kapur Stone area, Guayaguayare, south Trinidad.

Globigerina triloculinoides Plummer, 1926 Plate 3, figs. 13-18

Globigerina triloculinoides Plummer, 1926, Univ. Texas, Bull., No. 2644, pp. 134-135, pl. 8, figs. 10a-c; Plummer, 1937, Pub. Lab. Pal. Moscow University, Prob. Pal., vols. 2-3, pl. 4, figs. 33a-b; Plummer, 1942, Cushman Lab. Foram. Research, Contr., vol. 18, p. 43, pl. 8, figs. 1,2. (See further references in Plummer, 1942.)

The trochoid test is composed of $1\frac{1}{2}$ to 2 volutions, the last of which contains four subglobular chambers. The chambers increase rapidly in size and the last one almost equals in size the whole preceding spiral. The spiral side is plane to slightly depressed across the initial portion. The umbilicus is shallow. The straight sutures are well marked; those of the spiral side are almost at right angles. The arcuate aperture with its more or less prominent lip is opening into the umbilicus. The thin walls are perforate. The surface is pitted, early chambers rather coarsely, and small papillae occur on the umbilical portions of the inner chambers of the last whorl. The species is coiled in both directions, with preference to dextral coiling.

Holotype.—*Globigerina triloculinoides* Plummer, 1926, University of Texas, Bull. No. 2644, pl. 8, fig. 10a (spiral side of type); from Station 23, shallow ditch at road corner southeast of new Corsicana reservoir on the road to Mildred, Texas, upper Midway.

Remarks.—The Trinidad specimens agree with Plummer's description and figures of *G. triloculinoides* (Plummer, 1926, pl. 8, figs. 10a,b). The maximum diameter of the investigated specimens ranges from about 0.125 mm. to 0.37 mm. Plummer noted 0.35 mm. usually less, for the greatest diameter. The development of the protruding lip appears to be variable. Sixteen out of 21 specimens coil dextrally. Three specimens of *G. triloculinoides* from U.S.G.S., locality No. 5647, Naheola formation, Midway, upper fossiliferous horizon, greensand bed, Naheola Landing on Tombigbee River, Choctaw Co., Alabama, were compared with the specimens from Trinidad. The Naheola specimens have a greatest diameter of 0.262 mm., 0.275 mm. and 0.287 mm. and delicate and transparent walls. Arrangement and size of chambers, umbilicus and apertural features are identical with those observed in the Trinidad material. It is not quite clear why this species was named *triloculinoides* as the final whorl is invariably composed of four chambers.

Occurrence.—Lower zone of Lizard Springs formation, rare to common. Upper zone of Lizard Springs formation, doubtful specimens only. Sh. 100, 30 feet augerhole, T. L. L. Cat. No. 143838. Kapur Stone area, Guayaguayare, south Trinidad.

Family **GLOBOROTALIIDAE**

Genus **GLOBOROTALIA**

Globorotalia compressa (Plummer), 1926 Plate 2, figs. 19-24

Globigerina compressa Plummer, 1926, Univ. Texas, Bull., No. 2644, pp. 135-136, pl. 8, fivs. 11a-c; Plummer, 1937, Pub. Lab. Pal., Moscow Univ, Prob. Pal., vols. 2-3, pl. 4, figs. 32a-c; Plummer, 1942, Cushman Lab. Foram. Research, Contr., vol. 18, p. 44, pl. 8, figs. 5, 6.
(For further references see Plummer, 1942.)

The axially compressed trochoid test has a broad ellipsoid, lobulate outline. The final volution is composed of five, occasionally of six chambers. The spiral side is slightly depressed. The umbilicus is small, rather shallow, but distinct. The chambers increase gradually in size; they are axially compressed and the peripheral margin is bluntly angular. The chambers are overlapping at the spiral side. The well-defined sutures are curved in the direction of coiling at the spiral side, and more or less straight umbilically. The aperture is distinctly interiomarginal, extending from the umbilicus toward the periphery of the test. The aperture and part of the umbilicus are covered by a flaring lip. The walls are thin and extremely finely perforate. The surface is smooth. The species coils in both directions, apparently with slight preference for the left side.

Holotype.—Globigerina compressa Plummer, 1926, Univ. Texas Bull., No. 2644, pl. 8, fig. 11a. (Although the holotype is not especially designated it has to be inferred from the explanation on p. 184, that figure 11a is the dorsal view of the holotype); from Station 23 (p. 135), 24 in explanation to plate 8; Station 23 is probably correct as Plummer remarks (p. 50) that "this has been chosen as the type locality for a number of new forms." Shallow ditch at road corner southeast of new Corsicana reservoir on the road to Mildred, Texas, upper Midway.

Remarks.—Cushman (1942, p. 44) observed that *Globigerina compressa* from the Naheola formation should possibly be placed under *Globorotalia.* The compressed test and the obtusely angular chambers are suggestive that this species could be a *Globorotalia* to which genus it is here assigned on account of the interiomarginal aperture as typically developed in *Globorotalia menardii* and related forms. The Trinidad specimens agree with those described by Plummer from the Midway of Texas, and with a specimen from U.S.G.S. locality 5647, Naheola formation. The maximum diameter of the figured specimens from Trinidad is 0.212 mm. and 0.231 mm. The Naheola specimen, which coils to the left, has a greatest diameter of 0.25 mm. and Plummer records an average of 0.3 mm. and an upper extreme of 0.4 mm. for the Midway material.

Occurrence.—Lower zone of Lizard Springs formation, rare. Sh. 100, 30 feet augerhole, T. L. L. Cat. No. 143838, Kapur Stone area, Guayaguayare, south Trinidad.

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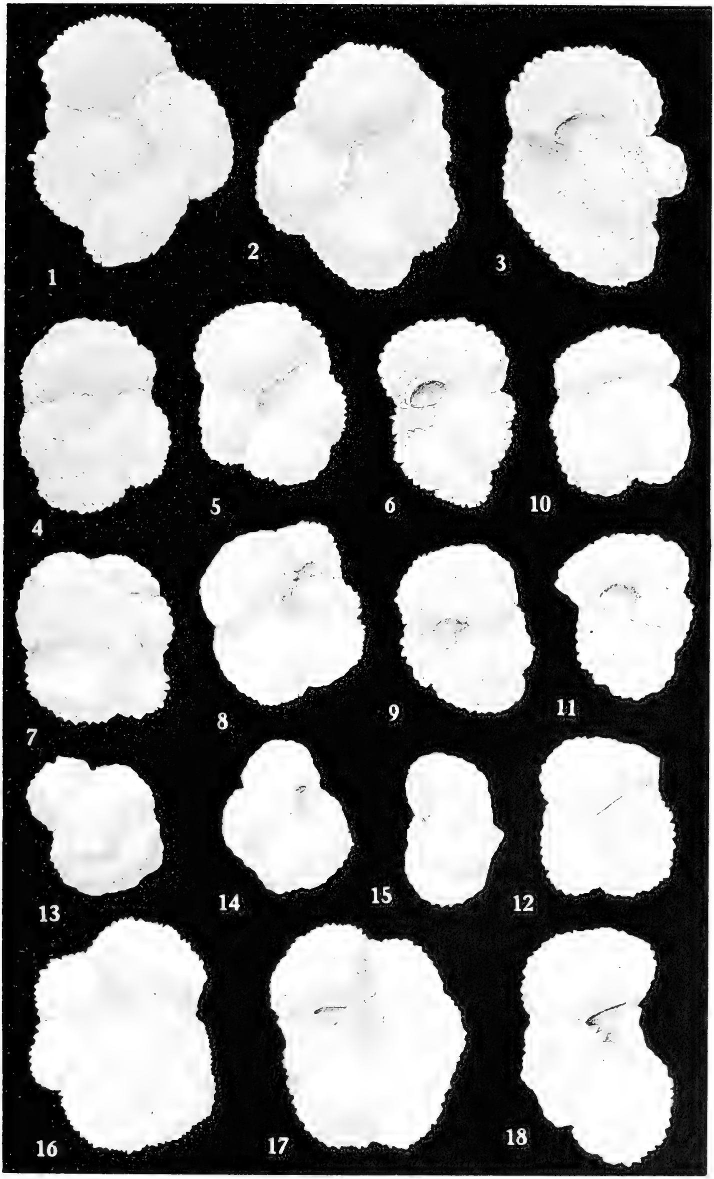
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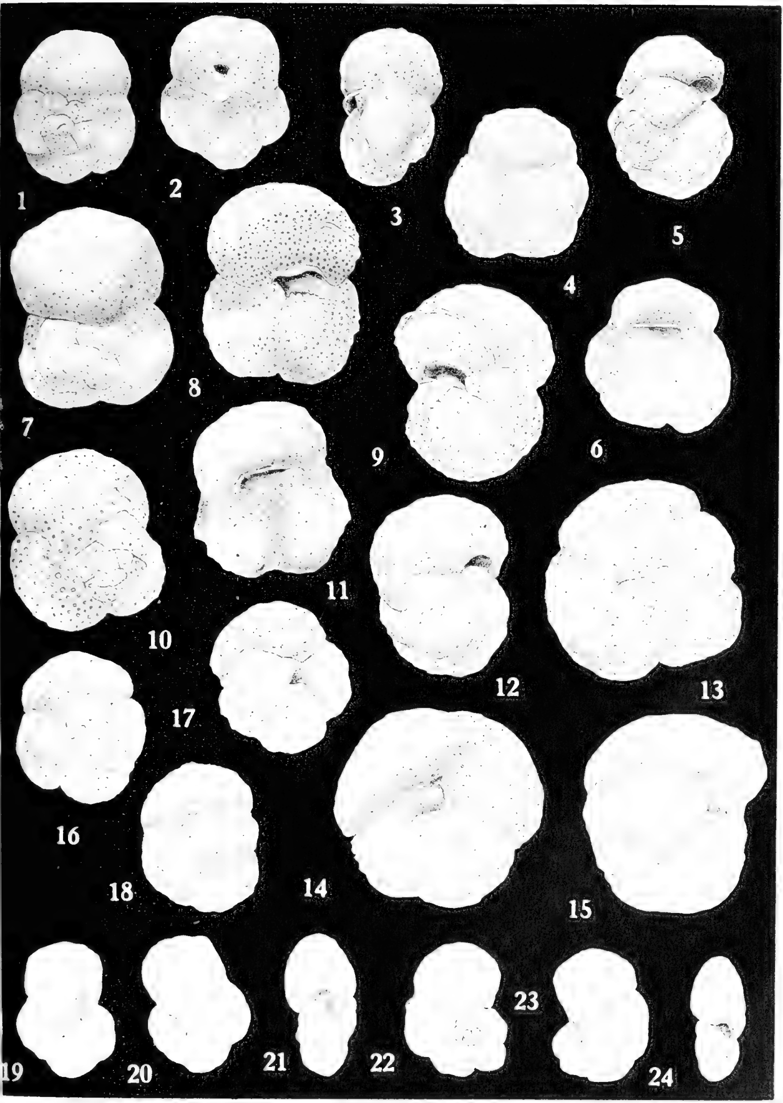
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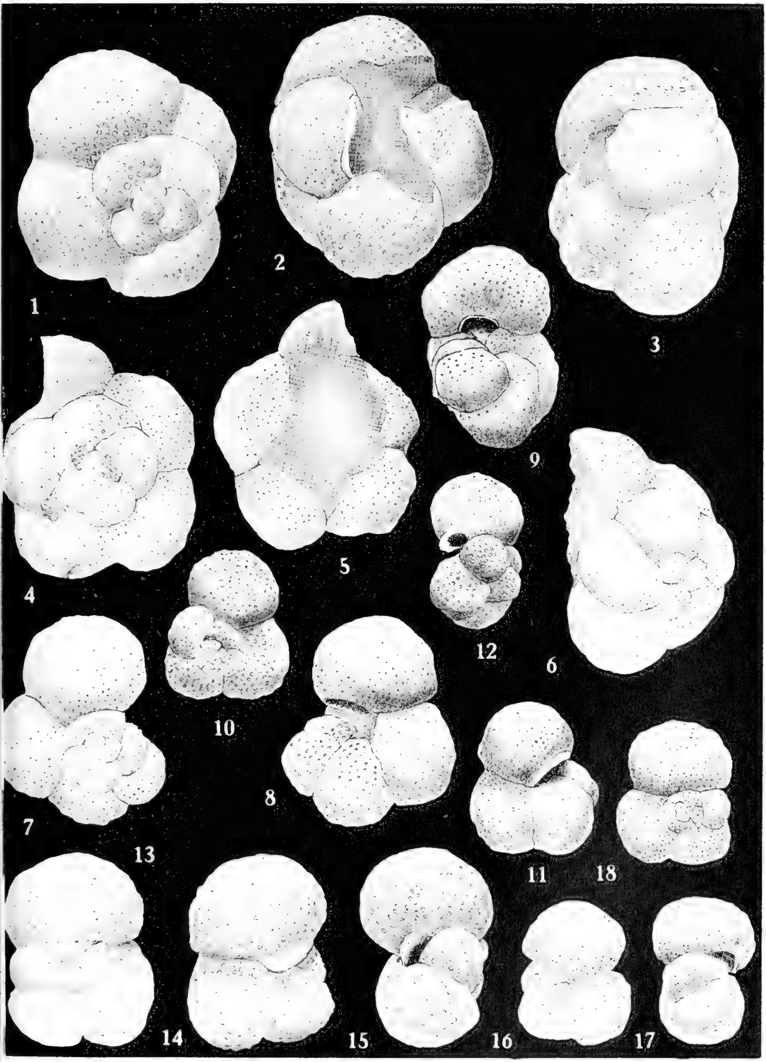

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ORDOVICIAN AND SILURIAN CEPHALOPODS FROM TASMANIA, AUSTRALIA

By

Curt Teichert and Brian F. Glenister
University of Melbourne

March 9, 1953

Paleontological Research Institution
Ithaca, New York
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ORDOVICIAN AND SILURIAN CEPHALOPODS FROM TASMANIA, AUSTRALIA

Curt Teichert and Brian F. Glenister
University of Melbourne

ABSTRACT

Considerable collections of new or inadequately known early Paleozoic nautiloids from various localities in Tasmania are described. It is concluded that these faunas range in age from Upper Canadian to Lower or possibly Middle Silurian (Niagaran). New genera described as *Allocotoceras*, *Mysterioceras*, *Gordonoceras* and *Stromatoceras* and new species of *Nybyoceras*, *Orthonybyoceras*, *Ormoceras*, *Anaspyroceras*, *Ephippiorthoceras*, *Beloitoceras*, *Hecatoceras*, *Trocholitoceras* and *Gasconsoceras* are included.

INTRODUCTION

Although the presence of early Paleozoic cephalopods in Tasmania has been known since 1862, no species were described and named until 1947 when one of us (C. T.) described a small fauna of piloceroids and endoceroids from Adamsfield (Teichert, 1947). Interest in Tasmanian cephalopods was further stimulated when one of us (C. T.) attended the Tasmanian meeting of the Australian and New Zealand Association for the Advancement of Science in January, 1949. A number of important Ordovician sections were inspected under the leadership of Mr. M. R. Banks. On this occasion some important collections were made, particularly from the Smelter's Quarry, near Zeehan in western Tasmania. In addition many interesting specimens were obtained on loan from the Queen Victoria Museum, Launceston; from the Department of Geology, University of Tasmania, Hobart; and from the Tasmanian Museum, Hobart. We are greatly indebted to Messrs. N. J. B. Plomley, Bruce Ellis, M. R. Banks, Dr. J. Pearson and to Professor S. W. Carey for making this unique material available to us for study.

PREVIOUS RECORD OF ORDOVICIAN AND SILURIAN CEPHALOPODS FROM TASMANIA

Gould (1862) was the first to notice the occurrence of cephalopods ("*Orthoceratites*" and "*Lituites*") in limestone from the lower twenty miles of the Gordon River, Macquarie Harbour, western

Tasmania. Their exact localities are unknown. He again referred to them in 1866. However, these and other early collections were ill-fated and were never described. Specimens were sent to Salter in England. He gave a number of manuscript names which were published by Bigsby (1868), republished by Etheridge (1878), and again by Johnston in 1888. The species named were *Lituites Gouldii, Orthoceras antilope, O. theca, O. Murchisoni,* and *O. Youngii,* but none of these have ever been described and the names remain *nomina nuda.* Johnston (1888, pl. IV) figured four specimens of "*Orthoceras* sp. indet." and one of "*Phragmoceras* sp. indet., allied to *P. compressum* (Sow.)," all of which most probably came from rocks of lower Silurian age, although no accurate localities were given. Some of Johnston's specimens are refigured and described in the present paper.

In 1909, Twelvetrees reported the presence of "numerous specimens of *Actinoceras*" from Railton in northern Tasmania, and later Twelvetrees and Ward (1910, p. 41) added some cephalopods from Zeehan in western Tasmania to the list under the names "*Orthoceras* sp. ind." and "*Actinoceras* sp. ind." The fossils from Railton were again referred to by A. M. Reid in 1924 (pp. 25-26) who quoted F. Chapman's identification of them as *Actinoceras* cf. *tatei* Ethridge and *Trochoceras* sp. (?). This suggested correlation with the Larapintine formation of central Australia, of known Ordovician age, but as will be shown below, the evidence was not correctly interpreted. Finally, another locality for Ordovician cephalopods was put on record by Thomas (1945) who observed them in marly sandstones underlying limestone beds at Adamsfield in southcentral Tasmania.

Up to this time no Tasmanian cephalopod had been accurately described and correctly named. In 1947, Teichert described a small fauna of piloceratids and endoceratids from the marly sandstones at Adamsfield, proving their early Ordovician (Upper Canadian) age. In a recent paper (1952) the present authors gave a summary report on Tasmanian nautiloids, describing two new genera under the names of *Hecatoceras longinquum* and *Tasmanoceras zeehanense.* Two species of *Nybyoceras* and one of *Ormoceras* were recorded from the limestone at Railton, *Anaspyroceras* was recorded from Zeehan and *Beloitoceras* from Queenstown.

The present paper contains descriptions of a number of fossils whose exact localities are unknown. The authors have described them because frequent reference has been made to them in earlier publications, and some are of considerable taxonomic value. Specimens whose exact localities are unknown are: the hypotypes of *Tasmanoceras zeehanense* and *Anaspyroceras*, sp. and the holotypes of *Stromatoceras eximium, Gordonoceras bondi, Ephippiorthoceras decorum* and *Gasconsoceras insperatum*.

LOWER PALEOZOIC ROCKS OF TASMANIA AND THEIR CEPHALOPOD FAUNAS

As recently as 1938, an official publication on the geology of Tasmania (Nye and Blake, 1938) listed only two records of Ordovician fossils, one of which was later proved to be incorrect (Thomas, 1948). The literature on the Lower Paleozoic formations of Tasmania prior to about 1940 is not without interest because it demonstrates a series of attempts to do stratigraphy "without William Smith." Fossils were either overlooked or, if found, generally incorrectly identified. This story has been told by Thomas (1948) to whose paper the reader can be referred.

Since about 1940 there has been an increasing realization of the widespread occurrence of Ordovician rocks in Tasmania and of the importance of the limestone facies in this period (see Lewis, 1940; Kobayashi, 1940 b; Hill, 1942, 1943; Hill and Edwards, 1941; Teichert, 1947, and Brown, 1948). A summary of some of these modern developments was presented by Hills and Carey (1949) who listed 16 separate occurrences of fossiliferous Ordovician limestone. More recently further additions to the knowledge of the Ordovician rocks of Tasmania have been made by members of the Geology Department of the University of Tasmania. Hills and Carey applied the name Gordon River limestone to all Ordovician limestones of Tasmania—and to some that might be of early Silurian age.

Recently one of us (B. F. G.) spent four weeks inspecting the Lower and Middle Paleozoic sections of Bubbs Hill, Queenstown, the lower Gordon River, Adamsfield, Rasselas Valley, Florentine Valley, Maydena and Ida Bay under the guidance of Professor S. W. Carey (to whom grateful acknowledgment is hereby made). Field observations indicate that the limestones which outcrop in these areas belong to the one formation, namely the Gordon limestone, and it would seem reasonable to assume that the limestones of Zeehan and Railton also belong here. Many of the areas mentioned above are joined by a continuous outcrop of the Gordon limestone despite tectonic disturbance and the fact that the limestone is readily soluble and thus tends to produce physiographically low belts. The Gordon limestone is generally underlain conformably by the West Coast Range conglomerate and overlain by rocks of the Eldon group, either conformably or with a possible disconformity. The West Coast Range conglomerate varies markedly in thickness and the Caroline Creek sandstones and Florentine shales probably represent two facies of the same formation. The marly sandstones of Adamsfield containing the piloceroid and endoceroid fauna represent a facies variant of

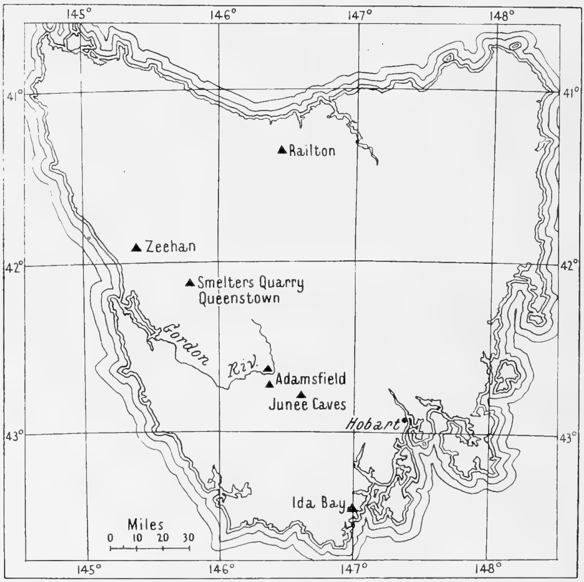


Fig. 1. Tasmania, showing localities where lower Paleozoic nautiloids have been found.

the West Coast Range conglomerate. Identical stratigraphic successions in the passage beds from West Coast Range conglomerate are thus not to be expected in geographically separated areas.

Both the bottom and the top of the Gordon limestone are probably transgressive, and the thickness varies considerably. When this and the imperfection of the fossil collections are realized, the variation in age of faunas from different localities can be readily understood. At present only isolated horizons have been thoroughly searched. Thus the cephalopod collections from the marly sandstones immediately below the Gordon limestone at Adamsfield are of Upper Canadian (pre-Chazyan) age, those of the Gordon limestone at Railton Chazyan or younger, those of the Gordon limestone at Zeehan and Queenstown Upper Ordovician. The limestones from which Johnston (1888) figured a number of cephalopods and other fossils and which probably belong to the original Gordon limestone of Gould contain a few forms with Middle Silurian affinities.

A full discussion of the present state of knowledge of the Ordovician and Silurian rocks of Tasmania is being prepared by Carey and Banks, but the following notes on the occurrence of the fossils described below may be helpful. Cephalopods are almost entirely restricted to limestones, and the noncalcareous facies of the Ordovician and Silurian of Tasmania will not be discussed.

1. *Adamsfield.*—This occurrence has been discussed by Teichert (1947) who described from it *Piloceras tasmaniense, Manchuroceras steanei, M. excavatum, Utoceras?* sp., and *Suecoceras robustum.* These are the oldest known cephalopod-bearing rocks of Tasmania and are of early Ordovician (Upper Canadian) age. They are marly sandstones and probably represent a transition facies in the West Coast Range conglomerate lying immediately below the Gordon limestone. To the above-mentioned species a new genus, *Allocotoceras* is added in the present paper.

2. *Ida Bay.*—These limestones were briefly described by Twelvetrees (1915) but no reference was made to fossils. Fossils were first found, in more recent years, by Mr. D. Dickenson and later by members of the Geology Department of the University of Tasmania. Ida Bay is one of the inner ramifications of a major inlet, known as Southport, on the east coast of Tasmania, 50 miles south of Hobart, not far from the southern extremity of the island. The thickness of

the Ordovician limestone in this district is considerable but has not yet been accurately measured. Most of the rocks are hard, and fossils are difficult to extract. We have previously described *Hecatoceras longinquum* from this locality (Teichert and Glenister, 1952). A new genus, *Mysterioceras* and a new species, *Trocholitoceras idaense* are described in the present paper.

3. *Zeehan, Smelter's Quarry.*—The geology of this locality, which lies 2 miles south of Zeehan, has never been accurately described, but it has been mentioned in papers by Twelvetrees and Ward (1910), Hills (1927), Edwards (1939), and Gill and Banks (1950). This limestone contains *Tetradium tasmaniense* Chapman which indicates Middle to Upper Ordovician age. From this locality we have previously described (Teichert and Glenister, 1952) two new genera, *Hecatoceras longinquum* and *Tasmanoceras zeehanense.* Two additional new species, *Hecatoceras obliquum* and *Anaspyroceras anzaas* are described in the present paper. The associated fauna is particularly interesting and includes gastropods which belong to *Helicotoma, Holopea*, *Hormotoma*, *Lophospira*, *Raphistoma*, and other genera. The aspect of this fauna is Upper Ordovician. It resembles most an American Trenton fauna but may possibly be as young as Richmond.

The holotype of *Ormoceras johnstoni* comes from a sheared limestone, King Extended Hill, Zeehan.

4. *Railton.*—The limestones in this locality have been described by Reid (1924, pp. 20-27) who applied the name Railton limestone to them. Although the rocks are folded and sheared, they are being quarried extensively. Fossils are, however, very rare. The record of "*Actinoceras* cf. *tatei*" (*fide* Chapman, in Reid 1924, p. 26) almost certainly refers to specimens which are here described as *Nybyoceras paucicubiculatum* and *Nybyoceras multicubiculatum.* We have shown elsewhere (Teichert and Glenister, 1952) that "*Actinoceras tatei*" from the Larapintine formation of central Australia belongs to *Madiganella*, a genus of Cyrtogomphoceratidae, and there is thus no basis for a correlation of the Railton limestone with the Larapintine formation.

5. *Old Flux Quarry, near Queenstown.*—This occurrence has been discussed (as part of the "Queen River Series") by Edwards (1939, p. 69) and by Edwards and Hill (1941). The only cephalo-

pod from this limestone is *Beloitoceras kirtoni.* From the corals Edwards and Hill give the age of the deposit as Upper Ordovician. Three species of *Tetradium* are known from this locality.

6. *Junee Caves.*—This locality is situated in the Tyenna Valley. Limestones form part of a thick Paleozoic section which has been briefly described by Lewis (1940), who referred to the limestones as "Blue Junee Limestone." The only identifiable cephalopod from the Junee limestone is *Orthonybyoceras tasmaniense*, representing a genus which is widespread in the Ordovician of North America.

7. *Gordon River.*—Two new genera, *Gordonoceras* and *Stromatoceras*, together with three new species, *Ephippiothoceras decorum*, *Anaspyroceras,* sp. and *Gasconsoceras insperatum* are described from the Gordon River. The localities of the specimens are unknown beyond the general locality, Gordon River, western Tasmania. The presence of *Gasconsoceras* indicates affinities with the Middle Silurian of North America. The Tasmanian species, however, is not a typical member of the genus and although *Gasconsoceras insperatum* has an undoubted Silurian aspect, it is possible that it is of Lower Silurian age. We may thus conclude that the Gordon limestone extends into the Silurian, but the exact age of its upper limit must remain uncertain until new collections are made.

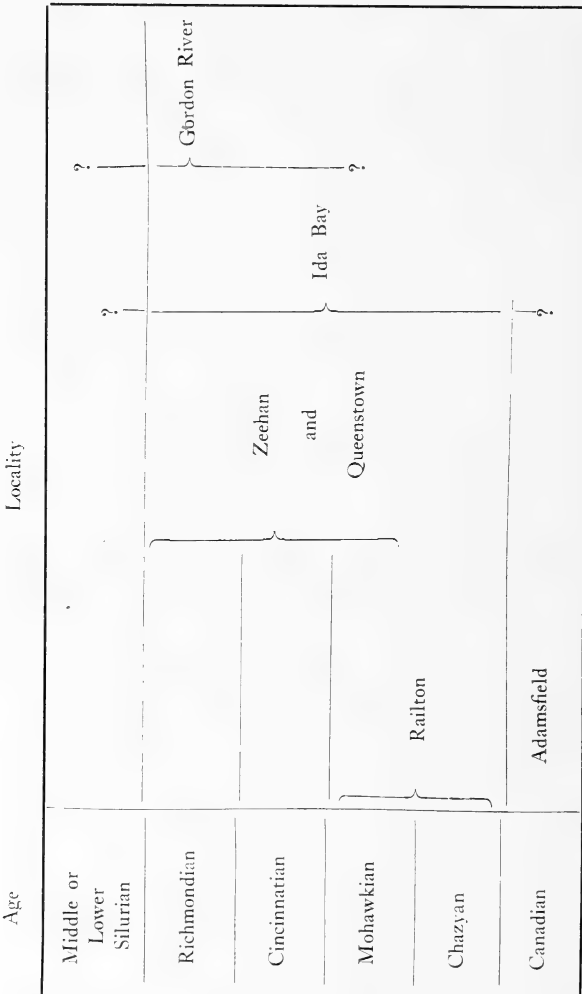
SUCCESSION AND AFFINITIES OF CEPHALOPOD FAUNA

The older Paleozoic cephalopod faunas of Tasmania are predominantly of east Asiatic and to a lesser extent of North American affinities. There is a strong endemic element, and there are few if any relationships with the fauna of central and western Australia. Part of this diversity is due to differences in age, since most of the Tasmanian nautiloids are younger than the central and northwestern Australian ones.

The fauna of the marly sandstones underlying the Gordon limestone at Adamsfield is the oldest. It is an Upper Canadian fauna of strong east Asiatic affinities and has nothing in common with the at least partly contemporaneous fauna of the Emanuel limestone of northwestern Australia.

The relative ages of the limestones of Zeehan, Railton, and Ida Bay cannot be decided with certainity. The thick section at Ida Bay

SUCCESSION OF FAUNA STUDIED



may represent a considerable part of the Ordovician and coral evidence suggests that the top of the limestone is of early Silurian age. The occurrence of *Trocholitoceras* suggests presence of Upper Canadian, although the Tasmanian species has certain features linking it to the Middle and Upper Ordovocian *Discoceras,* and may therefore be younger. *Hecatoceras* also occurs in the limestone at Zeehan.

Actinoceroids of the type found at Railton are most common in the American Chazyan and Mohawkian and corresponding rocks of Europe and Asia. The limestone at Zeehan which contains only new genera (*Tasmanoceras, Hecatoceras*) is, according to other evidence, Upper Ordovician.

The limestone from the Gordon River contains at least one cephalopod (*Gasconsoceras*) of Middle Silurian (Niagaran) aspect and the remaining genera are likewise of North American affinities.

SYSTEMATIC DESCRIPTIONS

Family **MANCHUROCERATIDAE** Kobayashi, 1935

Genus **MANCHUROCERAS** Ozaki, 1927

Manchuroceras steanei Teichert, 1947 Pl. 1, figs. 1, 2

1947. *Manchuroceras steanei* Teichert, Jour. Paleont., vol. 21, No. 5, pp. 426-427, pl. 58, figs. 6-8, 12.

Knowledge of this species can be supplemented by description of another specimen which is here selected as a hypotype (No. 20514, Department of Geology, University of Tasmania). The specimen under consideration is part of the internal mould of a siphuncle which is 41.5 mm. long. The dimensions and external features are very similar to those of the holotype. Unlike the holotype this specimen is annulated to its adapical tip.

The inside of the siphuncle is lined with calcitic material representing recrystallized endosiphuncular sheaths. This layer is poorly preserved but appears to be of uniform thickness. A further deposit, which is oval in cross-section, almost fills the endosiphocone. This is the endosiphuncular wedge described by Teichert (1947). A narrow longitudinal groove runs down its dorsal surface. Where the siphuncle has a dorso-ventral diameter of 15.6 mm. and a lateral diameter of 16.5 mm., the endosiphuncular wedge has dorso-ventral and lateral diameters of 10.9 mm. and 13.0 mm., respectively, and the maximum width of the unoccupied endosiphocone, measured in the dorso-ventral mid-plane, is 2.4 mm.

Comparisons.—The holotype of *Manchuroceras steanei* shows a thin endosiphuncular wedge, lenticular in cross-section and occupying roughly one-quarter the volume of the endosiphocone. The hypotype is significant in that it demonstrates the possibility of the endosiphuncular wedge growing in dimensions so that it would eventually fill the space inside the last endocone. Under a variety of conditions of fossilization and preservation (including those prevalent at Adamsfield) the presence of an endosiphuncular wedge developed to this degree would be almost impossible to detect.

Occurrence.—Ordovician (Upper Canadian) marly sandstones from Adamsfield, south central Tasmania.

Family **ENDOCERATIDAE** Hyatt

Genus **ALLOCOTOCERAS** Teichert and Glenister, n. gen.

Type species.—*Allocotoceras insigne* Teichert and Glenister, n. sp.

Description.—Shells with straight to gently curved siphuncles which expand slowly and uniformly adorally; siphuncle round and almost in contact with ventral shell wall; annulations of siphuncle moderately pronounced, slope backwards from ventral (convex) side to the dorsal (concave) side; septal necks holochoanitic, segments of siphuncle gentle concave; endosiphuncular sheaths arranged symmetrically leaving a circular endocone; endosiphuncular wedge present in dorsal portion of endocone.

The name is derived from the Greek word meaning eccentric.

Affinities.—The genus *Kotoceras* Kobayashi (1936) is somewhat similar in having a spiculum which is flattened on one side but differs from *Allocotoceras* in having the flattening on the ventral side. From the description by Kobayashi it is not clear if this flattening is due to the endocones being shaped in this way or whether an endosiphuncular wedge is present. Unfortunately *Kotoceras* and other genera of Endoceratidae established by Kobayashi in 1934 were based on alleged features whose reality cannot be accepted without serious misgivings. In *Kotoceras*, according to its author, the siphuncle is supposed to be "actually in contact with shell wall on wide flattened ventral side" and it is made clear that this is to be understood to mean that septa and septal necks are absent from a median region along the ventral part of the shell.

Two other genera are supposed to be characterized by the same feature. These are *Paravaginoceras,* which is said to differ from *Kotoceras* in having a strongly depressed cross-section of the conch, and *Kawasakiceras* which has an annulate shell. Some years ago the senior author received from Dr. Kobayashi a plaster cast of the holotype of *Kotoceras typicum,* and he has examined many specimens of European endoceroids in a very similar state of preservation. Fossil Endoceratida are commonly preserved in such a way that the shell has been completely removed as has also the septal substance and the septal necks along the ventral side of the specimen. If the septal necks along the ventral side are straight and their posterior edges fit smoothly into the preceding septal neck, the internal mould will be quite smooth. Endoceratida of this kind and in this type of preservation have been described and figured from Sweden, Estonia, and North America and in no case is there any reason to assume actual discontinuity of the septa and the sutures across the venter.

Kobayashi's contention also raises difficulties in physiological interpretation. Septum and septal neck are secretions of the mantle which completely envelopes the posterior end of the cephalopod animal. To assume that no septal substance was secreted along the ventral zone implies important differences in organization of the animal. One would have to postulate either a ventral zone of non-secretion of septal substance or an actual discontinuity in the mantle. The latter is unknown among molluscs, and either assumption would suggest fundamental anatomical differences of much greater taxonomic significance than on the generic level.

We believe, therefore, that the morphological criteria on which *Paravaginoceras, Kotoceras,* and *Kawasakiceras* have been based are invalid. It may be possible to retain *Kotoceras* for Endoceratidae with ventrally flattened spiculum. The holotypes of the type species of *Paravaginoceras, P. parvodepressum,* and *Kawasakiceras, K. densistriatum* are poorly preserved and fail to show diagnostic internal structures, so that these two genera will for the present remain unrecognizable.

Allocotoceras insigne Teichert and Glenister, n. sp. Pl. 1, figs. 3-5

Description of holotype (No. 21181, Department of Geology, University of Tasmania).—The holotype is a gently curved internal mould of a siphuncle with a narrow strip of shell adhering to the ventral surface. The specimen has been slightly distorted near its apical end, but the curvature was apparently exogastric, the siphuncle lying close to the ventral wall of the shell. The specimen is 63.6 mm. long and expands uniformly adorally. Near its posterior end both the lateral and dorso-ventral diameters measure 4.6 mm., while at the anterior end the lateral diameter is 8.6 mm. and the dorso-ventral diameter, 8.4 mm.

The surface of the siphuncle bears annulations which slope backwards from the convex towards the concave side at an angle of 75° to the longitudinal axis. The distance between successive annulations is one-third the diameter of the siphuncle. The annulations are pronounced across the dorsum and flanks but become less distinct ventrally and can not be traced across the venter. The annulations occur immediately anterior to the anterior end of the holochoanitic septal necks, so that the segments of the siphuncle are gently concave.

The endocones have recrystallized into a wall which is somewhat thicker on the ventral than on the dorsal side, leaving a gently tapering endosiphocone 14 mm. in depth. This lining is thickened on the mid-ventral (convex) side to form a low ridge projecting into the endosiphocone. On the dorsal (concave) side a wedge-shaped deposit has partially filled the endosiphocone; its ventral face is slightly convex. The same type of structure was observed by Teichert (1947) in *Manchuroceras* and named "endosiphowedge," but the term "endosiphuncular wedge" seems preferable.

Occurrence.—Ordovician (Upper Canadian) marly sandstones from Adamsfield, south central Tasmania.

Genus **TASMANOCERAS** Teichert and Glenister, 1952

Tasmanoceras zeehanense Teichert and Glenister, 1952 Pl. 4, figs. 4, 5

1952. *Tasmanoceras zeehanense* Teichert and Glenister, Jour. Paleont., vol. 26, No. 5, p. 739, pl. 104, figs. 3-9.

Description of hypotype (No. B845, Tasmanian Museum, Hobart).—In an earlier paper (1952) the present authors described a small, slowly expanding straight or weakly curved endoceroid under the new generic name of *Tasmanoceras.* The genus was described from two siphuncle fragments. At the time it was pointed out that the holotype belonged to a conch which was probably gently curved endogastrically whereas the paratype was gently exogastric.

Since the presentation of the manuscript containing the descriptions of the original type material, another specimen belonging to this species has come into our possession. Like the holotype this specimen is a fragment of a siphuncle belonging to a gently curved endogastric conch. Recrystallization has obliterated the endocones, but along the flanks of the siphuncle, where they originally reached the periphery, weathering has produced furrows between successive endocones, leaving them standing out as longitudinal ridges.

Occurrence.—Gordon River, western Tasmania. Exact locality unknown. The holotype of this species occurs in the Smelter's Quarry, Zeehan, of Middle to Upper Ordovician age. This fact suggests that Ordovician as well as Silurian limestones occur on the Gordon River.

Family **ARMENOCERATIDAE** Troedsson, 1926

Genus **NYBYOCERAS** Troedsson, 1926

The genus *Wutinoceras* Shimizu and Obata (1936) is to be regarded as a synonym of *Nybyoceras.* It was established with *Nybyoceras foerstei* Endo (1930) as the type species, but unfortunately Shimizu and Obata had several wrong conceptions about *Nybyoceras foerstei* as well as about *Nybyoceras bekkeri* Troedsson, the type species of *Nybyoceras. Wutinoceras* is supposed to be distinguished from *Nybyoceras* by being longiconic, by having ormoceratoid septal necks, and by the connecting rings being in broad contact ventrally with the adoral surfaces of the septa in such a way that the latter are bent forward and follow the connecting rings for about half of their circumference, then bend abruptly and obliquely forward and outward until they meet the wall of the conch. Study of the holotypes of the type species of *Nybyoceras* and *Wutinoceras* shows that only the last mentioned feature has any reality. The basal adnation area on the ventral side of *Nybyoceras foerstei* is indeed considerably broader than in *Nybyoceras bekkeri.* As regards the other alleged differences it is true that Troedsson (1926, p. 106) described *Nybyoceras* as a "brevicone", but there is no reason to suppose that the somewhat fragmentary holotype of *Nybyoceras bekkeri* is any more breviconic than other large actinoceroids. In fact, it would probably be more correct to call it longiconic. The shapes of the septal necks of *Nybyoceras bekkeri* and *Nybyoceras foerstei* are very similar and those of the latter are by no means ormoceratoid but typically armenoceratoid (see Teichert, 1933, pl. 10, fig. 9).

The width of the ventral posterior adnation surface of segments of the siphuncle cannot be regarded as a feature on which generic differences can be based. Shimizu and Obata themselves (1936, p. 29) have referred to *Wutinoceras* the holotype of *Nybyoceras aigawaense* Endo (1935, pl. 11, fig. 13), a species in which the shape of the septa on the ventral side of the siphuncle is the same as in *Nybyoceras bekkeri*.

Nybyoceras paucicubiculatum Teichert and Glenister, n. sp.
Pl. 1, figs. 6, 7, 9

Description of holotype (No. O. S. 37:10, Queen Victoria Museum, Launceston, Tasmania).—The holotype is a well-preserved phragmocone which has been sectioned in the dorso-ventral mid-plane. It is straight and has a length of 252 mm. The conch cross-section is subcircular but slightly flattened across the venter so that the dorso-ventral diameter is smaller than the lateral diameter. Towards the apical end of the specimen the dorso-ventral diameter is 32 mm. and the lateral, 33 mm., while 210 mm. adorally from this point the corresponding measurements are 60 mm. and 62 mm., indicating an apical angle of 8°. The number of camerae in a length equal to the dorso-ventral diameter of the conch varies between 8 and 10 in different parts of the shell. At the apical end of the specimen the highly nummuloidal siphuncle has a diameter of 9 mm., and its ventral surface lies 4 mm. from the ventral surface of the conch, while at the adoral extremity the siphuncular diameter has increased to 14 mm., and its distance from the ventral conch surface is 7 mm. The diameter of the siphuncle averages .28 that of the whole conch, and the septal necks are constricted to half the diameter of the outer surfaces of the connecting rings. Two camerae together have a height equal to the diameter of the siphuncle.

The sutures slope gently backwards from the dorsal towards the ventral side of the conch. The curvature of the septa shows a marked variation, the maximum concavity, which occurs in the middle of the conch, ranging from 7.5 mm. to 14 mm. Along lines dorsal to the siphuncle where the connecting rings cease to be adnate to the adapical surface of the septa, the uniform curvature of any particular septum is destroyed by a sharp backward swing of the septum.

Cameral deposits are present in all camerae. Near the apical end of the conch these deposits almost completely fill the camerae. They occupy only a small percentage of the camerae towards the adoral end of the specimen. Episeptal deposits generally develop before hyposeptal deposits. The hyposeptal deposits in the ventral portion of the camerae are invariably the last to develop.

Septal necks range in length from .35 mm. to 1.0 mm. and are generally sharply recurved. They are often flattened against the underside of the septum but in some cases are gently rounded and open as in *Actinoceras*. On the dorsal side of the siphuncle, the connecting rings are adnate to the adoral surfaces of the septa for widths up to 2.1 mm. On the adapical side they are attached to the brims and adapical surfaces of the septa for distances up to 3.9 mm. An entirely different structure is seen on the ventral side, where the area of adnation is up to 4.8 mm. wide on the adoral surface. The connecting rings generally do not come into contact with the adapical septal surface although a few are adnate to the septum for as much as 1.6 mm. Brims of 2.3 mm. width, on the dorsal side, and 1.2 mm. on the ventral side, do occur, but the average length is about .9 mm. on both sides. Laterally this asymmetry is no longer found as the connecting rings are in contact with the septa for a distance of 1.5 mm. on both surfaces of the septum.

The diameter of the endosiphuncular canal averages .25 that of the whole siphuncle. A ring of radial canals is given off in each segment; these radial canals are characteristically irregular and simple, though a few bifurcate. In cross-section the radial canals are seen to be made up of numerous thin concentric layers. On the dorsal side of the siphuncle the radial canals are directed backwards and empty into the perispatium in the adapical half of the segment, whereas on the ventral side the radial canals are bent forward and enter the perispatium in the adoral half of the segment. Laterally the canals enter the perispatium more or less symmetrically. In eccentric sections it becomes apparent that each ring of radial canals has its individual canals joined by a thin irregular lamella of tissue for which the name *siphuncular membrane* is here proposed. In the adapical portion of the shell, primary calcareous deposits fill that part of the endosiphuncle not occupied by the canal system and the perispatium. In many cases these deposits show a clearly laminated structure. The perispatia are narrow and generally stretch almost the whole distance between adjacent septa. Laminated perispatial deposits completely fill the perispatium at the adapical end of the specimen and fill at least part of it even in the youngest segment of the siphuncle.

Affinities.—The relationships of this species with *Nybyoceras multicubiculatum* will be discussed in connection with the latter species below.

Occurrence.—Ordovician limestones at Railton, northern Tasmania.

Nybyoceras multicubiculatum Teichert and Glenister, n. sp. Pl. 2, figs. 1-3

Description of holotype (No. O. S. 37:15, Queen Victoria Museum, Launceston, Tasmania).—The holotype is a phragmocone, 160 mm. long which has been sectioned in the dorso-ventral midplane. The conch is not quite straight, but it is thought that the irregularities are due to crushing and shearing in the parent rock. The dorsal portion of the shell is well preserved, but the conch on the ventral side of the siphuncle has been destroyed. Few conch dimensions can be measured with accuracy, but the lateral diameter at the apical end of the specimen was 20 mm., and it is probable that the dorso-ventral diameter was slightly less. The siphuncle measures 9.5 mm. in the dorso-ventral mid-section at the apical end of the specimen and has increased to 13.6 mm. at the oral end. It is highly annulated being reduced in diameter at the septal necks to 3.4 mm. at the apical end of the specimen and 5.4 mm. at the oral end. One and a half to two camerae have a height equal to the diameter of the siphuncle.

Cameral deposits are present in all camerae but do not fill them completely. Episeptal and hyposeptal deposits appear simultaneously and are developed to an equal degree. The destruction of the conch ventral to the siphuncle suggests that cameral deposits were not well developed in this region.

On the dorsal side of the siphuncle the septal brims are up to 1.1 mm. wide and the septal necks reach a maximum length of .6 mm. The septal necks are sharply recurved and the edges of the brims are generally pressed against the adapical surface of the septa. On the adoral surface of the septa at the dorsal side of the siphuncle, the area of adnation reaches a maximum width of .5 mm. while on the adapical side of the septa the connecting rings are adnate to the septum for a maximum distance of 1.8 mm. Ventrally the septal brims measure up to 1.1 mm. in length and the septal necks have a maximum length of .7 mm. They are entirely different in shape from the septal necks on the dorsal surface being open at the outer extremities and never pressed against the adapical surface of the septa. The area of adnation on the adoral surface of the septum probably reaches a maximum of 5.0 mm., but because of the destruction of the ventral surface of the siphuncle the maximum measurement taken was 4.2 mm. The connecting rings are never adnate to the adapical surface of the septa on the ventral surface of the siphuncle.

The endosiphuncular canal has a diameter measuring about one-third that of the whole siphuncle. It gives rise to a system of irregular radial canals. Individual canals almost invariably branch at least once, and some have been observed with four branches. The siphuncular membranes, which join these branches, may themselves branch, with the result that the siphuncle becomes divided into many small chambers. Where preserved, the perispatium is very narrow and almost completely filled with laminated perispatial deposits. Primary calcareous deposits are developed throughout the siphuncle; at the adapical extremity they fill all the space not occupied by the canal system and perispatium but towards the adoral end of the siphuncle they appear as thick discrete rings around the septal necks and do not fill all the available space.

Description of paratype (No. O. S. 37:9, Queen Victoria Museum, Launceston, Tasmania).—The paratype and only other specimen known is a straight phragmocone with well-preserved siphuncle and adjacent parts of the camerae, from which the external part of the conch has been removed. It has been sectioned at an angle of 15° to the lateral plane over most of its length but a small portion at the adoral end has been ground in the dorso-ventral plane. The specimen is 140 mm. long and has a siphuncle of diameter 13 mm. The shape of the conch cross-section is difficult to determine, but it is probable that the conch was flattened ventrally and that the ventral surface of the siphuncle was situated 3 mm. from the ventral shell surface. The number of camerae which occupy a length equal to the siphuncular diameter varies between two at the adapical end of the specimen and three at a point 100 mm. adorally from it. This variation is, however, quite irregular.

In the apical half of the specimen cameral deposits completely fill the camerae on the dorsal side of the siphuncle and leave only small spaces on the ventral side of the siphuncle. A small space around the connecting ring is free of organic cameral deposits. In the adoral part of the conch both episeptal and hyposeptal deposits are developed in all camerae but do not fill them. Episeptal and hyposeptal deposits begin to develop simultaneously and develop at equal rates until at maturity they fill equal volumes of the camerae.

In the lateral section the brims of the septal necks are up to 1.1 mm. wide. The connecting rings are adnate to both the anterior and the posterior surfaces of the septa for a width of 2.0 mm. Primary calcareous deposits fill the entire space in the siphuncle except that occupied by the perispatium and canal system. In some places these deposits are finely laminated with the lamellae centering on the septal necks.

Comparisons.—*Nybyoceras multicubiculatum* is similar to *Nybyoceras paucicubiculatum* from the same locality. They may be readily distinguished by the nature of the cameral deposits and the endosiphuncular canal system. In the case of *Nybyoceras paucicubiculatum* the episeptal deposits are the first to develop. They almost reach maturity before hyposeptal deposits first start to develop in the dorsal part of the camerae. When maturity is reached the episeptal deposits fill over two-thirds of the camerae and pronounced pseudosepta are unknown. The episeptal and hyposeptal deposits of *Nybyoceras multicubiculatum* start to develop simultaneously and at maturity fill equal volumes of the camerae, leaving pronounced pseudosepta. Both *Nybyoceras multicubiculatum* and *Nybyoceras paucicubiculatum* have a single set of radial canals to each siphuncular segment. In the latter the individual canals are typically unbranched, although bifurcation is sometimes observed, and are joined by a simple unbranched sheet of siphuncular membrane. *Nybyoceras multicubiculatum*, on the other hand, shows radial canals with up to four branches, each of which is joined by a complex system of siphuncular membranes.

Specimens from the Chinese province of Jehol, described as *Jeholoceras robustum* by Kobayashi and Matumoto (1942) have a somewhat similar structure. The genus *Jeholoceras* was described by its authors as follows: "Orthoconic armenoceroid having a broad marginal siphuncle and neck rings composed of vertical lamellae which are protruded inward in different lengths." The value of these "lamellae" for generic diagnosis may be doubted, because similar structures have been described in species belonging to other genera. Such "lamellae" are in fact the remnants of membranes connecting the radial canals within one siphuncular segment as, *e. g.* those described by Teichert (1933) in *Cyrtonybyoceras haesitans* (Billings). If the canal system is complex and the radial canals branch, the connecting membranes may be arranged more or less vertically in the siphuncle. In the present state of our knowledge, it seems inadvisable to regard the presence of vertical membranes as a feature for generic distinction.

Occurrence.—Ordovician limestones at Railton, northern Tasmania.

Genus **ORTHONYBYOCERAS** Shimizu and Obata, 1935

In 1942, Flower established a genus *Treptoceras* for actinoceroids with fairly narrow siphuncles and siphuncular segments with gradually decreasing diameters. As type species he designated *"Orthoceras duseri* Miller," although the only species of that name was established not by Miller, but by Hall and Whitfield (1875). Since no bibliographic reference was given and the "type species" was not further discussed in Flower's paper, it appears that the genus *Treptoceras* was proposed without a valid type species and that the name is, therefore, a *nomen nudum.* Among the species which Flower proposed to include in his new genus was *Ormoceras? covingtonense* Foerste and Teichert which, however, is the type species of *Orthonybyoceras* established by Shimizu and Obata in 1935. It is not certain whether the diameter of the siphuncular segments decreases appreciably in *Ormoceras? covingtonense.* Nevertheless, this species is probably a member of the group for which Flower intended to use the name *Treptoceras* and for the time being the name *Orthonybyoceras* may take its place because it was validly established, although on erroneous precepts. Thus the scope of *Orthonybyoceras* is that of *Treptoceras*, as defined by Flower (1942, pp. 55-56).

Orthonybyoceras tasmaniense Teichert and Glenister, n. sp. Pl. 2, fig. 4

Description of holotype (No. 21146, Department of Geology, University of Tasmania).—The holotype is part of an orthoconic phragmocone which is 27.1 mm. long. It is circular in cross-section and expands in diameter from 10.9 mm. at the posterior end to 14.7 mm. at the anterior end. The siphuncle is moderately large and is situated ventral to the centre of the conch. Eight camerae occupy a distance equal to the diameter of the conch and the siphuncle has a diameter equal to the height of one and a half camerae. The septa have a concavity equal to the height of one camera. The sutures are not well preserved but are probably straight and transverse. The shell surface is smooth.

Cameral deposits occur in all camerae. Between the dorsal side and the siphuncle only episeptal deposits occur, extending as a thin layer along the surface of the septa from the shell wall two-thirds of the distance towards the siphuncle. Between the siphuncle and the ventral side of the conch episeptal deposits almost completely fill the camerae. Hyposeptal deposits may occur but only as a thin layer.

The broadly nummuloidal siphuncle has a diameter of 1.9 mm. at the posterior end of the specimen and is situated 5.3 mm. from the dorsal wall of the shell. At the anterior end, its diameter has increased to 3.0 mm. and its distance from the dorsal wall to 7.9 mm. The connecting rings are evenly inflated. In a typical segment the greatest diameter of the siphuncle is 2.85 mm., the height of the segment is 1.65 mm. and the diameter of the septal foramen is 1.4 mm. Septal necks are short and bear brims averaging .2 mm. in length which are recurved and flattened against the adapical surface of the septa. The connecting rings are adnate to the adoral surface of the septa for a distance equal to the length of the brims. Recrystallization has obscured much of the structure of the siphuncle but it appears that endosiphuncular calcareous deposits are present, leaving an endosiphuncular canal and simple radial canals which empty into a large perispatium in each segment.

Occurrence.—A single specimen is known from near the entrance to the Junee Caves, Maydena, south central Tasmania; stratigraphically about 150 feet above the entrance to the caves.

Family **ORMOCERATIDAE** Saemann, 1853

Genus **ORMOCERAS** Stokes, 1838

The relationships between the genera *Ormoceras* and *Sactoceras* have long been in doubt. The genus *Ormoceras* and its type species *Ormoceras bayfieldi* Stokes were redescribed and discussed by Foerste (1924). *Sactoceras* was established by Hyatt in 1884 with the type species *Orthoceras richteri* Barrande. This genus and its type species were again discussed by Miller, Dunbar and Condra in 1933. On it, Troedsson (1926) based a new family, *Sactoceratidae,* to include *Sactoceras, Ormoceras* and similar genera, but Flower (1946) felt doubtful about the distinction between the two genera. He was inclined to regard *Sactoceras* as a synonym of *Ormoceras* but refrained from changing the name of the family pending further investigation. Since the family Ormoceratidae had, however, been validly established by Saemann in 1853 it is used here in the same sense as Sactoceratidae Troedsson. Even if *Sactoceras* should prove to be different from *Ormoceras* the family name based on the latter genus has priority.

From a study of the figures and descriptions of the type species of the two genera it would appear that the only significant difference between the two can be found in the width of the siphuncle relative to the diameter of the conch. Both genera have straight conchs; their septal necks are crytochoanitic and between 0.5 and 1 mm. long. No lectotype of *Sactoceras richteri* has as yet been selected, but the specimens figured by Barrande (1868) on plates 318, 322, 323, and 349 are all rather similar. The segments of the siphuncles have proportions similar to that of *Ormoceras bayfieldi* with a ratio of length to width approximating 3:4. Also the degree of constriction of the siphuncle at the septal necks is similar in both species, and the endosiphuncular deposits are of a very similar, rather simple type. However, the width of the siphuncle in *Ormoceras bayfieldi* is one-third the diameter of the conch, whereas in *Sactoceras richteri* it is only between one-fifth and one-sixth. Considering the fact that the relative width of the siphuncle in Actinoceratida is a somewhat variable figure which may change considerably during the ontogeny of one specimen and differs in different species of most genera, not much weight can be attached to this feature. *Sactoceras* is, therefore, here regarded as a synonym of *Ormoceras,* the latter being expanded to include Actinoceratida with comparatively narrow siphuncle and with only moderately inflated siphuncular segments.

Another genus which must be considered in this connection is *Linormoceras* Kobayashi and Matumoto (1942). *Ormoceras johnstoni*, to be described below, is somewhat similar to a species described as *Linormoceras centrale* by Kobayashi and Matumoto in 1942. These authors defined the new genus *Linormoceras* as follows: "Orthoconic ormoceroid having a large subcentral siphuncle in which the stereoplasmic deposits form connecting rings at first but later endosipholinings." It should be noted that in this diagnosis "connecting ring" is apparently a typographical error for "neck ring" which is used by the authors for the endosiphuncular deposit formed in the vicinity of and more or less concentrically around the septal neck. In the description of *Linormoceras centrale* it is stated that "the endosiphuncular lining is the most significant characteristic of this nautiloid. When the lining is made, the radial canal is disconnected from the endosiphuncle." If we interpret the authors' intentions correctly, they seem to suppose that in the siphuncle of *Linormoceras centrale* calcareous deposits at first form in the way which is normal for actinoceroid siphuncles. That is, they begin to grow just inside the septal necks, enlarge gradually anteriorly, posteriorly and towards the centre, until only the central canal, radial canals, and perispatia are left free. Kobayashi and Matumoto apparently contend that at some stage, when the radial canals were already well formed but the central canal was still rather wide, the mode of deposition of calcareous matter changed completely; the radial canals were sealed off at their proximal ends by a calcareous lining which formed as a continuous layer on the walls of the central canal, successive layers being added at later stages.

From a study of Kobayashi and Matumoto's illustration, as well as from a study of numerous specimens of *Armenoceras* and *Ormoceras,* we are inclined to doubt this interpretation. It is not unusual for the endosiphuncular deposits in actinoceroids to show lamellar structure. In well-preserved specimens the lamellae are concentrically arranged around the septal necks. With increasing distance from the septal necks they become less curved and on the internal side of the deposits they are more or less parallel to the longitudinal axis of the siphuncle. In wide siphuncles where there is considerable centripetal growth of deposits from the septal necks this longitudinal lamination may become quite prominent. An instructive example is a specimen figured as *Actinoceras richardsoni magnum* by Parks (1915, pl. 2, fig. 1) and refigured as *Armenoceras magnum* by Foerste and Savage (1927, pl. 8, fig. 1). In this specimen the siphuncular segments are 55 mm. wide, but only 8 to 9 mm. high. The peripheral parts of the segments are rapidly filled with calcareous deposit and the latter can then only grow centipetally. The laminae at this stage are arranged longitudinally in the direction of the axis of the siphuncle. Except where they are pierced by radial canals they may appear to be continuous from one segment to the next.

If Kobayashi and Matumoto's interpretation of the structure of *Linormoceras* were correct, it would indicate a fundamental difference in structure from ordinary Actinoceratida of much more than generic rank. In all other genera of Actinoceratida the preservation of the whole endosiphuncular canal system, consisting of central canal, radial canals and perispatia, is an essential part of their organization. The sealing off of the radial canals and perispatia at some ontogenetical stage could indicate a fundamental change in physiological function of the siphuncle. Such a change has never been indicated by independent observation on other specimens and for the time being we are inclined to regard *Linormoceras* as a synonym of *Ormoceras*.

Ormoceras johnstoni Teichert and Glenister, n. sp. Pl. 1, fig. 8; Pl. 2, fig. 5

Description of holotype (No. O. S. 37:12, Queen Victoria Museum, Launceston, Tasmania).—The holotype is the only known specimen belonging to the species. It is part of a straight phragmocone and is 160 mm. long. The siphuncle and surrounding parts of the camerae are well preserved, but much of the shell and the external parts of the camerae are missing. At a point 105 mm. from its posterior end, the conch has a lateral diameter of 35 mm. The dorso-ventral diameter is smaller, probably about 30 mm., due to a pronounced ventral flattening. The conch enlarges laterally at an angle of 3 degrees. The diameter of the siphuncle remains uniform at 11 mm. throughout its length. One and a half camerae occupy a length equal to the diameter of the siphuncle and four and a half camerae occupy a length equal to the lateral diameter. The suture was probably straight and transverse. The maximum concavity of the septa it 10 mm.

Episeptal and hyposeptal deposits fill about one quarter of the volume of all camerae, the episeptal deposits showing the more extensive development.

The ventral surface of the siphuncle is situated 5 mm. from the ventral surface of the conch. At the septal necks, the siphuncle is constricted to 5 mm. The septal necks range in length from 1.0 mm. at the posterior end of the specimen to 2 mm. at the anterior end. The length of the brims varies between .7 mm. and 1.1 mm. They are approximately parallel to the septa. On the ventral side of the siphuncle the connecting rings are adnate to the adoral surface of the septa for 2.5 mm., but on the dorsal side this area of adnation measures only 1 mm. Laterally the connecting rings are adnate to the adoral surfaces of the septa for 1.5 mm. The well-defined endosiphuncular canal has a diameter one-fifth that of the whole siphuncle. A ring of radial canals is given off from the endosiphuncular canal in each segment of the siphuncle. The radial canals meet the connecting rings at about the mid-height of the segments. Bifurcation of the radial canals occurs rarely, but most of them are straight and simple. In eccentric sections the radial canals are seen to be joined by a network of siphuncular membranes similar to those observed in the Tasmanian species of *Nybyoceras.* Calcareous organic deposits fill that part of the endosiphuncle not occupied by the canal system and the perispatia. In rare cases these calcareous deposits are finely laminated. The lamellae are at first parallel to the radial canals and then swing adapically to parallel the connecting rings. Thin dark coloured lamellae regularly alternate with thicker light coloured lamellae. Perispatia are narrow and extend from one septum to the next. They thicken considerably at either extremity. Laminated perispatial deposits generally fill the perispatia.

Affinities.—The relationships of *Ormoceras johnstoni* to *Linormoceras centrale* from China have already been discussed. A rather similar form has been described as *Ormoceras holmi* from the Baltic province by Troedsson (1926).

Occurrence.—A single specimen is known from King Extended Hill, Zeehan, western Tasmania.

Family **MICHELINOCERATIDAE** Flower, 1945

Genus **ANASPYROCERAS** Shimizu and Obata, 1935

Anaspyroceras shares richly in the confusion produced by Shimizu and Obata. The above mentioned authors founded the genus with *Orthoceras anellum* Conrad, from the Beloit member of the Black River formation, as type species. The siphuncle of this species is unknown. It is possible that with further study *Anaspyroceras* may prove a synonym of the imperfectly known genus *Subspyoceras. Anaspyroceras* is also related to *Metaspyroceras* and may grade into this genus. *Anaspyroceras*, as defined by Flower (1943), includes forms of the external aspect of *Spyroceras* with simple transverse sutures and orthochoanitic siphuncles.

Anaspyroceras anzaas Teichert and Glenister, n. sp. Pl. 3, figs. 1-4

Description of holotype (No. 1991, Department of Geology, University of Melbourne, Victoria).—The holotype is a well-preserved phragmocone 26.8 mm. in length. At the anterior extremity of the specimen, the dorso-ventral diameter is 7.9 mm. and the lateral diameter 5.8 mm., while the corresponding measurements at the posterior end are 4.5 mm. and 4.1 mm. The conch is gently cyrtoconic. The siphuncle is small and excentric, being situated slightly nearer to the ventral (convex) surface of the conch than to the dorsal surface.

Ornamentation consists of narrow longitudinal ridges, broad annulations and transverse lirae. The longitudinal ridges are undivided but intercalations do occur. These intercalations begin as fine ill-defined ridges but increase in size adorally so that within 10 mm. they attain the average size of the other ridges. Thus there are 26 ridges at the posterior end of the specimen and 33 at the anterior end. The annulations are rather irregularly placed. They are broad and low and are parallel to the septa, so that at the posterior end of the specimen they slope forwards from the ventral to the dorsal surface and at the anterior end they slope backwards from the ventral surface. The lirae run parallel to the annulations over the whole surface of the conch.

The septa are shallowly and uniformly concave and as stated above the sutures run parallel to the transverse annulations and lirae. The centre of the siphuncle is situated 2.0 mm. from the ventral surface of the conch at the posterior end of the specimen and 3.3 mm. from it at the anterior end.

The adapical five chambers of the holotype were sectioned in the dorso-ventral mid-plane. The siphuncle is cylindrical and has a diameter of .8 mm. The septal necks are orthochoanitic and the connecting rings expand little, if at all, between septal foramina. Four siphuncular segments occupy a distance equal to the dorso-ventral diameter.

Description of paratype (No. 1992, Department of Geology, University of Melbourne, Victoria).—The paratype is part of a phragmocone 27.3 mm. in length. It has been sectioned in the dorso-ventral median plane. The conch has been subjected to lateral pressure, so that in many places the conch wall is damaged and the lateral diameter is difficult to determine. At the anterior end of the specimen, the dorso-ventral diameter is 8.5 mm., while at the posterior end it is 5.8 mm. The siphuncle is central and the conch gently cyrtoconic. From six to seven camerae occcpy a distance equal to the dorso-ventral diameter.

The septa are shallowly concave and at their outer extremities reach the same height on either side of the siphuncle. Organic cameral deposits are not present.

The siphuncle is cylindrical, and ranges in diameter from .8 mm. at the anterior end of the specimen to .75 mm. at the posterior end. The septa thicken considerably near the septal necks until at the septal neck they reach a thickness of .5 mm., which is twice the average thickness of the free part of the septa. The connecting rings expand little if at all between septal foramina. Immediately posterior to the septal necks they become thicker and break into two branches, one going either side of the septal neck. The connecting rings are adnate only to the end two-thirds of the septal necks. Organic siphuncular deposits are absent.

Additional material.—Three further specimens, each a small phragmocone, were available for study.

The name is derived from the letters A.N.Z.A.A.S. which are abbreviations for Australian and New Zealand Association for the Advancement of Science. It is given to commemorate the Tasmanian meeting of the Association in 1949 when all the known specimens of this species were collected.

Comparisons.—The slight curvature and irregular annulations distinguish the Tasmanian species from the more typical species assigned to *Anaspyroceras.*

Occurrence.—Gordon limestone, Smelter's Quarry, Zeehan, western Tasmania.

Anaspyroceras, sp. Pl. 3, figs. 5, 6

Description of hypotype (No. B850, Tasmanian Museum, Hobart).—This specimen is a well-preserved fragment of a phragmocone, 12 mm. long. The diameter is 12.8 mm., the cross-section circular, and the siphuncle small and almost central. Three camerae have a length equal to the diameter of the conch.

Ornamentation consists of annulations and fine longitudinal lirae. The annulations are slightly oblique, sharp and narrow, and separated from each other by areas which are almost flat. The sutures are straight and parallel to the annulations.

The septal necks are short and orthochoanitic, the connecting rings thin and tubular. The length of the septal necks is .5 mm., the diameter of the septal foramen, 1.0 mm., and the diameter of the inside of the connecting ring at the mid-height of the camera, 1.1 mm.

Comparisons.—A specimen closely allied to *Anaspyroceras,* sp. occurs in the limestone at Railton of Middle Ordovician age. This fact suggests that limestones of Ordovician, as well as Silurian age, occur along the Gordon River. The specimen described above is a typical representative of *Anaspyroceras.* The widely spaced regular annuli distinguish it, but the material does not permit closer comparisons.

Occurrence. — Gordon River, western Tasmania; the exact locality is unknown.

Family **PSEUDORTHOCERATIDAE** Flower and Caster, 1935

In his monograph on the Pseudorthoceratidae, Flower (1939) came to the conclusion that the affinities between this family and the orthochoanitic annulosiphonate cephalopods were so strong that there is probably not a good generic break between the two groups and the position of the boundary might be questioned. For convenience in definition and recognition he limited the Pseudorthoceratidae to cyrtochoanitic forms. It was pointed out that in the current state of knowledge there was a sharp morphological break between the orthochoanitic Silurian forms and the cyrtochoanitic Lower Devonian forms (the latter were at that time the earliest known members of the Pseudorthoceratide). A stratigraphical break also occurred, but Flower realized that with more extensive knowledge of the Upper Silurian cephalopods, both this and the morphological gaps might conceivably disappear.

The Tasmanian material makes an important contribution to our knowledge of this group. The present authors have come to the conclusion that a new genus from the Middle Ordovician described below as *Mysterioceras australe* is a primitive member of the Pseudorthoceratidae. The cameral deposits are of the mural and episeptal variety, the septal necks cyrtochoanitic with narrow brims and the siphuncular segments gently inflated. Siphuncular deposits are parietal, eventually fusing to give a continuous lining to the siphuncle. These siphuncular deposits are most unusual in that they originate immediately behind the septal necks and grow posteriorly to the preceding septal neck. A link with the type of siphuncular deposits usually observed in the Pseudorthoceratidae is found in a new genus from the Middle Silurian described below as *Stromotoceras eximium. Stromatoceras* is a true pseudorthoceratid having cameral deposits of the mural variety, cyrtochoanitic septal necks, and a nummuloidal siphuncle. The siphuncular deposits consist of a discontinuous laminated outer layer and a continuous inner layer which probably represents fused deposits of conchiolin. The outer calcareous layer is interesting in that it is a parietal deposit growing from the septal neck both anteriorly and posteriorly. A new species described as *Ephippiorthoceras decorum* and a new genus *Gordonoceras bondi*, both from the Middle Silurian, show siphuncular deposits which originate at the septal neck and grow anteriorly along the connecting ring.

The poorly known Stereoplasmoceratidae appear to possess strong affinities with these primitive members of the Pseudorthoceratidae. At least some species assigned to the Stereoplasmoceratidae by Kobayashi (1936) are certainly primitive pseudorthoceratids, *e. g. Stereoplasmoceras teicherti* Kobayashi (1936). The siphuncular deposits of *Mysterioceras australe* join to produce a continuous lining to the connecting rings at an early stage and it is considered likely by the present authors that further study will show that the siphuncular deposits of the Stereoplasmoceratidae are discontinuous in their early stage of development and later fuse to give a continuous lining as in the Pseudorthoceratidae. The cameral deposits too may prove to be fundamentally similar to the mural episeptal type.

The evidence presented above seems to indicate that rather than developing from the Michelinoceratidae, the Pseudorthoceratidae developed from some more primitive stock, possibly direct from the Baltoceratidae. It also indicates that at our present state of knowledge the evidence supporting the retention of the Stereoplasmoceratidae as a separate family is far from convincing.

Genus **MYSTERIOCERAS** Teichert and Glenister, n. gen.

Type species.—*Mysterioceras australe* Teichert and Glenister, n. sp.

Description.—Orthoconic, slowly expanding conchs with circular cross-sections and smooth surface. Sutures straight and transverse. Siphuncle subcentral and moderately large. Cameral deposits of the mural and episeptal type well developed. Connecting rings gently inflated, siphuncular segments higher than wide. Septal necks short and cyrtochoanitic with very narrow brims. Siphuncular lining present; first develops along the connecting ring immediately posterior to septal necks but extends along connecting ring posteriorly to preceding septal neck and anteriorly along septal neck so that deposits of adjacent segments fuse to give a continuous sheath lining the siphuncle.

Name is derived from the locality of the type species.

Affinities.—Although *Mysterioceras* is much older than any of the genera included in the Pseudorthoceratidae (the holotype occurred in the same block of limestone as a species of *Trocholitoceras*) it would seem that the genus must be included in this family. The camer l deposits are predominantly of the mural type characteristic of the Pseudorthoceratidae. The discontinuous linings of the siphuncular segments which fuse to produce a continuous sheath are also similar to those of the Pseudorthoceratidae, although in the latter these deposits originate around the septal necks and extend adorally whereas in *Mysterioceras* they first appear posterior to the septal necks and extend both adorally and adapically.

Mysterioceras australe Teichert and Glenister, n. sp. Pl. 3, figs. 10-11; text fig. 2A

Description of holotype (No. 20883a, Department of Geology, University of Tasmania).—The holotype is part of a phragmocone with circular cross-section. It is 51.5 mm. long and expands uniformly from a diameter of 9.3 mm. at the posterior end to 12.1 mm. at the anterior end. The siphuncle is moderately large and subcentral in position. Four camerae occupy a distance equal to the diameter of the conch. The concavity of the septa is equal to half the height of the camerae. Sutures are straight and transverse. The shell surface is smooth.

The specimen has been sectioned in the dorso-ventral mid-plane. Cameral deposits are developed in all camerae; they are typical mural deposits. At the posterior end of the specimen they occupy almost half the camerae, but at the anterior end they form only a thin film lining the shell wall and the septa adjacent to it.

At the posterior end of the specimen the siphuncle has a maximum diameter of 1.5 mm. and is situated 3.3 mm. from the ventral surface and 4.5 mm. from the dorsal surface; 28 mm. adorally from this point the siphuncular segment has a maximum diameter of 1.9 mm. and is situated 4.3 mm. from the ventral surface and 5.4 mm. from the dorsal surface, while the septal foramen constricts the siphuncle to a diameter of 1.45 mm. Septal necks are short and cyrtochoanitic but with such narrow brims that they sometimes appear orthochoanitic. In the last mentioned segment the septal necks have a length of .35 mm. and the brims a width of .05 mm. Siphuncular deposits are developed in all segments of the siphuncle. They originated as discontinuous deposits in contact with the connecting ring but in the posterior part of the specimen they fuse to give a continuous lining to the siphuncle. This lining is fairly uniform in thickness along the connecting ring but becomes much thinner at the septal necks.

Description of paratype (No. 20883b, Department of Geology, University of Tasmania).—The paratype is an orthoconic phragmocone with circular cross-section and smooth shell. It is 21.7 mm. long and expands from a diameter of 10.3 mm. at the posterior end to 11.2 mm. at the anterior end. A thin section has been made in the dorso-ventral mid-plane.

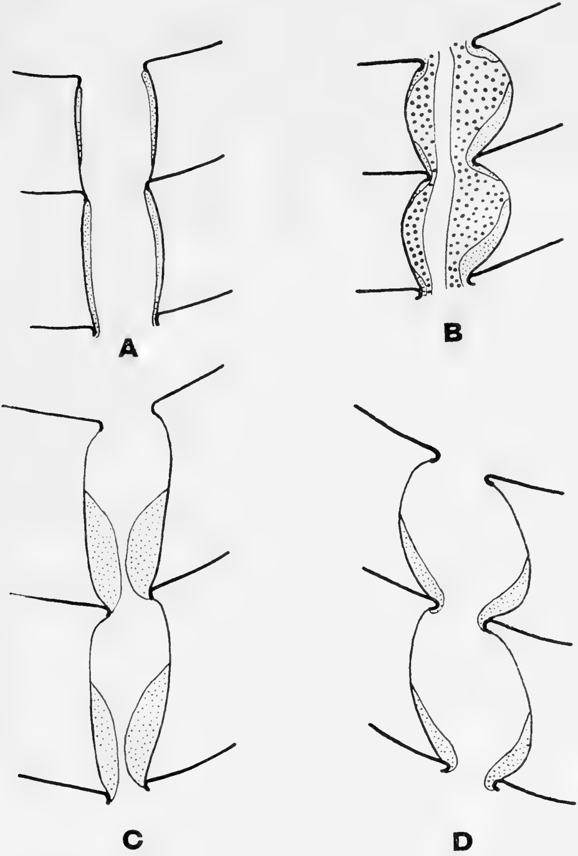


Fig. 2. Siphuncles of Tasmanian species of the Pseudorthoceratidae. A. *Mysterioceras australe,* n. gen., n. sp., Middle Ordovician. Parietal deposits originate at the septal neck and grow adapically. B. *Stromatoceras eximium,* n. gen., n. sp., Middle Silurian. Siphuncular deposits consist of two distinct components; the outer is discontinuous, growing from the septal neck both adorally and adapically, the inner is continuous but is probably the product of the fusion of discrete pendant deposits. C. *Gordonoceras bondi,* n. gen., n. sp., Middle Silurian. Parietal deposits grow adorally from the septal neck. D. *Ephippiorthoceras decorum,* n. sp., Middle Silurian. Parietal deposits grow adorally from the septal necks.

Cameral deposits of the mural type are present in all camerae. On the dorsal side of the siphuncle they almost completely fill the camerae but fill less than half the available space ventral to the siphuncle. Mural deposits and episeptal deposits on the free part of the septa are strongly developed and are separated by a groove which is directed towards the posterior-lateral corner of the camerae. The whole deposit is continuous, the groove merely marking an area of less vigorous secretion. As the development of the cameral deposits proceeds they extend along the connecting ring and then along the adapical surface of the septa, developing outwards from the siphuncle until they almost meet the deposits forming along the wall of the shell. Eventually only a small V-shaped circular groove running around the camerae remains free from cameral deposits.

At the posterior end of the specimen the siphuncle has a maximum diameter of 1.85 mm. and is situated 3.75 mm. from the ventral wall of the conch and 4.7 mm. from the dorsal wall, while at the anterior end the siphuncle has a diameter of 2.0 mm. and is situated 4.15 mm. from the ventral wall and 5.1 mm. from the dorsal wall. A typical segment has a height of 3.0 mm., has the connecting rings inflated to a diameter of 1.85 mm. and is constricted at the septal foramen to 1.15 mm. The septal necks are .2 mm. long and the brims .05 mm. wide. The connecting rings are slightly more inflated on the ventral than on the dorsal side. Siphuncular deposits are present in all segments. They first appear immediately behind the septal necks and grow backwards to the preceding septal neck along the connecting ring and to a smaller extent forward along the septal neck. Eventually the deposits from adjacent segments fuse to give a continuous lining of the siphuncle. It is thinnest in the vicinity of the septal necks.

Occurrence.—Common in Ordovician limestones at Mystery Creek Caves, Ida Bay, southeastern Tasmania.

Genus **STROMATOCERAS** Teichert and Glenister, n. gen.

Type species.—Stromatoceras eximium Teichert and Glenister, n. sp.

Description.—Slowly expanding cyrtocones with circular to slightly depressed cross-section. Sutures consist of a pair of lateral saddles separated by a dorsal and a ventral lobe. Siphuncle nummuloidal and situated about halfway between centre of conch and convex surface of coiling. Ornamentation consists of regular longitudinal ribs and irregular transverse annuli. Cameral deposits of mural type well developed. Siphuncular deposits consist of two distinct components; on the outside is a calcareous laminated parietal deposit which is discontinuous and grows from the septal neck along the connecting ring both anteriorally and posteriorally; inside this is a continuous layer which is probably the result of fusion of discontinuous pendant deposits of conchiolin.

Name derived from Greek word meaning layer, an allusion to the laminated structure of the siphuncular deposits.

Affinities.—Because of the differentiation of its siphuncular deposits into two layers *Stromatoceras* must be placed amongst the Cayutoceratinae. All other genera at present placed in this subfamily are orthoconic and show no pronounced ornamentation.

Stromatoceras eximium Teichert and Glenister, n. sp. Pl. 5, figs. 1-3; text fig. 2B

1888. *Orthoceras,* sp. indet., Johnston, Geology of Tasmania, pl. 4, fig. 1.

Description of holotype (No. B774, Tasmanian Museum, Hobart).—The holotype is a well-preserved phragmocone, the posterior third of which has been sectioned in the dorso-ventral mid-plane. It is a slightly depressed cyrtocone 126 mm. long. At the posterior end of the specimen the dorso-ventral diameter is 25.0 mm. and the lateral diameter is 25.3 while 79 mm. adorally from the posterior end of the specimen the dorso-ventral diameter has increased to 33.2 mm. and the lateral diameter to 33.5 mm.

Ornamentation consists of regular longitudinal ribs and irregular transverse annuli. The longitudinal ribs are continuous for the whole length of the specimen; approximately 75 are present. The transverse annuli are ill-defined and irregular, being more prominent at the anterior end of the specimen than at the posterior end.

Five and a half camerae together have a height equal to the dorso-ventral diameter of the conch. The septa have a concavity equal to half the height of a camera. A pair of shallow rounded saddles occur on the flanks and are separated by a sharper lobe across the dorsum and the venter. The siphuncle is moderately large and nummuloidal and is situated halfway between the centre of the conch and the convex surface of curvature. Where the dorso-ventral diameter of the conch is 28.9 mm. the siphuncle has a maximum diameter of 5.1 mm. and is situated 5.1 mm. from the convex surface of the conch.

Cameral deposits are present in all camerae but are to a large extent recrystallized so that their structure cannot be interpreted with any certainty. In one camera near the posterior end of the specimen the cameral deposits are well preserved, and there they appear as mural deposits filling half of the camera.

Septal necks are cyrtochoanitic and bear brims of length about half that of the septal necks. The connecting rings inflate rapidly to their maximum diameter just posterior to the septal necks and then taper gently to the preceding septal foramen. The connecting rings are adnate only to the septal necks. In a typical segment whose height is 4.8 mm. the connecting rings have a maximum inflated diameter of 5.1 mm. and are constricted at the septal neck to 2.3 mm. The septal necks have a length of .55 mm. and bear brims of width .3 mm.

The siphuncular deposits consist of two separate components. On the outside are calcareous laminated parietal deposits which are discontinuous and grow from the septal neck along the connecting ring both adorally and adapically. They are much thicker on the convex side of the siphuncle than on the concave. On the convex side these parietal deposits can be clearly seen extending from the septal neck almost two-thirds of the distance to the succeeding septal foramen and about one-third the distance to the preceding septal foramen. They are thin at the septal neck and posterior to it, expand rapidly to their maximum thickness just anterior to the septal neck, and then taper uniformly to their anterior extremity. In no case do the deposits from adjacent septal necks join. On the inside of these parietal deposits is a thicker continuous lining which occupies most of the siphuncle, leaving only a thin central tube free from primary deposits. It is probable that this layer originated by fusion of pendant deposits consisting of conchiolin.

Occurrence.—One specimen only is known. It comes from the Gordon River, western Tasmania. The exact locality is unknown. Probably collected from the Gordon limestone and of Lower or Middle Silurian age.

Genus **GORDONOCERAS** Teichert and Glenister, n. gen.

Type species.—Gordonoceras bondi Teichert and Glenister, n. sp.

Description.—Moderately large gently cyrtoconic conchs with circular cross-section and no conspicuous ornamentation. Sutures straight and transverse, camerae high and septa shallowly concave. Siphuncle small, almost tubular, and situated about halfway between the centre of the conch and the convex shell wall. Cameral deposits of the mural type and showing greatest development on concave side. Septal necks cyrtochoanitic with narrow brims. Siphuncular deposits of the *Michelinoceras* type as described by Flower (1939, p. 88).

The name is derived from the locality of the type species.

Affinities.—Gordonoceras belongs to the Dolorthoceratinae of Flower. The only comparable genus is *Sceptrites* from which it differs in having a more excentric and more nearly tubular siphuncle. Siphuncular deposits are unknown in *Sceptrites* and cameral deposits are not widely developed.

Gordonoceras bondi Teichert and Glenister, n. sp. Pl. 4, figs. 1-3; text fig. 2C

1888. *Orthoceras,* sp. indet., Johnston, Geology of Tasmania, pl. 4, fig. 8.

Description of holotype (No. B805, Tasmanian Museum, Hobart).—The holotype is a silicified specimen the posterior third of which has been sectioned in the dorso-ventral mid-plane. It is a gently cyrtoconic, slowly tapering phragmocone, 81.5 mm. long, with circular cross-section and excentrically situated siphuncle. At the posterior end of the specimen the lateral diameter is 14.8 mm. and the dorso-ventral diameter 14.9 mm. while at the anterior end both diameters measure 22.7 mm. No ornamentation is visible.

The sutures are straight and transverse and the septa have a concavity equal to half the height of the camerae. Four camerae together have a height equal to the diameter of the conch. The siphuncle is almost tubular and has a maximum diameter equal to one-seventh the conch diameter. It is situated about halfway between the central axis of the conch and the convex shell wall. Where the conch diameter is 16.1 mm., the siphuncle has a maximum diameter of 2.1 mm. and is situated 3.6 mm. from the shell wall.

Cameral deposits are present in all camerae and are most strongly developed on the concave side of the conch. They are typical mural deposits showing their most extensive development against the shell wall and the adoral surface of the septa. In the absence of more reliable information, the concentration of cameral deposits on the concave side seems to suggest endogastric curvature.

The septal necks are cyrtochoanitic with narrow brims. The connecting rings expand to their maximum diameter close to the septal foramina and then taper gently to the preceding septal foramina. Siphuncular segments have a height equalling about twice their greatest width. A typical segment whose height equals 4.4 mm. is constricted to 1.3 mm. at the septal foramen. The septal neck is .3 mm. long and bears a brim of width, .1 mm. The connecting rings have a maximum diameter of 2.2 mm. and are adnate only to the septal necks. Siphuncular deposits are developed equally on both sides of the siphuncle. They originate as thin rings around the septal necks, thicken adorally to their mid-height and then taper to their anterior extremity. In the segment where they show maximum development these deposits extend only halfway to the succeeding septal foramen.

This species is named in honor of Mr. E. Bond, the Hermit of the Valley of the Rasselas, prospector, philosopher, guide, and friend to those who stray from the beaten track.

Occurrence.—A single specimen is known from the Gordon River, western Tasmania. The exact locality is unknown. Probably from the Gordon limestone and of Lower or Middle Silurian age.

Genus **EPHIPPIORTHOCERAS** Foerste, 1925

Ephippiorthoceras decorum Teichert and Glenister, n. sp. Pl. 3, figs. 7-9; Pl. 4, fig. 9; text fig. 2D

1888. *Orthoceras,* sp. indet., Johnston, Geology of Tasmania, pl. 4, fig. 9.

Description of holotype (No. B804, Tasmanian Museum, Hobart).—The holotype is portion of an orthoconic phragmocone measuring 44.9 mm. in length. It is compressed laterally. At the posterior end of the specimen the lateral diameter is 21.8 mm. and the dorso-ventral diameter 24.5 mm., while at the anterior end the lateral and dorso-ventral diameters have increased to 25.6 mm. and 31.2 mm., respectively. The shell is missing and the surface of the cast covered with complex concentric colloform replacement patterns (it is partially silicified) so that no ornamentation is present. Four camerae together have a height equal to the dorso-ventral diameter. The siphuncle is moderately large, nummuloidal, depressed in cross-section and situated about halfway between the central axis of the conch and the venter. In the posterior camera it has a maximum diameter of 4.8 mm. and is situated 1.9 mm. from the ventral surface of the conch, whereas in the anterior camera the maximum diameter is 5.1 mm., and it is situated 3.2 mm. from the venter.

The sutures show two broad shallow lateral lobes separated by a pair of sharper dorsal and ventral saddles. The septa have a concavity equal to the height of one camera.

Cameral deposits are present in all camerae. They are typical episeptal and mural deposits, developing along the adoral surface of the septa, along the shell wall, and to a smaller extent along the adapical surface of the septa adjacent to the shell wall. Ventral to the siphuncle these deposits fill the camerae except for a small ring bounded by part of the adapical surface of the septa and part of the connecting ring. Dorsal to the siphuncle they fill about half of the camerae. There are two centres of vigorous growth, one on the shell wall and the other on the adoral surface of the septa close to the siphuncle.

Septal necks are short and cyrtochoanitic. The connecting rings inflate quickly posterior to each septal foramen and then taper to the preceding septal foramen. In a typical siphuncular segment the septal necks are .4 mm. long and bear brims of width .2 mm., the septal foramen has a dorso-ventral diameter of 2.1 mm. and the maximum dorso-ventral diameter of the segment is 5.1 mm. The connecting rings are adnate only to the septal necks.

Organic deposits are present in the siphuncle. They originate at the septal necks and extend adorally as thin tubular linings to the connecting ring. In the most mature segment the deposits extend only halfway to the succeeding septal foramen. The siphuncular deposits are thin at the septal neck, thicken to about their mid-height and then taper again adorally. They are developed to a similar extent all around the siphuncle.

Comparisons.—The Tasmanian species is a typical *Ephippiortho-ceras* in respect to its suture and the shape of the siphuncular segments. It differs from all other described species in having a submarginal siphuncle. The cameral and siphuncular deposits of the genus are not well known. Flower and Kummel (1950) placed it in the Stereoplasmoceratidae, but the Tasmanian species without doubt belongs in the Pseudorthoceratidae. *Ephippiorthoceras formosum* the type species of *Ephippiorthoceras* occurs in the Richmond but related forms have been recorded from the Black River and Trenton, and one species, *E. ekwanense* Foerste and Savage (1927), is known from the Middle Silurian Attawapiskat limestone of the Hudson Bay area in Canada.

Occurrence.—The Tasmanian species is known by a single specimen coming from the Gordon River, western Tasmania. The exact locality is unknown. Probably from the Gordon limestone and of Lower or Middle Silurian age.

Family **ONCOCERATIDAE** Hyatt, 1884

Genus **BELOITOCERAS** Foerste, 1933

Beloitoceras kirtoni Teichert and Glenister, n. sp. Pl. 4, figs. 6-8, 10

Description of holotype (No. 1990, Department of Geology, University of Melbourne).—The holotype is a well-preserved slightly cyrtoconic phragmocone 70 mm. long. Most of the conch wall is missing. The posterior four camerae have been sectioned in the dorso-ventral mid-plane. At the posterior end of the specimen the dorso-ventral and lateral diameters are 24.8 mm. and 21 mm., respectively, while the diameter of the siphuncle is 2.6 mm., its ventral margin being separated from the conch wall by .6 mm.; 30 mm. adorally from the posterior end of the specimen, the dorso-ventral and lateral diameters have increased to 32 mm. and 27.2 mm., while the siphuncle has a diameter of 3.9 mm. and appears to be in contact with the wall of the conch at points where its connecting ring is inflated. In transverse section the conch is compressed and oval, the venter being slightly more sharply rounded than the dorsum. Twelve camerae occupy a distance equal to the dorso-ventral diameter. At the posterior end of the conch the diameter of the siphuncle is one-tenth that of the dorso-ventral section. The sutures form shallow saddles on both the dorsum and venter with intervening lateral lobes along the flanks. The maximum concavity of the septa lies in the centre of the conch and averages .07 of the dorso-ventral diameter.

The outer wall of the conch is poorly preserved but apears to have been smooth except for a few fine growth lines whose courses can not be traced. The internal mould shows well-developed longitudinal costae indicating that the internal surface of the shell was strongly ribbed. The ribs across the dorsum and venter are irregularly spaced and indistinct, but the flanks exhibit distinct and evenly spaced ornamentation. Along the flanks, where the dorso-ventral diameter is 30 mm. there are 12 costae in a distance of 28 mm. Five or six fine longitudinal striations are sometimes observed between adjacent costae.

The connecting rings are moderately and uniformly inflated between septal foramina. At the posterior end of the specimen, the septal necks constrict the siphuncle from its maximum diameter of 2.6 mm. to 1.6 mm. The septal necks appear to be about .3 mm. in length and are flattened against the adapical surface of the septa. Septal brims average .3 mm. in width. On the dorsal side of the siphuncle, the connecting rings are adnate only to the septal neck adorally but adapically they are adnate along the brim and lower surface of the septum for a distance of .9 mm. On the ventral side of the siphuncle the area of adnation measures .9 mm. adorally and the connecting ring is attached to the whole width of the brim adapically. The connecting rings are conspicuously thickened, especially in the vicinity of the septa where they may attain a thickness of .3 mm. The camerae and siphuncle are free from calcareous organic deposits.

Comparisons.—Although only the phragmocone is known, the Tasmanian species is sufficiently similar to *Beloitoceras pandion* (Hall) the type species of *Beloitoceras* to leave little doubt concerning its proper placement.

This species is named in honour of Mr. C. Kirton who collected the type material.

Occurrence.—In limestones of Ordovician age from the Flux Quarries of the Mt. Lyell Mine, Queenstown, western Tasmania.

Family **DISCOSORIDAE** Teichert, 1931

Genus **HECATOCERAS** Teichert and Glenister, 1952

Hecatoceras longinquum Teichert and Glenister, 1952 Pl. 6, fig. 11; text fig. 3B

1952. *Hecatoceras longinquum* Teichert and Glenister, Jour. Paleont., vol. 26, No. 5, p. 740, pl. 104, fig. 10, pl. 105, fig. 7.

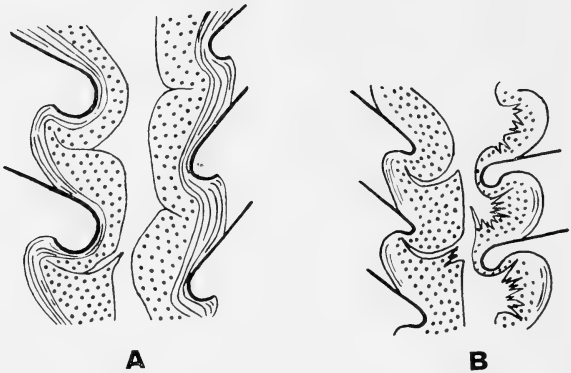


Fig. 3. Siphuncles of species of *Hecatoceras*, ×7. A. Dorso-ventral cross-section of the siphuncle of *Hecatoceras obliquum* Teichert and Glenister, n. sp. drawn from a photograph of paratype, No. 2001. B. Dorso-ventral cross-section of the siphuncle of *Hecatoceras longinquum* Teichert and Glenister, drawn from a photograph of hypotype, No. 1999.

Description of hypotype (No. 1998, Department of Geology, University of Melbourne).—This hypotype is a straight or weakly curved siphuncle consisting of four segments which together are 11.7 mm. long. The lateral diameter of the posterior segment is 5.9 mm., the dorso-ventral diameter, 5.2 mm., while the corresponding measurements for the anterior segment are 6.1 mm. and 5.6 mm. The smaller dorso-ventral diameters are due to a pronounced flattening on one side of the siphuncle, probably the ventral (this would correspond to the concave side of the type species, see Teichert and Glenister, 1952). The segments of the siphuncle slope backwards from the ventral towards the dorsal side at an angle of 83° with the axis of the siphuncle. Two siphuncular segments occupy a length equal to the dorso-ventral diameter of the siphuncle.

The septa sloped much more steeply on the ventral side than on the dorsal, indicating that the siphuncle was situated close to the ventral side of the conch. This conclusion is further verified by the fact that the septal foramina lie closer to the ventral than the dorsal side of the siphuncle. Siphuncular annulations are prominent, the siphuncle being constricted to a diameter of 2.5 mm. at the neck of the posterior septum. A deep narrow groove traverses the siphuncular annulations on the mid-ventral surface. It is proposed that this morphological feature should be termed the *"segmental furrow."* The furrows in the successive segments are in longitudinal alignment. A much shallower segmental furrow occurs on the mid-dorsal side of the siphuncular segments. The surfaces of the segments are otherwise smooth.

Description of hypotype (No. 1999, Department of Geology, University of Melbourne).—This hypotype consists of three siphuncular segments which have been sectioned in the dorso-ventral mid-plane. It is 7.6 mm. long and ranges in dorso-ventral diameter from 4.6 mm. in the posterior segment to 4.9 mm. in the anterior segment. The venter is flattened and traversed by a segmental furrow.

The siphuncle is constricted to a diameter of 1.7 mm. at the septal neck. On the dorsal side the septal necks are uniformly curved through an angle of 205°. They are .9 mm. long and bear brims of width .9 mm. The area of adnation measures 1.4 mm. on both the dorsal and ventral sides. On the ventral side the necks are slightly shorter while the brims have a width equalling only half the length of the septal neck.

Recrystallization has obscured much of the finer internal structure so that no sharp surface of delineation exists between the outer laminated endosiphuncular lining and the more massive layer on the inside of it. A thick irregular endosiphuncular canal occupies the centre of the siphuncle. From it a set of radial canals is given off in each segment. These radial canals are unbranched. They terminate against the inner edge of the endosiphuncular lining just behind the septal necks.

Comparisons.—Hypotype, No. 1999, of *Hecatoceras longinquum* shows siphuncular structures strikingly similar to those of a paratype of *Endodiscosorus* (*Endostokesoceras*) *eifliensis* illustrated by Schindewolf (1942, Abb. 7, p. 515). The Tasmanian specimen is a fragment coming from the posterior part of the siphuncle, adapically from the area where endocones occur. Recrystallized endocones are, however, present in the holotype of *Hecatoceras longinquum* (Teichert and Glenister, 1952). *Hecatoceras longinquum* is distinct from all other described discosoroids in having a deep regular segmental furrow.

Occurrence.—Ordovician limestone at Smelter's Quarry, Zeehan, western Tasmania.

Hecatoceras obliquum Teichert and Glenister, n. sp. Pl. 6, figs. 5-10, text fig. 3A

Description of holotype (No. 2000, Department of Geology, University of Melbourne).—The holotype is a straight or weakly curved portion of a siphuncle, consisting of three segments which together are 12.3 mm. long. The siphuncle has a lateral diameter of 5.6 mm. and a dorso-ventral diameter of 4.7 mm. It is flattened across the venter. The siphuncular segments slope backwards from the ventral side to the dorsal side at an angle of 65° with the axis of the siphuncle. One and a half segments occupy a distance equal to the lateral diameter of the siphuncle.

Ventrally the septa sloped much more steeply than on the dorsal side indicating that the siphuncle was situated close to the ventral side of the conch. The septal foramina lie close to the ventral side of the siphuncle. On the ventral surface, the septal necks are long and uniformly curved through approximately 170°. Dorsally the septal necks are larger and recurved through about 210°. The siphuncle is constricted to a diameter of 2.7 mm. at the septal neck. A segmental furrow occurs on the ventral surface but is not well preserved. The surfaces of the segments are roughened by weathering of the granular matrix.

Description of paratype (No. 2001, Department of Geology, University of Melbourne).—The paratype is the only other known specimen belonging to this species. It consists of two siphuncular segments, is 7.4 mm. long, has a lateral diameter of 5.8 mm. and a dorso-ventral diameter of 5.2 mm. The specimen has been sectioned in the dorso-ventral mid-plane. The siphuncle is constricted to a diameter of 2.7 mm. at the septal foramina.

On the dorsal side the septal necks are uniformly curved through an angle of 210°; the necks have a length of 1.4 mm. and the brims a width of 1.2 mm. The septal necks on the ventral side are 1.2 mm. long, the brims only half this length; the septal necks are bent through 150°. The area of adnation measures 1.2 mm. on the dorsal side and 2.5 mm. on the ventral.

The endosiphuncular lining completely lines the siphuncle. It is thickest on the ventral side. Partial recrystallization has not obliterated the fine laminated structure of this deposit. On the inside of the endosiphuncular lining lies a massive organic deposit penetrated by the radial canals. A large irregular endosiphuncular canal is present and from it branch simple radial canals in each segment of the siphuncle. These radial canals traverse the massive endosiphuncular deposit but end at the inside of the endosiphuncular lining.

Comparisons.—*Hecatoceras obliquum* differs from *Hecatoceras longinquum* in having a more highly nummulodial siphuncle with longer, more oblique segments.

Occurrence.—In limestones of Ordovician age from the Smelter's Quarry, Zeehan, western Tasmania.

Family **TROCHOLITIDAE** Chapman, 1857

Genus **TROCHOLITOCERAS** Hyatt, 1894

Trocholitoceras idaense Teichert and Glenister, n. sp. Pl. 5, figs. 4-6

Description of holotype (No. 20883, Department of Geology, University of Tasmania).—The holotye is one-half of the phragmocone of a well-preserved discoidal tarphycone with a diameter of 49.5 mm. It consists of three and a half whorls, all of which are impressed dorsally and in contact with the preceding whorl. It is impossible to tell from the specimen whether the umbilicus was perforate or imperforate. The whorls are subrectangular in cross-section. They are flatly depressed in the earlier whorls, increasing in height in later whorls so that in the last whorl the height is almost as great as the width. In the last whorl where the width is 16.8 mm., the height is 13.7 mm. and the whorl is impressed dorsally to a depth of 1.2 mm. whereas in the first whorls where the width is 7.7 mm. the height is 4.9 mm. and the whorl is impressed dorsally to a depth of .9 mm. The siphuncle is small and almost in contact with the dorsal wall.

The shell is retained in several places. Strong ribs originate at the umbilical seam. They are directed radially for a short distance across the flanks but swing backwards to form a deep rounded sinus across the venter.

The sutures are simply undulating. A broad lobe occurs across the dorsum followed by a low saddle near the umbilical seam, a shallow lobe across the flanks and a low rounded saddle across the venter.

The septal necks are short and orthochoanitic, the connecting rings thin and the siphuncle tubular. Neither cameral nor siphuncular deposits have been observed.

Comparisons.—This species has affinities with both *Trocholitoceras* and *Discoceras*. At maturity typical *Discoceras* species have a trapezoidal or quadrangular whorl cross-section with flattened venter and flanks, whereas the flanks and venter of *Trocholitoceras* are uniformly rounded. The Tasmanian species is somewhat flattened across the flanks and venter. The sutures of *Discoceras* are characterized by ventral, lateral and dorsal lobes and ventro-lateral and dorso-lateral saddles whereas those of *Trocholitoceras* are directly transverse and nearly straight except on the dorsal side of the conch where they form shallow lobes. The Tasmanian species is intermediate having dorsal and lateral lobes and ventral and dorso-lateral saddles.

Occurrence.—Ordovician limestone, Mystery Creek Caves, Ida Bay, southeastern Tasmania.

Family **BARRANDEOCERATIDAE** Foerste, 1925

Genus **GASCONSOCERAS** Foerste, 1936

The genus *Gasconsoceras* was established by Foerste for conchs presenting the general aspect of a trochoceroid, but with the line of contact between the dorsal side of the living chamber and the preceding volution lying along the medium part of this chamber. The conch enlarges rapidly and so has few whorls. Strong transverse ribs are present and form a deep lobe across the venter.

Foerste did not assign this genus to a family, but Flower and Kummel (1950) listed it as a member of the Barrandeoceratidae. In view of the considerable difference in conch shape between *Gasconsoceras* and typical genera of this family, this assignment seems to be in need of verification. However, the Australian material affords no basis for a discussion of the affinities of the genus.

Gasconsoceras insperatum Teichert and Glenister, n. sp. Pl. 6, figs. 1-4

1888. *Phragmoceras,* sp. indet., Johnston, Geology of Tasmania, pl. 4, figs. 2, 3.

Description of holotype (No. B775, Tasmanian Museum, Hobart).—The holotype and only known specimen belonging to this species is a rapidly expanding, depressed gyrocone consisting of one and a half whorls. The outer half whorl, presumably the body chamber, is almost straight and diverges rapidly from the preceding volution. The whorls do not appear to be in contact. They are almost flat across the dorsum, the flanks are sharply rounded and the venter uniformly convex. The dorso-ventral diameter increases from 9 mm. to 26 mm. in a distance of 181 mm., measured along the venter, and the lateral diameter increases from 8 mm. to 40 mm. in the same distance. The whorl cross-section becomes strongly depressed and the dorsum flattened only in the straight portion of the shell.

The preservation is such that although the shell wall is well preserved, no trace of septa or siphuncle is discernible.

Irregularly spaced coarse ribs cover the adoral half whorl, but the shell of the inner whorl is smooth. The ribs are transverse across the dorsum and flanks but bend backwards sharply across the venter to form a deep lobe. Twelve ribs are present in a distance of 40 mm. in the straight portion of the conch. Numerous fine growth lines follow the same contours as the ribs indicating successive stages of a deep hyponomic sinus.

Comparisons.—In its observable features the Tasmanian specimen resembles the species of *Gasconsoceras* described by Foerste (1936) from the Middle Silurian of Gaspé Peninsula. The most closely comparable features are the mode of coiling, the rapid expansion of the conch and the deep sinus reflected in the strong ribs across the venter. The depressed cross-section, dorsal flattening, and absence of ornamentation in the earlier part of the conch distinguish the Tasmanian species from all those previously described.

Occurrence.—Gordon River, western Tasmania. The exact locality is unknown. Probably collected from the Gordon limestone and of Lower or Middle Silurian age.

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PLATES

Plate I (14)

EXPLANATION OF PLATE 1 (14)

Figure Page

1, 2. **Manchuroceras steanei** Teichert 13

Ordovician, Adamsfield, south central Tasmania. Hypotype, No. 20514. 1, lateral ×1; 2, dorso-anterior ×1.

3-5. **Allocotoceras insigne** Teichert and Glenister, n. gen., n. sp. 16

Ordovician, Adamsfield, south central Tasmania. Holotype, No. 21181, ×1. 3, anterior; 4, ventral; 5, lateral.

6, 7. **Nybyoceras paucicubiculatum** Teichert and Glenister, n. sp. .. 18

Ordovician, Railton, northern Tasmania. 6, hypotype, No. O. S. 37:11. Lateral section through centre of siphuncle ×1. 7, holotype, No. O. S. 37:10. Off centre, dorso-ventral section through siphuncle ×1.

8. **Ormoceras johnstoni** Teichert and Glenister, n. sp. 27

Ordovician, Zeehan, northern Tasmania. Holotype, No. O. S. 37:12. Dorso-ventral cross-section through centre of siphuncle ×1. See also Pl. 2, fig. 5.

9. **Nybyoceras paucicubiculatum** Teichert and Glenister, n. sp. ... 18

Ordovician, Railton, northern Tasmania. Holotype, No. O. S. 37:10. Section of siphuncle in dorso-ventral mid-plane ×3/4.

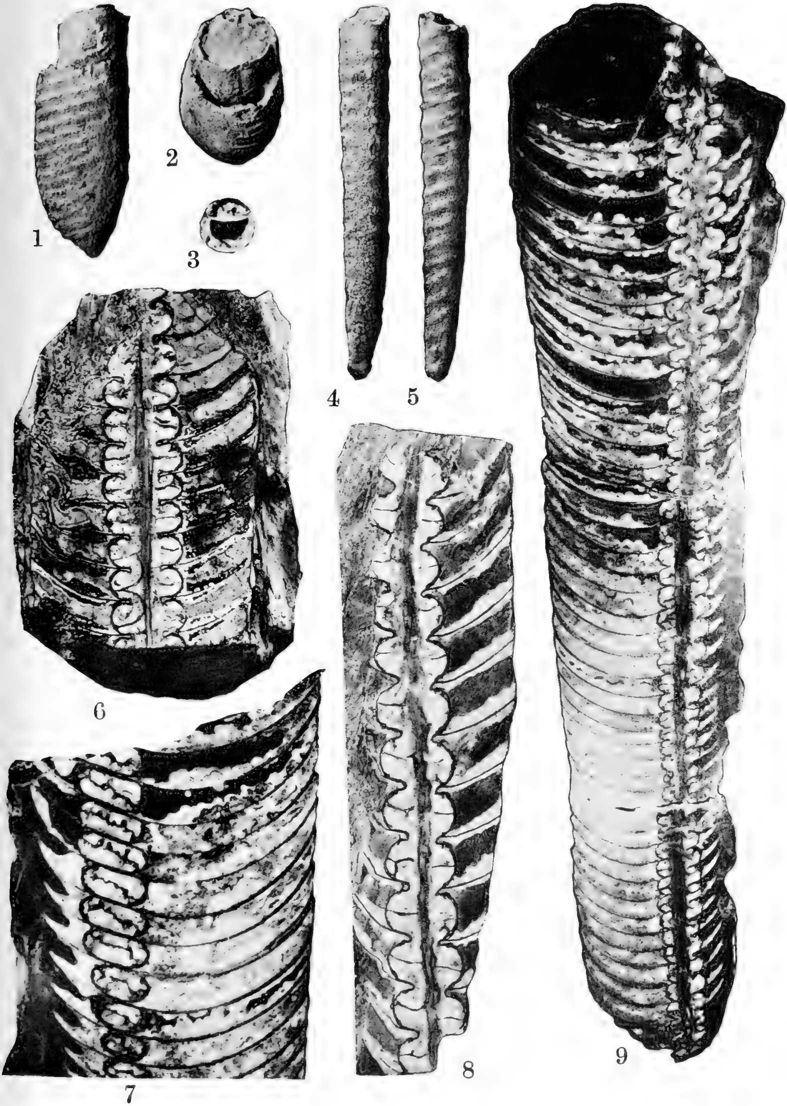
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PLATE 2 (15)

EXPLANATION OF PLATE 2 (15)

Figure Page

1-3. **Nybyoceras multicubiculatum** Teichert and Glenister, n. sp. 20

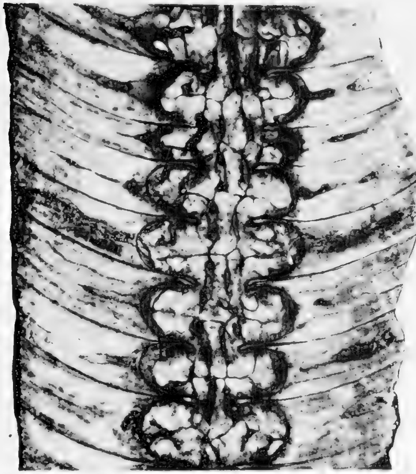
Ordovician, Railton, northern Tasmania. 1, holotype, No. O. S. 37:13. Section in dorso-ventral mid-plane ×1. 2-3, paratype, No. O. S. 37:9.2, section in lateral plane through centre of siphuncle ×2; 3, off centre cross-section ×1.

4. **Orthonybyoceras tasmaniense** Teichert and Glenister, n. sp. .. 24

Ordovician, Maydenna, south central Tasmania. Holotype, No. 21146. Dorso-ventral section in mid-plane ×2.

5. **Ormoceras johnstoni** Teichert and Glenister, n. sp. 27

Ordovician, Zeehan, northern Tasmania. Holotype, No. O. S. 37:12 Eccentric dorso-ventral cross-section ×1. See also Pl. 1, fig. 8.



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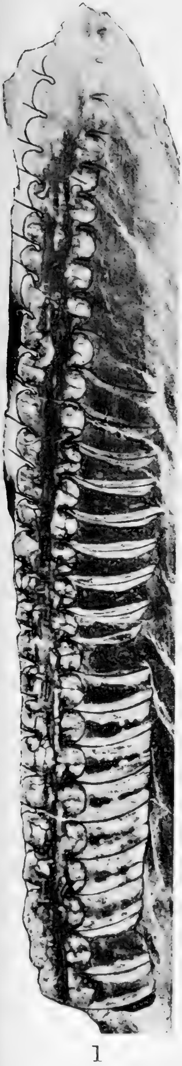

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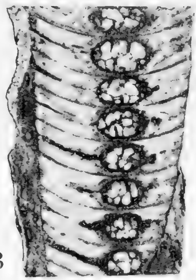

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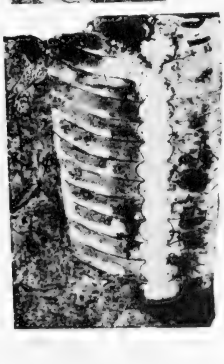

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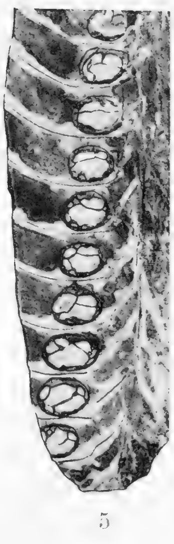

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PLATE 3 (16)

EXPLANATION OF PLATE 3 (16)

Figure		Page
1-4.	**Anaspyroceras anzaas** Teichert and Glenister, n .sp.	29
	Ordovician, Zeehan, western Tasmania. 1-3, holotype, No. 1991, ×3/2. 1, lateral; 2, ventral; 3, dorsal; 4, paratype, No. 1992, dorso-ventral mid-section ×2.	
5, 6.	**Anaspyroceras**, sp.	31
	Ordovician?, Gordon River, western Tasmania. Hypotype, No. B850. 5, lateral ×1; 6, dorso-ventral ×2.	
7-9.	**Ephippiorthoceras decorum** Teichert and Glenister, n. sp.	40
	Silurian, Gordon River, western Tasmania. Holotype, No. B804. 7, dorsal ×1; 8, lateral ×1; 9, anterior ×1. See also Pl. 4, fig. 9.	
10, 11.	**Mysterioceras australe** Teichert and Glenister, n. gen., n. sp. ..	34
	Ordovician, Ida Bay, southeastern Tasmania. 10, holotype, No. 20883a. Dorso-ventral cross-section ×2. 11, paratype, No. 20883b. Dorso-ventral cross-section ×4.	


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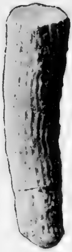
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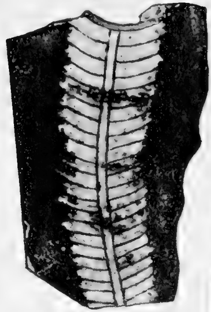
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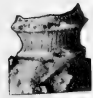
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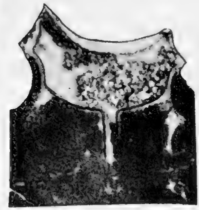
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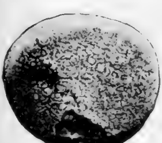
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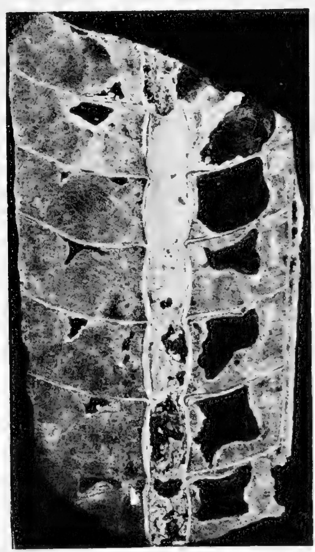
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PLATE 4 (17)

EXPLANATION OF PLATE 4 (17)

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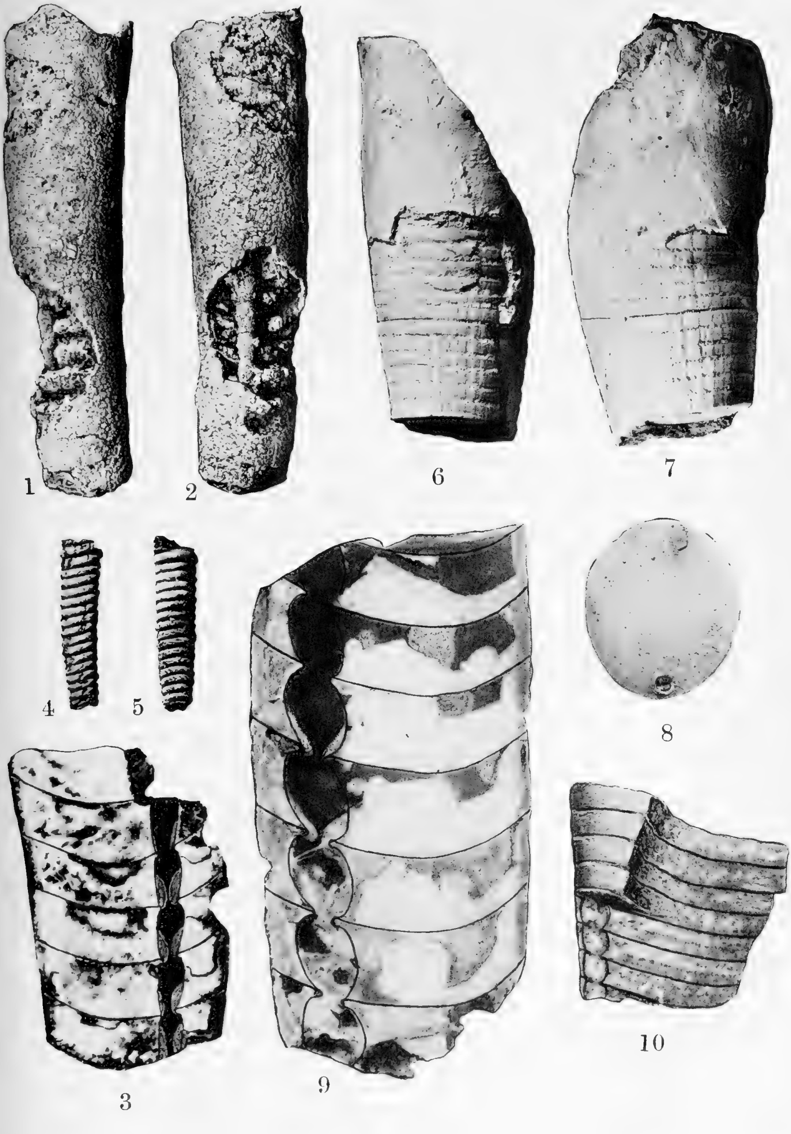
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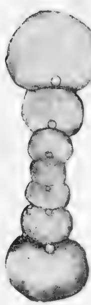

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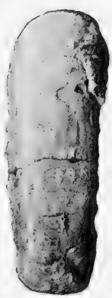

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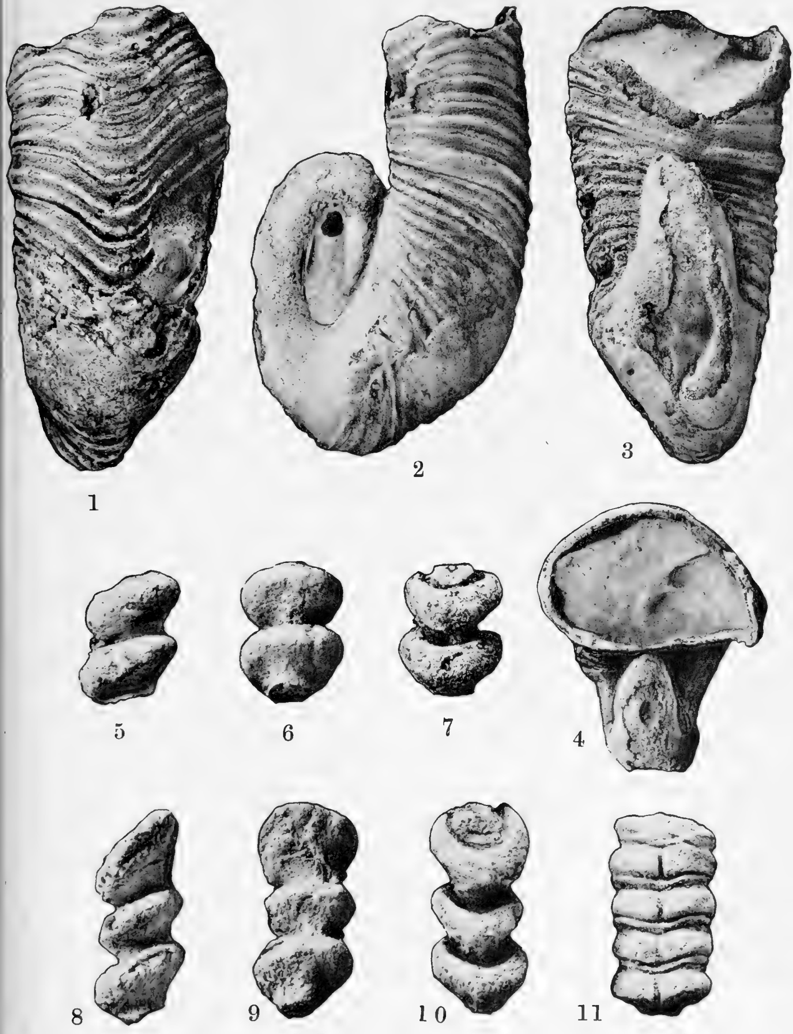
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A BIBLIOGRAPHY OF THE CONULARIDA

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July 19, 1954

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PREFACE

Almost fifteen years ago I became interested in the problematic fossils then placed in the genus *Conularia.* Systematic study was begun, at first of the Ordovician forms, later of the group as a whole. This expansion of my interest was due in large part to the encouragement of the late Dr. E. M. Kindle. A number of short papers were published, which presented descriptions and summaries of individual genera. In 1946 completion of a monographic study of the entire group seemed possible within a reasonable time and publication of disconnected fragments appeared no longer necessary. By 1948 this work had advanced sufficiently to warrant its presentation to the Faculty of Graduate Studies and Research of McGill University as a doctoral thesis.

Since then my progress has been discouraging. A great many loose ends remain. Each month turns up new material demanding incorporation and revision and my ignorance of the biologic position of the group is as profound as it ever was. In short, completion of a truly monographic study seems as far away as it did six years ago. Many friends and colleagues have expressed their confidence in the work by the loan of material, in some cases for periods of years. I think it an obligation to them to publish now what I know of the conularids leaving future discoveries to appear as supplements.

This bibliography is published first in order to avoid repetition of references in the systematic parts of the work and to give other workers the benefit of this phase of the research, which we hope may stand by itself as a useful contribution.

While a graduate student at Pennsylvania State College Mr. Richardson worked with Professor Frank M. Swartz on a faunule of Devonian conularids and in connection with that study compiled a great many references to conularid literature in general. When I met Mr. Richardson in 1945 we realized that while in part we had been working the same ground, still our varied opportunities for study had led each to sources the other had missed, and we decided to pool our bibliographic notes. Since then Mr. Richardson has gone on to other responsibilities and other fields of research, but the completion of this bibliography has been a joint work. For the past seven years we have exchanged slips, comments, and criticisms.

I regret that I have found no way to include what must have been my earliest introduction to *Conularia* — a figure decorating the spine of a uniform edition of Hugh Miller which I bought piece meal from Thorburn and Abbott's second-hand bookstall in Ottawa, long before I knew there was such a genus.

G. Winston Sinclair

Delaware, Ohio
October 20, 1952.

INTRODUCTION

We believe this bibliography includes essentially all the works in which conularids have been described or figured. That we have here all records of the occurrence of conularids we seriously doubt, but we do feel that for North American species it is fairly complete.

So far as we could we have verified dates and other information, especially for papers in which genera and species are defined. Many entries remain incomplete. We must leave them for later amendment, asking the assistance of colleagues who have access to data we lack.

References to secondary sources such as textbooks have not been particularly sought, but we have included them when found. To omit them would be to omit the first publication of some species, new figures of others, and of still others accessible figures taken from rare primary sources. It seemed impossible, and in terms of our present purpose not wholly desirable, to draw a line to include the texts we thought "useful", and to exclude the twentieth repetition of the hoary figure of *C. ornata*.

We have been similarly uncritical of faunal lists. Many of these are patently useless or redundant. Their usefulness should be a concern not of the bibliographer, but of the systematist, and they will be evaluated elsewhere. Faunal lists are the raw material for all our generalizations about range and distribution, and so we have included all papers known to us in which the occurrence of conularids is noted, but not texts and such works in which species are simply referred to without illustration. Records in the form "*Conularia* sp." have not ordinarily been noticed, except where this is the only record of the group in a formation or geographic area, or unless it is to be definitely referred to in other parts of the work.

Under each entry we give (except for a few compendia) the trivial names of the conularids noticed in it. This brevity is possible since no valid trivial name seems to be duplicated in the group, except *quadrata,* which has been applied to a *Climacoconus* and a *Conulariopsis.* The relative importance of the records is indicated typographically. The first valid description of a species is noted by the use of capitals. A reference, other than the first description, in which something is added to our knowledge of the species (an illustration or a supplementary description) is noted by an asterisk. Thus, a lower case name without asterisk indicates that the species was simply listed, and the reference may be ignored by a student interested only in morphology.

Many of these citations are incorrect, in terms of our current understanding of the group. We experimented with various ways of indicating synonymies, only to decide that any clear system would be far too cumbersome and, more important, could not include data to permit the reader to judge the accuracy of our assignments. Therefore, only in some obvious cases do we indicate that a citation refers to some species other than that named. We have indicated, by the use of italics, that a name is for some reason unacceptable. For example, the species *Conularia sowerbyi* appears in many lists of European fossils, although the name is an objective junior synonym of *C. quadrisulcata* and cannot be used for any species. We have not tried to show what we think each author meant by this name but have simply italicized it to indicate that it is not correct as it stands.

An index without synonymies would be meaningless, but we have appended a list of the trivial names used in the group (italicizing those not accepted) with their author and date for reference to the original description.

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grandis, fecunda, bohemica, anomala

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aliena, fragilis, proteica, *sowerbyi*

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Barrois, Charles [Eugène]

1877. *Note préliminaire sur la terrain silurien de l'Ouest de la Bretagne.* Société géologique du Nord, Annales, tome 4, pp. 38-57, fig.
nobilis

1882. *Recherches sur les terrains anciens des Asturies et de la Galice.* Société géologique du Nord, Mémoires, tome 2, No. 1, 630 pp., 20 pl.
gervillei*

1889. *Faune du calcaire d'Erbay (Loire inférieur . Contribution à l'étude du terrain dévonien de l'ouest de la France.* Lille. 364 pp., 17 pl.
koninckii, gervillei, brongniarti

1891. *Mémoire sur la Faune du Grès amoricain.* Société géologique du Nord, Annales, tome 19, livr. 3/4, pp. 134-237; livr. 5/6, pl. 1-5 (1892).
C. sp.*

.........., **Pruvost, P., and Dubois, G.**

1922. *Supplément a l'étude des Crustacées et Ptéropodes siluro-dévoniens de Liévin.* Société géologique du Nord, Mémoires, tome 6, pt. 2, fasc. 2, pp. 105-126, pl. 15.
quadrisulcata*

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quadrisulcata

1922b. *Considérations générales sur les couches siluro-dévoniennes de l'Artois.* Société géologique du Nord, Mémoires, tome 6, pt. 2, fasc. 2, pp. 163-225, figs., tables.
quadrisulcata

Bassler, Ray S[mith]

1908. *The Nettleroth Collection of invertebrate fossils.* Smithsonian Miscellaneous Collections (Quarterly Issue), vol. 52, pt. 2, pp. 121-152, pl. 9-11.
micronema, newberryi

1911. *The early Paleozoic Bryozoa of the Baltic provinces.* United States National Museum, Bulletin 77, xxi+382 pp., 13 pl., 226 figs.
buchi, quadrisulcata, trentonensis

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byblis

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trentonensis*

1932. *The stratigraphy of the central basin of Tennessee.* Tennessee Division of Geology, Bulletin 38, x+268 pp., including 49 pl., frontispiece, 3 figs., map.
gattingeri

[Bather, Francis Arthur]

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*quadrisulcata**

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C. sp. (Dubuque)

Beachler, Cha[rle]s S.

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subcarbonaria, crawfordsvillensis

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subcarbonaria, crawfordsvillensis

Beede, J[oshua] W[illiam]

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crustula

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SORROCULA, planicostata

Begg, J[ames] L[ivingstone]

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TRUEMANI, *CURRIEAE* (=megista)

Bekker, Hendrik

1924. *Mõned uued andmed Kukruse lademe stratigraafiast je faunast. Stratigraphical and Paleontological Supplements on the Kukruse Stage of the Ordovician rocks of Eesti (Estonia).* Universitatis Dorpatensis, Acta et Commentationes, ser. A, vol. 6, No. 1, 19 pp., 2 pl., map. Also issued as: [University of Tartu], Geological Institution, Publication 1.
trentonensis*

Bell, W[alter] A[ndrew]

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planicostata

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planicostata

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planicostata*, tenuis*, sorrocula*

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planicostata

Bennett, John

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crustula

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crustula

Benson, W[illiam] N[oël]

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C. sp. (Burindi group)

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quadrisulcata

Bernard, Félix

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acuta*, *quadrisulcata**, quichua*

Bevan, George Phillips

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quadrilineata

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quadrisulcata

Beyrich, [August Heinrich Ernst]

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trentonensis, byblis, victa

Bigot, A[lexandre Pierre Désiré]

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pyramidata

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pyramidata

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pyramidata

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pyramidata

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Bigsby, John J[eremiah]

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quadrisulcata

1825. *A sketch of the geology of the Island of Montreal.* Lyceum of Natural History of New York, Annals, vol. 1, pt. 2, pp. 198-219, pl. 15.
quadrisulcata

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sowerbyi

1858. *On the Palaeozoic basin of the State of New York. Part I. A synoptical view of the mineralogical and fossil characters of the Palaeozoic strata of the State of New York.* Geological Society of London, Quarterly Journal, vol. 14, pt. 1, No. 3, pp. 335-427, tables.

gracilis, granulata, longa, niagarensis, papillata, *quadrisulcata,* trentonensis

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gracilis, granulata, longa, niagarensis, papillata, trentonensis, elongata, *sowerbyi,* subtilis

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Notes 41 species.

Billings, E[lkanah]

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trentonensis

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SPLENDIDA, ASPERATA

Bittner, A[lexander]

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C. sp.*

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TRIADICA

Blainville, H[enri] M[arie] Ducrotay de

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SOWERBYI (=quadrisulcata)

Blake, J[ohn] F[rederick]

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africana

Blanford, W[illiam] T[homas]

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laevigata, tenuistriata, irregularis

Bogatschew, J. T. (Я. Т. Богачев)

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C. sp. (Pinega series)

[Bogolioubow, Nikolai Nikolaevich] Н. Н. Боголюбовъ

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elongata

Bohlin, Birger

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aurora

Bolton, John

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cancellata, subtilis

Bonissent, P.

1864. *Essai géologique sur le département de la Manche, suite.* Société impériale des sciences naturelles de Cherbourg, Mémoires, tome 10, pp. 169-224.
gervillei

Borden, William Wallace

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doani

Borghi, Piero

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acuta*

Boswell, P[ercy] G[eorge] H[amnall]

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quadrisulcata

Bouček, Bedřich

1924. *Faunistické seznamy z různých nalezišť Barrandienu, I. Libeň.* Praha, Národi Museum, Časopis, Roč. 98, pp. 150-152.
tenella, bohemica, nobilis, grandissima, fecunda, exquisita

1924a. *Faunistické seznamy z různých nalezišť Barrandienu, II. Velká Chuchle.* Praha, Národi Museum, Časopis, Roč. 98, pp. 152-154.
nobilis, *modesta,* fecunda

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exquisita, fecunda, grandissima

1925a. *Faunistické seznamy z různých nalezišť Barrandienu, VI. Praha III. Nerudova Ulice.* Praha, Národi Museum, Časopis, Roč. 99, pp. 152-153.
modesta

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CONULARIELLA robusta*, sulcata*, Conularia insignis*, fecunda*, KOLIHAI, DISTINCTA, primula*, invertens*, exquisita*, bohemica*, tenella*, imperialis*, conjuncta*, munita*, CONCRETA, anomala*, KETTNERI, DENSISSIMA, POČTAI, consobrina*, pyramidata*, solitaria*, LONGISTRIATA, aliena*, bilineata*, fragilis*, SUPERSTES, simplex*, proteica*, HANUŠI, perneri*, RARICOSTATA, TRANSIENS, grandissima*, nobilis*, KLOUČEKI, HOLUBI, rugulosa*

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fecunda, insignis, grandissima, nobilis, exquisita, rugulosa, anomala, consobrina, pyramidata, proteica

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subparallela

1937a. *Conularida [review of Kiderlen 1937].* Fortschritte der Paläontologie, Bd. 1, pp. 100-101.

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anomala, pyramidata, consobrina, grandissima, fecunda, exquisita

1939. *Conularida,* in, O. H. Schindewolf: *Handbuch der Paläozoologie.* Berlin. Bd. 2 A, pp. A113-A131, 13 figs.
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consobrina

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kolihai, grandissima

1944. *O profilu spodním ordovikem na vrchu Babě u Hostomic. Über das Profil das untere Ordovicium am Berge Baba bei Hostomitz.* Separate only seen, with no serial noted. Pp. 41-64.
insignis

......, **and Ulrich, Fr.**

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Boule, Marcellin, and Piveteau, Jean

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pyramidata*

Bourcart, Jacques, and Monod, Théodore

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africana, undulata

Bowman, John Eddowes

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quadrisulcata

Bradley, John H[odgdon], Jr.

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occidentalis

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OCCIDENTALIS

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crustula*

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Notes 16 species of Paraconularia.

Branson, E[dwin] B[ayer]

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blairi*, sampsoni*, TENUICOSTATA

1938a. *Summary, comments, and lists of species,* in, Branson et al.: *Stratigraphy and paleontology of the Lower Mississippian of Missouri. Part II.* University of Missouri Studies, vol. 13, No. 4, pp. 179-189.
blairi, sampsoni, tenuicostata

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trentonensis, occidentalis, heymanni, marionensis, blairi, sampsoni, tenuicostata, missouriensis, crustula

Braun, Fred[erick]

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crawfordsvillensis

Brinkmann, Roland

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exquisita*

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crustula

Brøgger, W[aldemar] C[hristofer]

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C. sp.

Bronn, Heinrich Georg

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*quadrisulcata**

1838. *Lethaea Geognostica,* usw., II Bd., pp. 769-1346. Stuttgart.
PYRAMIDATA

1848. *Index palaeontologicus oder Übersicht der bis jetzt bekannten Fossilen Organismen. Erste Abtheilung. Nomenclator palaeontologicus, in alphabetischer Ordnung.* Stuttgart. lxxxiv+1381 pp.

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sowerbyi

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C. sp. (Burindi group)

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mitchelli, chapmani, *distincta*

Brown, Thomas

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quadrisulcata*. *teres**

1889. *An atlas of the fossil conchology of Great Britain and Ireland with descriptions of all the species.* London. iii pp., 114 plates (1-98). These plates were engraved from those of Brown 1849.
quadrisulcata*

Browne, W[illiam] R[owan], and Dun, W[illiam] S.

1924. *On the stratigraphy of the basal portions of the Permo-Carboniferous system in the Hunter River district.* Royal Society of New South Wales, Journal and Proceedings, vol. 58, pp. 198-206, fig.
laevigata*

Bubnoff, Serge von

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[simplex*]

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latior, formosa

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niagarensis

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HERSMANI

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trentonensis

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inaequicostata

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laevigata

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ornatissima

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pyramidata*

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deflexicostata*, quadrisulcata*, pyramidata*, ornata*, gerolsteinensis*, *convexa**

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proteica, perneri, nobilis

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rallus, triangulata, irrasa, raymondi, undosa, quadratus, clarki, trentonensis

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warthi

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acuta*, bodana*

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congregrata

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undulata

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desiderata*

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congregata, crebristiata

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lata, desiderata

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gracilis

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desiderata*, tuzoi*, penouili*, lata*

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huntiana*

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trentonensis

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africana*, ulrichana*, quichua*

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lata

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cayuga, congregata, continens, rudis, huntiana, lata, infrequens, newberryi, trentonensis, undulata, gracilis

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amazonica

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laevigata

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C. sp.

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pyramidalis*

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MILWAUKEENSIS

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quadrisulcata

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formosa

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sub-carbonaria, crawfordsvillensis

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sub-carbonaria, crawfordsvillensis

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missouriensis, subcarbonaria, micronema, newberryi

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niagarensis

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trentonensis

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quadrisulcata

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complanata, deflexicostata, *quadrisulcata,* subparallela

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hastata

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hastata

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warthi

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quadrisulcata, undulata

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quadrisulcata

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UNDULATA, LAQUEATA

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newberryi

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ornata*

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C. sp. (Beauceville)

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newberryi, byblis, victa, *gracilis,* micronema, multicosta

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newberryi

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africana

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homfrayi

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homfrayi

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quadrisulcata

Croneis, Carey [Gardiner]

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crustula

Cumings, E[dgar] R[oscoe]

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missouriensis*, subulata*, greenei*

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formosa*

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formosa, infrequens, micronema, crawfordsvillensis, intertexta, subcarbonaria, greenei, missouriensis

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formosa

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niagarensis

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newberryi

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tenuis*

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anomala*

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quadrisulcata*

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trentonensis

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inornata

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*quadrisulcata**

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formosa

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levigata

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INORNATA, levigata*, tenuistriata*

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*gracilis** (=trentonensis)

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trentonensis*

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pyramidata

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trentonensis

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levigata, tenuistriata, inornata

1950. *The Geology of the Commonwealth of Australia.* Edited and much supplemented by W. R. Browne, vol. 1. London. xx+747 pp., 209 figs., 18 tables, 58+[1] plates.
*tasmaniensis**, warthi

[Davitshvili, L. SH.] Л. Ш. Давиташвили

1949. *Курс палеонтологии.* Министерства геологии СССР. Москва. 835 pp., 782 figs.
*quadrisulcata**, pyramidata* fecunda*

Davoust,

1856. *Recherches faites par M. l'Abbé Davoust, sur la dizième question de deuxième paragraphe. Quelles sont, parmi les coquilles fossiles receuillies en France, celles qui n'ont encore été trouvées que dans le département de la Sarthe?* Société d'Agriculture, Sciences et Arts de la Sarthe, Bulletin, tome 11 (2e série, tome 3), pp. 463-517.
koninckii

Dawson, John William

1844. *On the Lower Carboniferous rocks, or gypsiferous formation of Nova Scotia.* Geological Society of London, Proceedings, vol. 4, pt. 2, No. 99, pp. 272-281, 6 figs., map.
C. sp.

1868. *Acadian geology. The geological structure, organic remains, and mineral resources of Nova Scotia, New Brunswick, and Prince Edward Island.* Second edition. London. 694 pp., 231 figs., frontispiece.
PLANICOSTATA

[1880.] *The chain of life in geological time. A sketch of the origin and*

succession of animals and plants. London (The Religious Tract Society). xiv+272 pp., 192 figs., frontispiece.
planicostata*

1883. *Preliminary notice of new fossils from the Lower Carboniferous limestones of Nova Scotia and Newfoundland.* Canadian Naturalist and Quarterly Journal of Science, n. s., vol. 10, No. 7, pp. 411-416. Also issued as: Report on the Peter Redpath Museum of McGill University, No. 2, pp. 10-15.
planicostata

1889. *Handbook of geology.* Montreal. 250 pp., figs.
*quadrisulcata** (=planicostata)

1891. *Acadian geology, &c., supplementary note to the fourth edition, 1891.* [Montreal?]. 37 pp.
planicostata

Decker, Charles E[lijah]

1933. *Viola limestone, primarily of Arbuckle and Wichita Mountain regions, Oklahoma.* American Association of Petroleum Geologists, Bulletin, vol. 17, No. 12, pp. 1405-1435, including 3 plates.
papillata, trentonensis

1951. *Preliminary note on age of Athens shale.* American Association Petroleum Geologists, Bulletin, vol. 35, No. 4, pp. 912-915.
trentonensis

.........., and Merritt, Clifford A[ddison]

1931. *The stratigraphy and physical characteristics of the Simpson group, with descriptions and illustrations of ostracodes and conodonts by Reginald W. Harris.* Oklahoma Geological Survey, Bulletin 55, 112 pp., including 15 pl., map.
C. sp. (Bromide formation)

De la Beche, Henry Thomas

1831. *A geological manual.* London, Paris and Strasburg. 535 pp., illus. Third edition, 1833, 629 pp.
quadrisulcata, *teres*, pyramidata

1832. *Handbuch der Geognosie. (Nach der zweiten Auflage des Engl. Originals, bearbeitet von H. von Dechen).* Berlin. xvi +612 pp.

1832a. *A geological manual.* Philadelphia. viii+535 pp., 103 figs. This American edition is from the same sheets as the first English, with a new title page.

Delgado, J[oaquim] F[ilippe] N[ery]

1897. *Fauna Silurica de Portugal. Novas observações ácerca de Lichas (Uralichas) Ribeiroi.* Direcção dos trabalhos geologicos de Portugal. 34 pp., 4 pl.
nobilis, fecunda, *tenuistriata*, bohemica

1908. *Système silurique de Portugal. Étude de stratigraphie paléontologique.* Commission du Service géologique du Portugal. 245 pp., 8 pl.
bohemica, fecunda, simplex, *tenuistriata*

Delle, N.

1937. *Zemgales līdzenuma, Augšzemes un Lietuvas devona nogulumi. Devon-Ablagerungen der Niederung von Zemgales, des Gebietes der Augšzame (Oberkurland) und Litauens.* Universitas Lat-

viensis, Acta, Matēmatikas un Dabas Zinātņu Fakultātes, ser. 2, vol. 5, pp. 105-384, 384a-384t, pl. 1-14, E-F, 4 figs.
LATVIENSIS

Demanet, Félix [D.]

1941. *Faune et stratigraphie de l'étage Namurien de la Belgique.* Musée royal d'Histoire naturelle de Belgique, Mémoire 97, 327 pp., 18 pl.
destinezi*, crustula*

1943. *Les horizons marins du Westphalien de la Belgique et leurs faunes.* Musée royal d'Histoire naturelle de Belgique, Mémoire 101, 166 pp., 9 pl.
crustula*

.........., **and Van Straelen, Victor**

1938. *Faune houillère de la Belgique,* in, Armand Renier et al.: *Flore et Faune houillères de la Belgique, pt. 3.* Bruxelles (Musée royal d'Histoire naturelle de Belgique), pp. 99-246, pl. 106-144, fig. 28-130.
crustula*, destinezi*

Denizot, Georges

1943. *Petit atlas des fossiles.* I. *Fossiles primaires et triasiques. Edition 2e.* Paris. 33 pp., 18 pl.
pyramidata*

Dennis, D[avid] W[orth]

1878. *An analytical key to the fossils of the vicinity of Richmond, Ind.* Richmond. 63 pp., 2 pl.
DOANI (=formosa)

1889. *A reprint of the tables of an analytical key to the fossils of Richmond, Ind., published in 1878.* [Richmond.] 48 pp.
doani, papillata

Derby, Orville Adelbert

1877. *Contribuições para a geologia da Região do Baixo Amazonas.* Museo Nacional do Rio de Janeiro, Archivos, vol. 2, pp. 77-104. Also issued, 1879, as: *A contribution to the geology of the Lower Amazonas.* American Philosophical Society, Proceedings for 1879, vol. 18, pp. 155-178.
C. sp.

Desio, Ardito

1941. *Fossili neosilurici del Fezzan Occidentale.* Museo Libico di Storia Naturale, Annali, vol. 2, pp. 13-45, pl. 1-3. Also issued as: Universita di Milano, Instituto di Geologia, Paleontologia e Geografia fisica, Publication (serie P) No. 19, 35 pp., pl. 1-3.
C. sp.

1941a. *Vestigia problematiche paleozoiche della Libia.* Museo Libico di Storia Naturale, Annali, vol. 2, pp., 47-92, pl. 4-13. Also issued as: Universita di Milano, Instituto di Geologia, Paleontologia e Geografia fisica, Publication (serie P) No. 20, 45 pp., pl. 4-13.
C. sp.

Deslongchamps, [Eugène François Guillaume] Eudes—

1864. *Notes pour servir a la géologie du Calvados. III.—Difficultés*

de l'étude des séries siluriennes. Société linnéenne de Normandie, Bulletin, tome 8, pp. 206-210.
ONDULATA (=pyramidata)

Deslongchamps, [Jacques Amand Eudes-]

1825. *Mémoire sur les corps organisés fossiles du grès intermédiaire de Calvados.* Société linnéenne de Calvados, Mémoires, Année 1825, pp. 290-317, 2 plates.
Conulaire ondulée, acutangle**

Dewalque, G[illes Joseph Gustave]

1880. *Prodrome d'une description géologique de la Belgique.* 2e édition. Bruxelles. 501 pp.
namurcana, irregularis

De Witt, Wallace, Jr.

1951. *Stratigraphy of the Berea sandstone and associated rocks in northeastern Ohio and northwestern Pennsylvania.* Geological Society of America, Bulletin, vol. 62, No. 11, pp. 1347-1370, 2 pl., 10 figs.
missouriensis

Diener, Carl

1899. *Anthracolithic fossils of Kashmir and Spiti.* Geological Survey of India, Memoirs, Palaeontologia Indica, series 15, vol. 1, pt. 2, 95 pp., 8 pl.
tenuistriata*

1913. *Triassic Faunae of Kashmir.* Geological Survey of India, Memoirs, Palaeontologia Indica, n. s., vol. 5, Memoir 1, 133 pp., 13 pl.
C. sp.*

1915. *The Anthracolithic Faunae of Kashmir, Kanaur and Spiti.* Geological Survey of India, Memoirs, Palaeontologia Indica, n. s., vol. 5, Memoir 2, 135 pp., 11 pl.
HAYDENI

1926. *Glossophora triadica. Fossilium Catalogus. I. Animalia.* Pars 34. Berlin. 242 pp.
triadica, stromeri

1927. *Leitfossilien des marinen Perm,* in George Gürich: *Leitfossilien,* Lief. 5. Berlin. 84 pp., 14 pl., 10 figs.
laevigata*

Dienst, P.

1928. *Zusammenstellung der im Geologischen Landesmuseum zu Berlin aufbewahrten Originale. I. Paläozoologischer Teil.* Preussischen Geologischen Landesanstalt. 133 pp.
hummeli, latecostata, mediorhenana, thuringa

Dorlodot, Jean de, and Delépine, G[aston]

1931. *Faune marine de terrain houiller de la Belgique. Répartition stratigraphique dans le région de Charleroi et de la Basse-Sambre.* Institut géologique de l'Université de Louvain, Mémoires, tome 6, No. 1, 112 pp., 10 pl., 4 figs., 2 tables.
C. sp.

Dorsmann, L.

1945. *The marine fauna of the Carboniferous in the Netherlands.* Me-

dedellingen von de Geologische Stichtung, series C-IV, vol. 3, No. 3, 101 pp., 11 pl.
crustula*

Douglas, James Archibald

1920. *Geological sections through the Andes of Peru and Bolivia: II.—From the Port of Mollendo to the Inambari River.* Geological Society of London, Quarterly Journal, vol. 76, pt. 1 (No. 301), pp. 1-61, pl. 1-6, 5 figs.
africana*, baini*, quichua*, acuta*

Dowling, D[onaldson] B[ogart]

1900. *Report on the geology of the west shore and islands of Lake Winnipeg.* Geological Survey of Canada, Annual Reports, vol. 11, pt. F (No. 704), 100 pp., 2 pl., figs. This paper also appeared in volume form in 1901 in English, and in 1902 in French, dated 1901.
asperata

Dresser, John A[lexander], and Denis, T. C.

1944. *Geology of Quebec.* Volume 2: *Descriptive geology.* Quebec Department of Mines, Geological Report 20, 544 pp., 44 pl., 41 figs., maps. Also issued in a French edition.
trentonensis*, triangulata, *sowerbyi,* lata, tuzoi, desiderata

Drevermann, Fritz

1901. *Die Fauna der oberdevonischen Tuffbreccie von Langenaubach bei Haiger.* Königlich Preussische geologische Landesanstalt und Bergakademie, Jahrbuch, Bd. 21, pt. 3, pp. 99-207, pl. 12-16.
acuta*

Dumont, André

1848. *Mémoire sur les terrains ardennais et rhénans de l'Ardenne, du Rhin, du Brabant et du Condros.* Académie royale des sciences, lettres et beaux-arts de Belgique, Mémoires, tome 22, 451 pp.
gervillei

Dun, William S.

1905. *List of fossils occurring in the Upper Marine series at Gerringong and Black Head.* Geological Survey of New South Wales, Records, vol. 8, pt. 2, pp. 106-107.
laevigata, inornata

1911. [*Exhibition of specimens.*] Royal Society of New South Wales, Journal and Proceedings, vol. 44, pt. 4, pp. liii-liv.
laevigata

Dunbar, Carl O[wen]

1919. *Stratigraphy and correlation of the Devonian of western Tennessee.* Tennessee, State Geological Survey, Bulletin 21, 127 pp., including 4 pl., 11 figs.
huntiana

Dupont, Édouard François

1863. *Sur la calcaire carbonifère de la Belgique et du Hainaut français.* Académie royale des sciences, lettres et beaux-arts de Belgique, Bulletin, série 2, tome 15, No. 1, pp. 86-137, figs.
irregularis

Durocher, J[oseph Marie Elizabeth]

1856. *Études sur la structure orographique et la constitution géologique de la Norwége, de la Suède et de la Finlande.* Société géologique de France, Mémoires, série 2, tome 6, pt. 1, 207 pp., maps.
quadrisulcata

Du Toit, Alex[ander] L[ogie]

1922. *The Carboniferous glaciation of South Africa.* Geological Society of South Africa, Transactions, vol. 24, pp. 188-227, 3 figs.
C. sp. (Dwyka)

1926. *The geology of South Africa.* Edinburgh and London. x+463 pp., 39 pl., 63 figs., map.
africana, baini, gamkaensis, quichua, ulrichana

1930. *A brief review of the Dwyka glaciation of South Africa.* International Geological Congress. Compte Rendu of the XV Session, South Africa, 1929, volume II, pp. 90-102.
C. sp.

Dyer, W[illiam] S[pafford]

1921. *On Conularia rugosa from the Lockport limestone at Hamilton, Ontario.* Royal Society of Canada, Section IV, Transactions, series 3, volume 15, pp. 65-67, 2 pl.
rugosa*

Earp, John Rowland

1938. *The higher Silurian rocks of the Kerry district, Montgomeryshire.* Geological Society of London, Quarterly Journal, vol. 94, pt. 1 (No. 373), pp. 125-160, pl. 12-13, 8 figs.
cancellata

Eastman, Charles R[ochester], editor.

1913. *Textbook of palaeontology, adapted from the German of Karl A. von Zittel.* Vol. 1. Second edition. London. xi+839 pp., 1594 figs.
anomala*, *quadrisulcata**

Eastwood, T[om], et al

1931. *The geology of the Whitehaven and Workington district.* Geological Survey of England and Wales, Memoirs. Explanation of sheet 28, xi+304 pp., 8 pl., 27 figs.
quadrisulcata

Eaton, Amos

1832. *Geological equivalents.* American Journal of Science, vol. 21, No. 1, pp. 132-138.
quadrisulcata

1832a. *Four cardinal points in stratiographical geology, established by organic remains.* American Journal of Science, vol. 21, No. 1, appendix, pp. 199-200.
quadrisulcata

Eichwald, Carl Edouard d' (Eduard Iwanowitsch von Eichwald)

1840. *Ueber das silurische Schichtensystems in Ehstland.* Zeitschrift für Natur.-und Heilkunde, Hefte 1/2. Only author's edition seen. 210 pp.
quadrisulcata*, BUCHII

1851. *Ein Paar Worte über die Eifel und die Grauwacke uberhaupt,* in, *Naturhistorische Bemerkungen als Beitrag zur vergleichenden Geognosie, auf einer Reise durch die Eifel, Tyrol, Italien, Sizilien und Algier.* Moskau und Stuttgart. pp. 1-74, pl. 1. A note says that this paper [464 pp., 2+2 pl.] forms Band IX of the Nouveaux Mémoires de la Société des Naturalistes de Moscou, but we have not seen it in that form.
gerolsteinensis, deflexicosta, acuta, quadrisulcata, buchii

1855. *Lethaea Rossica, ou Paléontologie de la Russie.* Vol. 1. *L'Ancienne période.* Atlas. Stuttgart. 59 pl.
LATESULCATA, LINEATA, STRIATA, MARGINATA, CONSTRICTA, subtilis*, trentonensis*

1857. *Beitrag zur geographischen Verbreitung der fossilen Thiere Russlands. Alte période.* Part 4. Société impérial des Naturalistes de Moscou, Bulletin, tome 29, 2e partie, No. 4, pp. 555-608.
lineata*, buchi*

1857a. *Beitrag zur geographischen Verbreitung der fossilen Thiere Russlands. Alte Periode.* Moskau. 242 pp. Reprinted from the Bulletin of the Société impérial des Naturalistes de Moscou, 1855-1857.
lineata*, buchi*.

1860. *Lethaea Rossica, ou Paléontologie de la Russie,* tome I, *L'Ancienne periode.* Pt. 2, pp. 681-1657. Stuttgart.
latesulcata*, lineata*, buchii*, striata*, *sowerbyi**, subtilis*, trentonensis*, constricta*, marginata*

Elles, Gertrude Lilian

1922. *The Bala country: Its structure and rock-succession.* Geological Society of London, Quarterly Journal, vol. 78, pt. 2 (No. 310), pp. 132-175, pl. 2 (map), 10 figs.
sowerbyi

1940. *The stratigraphy and faunal succession in the Ordovician rocks of the Builth-Llandrindod inlier, Radnorshire.* Geological Society of London, Quarterly Journal, vol. 95, pt. 4 (No. 380), pp. 383-445, pl. 27-32, 10 figs.
coronata, quadrisulcata, SILURIANA, caereesiense

Ells, R[obert] W[heeler]

1888. *Second report on the geology of a portion of the Province of Quebec.* Geological Survey of Canada, Annual Reports, n. s., vol. 3, pt. K. 120 pp. Issued in volume form, in both French and English editions, in 1893.
trentonensis

1900. *Report on the geology of the Three Rivers map-sheet or northwestern sheet of the "Eastern Townships" map, Quebec.* Geological Survey of Canada, Annual Reports, n. s., vol. 11, pt. J (No. 707). 70 pp., 4 pl., map. Issued in volume form in English in 1901, and in French in 1902, dated 1901.
trentonensis

Emerson, B[enjamin] K[endall]

1879. *On the geology of Frobisher Bay and Field Bay.* Appendix III to: *Narrative of the second Arctic Expedition made by Charles F. Hall.* U. S. 45th Congress, 3d session, Executive document No. 27, pp. 553-583, figs.
trentonensis

Emmons, Ebenezer

1846. *Conularia vernuelia n. s. Emmons.* American Quarterly Journal of Science and Agriculture, vol. 4, No. 8, p. 330, 2 figs. This article was not signed.
VERNUELIA

1855. *American geology.* Vol. 1, pt. 2, Albany. 251 pp., 18 pl., 84 figs.
HUDSONIA

1860. *Manual of geology: designed for the use of colleges and academies.* Second edition. New York. xi+297 pp., 218 figs.
hudsonia*, verneuilli*

Etheridge, Robert (1819-1903)

1888. *Fossils of the British Islands, stratigraphically and zoologically arranged.* Volume I, *Palaeozoic,* &c. Oxford. viii+468 pp.
cancellata, corium, elongata, homfrayi, laevigata, *sowerbyi,* llanvirnensis, margaritifera, pyramidata, subtilis, *quadrisulcata*

Etheridge, Robert (1847-1920)

1873. *Contributions to Carboniferous palaeontology. I. Note on the genus Conularia, Miller.* Geological Magazine, vol. 10, No. 109, pp. 295-297, 3 figs.
quadrisulcata

1878. *On our present knowledge of the invertebrate fauna of the Lower Carboniferous or Calciferous sandstone series of the Edinburgh neighbourhood, especially of that division known as the Wardie shales; and on the first appearance of certain species in these beds.* Geological Society of London, Quarterly Journal, vol. 34, pt. 1 (No. 133), pp. 1-26, pl. 1-2.
C. sp.

1878a. *A catalogue of Australian fossils (including Tasmania and the Island of Timor) stratigraphically and zoologically arranged.* Cambridge. xi+232 pp.
sowerbyi, inornata, laevigata, *torta, quadrisulcata,* tenuistriata

1881. *On the analysis and distribution of the British Palaeozoic fossils.* Geological Society of London, Proceedings, session 1880-81, pp. 51-235.
homfrayi, corium, margaritifera, llanvirnensis, *sowerbyi,* subtilis, *cancellata, quadrisulcata*

1882. *The Palaeozoic conchology of Scotland.* Royal Physical Society of Edinburgh, Proceedings, vol. 7, pt. 1, pp. 1-94.

1890. *On the further structure of Conularia inornata Dana, and Hyolithes lanceolatus Morris sp. (=Theca lanceolata, Morris).* Linnean Society of New South Wales, Proceedings, series 2, vol. 4, pt. 3, pp. 751-756, pl. 20.
inornata*

1901. *Aperture of Conularia.* Australian Museum, Records, vol. 4, No. 1, p. 52.
laevigata, *tasmanica, undulata*

Evans, David Cledlyn

1906. *The Ordovician rocks of western Caermarthenshire.* Geological Society of London, Quarterly Journal, vol. 62, pt. 4 (No. 248), pp. 597-643, pl. 46 (map), 7 figs.
margaritifera, homfrayi

Faessler, C[arl], and Laverdière, J. W.

1936. *Quelques observations sur la géologie de la Côte de Beaupré.* Naturaliste Canadien, tome 63, No. 2 (série 3, tome 7), pp. 33-44, 5 figs. Also issued, with same pagination, as: Université Laval, Faculté des Sciences, Géologie et Mineralogie, Contributions, No. 25.
trentonensis

Fairbridge, Rhodes W.

1949. *Geology of the country around Waddamana, central Tasmania.* Royal Society of Tasmania, Papers and Proceedings for 1948, pp. 111-149, pl. 5-9, figs.
inornata

Fearnsides, William George

1905. *On the geology of Arenig Fawr and Moel Llyfnant.* Geological Society of London, Quarterly Journal, vol. 61, pt. 3 (No. 243), pp. 608-640, pl. 41 (map), 2 figs.
homfrayi

Felix, Johannes Paul

1924. *Leitfossilien aus dem Pflanzen- und Tierreich in systematischen Anordnung,* 2 Auflage. Leipzig. 228 pp., figs.
simplex*

Feruglio, Egidio

1933. *Fossili devonici della Sierra del Porongal nella regione subandina dell'Argentina settentrionale.* R. Museo geologico di Bologna, Annali, Giornale di Geologia, Serie 2a, vol. 8, pp. 127-146, plate.
ulrichana*

Field, Richard M[ontgomery]

1919. *The Middle Ordovician of central and south central Pennsylvania.* American Journal of Science, series 4, vol. 48, No. 288, pp. 403-428, 3 figs.
trentonensis

Fischer, Paul [Henri]

1883. *Manuel de Conchyliologie et de paléontologie conchyliologique,* fasc. V, pp. 417-512, figs. Paris.
quadrisulcata*

Fischer de Waldheim, G[otthelf Friedrich]

1848. *Notice sur quelques céphalopodes du calcaire de montagne de Kalouga et de Moscou.* Société impérial des Naturalistes de Moscou, Bulletin, tome 21, No. 3, pp. 85-133, pl. 5.
CONVEXA, ELONGATA (cephalopods)

1848a. *Notice sur quelques fossiles du Gouvernement d'Orel.* Société impérial des Naturalistes de Moscou, Bulletin, tome 21, No. 4, pp. 455-469, pl. 11.
INCLINATA (a cephalopod)

Fleming, John

1828. *A history of British animals, exhibiting the descriptive characters and systematical arrangements of the genera and species of quadrupeds, birds, reptiles, fishes, Mollusca, and Radiata of the United Kingdom,* &c. Edinburgh. xxiii+565 pp.
quadrisulcata, *teres*

Fletcher, Harold O.

1938. *A revision of the Australian Conulariae.* Australian Museum, Records, vol. 20, No. 3, pp. 235-255, pl. 24-26.
MITCHELLI, CHAPMANI, TUBERCULATA, EXPANSA, ACUTILIRATA, CRENULATA, *DISTINCTA*, SALTERI, warthi*, torta*, levigata*, inornata*, tenuistriata*, derwentensis*, ornatissima*

1946. *Notes on the nomenclature of Conularia distincta Fletcher and Conularia tenuistriata McCoy.* Australian Museum, Records, vol. 21, No. 7, p. 394.
BOWNINGENSIS

Fletcher, Hugh

1878. *Report on the geology of part of the counties of Victoria, Cape Breton and Richmond, Nova Scotia.* Geological Survey of Canada, Report of Progress for 1876-1877, pp. 402-456, 5 figs., map. This report also appeared in a French edition, with different pagination.
planicostata

Foerste, August F[rederick]

1889. *Notes on Clinton group fossils, with special reference to collections from Indiana, Tennessee and Georgia.* Boston Society of Natural History, Proceedings, vol. 24, pp. 263-355, pl. 5-9.
niagarensis*

[1895]. *Fossils of the Clinton group in Ohio and Indiana.* Geological Survey of Ohio, Report, vol. 7, pp. 516-601, pl. 25-37a. Although this volume was dated 1893, only the first 290 pages appeared in that year (see p. xiv), and although on that page the whole volume was said to be published in 1894, it had not yet appeared in January 1895 (see p. 80a).
niagarensis*, *BILINEATA*

1913. *The identification of Trenton and lower geological horizons.* Kentucky Geological Survey, series 4, vol. 1, pt. 1, pp. 365-376, pl. 5-10.
quadrata

1914. *The Rogers Gap fauna of central Kentucky.* Cincinnati Society of Natural History, Journal, vol. 21, No. 4, pp. 109-156, 4 pl., figs.
ROGERSENSIS

1916. *Notes on Cincinnatian fossil types.* Denison University, Scientific Laboratories, Bulletin, vol. 18, articles 4-7, pp. 285-355, including pl. 1-7.
Notes conularids as hosts to *Crania.*

1917. *Notes on Richmond and related fossils.* Cincinnati Society of Natural History, Journal, vol. 22, No. 2, pp. 42-55, 3 pl.
MISENERI (a hyolithid)

1918. *The Richmond faunas of Little Bay de Noquette, in Northern Michigan.* Ottawa Naturalist, vol. 31, No. 9, pp. 97-103, pl. 4-6; No. 10, pp. 121-127.
formosa

1920. *The Kimmswick and Plattin limestones of northeastern Missouri.* Denison University Bulletin, Scientific Laboratories, Journal, vol. 19, No. 3, pp. 175-224, pl. 21-23.
HEYMANI, *PLATTINENSIS* (=heymani)

1924. *Upper Ordovician faunas of Ontario and Quebec.* Geological

Survey, Canada, Memoir 138 (Geological Series 121), iv+255 pp., 46 pl., 14 figs.
asperata

1928. *American Arctic and related cephalopods.* Denison University Bulletin, vol. 38, No. 2; Scientific Laboratories, Journal, vol. 23, articles 1-2, pp. 1-110, pl. 1-29.
METACONULARIA ULRICHI, papillata*, granulata*, delicata*

1929. *The cephalopods of the Red River formation of southern Manitoba.* Denison University Bulletin, vol 29, No. 7; Scientific Laboratories, Journal, vol. 24, articles 6-9, pp. 129-235, pl. 11-39.
asperata

Follmann, O[tto]

1925. *Die Koblenzschichten am Mittelrhein und in Moselgebiet.* Naturhistorischen Vereins der preussischen Rheinlande und Westfalens, Verhandlungen, Jahrgang 1921/22 (Bd. 78/79), p. 1-105.
subparallela

Fomitchev, V. D. (В. Д. Фомичев)

1935. *Стратиграфия и тектоника инского и плотниковского районов кузнецкого бассейна.*
The stratigraphy and tectonics of the Inia and Plotnikovo regions of Kuznetsk basin. U. S. S. R., United Geological and Prospecting Service, Transactions, fasc. 333, 99 pp., maps, figs.
C. sp. (Lower Carboniferous)

1940. *Детальная геологическая карта кузнецкого каменноугольного бассейна, планшет N-45-16Г (Мозжухинский).*
Detailed geological map of the Kuznetsk Coal Basin, sheet N-45-16-Г (Mozjukha). U. S. S. R., Central Geological and Prospecting Institute, fasc. 119, 164 pp., 25 figs.
C. sp. (Upper Carboniferous)

Forsyth, David

1885. *The Silurian rocks of the Girvan District.* Geological Society of Glasgow, Transactions, vol. 7, pt. 2, pp. 358-369, pl. 14-15.
sowerbyi

Foster, Helen L[aura]

1947. *Paleozoic and Mesozoic stratigraphy of northern Gros Ventre Mountains and Mount Leidy Highlands, Teton County, Wyoming.* American Association of Petroleum Geologists, Bulletin, vol. 31, No. 9, pp. 1537-1593, 9 figs.
kaibabensis

Fox, Cyril S[ankey]

1931. *The Gondwana system and related formations.* Geological Survey of India, Memoirs, vol. 58, v+241 pp., 10 pl., frontispiece.

Fox, Howard

1895. *On some fossils from the coast sections in the parishes of Padstow and St. Merryn.* Royal Geological Society of Cornwall, Transactions, vol. 11, pt. 9, 81st Annual Report, &c., pp. 634-644.
C. sp.

1900. *Geological notes.* Royal Geological Society of Cornwall, Transactions, vol. 12, pt. 5, 86th Annual Report, &c., pp. 342-361, pl. 16.
C. sp.

1900a. *Notes on the geology and fossils of some Devonian rocks on the north coast of Cornwall.* Geological Magazine, n. s., decade 4, vol. 7, No. 4, pp. 145-152, pl. 7.
C. sp.

1902. *On the distribution of fossils on the north coast of Cornwall south of the Camel.* Royal Geological Society of Cornwall, Transactions, vol. 12, pt. 7, 88th Annual Report, &c., pp. 535-545, plate (map).
C. sp.

1905. *Further notes on the Devonian rocks and fossils in the parish of St. Minver.* Royal Geological Society of Cornwall, Transactions, vol. 13, pt. 1, 91st Annual Report, &c., pp. 33-57.
subparallela, deflexicosta

1905a. *Devonian fossils from the parish of St. Minver, North Cornwall.* Geological Magazine, n. s., decade 5, vol. 2, No. 4, pp. 145-150.
subparallela, deflexicosta

Foyles, Edward J[ohn]

1927. *Locality list of Vermont invertebrate fossils.* Vermont State Geologist, 15th Report, pp. 163-190.
trentonensis

Fraas, E[berhard]

1910. *Der Petrefaktensammler. Ein Leitfaden zum Sammeln und Bestimmen der Versteinerungen Deutschlands.* Stuttgart. vi+249 pp., 72 pl., 139 figs.
anomala*

Frech, Fritz

1889. *Ueber das rheinische Unterdevon und die Stellung des "Hercyn".* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 41, Heft 2, pp. 175-287, fig.
deflexicosta, gervillei

Freed, Stella B.

1894. *Catalogue of instruments, minerals, fossils, shells, &c. in the cabinet of Prof. A. Freed near Lancaster, Fairfield Co., O.* Canal Winchester, Ohio. 56 pp.
trentonensis, micronema, newberryi, missouriensis

Freeman, H[enry] C.

1868. *La Salle County.* Geological Survey of Illinois, vol. 3, pp. 257-287, [2] figs.
C. sp. (Coal Measures)

Freulon, J[ean] M[ichel]

1951. *Sur la série primaire du Fezzan nord-occidental.* Société géologique de France, Compte rendu sommaire des séances, No. 12, Séance du 18 Juin 1951, pp. 216-218.
C. sp.

Freyberg, Bruno von

1922. *Die Fauna und Gliederung der Thüringer Untersilurs.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 74, Hefte 2-4, pp. 237-276, pl. 4-5, fig. Also issued, with same pagination but without plates, as: Habilitationsschrift, Vereinigten Friedrichsuniversität Halle-Wittenberg.
fecunda*, THURINGA, LATECOSTATA

1923. *Die untersilurischen Eisenerzlager des ostthüringischen Schiefergebirges.* Halleschen Verbandes für die Erforschung der mitteldeutschen Bodenschätze und ihrer Verwertung, Jahrbuch, Bd. 4, Lief. 1, pp. 1-73, 7 pl., 13 figs.
Notes conularids in phosphate pebbles.

Fritsch, Karl von

1860. *Geognostische Skizze der Umgegend von Ilmenau am Thüringer Walde.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 12, Heft 1, pp. 97-155, pl. 3-5.
hollebeni

1901. *Führer durch das mineralogische Institut der kgl. ver. Friedrichs-Universität.* Halle-Wittenberg. (Not seen, *fide* Bouček)
modesta*

Fritz, Madeleine A[lberta]

1926. *The stratigraphy and palaeontology of the Workman's Creek section of the Cincinnatian series of Ontario.* Royal Society of Canada, Section IV, Transactions, series 3, vol. 20, pp. 77-107, 4 pl., table.
formosa

1944. *Catalogue of types in the Royal Ontario Museum of Palaeontology. Part IV.* Royal Ontario Museum of Palaeontology, Contributions, No. 8, 46 pp.
attenuata, formosa, *parva,* narrawayi, amoena, dubia, gibraltarensis

Frommurze, H. F., and Gevers, T. W.

1929. *South west Africa.* International Geological Congress, Guide Book, XV session, Excursion C. 21, pp. 1-46, 3 figs., map.
C. sp. (Dwyka)

Fuchs, Alexander

1915. *Beitrag zur Kenntnis der Hunrückschiefer und Unterkoblenzfauna der Loreleigegend.* Königlich Preussische geologische Landesanstalt und Bergakademie, Abh., Bd. 79, 79 pp., 18 pl.
MEDIORHENANA

Fuhrmann, August

1949. *Beiträge zur Geologie des Iberg-Winterberg-Massivs bei Bad Grund (Oberharz) im Lichte der neuen Aufschlüsse.* Neues Jahrbuch für Mineralogie, usw., Abt. B, Abhandlungen, Bd. 91, Heft 1, pp. 35-90, map.
acuta, bodana

Fulda, E[rnst]

1935. *Zechstein.* Band 7 of: *Handbuch der vergleichenden Stratigraphie Deutschlands.* Berlin. 409 pp., 100 figs.
hollebeni

Furon, Raymond

1941. *La Paléogéographie. Essai sur l'évolution des continents et des océans.* Paris. 530 pp., 136 figs., 16 maps.

1950. *Géologie de l'Afrique.* Paris. 350 pp., 34 figs.
africana

Garner, Robert

1844. *The natural history of the County of Stafford; comprising its geo-*

logy, zoology, botany, and meteorolgy: also its antiquities, topography, manufactures, &c. London. vii+551 pp., pl. 1-2, A-E, [2], [20] figs.
quadrisulcata

Garwood, Edmund Johnstone

[1913.] *The Lower Carboniferous succession in the north-west of England.* Geological Society of London, Quarterly Journal, vol. 68, pt. 4 (No. 272), pp. 449-572, pl. 44-56, 7 figs. This volume is dated 1912, but part 4 was issued January 13, 1913.
quadrisulcata

.........., et al.

1898. *Life zones in the British Carboniferous rocks.* British Association for the Advancement of Science, Report of the 67th (Toronto) Meeting, pp. 296-297. Also printed in: Geological Magazine, decade 4, vol. 4, pp. 556-557.

Gaudry, Albert

1883. *Les enchaînements du monde animal dans les temps géologiques. Fossiles primaires.* Paris. 317 pp., 285 figs.
pyramidata*

Geikie, Archibald

1868. *On the order of succession among the Silurian rocks of Scotland.* Geological Society of Glasgow, Transactions, vol. 3, pt. 1, pp. 74-95.
sowerbyi

1869. *Ayrshire: South-western district.* Geological Survey of Scotland, Memoirs. Explanation of sheet 7, 16 pp., map. Fossil lists by Robert Etheridge [the elder].
elongata

1869a. *Peebleshire, with parts of Lanark, Edinburgh, and Selkirk.* Geological Survey of Scotland, Memoirs. Explanation of sheet 24, 24 pp., map. Fossil lists by J. W. Salter.
quadrisulcata

1872. *Ayrshire (north part), with parts of Renfrewshire and Lanarkshire.* Geological Survey of Scotland, Memoirs. Explanation of sheet 22, 50 pp., map. Fossil lists by Robert Etheridge, Jr.
quadrisulcata

1873. *Lanarkshire: Central districts.* Geological Survey of Scotland, Memoirs. Explanation of sheet 23, 107 pp., map. Fossil lists by Robert Etheridge, Jr.
quadrisulcata

1873a. *Western Wigtownshire.* Geological Survey of Scotland, Memoirs. Explanation of sheet 3. 34 pp., map. Fossil lists by Robert Etheridge [the elder] and Prof. [John] Young.
elongata

1879. *Stirling (southern part). Lanarkshire (northern part). Linlithgowshire (western Borders).* Geological Survey of Scotland, Memoirs, Explanation of sheet 31, 87 pp., map. Fossil lists by R[obert] E[theridge], Jr.
quadrisulcata

1902. *Text-Book of geology.* New York. 1787 pp., 471 figs.
homfrayi*, *quadrisulcata**

Geinitz, Hanns Bruno

1845. *Grundriss der Versteinerungskunde.* Dresden und Leipzig. viii+813 pp., table. 28 plates (1-26) published in 1846.
quadrisulcata, *teres,* irregularis

1853. *Conularia Hollebeni Gein. aus dem unteren Zechstein von Ilmenau.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 5, Heft 2, pp. 465-466, fig.
HOLLEBENI

1861. *Dyas oder die Zechsteinformation und das Rothliegende. I. Die animalischen Ueberreste der Dyas.* Leipzig. xviii+130 pp., 23 pl. 8 figs.
hollebeni*

Gerth, H.

1932. *Geologie der Erde. Geologie Südamerikas.* [I. Bd.], I. Teil. Berlin. vii+389 pp.
quichua, striatula, quichua

Gevin, Pierre

1949. *Série paléozoïque d'Aouinet Legra (Sahara occidental).* Société géologique de France, Bulletin, série 5, tome 18, fasc. 6/7,pp. 369-381, 4 figs.
C. sp. (Devonian)

Giebel, C[hristoph] G[ottfried Andreas]

1852. *Deutschlands Petrefacten.* Leipzig. 706 pp.
acuta, gerolsteinensis, gervillei, deflexicosta, ornata

1852a. *Allgemeine Palaeontologie. Entwurf einer systematischen Darstellung der Fauna und Flora der Vorwelt.* Leipzig. 414 pp.
acuta, quadrisulcata, gervillei, gerolsteinensis, irregularis, elongata, ornata, pyramidata

Gill, Edmund D.

1942. *On the thickness and age of the type Yeringian strata, Lilydale, Victoria.* Royal Society of Victoria, Proceedings, n. s., vol. 54, pt. 1, pp. 21-52, pl. 4-6, figs.
C. sp.

.........., **and Banks, M. R.**

1950. *Silurian and Devonian stratigraphy of the Zeehan area, Tasmania.* Royal Society of Tasmania, Papers and Proceedings for the year 1949, pp. 259-271, pl. 1-3.
inornata

Gillette, Tracy

1940. *Geology of the Clyde and Sodus Bay quadrangles. With a chapter on the water resources by Bernard H. Dollen.* New York State Museum, Bulletin 320, 179 pp., 45 figs., map.
niagarensis

1947. *The Clinton of western and central New York.* New York State Museum, Bulletin 341, 191 pp., 20 figs.
longa, niagarensis

Girty, George Herbert

1903. *The Carboniferous formations and faunas of Colorado.* United States Geological Survey, Professional Paper 16 (Series C, No. 63), 546 pp., 10 pl.
crustula*

1910. *The fauna of the phosphate beds of the Park City formation in Idaho, Wyoming and Utah.* United States Geological Survey, Bulletin 436, 82 pp., 7 pl.
C. sp.*

1911. *On some new genera and species of Pennsylvanian fossils from the Wewoka formation of Oklahoma.* New York Academy of Sciences, Annals, vol. 21, pp. 119-156.
HOLDENVILLAE

1912. *Geologic age of the Bedford shale of Ohio.* New York Academy of Sciences, Annals, vol. 22, pp. 295-319.
byblis, newberryi

1915. *Fauna of the Wewoka formation of Oklahoma.* United States Geological Survey, Bulletin 544, 353 pp., 35 pl.
crustula*, holdenvillae*

1915a. *Invertebrate paleontology,* in, Henry Hinds and F. C. Greene: *The stratigraphy of the Pennsylvanian series in Missouri.* Missouri Bureau of Geology and Mines, series 2, vol. 13, pp. 263-376, pl. 27-32, 2 tables.
crustula

1922. [*Report of fossils*], in, W. J. Wright: *Geology of the Moncton map-area.* Geological Survey of Canada, Memoir 129 (Geological Series 110), pp. 18-19.
planicostata

1923. *Observations on the faunas of the Greenbrier limestone and adjacent rocks.* West Virginia Geological Survey. Tucker County [Report], pp. 450-488.
chesterensis

1927. *List of species,* in, A. O. Hayes: *Bituminous shale and other mineral occurrences in the vicinity of Sussex, N. B.* Geological Survey, Canada, Summary Report, 1925, part C, p. 130c.
planicostata

Glauert, Ludwig

1912. *Permo-Carboniferous fossils from Bryo Station, Murchison district.* Western Australian Museum and Art Gallery, Records, vol. 1, pt. 2, pp. 75-77.
C. sp. nov.*

1926. *A list of Western Australian fossils. Supplement No. 1.* Western Australia, Geological Survey, Bulletin 88, pp. 36-71.
warthi

Goldring, Winifred

1929. *Handbook of paleontology for beginners and amateurs, Part 1. The fossils.* New York State Museum, Handbook 9, 356 pp., figs. Second edition, 1950, 394 pp., 97 figs.
[undulata*]

1931. *Handbook of paleontology. Part 2. The formations.* New York State Museum, Handbook 10, 488 pp., 62 figs.
undulata*

1935. *Geology of the Berne Quadrangle, with a chapter on glacial geology by John H. Cook.* New York State Museum, Bulletin 303, 238 pp., 72 figs., map.
trentonensis*, multicosta

1943. *Geology of the Coxsackie Quadrangle, New York, with a chapter*

on glacial geology by John H. Cook. New York State Museum, Bulletin 332, 374 pp., 71 figs., map.
ulsterensis, trentonensis

Goodchild, J[ohn] G[eorge]

1901. *The Carboniferous Gasteropoda of the Clyde drainage area,* in, G. F. Scott Elliott, Malcolm Laurie and J. Barclay Murdoch: *Fauna, flora and geology of the Clyde area,* pp. 505-508. Glasgow (Local Committee for the Meeting of the British Association).
quadrisulcata

1904. *The Carboniferous Gasteropoda of the Clyde drainage area,* in, J. B. Murdoch et al.: *The geology and palaeontology of the Clyde drainage area,* pp. 505-508. Glasgow (Rooms of the Geological Society). This book is a reissue of the 1901 handbook, with corrections and additions, but with the original pagination retained.
quadrisulcata

Gorby, S[ylvester] S[cott]

1889. *List of specimens in the State Museum.* Indiana, Department of Geology and Natural History, 16th Annual Report, pp. 383-472.
crustula, *downii*, micronema, missouriensis, newberryi, niagarensis, quadrisulcata, subcarbonaria

Gosselet, [Jules Auguste Alexandre]

1887. *6e Note sur le Famennien.* Société géologique du Nord, Annales, tome 14, livr. 2/3, pp. 130-145.
simplex

Gould, Cha[rle]s N[ewton]

1925. *Index to the stratigraphy of Oklahoma, with lists of characteristic fossils by Charles E. Decker.* Oklahoma Geology Survey, Bulletin 35, 115 pp., table.
trentonensis, crustula

Grabau, Amadeus William

1899. *Geology and palaeontology of Eighteen Mile Creek and the lake shore sections of Erie County, New York. Part 2. Palaeontology.* Buffalo Society of Natural Sciences, Bulletin, vol. 6, No. 2/4, pp. 93-403, 263 figs.
undulata*

1901. *Guide to the geology and paleontology of Niagara Falls and vicinity.* New York State Museum, Bulletin 45 (volume 9), 284 pp., 18 pl. 190 figs., map. Also issued as: Buffalo Society of Natural Sciences, Bulletin, vol. 7, No. 1, with same pagination.
niagarensis*

1906. *Guide to the geology and paleontology of the Schoharie Valley in eastern New York.* New York State Museum, Bulletin 92 (Paleontology No. 13) (New York State Education Department Bulletin 370), pp. 76-386, 24 pl., 225 figs., map.
huntiana*, rudis, lata, pyramidalis

1919. *Significance of the Sherbourne sandstone in Upper Devonic stratigraphy.* Geological Society of America, Bulletin, vol. 30, No. 4, pp. 423-470.
congregata, undulata

1921. *A comprehensive geology.* Vol. 2. Boston, New York and Chicago. viii+976 pp., 1980 figs., frontispiece.
undulata*, micronema*

1924. *Stratigraphy of China. Part 1. Palaeozoic and older.* Geological Survey of China. xviii+528 pp., 6 pl., 306 figs.
SIMPLICOSTA

1937. *Palaezoic formations in the light of the pulsation theory.* Volume III. *Cambrovician pulsation.* Part III. *Appalachian, Palaeocordilleran, Pre-Andean, Himalayana and Cathaysian geosynclines.* The National University of Peking. xxx+850 pp., maps, charts.
undulata

1938. *Palaeozoic formations in the light of the pulsation theory.* Volume IV. *Ordovician pulsation.* Part 1. *Ordovician formations of the Caledonian geosyncline, with a review and summary of the Skiddavian pulsation system.* Peking. xxxiii+942 pp., 67 figs.
sowerbyi, hispida, planiseptata, vesicularis, trentonensis, imperialis, anomala, quadrisulcata

.........., and Shimer, Hervey Woodburn

1910. *North American index fossils, invertebrates.* Volume 2. New York. xv+909 pp., 1937 figs.
niagarensis*, huntiana*, undulata*, newberryi*, byblis*, micronema*, missouriensis*, subulata*, crustula*

Grange, Jules

1854. *Géologie, minéralogie et géographie physique du voyage. 2 Partie,* in, J. Dumont-d'Urville: *Voyage au pole sud et dans l'Océanie sur les corvettes l'Astrolobe et la Zélée . . . &c.* Paris. 218 pp.
levigata

Green, A[lexander Henry], and Strahan, Aubrey

1887. *The geology of the Carboniferous limestone, Yoredale rocks, and Millstone Grit of north Derbyshire.* Geological Survey, England and Wales, Memoir, 2d edition, 212 pp., illus.
quadrisulcata

Greene, George K.

1880. *Geology of Monroe County.* Indiana Department of Statistics and Geology, Second Annual Report, pp. 427-449, map.
subcarbonaria

Griffith, Richard John

1861. *The localities of the Irish Carboniferous fossils, arranged according to the stratigraphical subdivisions of the Carboniferous system adopted in the geological map of Ireland, with the Irish mining localities as appended to the synoptical table of fossils, engraved on the margin of that map, and as originally compiled for the use of the general valuation of Ireland.* Geological Society of Dublin, Journal, vol. 9, pt. 1, pp. 21-155.
quadrisulcata

Griffith, Robert

1842. *Notice respecting the fossils of the Mountain limestone of Ireland, as compared with those of Great Britain, and also with the Devonian system.* Dublin. 25 pp., sections.
quadrisulcata

Groom, Theodore

1910. *The Malvern and Abberley Hills, and the Ledbury district,* in,

Geology in the field, pp. 698-738, pl. 23, fig. 116-121. London (The Geologists' Association).
sowerbyi

Gross, Karl

1948. *Vorläufige Verzeichnis der Devon-Fossilien des Siegerlandes.* Neues Jahrbuch für Mineralogie, usw., Abt., B, Montshefte, Jahrgang 1945-1948, Hefte 1-4, pp. 138-153.
subparallela

Gross, L[udwig], (Freiherr) von

1844. *Geologie, Geognosie und Petrefactenkunde.* Weimar. 323 pp., 16 pl.
pyramidata*

Gross, Walter

1933. *Die Fische des baltischen Devons.* Palaeontographica, Bd. 79, Abt. A, Lief. 1/2, pp. 1-74, pl. 1-6.
[latviensis]

1934. *Zur Gliederung des baltischen Old Reds.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 86, Heft 7, pp. 410-424, 4 figs.
[latviensis]

Grossart, William

1868. *On the Upper Coal Measures of Lanarkshire.* Geological Society of Glasgow, Transactions, vol. 3, pt. 1, pp. 96-113.
quadrisulcata

Guèranger, Edouard Auguste François

1853. *Essai d'un répertoire paléontologique du département de la Sarthe, dressé suivant l'ordre de superposition des terrains, ou Liste des Fossiles observés jusqu'ici dans cette localité.* Le Mans. 44 pp. An *Album paléontologique* was prepared to illustrate this work, and published in 1867, in both folio and 18-mo. editions. We have not seen this Atlas, but according to Hector Leveille, Guèranger's biographer, only the first livraison dealing with the Cenomanian was issued. (See Leveille: Société d'Agriculture, Sciences et Arts de la Sarthe, Bulletin, tome 35, p. 22, 1895.)
KONINCKII

Gugenberger, Odomar

1934. *Über eine neue Conularia und das Vorkommen von Hyolithes in den Cardita-Schichten von Launsdorf (Kärnten).* Centralblatt für Mineralogie, usw., Jahrgang 1934, Abt. B, Nr. 4, pp. 190-192.
TRAUTHI

Guillier, Albert

1872. *Faune seconde silurienne entre Saint-Dennis-d'Orques et Chemiré-en-Charnie (note additionnelle).* Société d'Agriculture, Sciences et Arts de la Sarthe, Bulletin, tome 21 (2e série, tome 13), pp. 633-636.
quadrisulcata, mayeri

Gunn, W[illiam]

1900. *The geology of Belford, Holy Island, and the Farne Islands, Northumberland.* Geological Survey, England and Wales, Memoir. Quarter-sheet 110 S. E., new series, sheet 4, iv+155 pp., 8 figs.

Guppy, D. J., Lindner, A. W., Rattigan, J. H. and Casey, J. N.

1952. *The stratigraphy of the Mesozoic and Permian sediments of the Desert Basin, Western Australia.* XIXe Congrès géologique international. *Symposium sur les Séries de Gondwana,* pp. 107-114, map.

Gürich, Georg

1896. *Das Palaeozoicum im Polnischen Mittelgebirges.* Russisch-Kaiserliche Mineralogische, Gesellschaft, Verhandlungen, Ser. 2, Bd. 32, 539 pp., 15 pl.
ornata*, trentonensis*

1923. *Acrolepis Lotzi und andere Ganoiden aus den Dwyka-Schichten von Ganikobis. Südwestafrika.* Beiträge zur geologischen Erforschung der Deutschen Schutzgebiete, Heft 19, pp. 26-73, 3 pl., 23 figs.
C. sp. (Dwyka)

Haas, Hippolyt J[ulius]

1887. *Die Leitfossilien. Synopsis der geologisch wichtigsten Formen des vorweltlichen Tier- und Pflanzenreichs.* Leipzig. vii+328 pp., 582 figs.
simplex*

Häberle, D[aniel]

1908. *Paläontologische Untersuchungen triadischer Gastropoden aus dem Gebiet von Predazzo.* Naturhistorisch-Medicinischer Verein zu Heidelberg, Verhandlungen, n.F., Bd. 9, Hefte 2/3, pp. 247-631, pl. 2-6.
*C. sp.**

1910. *Cirripedier (?) aus den alpinen Trias.* Deutsche geologische Gesellschaft, Monatshefte, 1910 (Bd. 62), Nr. 1, pp. 71-72.
Corrects identification of 1908 specimen which is not a conularid.

Haines, Mary P.

1879. *List of fossils found in the Lower Silurian rocks in the vicinity of Richmond, Indiana.* Indiana Geological Survey, 8th, 9th and 10th Annual Reports, pp. 201-204.
papillata

Hall, James

1843. *Geology of New-York,* Part 4. *Survey of the Fourth Geological District.* Albany. xxii+683 pp., [34]+19 pl., 192 figs.
quadrisulcata*

1847. *Palaeontology of New-York.* Volume 1. *Containing descriptions of the organic remains of the lower Division of the New-York system, (equivalent to the Lower Silurian rocks of Europe).* Albany. xxiii+338 pp., 99 pl.
TRENTONENSIS, GRANULATA, PAPILLATA, GRACILE

1848. *Catalogue of specimens in the palaeontological department of the geological survey.* New York State, Senate paper 72 (Annual Report [first] of the Regents of the University on the condition of the State Cabinet of Natural History, with catalogues of the same.), Appendix, 15 pp.
trentonensis

1851. *Parallelism of the Palaeozoic deposits of the United States and Europe,* in, J. W. Foster and J. D. Whitney: *Report on the geology of the Lake Superior land district. Part II,* pp. 285-318. United

States Senate, Executive document, No. 4. We give the date as it appears on the title page, but it should be noted that this precise date, March 13, 1851, is not the date of publication, but only the date on which publication was ordered. The order to publish was unaccompanied by any authorization to pay for the printing, and on November 21, 1851, the printing had still not begun. This is a matter of some importance, since if the apparent date were correct *Dictyonema* would date from this report, as *Discosorus* does. We have seen a copy of this book with the printed notation on the title page: "December 19, 1851, ordered, that 5500 additional copies be printed for the use of the Senate."
niagarensis

1852. *Palaeontology of New-York.* Volume 2. *Containing descriptions of the organic remains of the lower middle division of the New-York system (equivalent in part to the Middle Silurian rocks of Europe).* Albany. viii+362 pp., 104 pl. We have given the date as it appears on the title page, although Hall (1860, p. 1, footnote) says that it "bears the date of 1853. . . but was finished in 1851".
NIAGARENSIS, LONGA

[1857.] *Description of new species of fossils from the Carboniferous limestones of Indiana and Illinois.* Albany Institute, Transactions, vol. 4, pp. 1-36. Volume 4 is dated 1858-1864, and Nickles (United States Geological Survey Bulletin 746, p. 445) gives the date of this paper as 1864, but it was reviewed in the September 1857 issue of the American Journal of Science (series 2, vol. 24, p. 276).
SUBULATA

1859. *Catalogue of the species of fossils described in volumes I, II and III of the Palaeontology of New-York; with corrections in nomenclature, as far as determined to the present time.* New York State, Assembly paper 186 (Annual Report [12th] of the Regents of the University, on the State Cabinet of Natural History), pp. 63-96.
huntiana, pyramidalis, i. a.

[1860.] *Geological Survey of New York. Palaeontology.* Volume 3. *Containing descriptions and figures of the organic remains of the Lower Helderberg group and the Oriskany sandstone. 1855-1859.* Albany. 532 pp. The date of this volume is uncertain, but it was not distributed late in 1860 (see American Journal of Science, series 2, vol. 31, p. 125), and the date on the title page, 1859, is incorrect.
PYRAMIDALIS, HUNTIANA, LATA

1861. *Geological Survey of New-York, Palaeontology.* Volume 3. *Part 2. Plates.* Albany. 141 plates.
DESIDERATA

1862. *Contributions to palaeontology; comprising descriptions of new species of fossils, from the Upper Helderberg, Hamilton and Chemung groups.* University of the State of New York, 15th Report of the Regents, &c. (Senate paper 116), pp. 29-197, 11 pl., figs. Pages 29-113 were prepublished in 1861.
undulata*, laqueata*

[1877.] *Illustrations of Devonian fossils: Gasteropoda, Pteropoda, Cephalopoda, Crustacea and corals of the Upper Helderberg, Hamilton and Chemung groups.* Albany. 7 pp., pl. 1-74 (Mollusca), 1-23 (Crustacea), 1-39 (Corals). Reviewed, December 1877, in the American Journal of Science (series 3, vol. 14, pp. 493-494), with

a note the previous month (p. 432) that the work had been received "too late for further notice here." Thus the stated date, 1876, is incorrect.
CREBRISTRIA, CAYUGA, CONGREGATA, CONTINENS, undulata*

1879. *Geological Survey of New York, Palaeontology.* Volume 5. *Part 2. Containing descriptions of the Gasteropoda, Pteropoda and Cephalopoda of the Upper Helderberg, Hamilton, Portage and Chemung groups.* Albany xv+492 pp., 120 pl. (in two volumes).
undulata*, crebristriata*, cayuga*, continens*, congregata*, RUDIS

1879a. *Descriptions of new species of fossils from the Niagara formation at Waldron, Ind.* Albany. 20 pp. figs. This pamphlet bears no reference to the Albany Institute Transactions, in which this paper (later?) appeared, as volume 10, pp. 57-76. The volume as a whole is dated 1883.
INFREQUENS

1882. *Descriptions of the species of fossils found in the Niagara group at Waldron, Indiana.* Indiana Department of Geology and Natural History, 11th Annual Report, pp. 217-345, pl. 1-36.
infrequens*

1883. [*Description of Spergen Hill fossils.*] Indiana, Department of Geology and Natural History, 12th Annual Report, pp. 319-375, pl. 29-32.
subulata*

1884. *List of Niagara fossils from Waldron, Indiana, arranged in table cases in the State Museum of Natural History, September, 1882.* Regents of the University of the State of New York, 36th Annual Report on the New York State Museum of Natural History, pp. 21-25.
infrequens

Hall, Townsend M[onckton]

1867. *On the relative distribution of fossils throughout the North Devon Series.* Geological Society of London, Quarterly Journal, vol. 23, pt. 1, No. 3, pp. 371-381.
quadrisulcata

Hambach, G[ustav]

1890. *A preliminary catalogue of the fossils occurring in Missouri.* Geological Survey of Missouri, Bulletin 1, pp. 60-85.
crustula, marionensis, missouriensis, osagensis, subulata, subcarbonaria, triplicata

Hare, Sid. J.

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crustula

Harkness, R[obert]

1865. *On the Lower Silurian rocks of the south-east of Cumberland and the north-east of Westmoreland.* Geological Society of London, Quarterly Journal, vol. 21. pt. 1, No. 2, pp. 235-249, 3 figs.
elongata

Harper, G[eorge] W., and Bassler, R. S.

1896. *Catalogue of the fossils of the Trenton and Cincinnati periods,*

occurring in the vicinity of Cincinnati, O. Cincinnati. ix+34 pp.
formosa, quadrata, trentonensis

Harrington, Horacio J.

1942. *A brief summary of the early Paleozoic formations and faunas of Argentina.* Eighth American Scientific Congress, Proceedings, vol. IV, Geological Sciences, pp. 69-78.
ulrichana

Harris, Gilbert Dennison

1899. *A key to the Upper Devonian of Southern New York designed for teachers and students in secondary schools.* Elementary Natural History Series, No. 2, vi+26 pp., 13 pl. Ithaca, N. Y.
congregata*

Hartnagel, C[hris] A[ndrew]

1907. *Geologic map of the Rochester and Ontario Beach quadrangles.* New York State Museum Bulletin 114, 35 pp.
niagarensis

Haswell, George C.

1865. *On the Silurian formation in the Pentland Hills.* Edinburgh. 47 pp., 4 pl.
*sowerbyi**

Hatch, F[rederick] H[enry], and Corstorphine, G. S.

1905. *The geology of South Africa.* London. xiv+348 pp., 89 figs., maps.
africana*

Hauer, Franz von

1878. *Die Geologie und ihre Anwendung auf die Kenntniss der Bodenbeschaffenheit der Österr.-Ungar. Monarchie.* 2 Auflage. Wien. 764 pp., 689 figs.
exquisita*

Haug, Emile

1905. *Sur les fossiles dévoniens de l'Ahenet occidental receuillis par M. Noël Villatte.* Paris. Académie des Sciences, Comptes rendus hebdomadaires des séances, tome 141, liv. 23, pp. 970-972.
africana

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pyramidata*

Haughton, S[idney] H[enry]

1929. *The Cape System,* in *Handbuch der Regionalen Geologie,* Bd. 7, Abt. 7a (Heft 27). *The Union of South Africa.* Pp. 120-126, fig. 30. Heidelberg.
africana, baini, ulrichana, quichua

1929a. *Cape to Kimberley.* International Geological Congress, Guide Book, XV session, Excursion A.5., pt. 1, pp. 1-16, pl. 1-2.
gamkaensis

Haupt, Karl

1878. *Die Fauna des Graptolithengesteines. Ein Beitrag zur Kenntniss der Silurischen Sedimentärgeschiebe der norddeutschen Tiefebene.*

Neues Lausitzisches Magazin, Bd. 54, Heft 1, pp. 29-113, pl. 1-5.
cancellata

Haworth, Erasmus

1895. *Stratigraphy of the Kansas Coal Measures.* American Journal of Science, series 3, vol. 50, No. 300, pp. 452-466, pl. 9, map.
crustula

1896. *Resume of the stratigraphy and correlations of the Carboniferous formations.* Kansas, University Geological Survey, vol. 1, pp. 145-194, pl. 22, fig. 7-8.
crustula

1898. *Stratigraphy of the Kansas Coal Measures.* Kansas, University Geological Survey, vol. 3, pt. 1, pp. 9-105, pl. 1-20, 31, 3 figs.
crustula

.........., and Bennett, John

1896. *A geologic section from Baxter Springs to the Nebraska State Line.* Kansas, University Geological Survey, vol. 1, pp. 35-71, pl. 2, fig. 2-3.
crustula

Hayasaka, Ichirô

1920. *A new Species of Conularia from southern Kitakami, Japan.* Geological Society of Tokyo, Journal, vol. 27, No. 327, pp. 87-90, figs.
RECTANGULARIS

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rectangularis

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rectangularis

Hayden, H[enry] H[ubert]

1904. *The geology of Spiti, with parts of Bashahr and Rupshu.* Geological Survey of India, Memoirs, vol. 36, pt. 1, vi+119 pp., 18 pl., table.
quadrisulcata

Hayes, Albert Orion, and Johnson, Helgi

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planicosta

Hector, James

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Hede, J. Ernhold

1919. *Djupborrningen vid Burgsvik på Gottland 1915. Paleontologisk-*

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C. sp.,

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laevis

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1910. *The stratigraphy of the Silurian strata of the Visby district.* Geologiska Föreningens i Stockholm, Förhandlingar, Bd. 32, Häfte 5, pp. 1455-1484, pl. 56-61, 5 figs. Reprinted as: *The Silurian Stratigraphy in the Neighbourhood of Visby.* XI Geologorum Conventus [Guide Book] 20, 30 pp., 6 pl., 5 figs.
cancellata, laevis, bilineata

Hefter, Jos.

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subparallela

Heidenhain, F[ranz]

1869. *Ueber Graptolithen führende Diluvial-Geschiebe der norddeutschen Ebene.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 21, Heft 1, pp. 143-182, pl. 1.
cancellata

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C. sp.

Hérault, [Alexandre G.]

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C. sp.

Hermite, Henri

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nobilis

Hernández Sampelayo, Primitivo

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anomala

Herpers, Henry

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gaspesia

Herrick, C[larence] L[uther]

1887. *Sketch of the geological history of Licking County. No. 2. Additional fossils from Coal Measures at Flint Ridge.* Denison University, Scientific Laboratories, Bulletin, vol. 2, pt. 2, pp. 144-148, pl. 14.
newberryi*

1888. *Geology of Licking County, Ohio. Parts III and IV. The Subcarboniferous and Waverly Groups.* Denison University, Scientific Laboratories, Bulletin, vol. 3, pt. 1, pp. 13-110, pl. 1-12. Title is marked "part IV", but corrected in a list of errata.
newberryi*, micronema*, byblis*

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victa*, micronema*, *GRACILIS* (=herricki)

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gracilis

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gracilis, micronema

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*gracilis**, victa*, newberryi*, micronema*

.........., and Bendrat, T. A.

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C. sp. (Sandia Mts.)

Herrmannsen, A[ugust] N[icolaus]

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Hessland, Ivar

1949. *Investigations of the Lower Ordovician of the Siljan District, Sweden. I. Lower Ordovician ostracods of the Siljan district, Sweden. III. A Lower Ordovician Pseudoconularia from the Siljan district. IV. Lithogenesis and changes of level in the Siljan district during a period of the Lower Ordovician.* University of Upsala, Geological Institution, Bulletin, vol. 33, pp. 97-408, 26 plates; 429-436, 4 plates; 437-510, 14 plates.
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Hicks, Henry

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Hignett, E. M.

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C. sp. (Ludlovian)

Hind, Wheelton

1905. *Notes on the palaeontology [of the marine beds in the Coal-Measures of north Staffordshire].* Geological Society of London, Quarterly Journal, vol. 61, pt. 3 (No. 243), pp. 527-546, pl. 35-36.
quadrisulcata

1910. *Staffordshire,* in, *Geology in the Field,* pp. 564-592, fig. 101-104. London (The Geologists' Association).
quadrisulcata

Hinds, Henry, and Greene, F. C.

1917. *Leavenworth-Smithville Folio, Missouri-Kansas.* United States Geological Survey, Geological Atlas of the United States, No. 206, 13 pp., [1] pl., 11 figs., maps.
crustula

Hisinger, W[ilhelm von]

1828. *Anteckningar i Physik och Geognosi under Resor uti Sverige och Norrige. Fjerde Häftet.* Stockholm. 258 pp., 9 pl.
quadrisulcata

1831. *Esquisse d'un tableau des pétrifications de la Svède. Nouvelle édition.* Stockholm. 43 pp., table.
quadrisulcata

1837. *Lethaea Svecica seu Petrificata Sveciae, iconibus et characteribus illustrata.* Holmiae. 124 pp., 34 pl.
*quadrisulcata**

1840. *Anteckningar i Physik och Geognosie under Resor uti Sverige och Norrige. Sjunde Häftet.* Stockholm. 147 pp.
quadrisulcata

Hoeninghaus, F[riedrich] W[ilhelm]

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pyramidata, quadrisulcata, *teres*

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quadrisulcata

Hoepen, Egbert Cornelius Nicolaus von

1910. *De Bouw von het Silur van Gotland.* Technische Hoogschool te Delft, Proefschrift. xi+161 pp., 8 pl., 16 figs., map.
aspersa

Hoernes, Rudolf

1884. *Elemente der Palaeontologie (Palaeozoologie).* Leipzig. xvi+594 pp., 672 figs.
simplex*

Holl, Friedrich

1843. *Handbuch der Petrefactenkunde. Bd. 3. Neue Ausgabe.* Pp. 233-378. Quedlinburg und Leipzig.
quadrisulcata

Holm, Gerhard [Edvard Johann]

1893. *Sveriges Kambrisk-Siluriska Hyolithidae och Conulariidae.* Sveriges Geologiska Undersökning, Afhandlingar och uppsatser, Series C., No. 112, ix+172 pp., 6 pl., figs.
LINNARSSONI, KJERULFI, SCALARIS, ÖLANDICA, BOTTNICA, LINDSTROMI, PULCHELLA, TELUM, AURORA, PECTINATA, laevis*, curta*, orthoceratophila*, *cancellata**, aspersa*, monile*, bilineata*

Holtedahl, Olaf

[1910.] *Studien über die Etage 4 des norwegischen Silursystem beim Mjösen.* Videnskabs-Selskabet i Christiania, Matematisk-naturvidenskapellig Klasse, Skrifter 1909, No. 7, iv+76 pp., 15 figs. Note on p. 76 "Trykt 9 Marts 1910".
pulchella

Holub, Karel

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bohemica

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robusta, primula

1912. *Doplňky ku fauné Eulomového horizontu v okolí Rokycan.* Česka akademie císaře Františka Josefa pro Védy, slovesnost a umění v Praze, Rozpravy, Tř. II, Roč. 21, čís. 33, 12 pp., plate. Abstract issued as: *Nachträge zur Fauna des Euloma-Horizontes in der Umgebung von Rokycan.* Académie des sciences de l'empéreur François Joseph I, Bulletin international (Classe des sciences mathématiques et naturelles, et de la médécine), annee 1912. 2 pp., (352-354), plate.
C. sp.

Holzapfel, Eduard

1895. *Das obere Mitteldevon (Schichten mit Stringocephalus Burtini und Maeneceras terebratum) in Rheinischen Gebirge.* Königlich

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deflexicosta

Honess, C[harles] W[illiam]

1924. *Geology of southern Leflore and northwestern McCurtain counties, Oklahoma.* [Oklahoma] Bureau of Geology, Circular 3, 23 pp., including 5 pl., 2 figs., map.
crustula

Honeyman, D[avid]

1878. *Nova Scotia geology, Precarboniferous, Lower Carboniferous, &c., retrospect, to 1859.* Nova Scotian Institute of Natural Science, Proceedings and Transactions, vol. 4, pt. 4, pp. 439-487.
C. sp. (Arisaig)

Hosking, Lucy F. V.

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warthi*

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warthi*

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warthi

Houghton, Frederick

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undulata

Houlbert, Constant

1934. *Guide et catalogue descriptif du Musée d'Histoire naturelle de la ville de Rennes.* Rennes. 51 pp., 8 pl., 12 figs.
plicosa, bohemica, pyramidata

Howell, B[enjamin] F[ranklin]

1942. *New localities for fossils in the Devonian Esopus grit of Ulster County, New York.* New York State Museum, Bulletin 327, pp. 87-93, fig. 15.
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multicosta*

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1915. *Columbus Folio, Ohio.* United States Geological Survey, Geologi-

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C. sp. (Bedford)

Huene, Friedrich von

1925. *Die südafrikanische Karroo-Formation als geologisches und faunistisches Lebensbild.* Fortschritte der Geologie und Palaeontologie, Heft 12, 124 pp., 50 figs., map.
C. sp. (Dwyka)

Hull, Edward

1877. *On the upper limit of the essentially marine beds of the Carboniferous Group of the British Isles and adjoining continental deposits; with suggestions for a fresh classification of the Carboniferous Series.* Geological Society of London, Quarterly Journal, vol. 33, pt. 4 (No. 132), pp. 613-651, table.
quadrisulcata

1878. *The physical geology and geography of Ireland.* London and Dublin. 291 pp., 26 figs., 2 maps.
elongata

Hume, G[eorge] S[herwood]

1921. *Great Slave Lake area.* Geological Survey of Canada, Summary Report, 1920, pt. B, pp. 30B-36B.
[esclavensis]

1926. *Ordovician and Silurian fossils from Great Slave Lake.* Geological Survey of Canada, Bulletin 44 (Geological Series No. 46), pp. 59-64, pl. 12-13.
ESCLAVENSIS

Hundt, Rudolf

1941. *Das Mitteldeutsche Phycodesmeer.* Jena. 136 pp., 124 figs.
C. sp.

Hunt, T[homas] Sterry

1857. *Report for the year 1853.* Geological Survey of Canada, Report of Progress for the years 1853-54-55-56, pp. 347-371.
Analyses of tests of conularids.

1861. *On some points in American geology.* American Journal of Science, series 2, vol. 31, No. 93, pp. 392-414.
Notes occurrence of conularids in coprolites.

Hunter, John R. S.

1867. *Geology of the Carboniferous strata of Carluke.* Edinburgh Geological Society, Transactions, vol. 1, pt. 1, pp. 34-57, table.
quadrisulcata

1883. *The geology and palaeontology of Bankend, Bellfield and Coalburn, Lesmahagow.* Geological Society of Glasgow, Transactions, vol. 7, pp. 143-157.
sulcata, quadrisulcata

Hussey, R[ussell] C[laudius]

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noquettensis

1952. *The Middle and Upper Ordovician rocks of Michigan.* Michigan,

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trentonensis, latior

Ihering, Hermann von

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Suggests conularids are cephalopods.

Isbister, A. K.

1855. *On the geology of the Hudson's Bay Territory, and of portions of the Arctic and northwestern regions of America.* Geological Society of London, Quarterly Journal, vol. 11, pt. 1, No. 4, pp. 497-520, pl. 14. Reprinted, without map: American Journal of Science, series 2, vol. 21, No. 63, pp. 313-338, 1856.
C. sp. (Winnipeg)

Jack, Robert L[ogan], and Etheridge, Robert, Jr.

1892. *The geology and palaeontology of Queensland and New Guinea.* Brisbane and London. xxxi+768+iv pp., 68 pl., atlas.
tenuistriata*

Jackson, J[ohn] Wilfrid

1925. *On the occurrence of Conularia in the Carboniferous Limestone of North Wales.* Manchester Literary and Philosophical Society, Memoirs and Proceedings, vol. 69, No. 6, pp. 53-56.
tenuis

Jacob, K[unien]

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laevigata, warthi, salaria, punjabica

Jaekel, Otto [Max Johannes]

[1890]. *Ueber das Alter des sogen. Graptolithen-Gesteins mit besonderer Berücksichtgung der in demselben enthaltenen Graptolithen.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 41, Heft 4, pp. 653-716, pl. 28-29, 7 figs. The title page of this Band is dated 1889, but that of Heft 4 bears the date 1890.
*sowerbyi**, deflexicosta*

1899. *Stammegeschichte der Pelmatozoen,* I. Bd. *Thecoidea und Cystoidea.* Berlin. x+441 pp., 18 pl., 88 figs.
Notes conularids as hosts to edrioasterids.

1902. [*Thesen über die Organisation und Lebenweise ausgestorbener Cephalopoden, nebst Discussion.*] Deutsche geologische Gesellschaft, Zeitschrift, Bd. 54, pp. *67-101,* 8 figs.
See Ruedemann 1903.

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Jahn, Jaroslav J[ilji]

1894. *Neues Thierreste aus dem böhmischen Silur.* [Austria] Kaiserlich-

königlichen geologischen Reichsanstalt, Jahrbuch 1894, Bd. 44, Heft 2, pp. 381-388 (1-8), pl. 7.
anomala*

1903. *Geologische Exkursionen im älteren Paläozoikum Mittelböhmens.* IX. Internationalen Geologen-Kongress. 45 pp., 10 figs.
anomala, solitaria, proteica, fragilis

James, Joseph F[rancis]

1890. *On the Maquoketa shales, and their correlation with the Cincinnati group of southwestern Ohio.* American Geologist, vol. 5, No. 6, pp. 335-356, fig.
trentonensis

James, U[riah] P[ierson]

1871. *Catalogue of the Lower Silurian fossils, Cincinnati group, found at Cincinnati and vicinity - within a range of forty or fifty miles.* Cincinnati. 14 pp.
papillata, trentonensis

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papillata, trentonensis

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formosa

Jameson, Robert

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quadrisulcata

Janiševski, M. E. (М. Э. Янишевский)

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C. sp.*

Johnson, Jesse Harlan

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crustula

Johnston, Rob[er]t M[ackenzie]

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DERWENTENSIS, laevigata*

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TASMANICA (= derwentensis), tenuistriata*, homfrayi, inornata, *torta,* laevigata, quadrisulcata

Jones, I[slwyn] W[inwaloc]

1931. *The Lesseps Area, Gaspé Peninsula.* Quebec Bureau of Mines, Annual Report, 1930, pt. D, pp. 195-226, 4 pl. Also issued in a French edition, paged 217-250.
C. sp.

Jones, Jeanette

1931. *Notes on the late Ordovician strata of the Green Bay-Lake Winnebago region.* Wisconsin Academy of Sciences, Arts and Letters, Transactions, vol. 26, pp. 121-126.
C. sp.

Jones, Paul M.

1892. *The geology of Nashville and immediate vicinity.* Nashville. 56 pp., map.
gattingeri

Jones, T[homas] Rupert, and Woodward, H[enr]y

1893. *On some Palaeozoic phyllopodous and other fossils.* Geological Magazine, n.s., decade 3, vol. 10, No. 5, pp. 198-203, pl. 10.
C. sp.*

Jukes, J[oseph] Beete

1858. *The iron ores of Great Britain.* Part III. *The iron ores of South Staffordshire.* Geological Survey of Great Britain, Memoirs, 164 pp.
quadrisulcata

Kassin, N. (Н. Г. Кассин)

1931. *Краткий геологический очерк северо-восточного Казакстана.*
Geological sketch of the north-eastern Kazakstan. U.S.S.R., United Geological and Prospecting Service, Transactions, fasc. 165, 77 pp., map.
inequicostata

1931a. *Общая геологическая карта Казакстана.* Описание баян-аульского и верхне-чидертинского листов.
General geological map of the Kazakstan. Description of the Baian-Aul and Upper Chiderta sheets. U.S.S.R., Geological and Prospecting Service, Transactions, fasc. 110, 260 pp., 3 pl., figs. 1-15.
inequicostata

Katzer, Friedrich

1892. *Geologie von Böhmen. Der geognostische Aufbau und die geologische Entwickelung des Landes. Mit besondrer Berücksichtigung der Erzvorkommen und der verwendbaren Minerale und Gesteine.* Prag. xxii+1606 pp., 1068 figs., 4 portraits, maps.
consobrina*, bohemica*, nobilis*, grandissima*, fecunda*, anomala*, exquisita*, proteica*

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amazonica*

Kay, G[eorge] Marshall

1929. *Stratigraphy of the Decorah formation.* Journal of Geology (Chicago), vol. 37, No. 7, pp. 639-671, 12 figs. Also issued, with same

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granulata, trentonensis

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trentonensis

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trentonensis

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C. sp. (Trenton)

1944. *Middle Ordovician of central Pennsylvania. Part II. Later Mohawkian (Trenton) formations.* Journal of Geology (Chicago), vol. 52, No. 2, pp. 97-116, figs. 11-18.
ulrichi

1953. *Geology of the Utica Quadrangle, New York. With a chapter on the Silurian System by W. L. Grossman Ph. D.* New York State Museum, Bulletin No. 347, 126 pp., including 66 figs., maps.
trentonensis, gracilis, papillata

Kayser, Friedrich Heinrich Emanuel

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gerolsteinensis

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aliena*

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quichua*

1908. *Lehrbuch der geologischen Formationskunde.* 3 Auflage. Stuttgart. 741 pp., figs.
exquisita*

Kegel, Wilhelm

1926. *Unterdevon von böhmischen Facies (Steinberger Kalk) in der Lindener Mark bei Giessen.* Preussische geologische Landesanstalt, Abhandlungen, n.F., Heft 100, 77 pp., 4 pl., 3 figs.
HUMMELI

Kelly, John

1855. *On localities of fossils from the Carboniferous limestone of Ireland.* Geological Society of Dublin, Journal, vol. 7, pt. 1, pp. 1-62.
quadrisulcata

1860. *On the graywacke rocks of Ireland, as compared with those of England.* Geological Society of Dublin, Journal, vol. 8, pp. 251-333, pl. 22.
elongata, *sowerbyi,* subtilis

Kelly, W[illiam] A[ulten]

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C. sp.

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C. sp.

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C. sp.

Kerforne, Fernand

1893. *Note sur l'Ordovicien de May-sur-Orne (Calvados).* Société des sciences et de la médécine de l'Ouest, Bulletin, série 2, tome 2, pp. 112-116. Abstract by L. B[ureau]: Société des sciences naturelles de l'Ouest de la France, Bulletin, tome 3, extraits et analyses, p. 67.
pyramidata

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gervillei

Kettner, Radim, and Bouček, Bedřich

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Keyes, Charles Rollin

1894. *Paleontology of Missouri (part I).* Missouri Geological Survey, volume IV, 271 pp., 32 pl., 11 figs., map.
marionensis, missouriensis, osagensis, subulata, crustula

1894a. *Paleontology of Missouri (part II).* Missouri Geological Survey, volume V. 266 pp., pl. 33-56.
marionensis*, triplicata*, osagensis*, subcarbonaria*, missouriensis*, subulata*, crustula*

.........., **and Rowley, R[obert] R[oswell]**

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victa

Kiaer, Johan [Aschehong]

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cancellata

Kiderlen, Helmut

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Kindelán, Vicente

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anomala, nobilis

Kindle, Edward M[artin]

1896. *The relation of the fauna of the Ithaca group to the faunas of the Portage and Chemung.* Bulletins of American Paleontology, vol. 2, No. 6, pp. 1-56, 1+[2] pl.
congregata

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Notes 13 species.

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C. sp.

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C. sp. (Carboniferous)

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undulata

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infrequens

.........., **and Taylor, Frank B.**

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niagarensis

King, William Bernard Robinson

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planiseptata

1928. *The geology of the district around Meifod (Montgomeryshire).* Geological Society of London, Quarterly Journal, vol. 84, pt. 4 (No. 336), pp. 671-702, pl. 52.
planiseptata, vesicularis, hispida

Kirkby, James W[alker]

1888. *On the occurrence of marine fossils in the Coal-Measures of Fife.* Geological Society of London, Quarterly Journal, vol. 44, pt. 4 (No. 176), pp. 747-754, fig.
quadrisulcata

Kjerulf, Theodor

1865. *Veiviser ved geologiscke Excursioner i Christiania Omegn.* Kongelige. Norske Universitet, program for andet Halvaar 1865, iv+43 pp., 45+[12] figs.
sowerbyi, elongata

1879. *Udsigt over det sydlige Norges Geologi.* Christiania. 262 pp., figs. Atlas, 39 pl., map.
sowerbyi

1880. *Die Geologie des südlichen und mittleren Norwegens. Deutsche Ausgabe von Adolf Gurlt.* Bonn. 350 pp., 280 figs.
sowerbyi

Klöden, Karl Friedrich von

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quadrisulcata*

Klouček, Celda

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imperialis

1917. *Novinky z krušnohoských vrstev -d1α (Část III).* Ceská akademie císaře Františka Josefa pro vědy, slovesnost a umění v Praze. Rozpravy, Tř. II, Roč. 26, čís. 42, 4 pp.
robusta

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robusta

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C. sp.

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C. sp.

Knight, J[ames] Brookes

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Knod, Reinhold

1908. *Devonische Faunen Boliviens. (Beiträge zur Geologie und Paläontologie von Südamerika, XIV.)* Neues Jahrbuch für Mineralogie, usw., Beil.-Bd. 25, Heft 3, pp. 493-600, pl. 21-31, fig. Also issued

as: Inaugural-Dissertation, Grossherzogl. Badischen Albert-Ludwigs-Universität zu Freiburg i. B.
acuta*, quichua*, undulata*, africana*

Knott, W. T.

[1885.] *Report on the geology of Marion County.* Geological Survey of Kentucky. 43 pp., map.
micronema, newberryi, subcarbonaria, crawfordsvillensis

Kobayashi, Teiichi

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Kodym, Odolen, Bouček, Bedřich and Šulc, Jaroslav

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proteica, sosia

.........., and Koliha, Jan

1928. *Průvodze ku geologické exkursi do údolí radotínského a do Přídolí. Excursion géologique dans la vallée de Radotín et à Prídolí.* Státního geologického ústavu Československé Republiky, Věstník, Roč. 4, čís. 3, 35 pp., 7 figs., 2 maps.
nobilis, modesta

Koken, Ernst [Friedrich Rudolph Karl]

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orthoceratophila*

Koliha, Jan

1938. *Sur le Trémadocien et sur l'Arénigien inférieur en Bohême.* Société géologique de France, Bulletin, série 5, tome 7, fasc. 8, pp. 477-495, table.
robusta

Koninck, L[aurent] G[uillaume] de

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It was reviewed in the American Journal of Science in February 1877 (series 3, volume 13, pp. 158-159).
*sowerbyi**

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tenuistriata*, quadrisulcata*, laevigata*, inornata*

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irregularis*, INAEQUICOSTATA

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Korn, Hermann

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*reticulata**

Kowalski, J[oseph]

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pyramidata*, plicosa*

Kozłowski, Roman

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C. sp.*

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africana*, STRIATULA, baini*, quichua*, ulrichana*

Krasnopolsky, A. (А. Краснопольскій)

1904. *Геологическій очеркъ окрестностей Лемезинскаго завода. Recherches géologiques dans les alentours de l'usine Lemesinsky (arrondissement minier d'Oufa).* Russia, Comité géologique, Mémoires, n. s., livr. 17, iv+61 pp., 6 figs., map.
C. sp. (Carboniferous)

Kraus, E[rnst]

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[latviensis]

Krause, Aurel

1877. *Die Fauna der sogen. Beyrichien- oder Choneten-Kalke des norddeutschen Diluviums.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 29, Heft 1, pp. 1-49, plate. Also issued as: Inaugural-Dissertation, Friedrich-Wilhelms-Universität zu Berlin. 48 pp.
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grandissima, fecunda.

Krishnan, M. S.

1949. *Geology of India and Burma.* Madras. xiv+544 pp., illus.
warthi*

Krüger, Johann Friedrich

1825. *Urweltliche Naturgeschichte der organischen Reiche.* Teil I. Quedlinburg und Leipzig. viii+406 pp.
quadrisulcata, *teres*

Kuhleman, Milton H[enry]

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crustula

Kuhn, Oskar

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*cambria**, consobrina*

Kulling, O[scar]

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cancellata

Kümmel, Henry Barnard, and Weller, Stuart

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trentonensis

Lacey, W. S.

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maculosa

Ladd, Harry Stephen

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pumila, *putilla*

Lake, Phillip, and Groom, Theo. T.

1893. *The Llandovery and associated rocks of the neighbourhood of*

Corwen. Geological Society of London, Quarterly Journal, vol. 49, pt. 3 (No. 195), pp. 426-439, 8 figs.
sowerbyi

Lamansky, W. (В. В. Ламанский)

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buchi, quadrisulcata

Lamont, Archie

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cancellata, laevis, subtilis

Lamouche, (Lt.-Colonel)

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pyramidata*

Lamplugh, G[eorge] W[illiam]

1903. *Geology of the Isle of Man with petrological notes by Prof. W. W. Watts.* Geological Survey of the United Kingdom, Memoir, 620 pp., 5 pl.
quadrisulcata

Lapparent, A[lbert Auguste] de

1883. *Traité de Géologie.* Paris. 1280 pp., figs.
pyramidata*

Lapworth, Charles

1873. *On the Silurian rocks of the South of Scotland.* Geological Society of Glasgow, Transactions, vol. 4, pp. 164-174.
sowerbyi

1882. *The Girvan succession. Part I. Stratigraphy.* Geological Society of London, Quarterly Journal, vol. 38, pt. 4 (No. 152), pp. 537-666, pl. 34-35, 31 figs.
sowerbyi

Laseron, Cha[rle]s F[rancis]

1910. *Palaeontology of the Lower Shoalhaven River.* Royal Society of New South Wales, Journal and Proceedings, vol. 44, pt. 2, pp. 190-225, pl. 15-19.
inornata*

1912. *Note on a new type of aperture in Conularia.* Royal Society of

New South Wales, Journal and Proceedings, vol. 45, pt. 3, pp. 247-249, pl. 11.
laevigata*

La Touche, J[ames] D[igues]

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sowerbyi, BIFASCIATA* (=aspersa)

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blairi

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trentonensis

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quadrisulcata

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quadrisulcata

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coronata

Le Conte, Joseph

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trentonensis*

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sowerbyi, quadrisulcata

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C. sp. (Magdalena formation)

Leme, Alberto Betim Paes

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C. sp. (Vira-Mundo)

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brongniarti, gervillei, gerolsteinensis, ornata

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quadrisulcata*

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intertexta*, planicostata*, subulata*

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buchi*, quadrisulcata*

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acuta

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hollebeni

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laevigata

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hollebeni*

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proteica, aspersa

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cancellata, MONILE,* LAEVIS, BILINEATA, ASPERSA

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cancellata, monile, laevis, bilineata, aspersa

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cancellata

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cancellata, monile, laevis, bilineata, aspersa

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aspersa

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trentonensis, quadrata

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trentonensis

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grandis

Logan, W[illiam] E[dmund]

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quadrisulcata

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granulata, *quadrisulcata*

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trentonensis

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trentonensis

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trentonensis, niagarensis, *sowerbyi*

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undulata

Low, A[lbert] P[eter]

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trentonensis

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manni

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subparallela

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subparallela, deflexicosta

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cancellata

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continens

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C. sp.

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quadrisulcata

Maack, Reinhard

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sowerbyi

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quadrisulcata

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C. sp. (Upper Tournaisian)

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deflexicosta

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sowerbyi

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sowerbyi, deflexicosta, congregata

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rugulosa*

Malaise, C[onstantin Henri Gérard Louis]

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niagarensis

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trentonensis

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congregata*

Marr, John Edward

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homfrayi, corium, *sowerbyi,* llanvirnensis, margaritifera

1913. *The lower Palaeozoic rocks of the Cautley district, (Yorkshire)* Geological Society of London, Quarterly Journal, vol. 69, pt. 1 (No. 273), pp. 1-17, 2 figs.
C. sp. (Ashgillian)

Marsille, Louis

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Marwick, J[ohn]

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multicosta

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multicosta

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quadrisulcata

Matthew, G[eorge] F[rederick]

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inaequicostata*

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salinensis

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crustula

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quadrisulcata*

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TORTA, TENUISTRIATA

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*cancellata**, subtilis*

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*quadrisulcata**

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lata, penouili, desiderata, gaspensia

McKay, A[lexander]

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gratus

McKee, Edwin D[inwiddie]

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Meek, F[ielding] B[radford]

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MICRONEMA, ELEGANTULA

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elegantula*

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micronema*, newberryi*

.........., and Worthen, A. H.

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MULTICOSTATA, SUBCARBONARIA, WHITEI

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subcarbonaria*, missouriensis*

Melendez, Bermudo

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C. sp.

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C. sp.

Meneghini, G[iuseppe Giovanni Antonio]

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Mertie, J[ohn] B[eaver], Jr.

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cancellata, wrangeli

Meunier, Stanislas

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pyramidata*

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pyramidata*

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pyramidata*

Meyendorff, André

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C. sp.

Mickleborough, John, and Wetherby, A. G.

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papillata, trentonensis, formosa

Miller, A[rthur] M[cQuiston]

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trentonensis

Miller, Hugh

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ornata*

Miller, Ralph L[eRoy]

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C. sp.

Miller, S[amuel] A[lmond]

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Notes 34 species.

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formosa, trentonensis

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SAMPSONI

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HERRICKI, i. a.

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INTERTEXTA

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continens, victa

Minato, Masao

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tyoanziensis

Miser, Hugh D[insmore], and Honess, C[harles] W[illiam]

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crustula

.........., **and Purdue, A[lbert] H[omer]**

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crustula

Mitchell, S. R.

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Möller, [Valerian Ivanovic] v[on]

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hollebeni

Monahan, Joseph W.

1931. *Studies of the fauna of the Bertie formation.* American Midland Naturalist, vol. 12, No. 10, pp. 377-400, including 4 plates.
perglabra*

Monroe, Charles E.

1902. *Notes on a collection of Hamilton fossils, from the town of Bethany, Genesee Co., N. Y.* Wisconsin Natural History Society, Bulletin, n. s., vol. 2, No. 1, pp. 57-67.
undulata

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[milwaukeensis]

Moore, Raymond C[ecil]

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byblis, marionensis, blairi, sampsoni, missouriensis, subcarbonaria

.........., Lalicker, Cecil G., and Fischer, Alfred G.

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*quadrisulcata**, ornata*, ulrichana*, laevigata*, trentonensis*, consobrina*, loculata*, attenuata*, slateri*, triangulata*, batteryensis*

Moraes Rego, Luiz Flores de

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ulrichana, africana, quichua

Moreels, L[ouis]

1888. *Note sur Conularia Destinezi, ptéropode nouveau de houiller inférieur (phanites) d'Argenteau.* Société géologique de Belgique, Annales, vol. 15, Bulletin, pp. cxviii-cxx, fig. A-B.
DESTINEZI

Moret, Léon

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pyramidata*

Morgan, J[acques Jean Marie] de

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bohemica, exquisita, fecunda, insignis, invertens

Morgan, Geo[rge] D[illon]

1924. *Geology of the Stonewall quadrangle, Oklahoma.* [Oklahoma] Bureau of Geology, Bulletin 2, 248 pp., including 53 pl., map.
crustula, holdenvillae

Morière, J[ules Pierre Gilles]

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enne de Normandie, Bulletin, série 3, tome 5, pp. 293-297.
davidsoni

Morin, Philippe

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C. sp. (Carboniferous)

Morningstar, Helen

1922. *Pottsville fauna of Ohio.* Geological Survey of Ohio, series 4, Bulletin 25, 312 pp., 16 pl.
crustula*, newberryi*

Morris, John

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elongata, quadrisulcata, *sowerbyi* and (2nd edition) subtilis

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LEVIGATA

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elongata, *sowerbyi,* subtilis, *quadrisulcata*

.........., and Owen, [Richard]

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africana

Morse, William Clifford

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huntiana, pyramidalis

Mouchkétov, D. (Д. И. Мушкетовъ)

1915. *Чиль-устунъ и Чиль-майрамъ.*
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C. sp. (Devonian)

Moura, Pedro de

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amazonica

Mourlon, Michel [Félix]

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sowerbyi, namurcana, irregularis

1908. *Le Calcaire carbonifère et les dépôts post-primaires que le recouvrent dans la vallée de l'Escaut, entre Tournai et Antoing.* Société belge de Géologie, de Paléontologie et d'Hydrologie, Bulletin, tome 22, pp. 89-105.
C. sp. (Assise de Hastière)

Müller, Arno Hermann

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*tulipa**

Münster, [Georg], (Graf von)

1830. *Bemerkungen über das Vorkommen von Pterodactylus, von fossiler Sepie und von Koprolithen in Deutschland.* Jahrbuch für Mineralogie, usw., Jahrgang 1, pp. 442-445.
Notes that finely striate belemnites are sometimes mistaken for conularids.

Munthe, Henr[ik Wilhelm]

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costata, aspersa, monile, *delicatissima*

Murchison, Roderick Impey

1834. *On the structure and classification of the transition rocks of Shropshire, Herefordshire and parts of Wales, and on the lines of disturbance which have affected that series of deposits, including the valley of elevation of Woolhope.* Geological Society of London, Proceedings, vol. 2, No. 34, pp. 13-18, table.
quadrisulcata

1839. *The Silurian System, founded on geological researches in the counties of Salop, Hereford, Radnor, Montgomery, Caermarthen, Brecon, Pembroke, Monmouth, Gloucester, Worcester, and Stafford; with descriptions of the coal-fields and overlying formations. Part 2.* pp. 579-768, 37 pl. London.
quadrisulcata*

1854. *Siluria. The history of the oldest known rocks containing organic remains. With a brief sketch of the distribution of gold over the earth.* London. xvi+523 pp., 37 pl., maps.
elongata, *sowerbyi,* subtilis

1857. *The Silurian rocks and fossils of Norway, as described by M. Theodor Kjerulf, those of the Baltic Provinces of Russia, by Professor Schmidt, and both compared with their British equivalents.* Geological Society of London, Quarterly Journal, vol. 14, pt. 1, No. 1, pp. 36-53.
quadrisulcata, *sowerbyi*

.........., **de Verneuil, Edouard, and Keyserling, Alexander von**

1845. *The geology of Russia in Europe and the Ural Mountains. Volume I. Geology.* London and Paris. pp. i-xxiv, 1-7 [9], 1*-39*, 1-662[2]. 652*-652***, 19 pl., maps, figs.
sowerbyi

1845a. *Géologie de la Russie d'Europe et des montagnes d'Ourals.* Vol-

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*sowerbyi**, buchii, quadrisulcata

1848. *Geologie des europäischen Russlands und des Urals von R. Murchison, E. v. Verneuil und A. v. Keyserling, bearbeitet von Gustav Leonhard.* Stuttgart. 634 pp., [2] pl., map.
quadrisulcata, *sowerbyi,* buchii

Murray, Alex[ander]

1852. *Report of Alex. Murray, Esq., Assistant Provincial Geologist.* Geological Survey of Canada, Report of Progress for 1850-1851, pp. 9-20.
C. sp.

1852a. *Report of Alex. Murray, Esq., Assistant Provincial Geologist.* Geological Survey of Canada, Report of Progress for 1851-1852, pp. 64-82.
gracilis

Nathorst, A[lfred] G[abriel]

1883. *Om förekomsten af Sphenothallus cfr angustifolius Hall i silurisk skiffer i Vestergötland.* Geologiska Föreningens i Stockholm, Förhandlingar, Bd. 6, Häfte 8 (No. 78), pp. 315-319, pl. 15.

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Naumann, Carl Friedrich

1854. *Lehrbuch der Geognosie.* Bd. 2. Leipzig, xiv+1222 pp., 70 plates in atlas.
*cancellata**

Neaverson, E[rnest]

1928. *Stratigraphic palaeontology.* London. xiii+525 pp., 70 figs.
*quadrisulcata**

Nettelroth, Henry

1889. *Kentucky shells, a monograph of the fossil shells of the Silurian and Devonian rocks of Kentucky.* Kentucky Geological Survey. 245+iv pp., 36 pl.
trentonensis*

Neumayr, Melchior

1879. *Zur Kenntniss der Fauna des untersten Lias in den Nordalpen.* [Austria] Kaiserlich-königlichen geologischen Reichsanstalt, Abhandlungen, Bd. 7, Heft 5, 46 pp., 7 pl.
Erects group Conulariden, parallel with Pteropoden.

1895. *Erdgeschichte.* II Bd., 2 Auflage. Viktor Uhlig, ed. Leipzig und Wien. x+700 pp., figs.
laevigata*

Newell, Norman D[ennis]

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C. sp. (Cabanillas group)

Newberry, J[ohn] S[trong]

1873. *The geological structure of Ohio.* Geological Survey of Ohio, Report, vol. 1, pt. pp. 89-167, fig. 1-42. Also issued as: *Geologischen*

Bau. Bericht über die Geologische Aufnahme von Ohio, I. Bd., I. Theil, pp. 85-160, fig. 1-42.
trentonensis

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newberryi, micronema, byblis

Newsom, John Flesher

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micronema, newberryi

[Newton, Edwin Tulley]

1878. *A catalogue of the Cambrian and Silurian fossils in the Museum of Practical Geology.* London. iii+144 pp.
rectistriata, edgellii, i. a.

Nicholson, Henry Alleyne

1868. *An essay on the geology of Cumberland and Westmorland.* London and Manchester. 93 pp., 3 pl.
elongata, *cancellata,* subtilis

1872. *A manual of palaeontology.* Edinburgh and London. xvi+601 pp., 401 figs.
ornata*

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trentonensis

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ornata*

.........., and Lydekker, Richard

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ornata*

Nickles, John M[ilton]

1902. *The geology of Cincinnati.* Cincinnati Society of Natural History, Journal, vol. 20, No. 2, pp. 49-100, plate. Also issued separately with title page and table of contents, 53 pp., plate.
quadrata, trentonensis, formosa

Noetling, Fritz

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laevigata, tenuistriata, warthi

1901. *Beiträge zur Geologie der Salt Range, inbesondere der permischen*

und triassischen Ablagerungen. Neues Jahrbuch für Mineralogie, usw., Beil.-Bd. 14, Heft 3, pp. 369-471, 4 figs.
laevigata

Noïnsky, M. (М. Ноинский)

1925. *Некоторые данные относительно строения и фациального характера казанского яруса в Приказанском районе (из результатов работ геологического кабинета Казанского Университета за последние годы)*

Quelques données sur la structure et la caractère facial de l'étage Kazanien dans la région de Kazan. Léningrad, Comité géologique, Bulletin, tome 43, No. 6, pp. 565-622.
hollebeni

Norin, Erik

1941. *Geologic reconnaissances in the Chinese T'ien-Shan.* Lunds geologisk-mineralogiska Institution, Meddelanden Nr. 88 (Report from the Scientific expedition to the North-western provinces of China under the leadership of Dr. Sven Hedin - The Sino-Swedish Expedition - Publication 16), xii+229 pp., 23 pl., 32 figs., maps.
C. sp.

North, F[rederick] J[ohn]

1928. *Types and figured fossils in the National Museum of Wales.* Geological Magazine, vol. 65, No. 5, pp. 193-210.
quadrisulcata, C. sp. Woodward and Jones

Novák, Ottomar [Pravoslav]

1886. *Zur Kenntniss der Fauna der Etage F-f1 in der palaeozoischen Schichtengruppe Böhmens.* Königlichen-böhmischen Gesellschaft der Wissenschaften, Sitzungsberichte, Jahrgang 1886, 27 pp., double plate.
C. sp.

1891. *Revision der Palaeozoischen Hyolithiden Böhmens.* Königlichen-böhmischen Gesellschaft der Wissenschaften, Abhandlungen (Matematische-naturwissenschaftliche Klasse), Folge 7, Bd. 4, Nr. 6, 48 pp., 6 pl., This volume is dated 1892.
DUSLII (=exquisita)

Obrutschew, W. A.

1926. *Geologie von Siberien.* Fortschritte der Geologie und Palaeontologie, Heft 15. xi+572 pp., 10 pl., 60 figs.
inequicostata

O'Connell, Marjorie

1916. *The habitat of the Eurypterida.* Buffalo Society of Natural Sciences, Bulletin, vol. 11, No. 3, 277 pp., 28 figs., tables.
monile, *sowerbyi*

Œhlert, D[aniel] P[aulin]

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C. sp.

Oldham, R[ichard] D[ixon]

1886. *A note on the Olive group of the Salt-range.* Geological Survey of India, Records, vol. 19, pt. 2, pp. 127-131.

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laevigata, tenuistriata, warthi

Oliveira, Avelino Ignácio de, and Leonardos, Othon Henry

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africana*, ulrichana*

Oliveira, Euzébio Paulo de

1937. *Fosseis Devonianos de Goyaz.* Brasil, Serviço Geologico e Mineralogico, Notas preliminares e Estudos, 15, pp. 2-4.
ulrichana

Omalius d'Halloy, J[ean Baptiste] J[ulien]d'

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gervillei*

Öpik, A[rmin]

1925. *Beiträge zur Kenntnis der Kukruse- (C2-) Stufe in Eesti. I.* Universitatis Dorpatensis, Acta et Commentationes, series A, vol. 8, No. 5, 18 pp., 2 pl., Also issued as: University of Tartu, Geological Institution, Publication 4.
holmii

Opitz, Rudolf

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bundenbachia*, gemündina*, tulipa*, mediorhenana*

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bundenbachia*

Orbigny, Alcide [Dessalines]d'

1843. [*Observations sur l'habitation des conulaires, et des trilobites.*] Société géologique de France, Bulletin, tome 14, pp. 563-564.

1850. *Prodrome de Paléontologie stratigraphique universelle des animaux mollusques et rayonnés.* Volume 1, lx+394 pp. Paris
Notes 12 species.

1851. *Cours élémentaire de Paléontologie et de Géologie stratigraphique.* Tome 2, fasc. 1, 382 pp., 392 figs. Paris.
ornata*

Orbigny, [Alcide] C[harles Victor Dessalines]d', and Gente, A.

1851. *Géologie appliquée aux arts et a l'agriculture, comprenant l'ensemble des révolutions du globe; Ouvrage orné de vignettes intercalées dans le texte, et d'un tableau gravé sur acier, représentant, par ordre chronologique, les terrains stratifiés et les principaux fossiles qui se caractérisent; suivi d'un vocabularie donnant la definition des termes scientifiques employés dans le cours de l'ouvrage.* Paris. 528 pp., plate, figs.
pyramidata

Orton, Edward

1873. *Report on the Third Geological District. Geology of the Cincin-*

nati group, or Blue Limestone formation. Geological Survey of Ohio, Report, vol. 1, pt. 1, pp. 367-418, map, 2 tables. Also issued as: *Bericht über den dritten geologischen District. Geologie der Cincinnati-Gruppe oder die Formation des Blauen Kalksteins.* Bericht über die Geologische Aufnahme von Ohio, I. Bd., I. Theil, pp. 357-408, map, tables.
trentonensis, papillata

Osborne, G[eorge] D[avenport]

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laevigata, inornata

Osswald, Kurt

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STROMERI, triadica*

Owen, D[avid] D[ale]

1843. *Catalogue of geological specimens, Illustrating the formations of the Ohio valley.* New Harmony, Ind[iana]. 3 pp.
sowerbii

1845. *Review of the New York geological reports (third paper).* American Journal of Science, vol. 48, No. 2, pp. 296-316, figs.
quadrisulcata

1846. *Review of the New York geological reports (fourth paper).* American Journal of Science, series 2, vol. 1, No. 1, pp. 43-70, figs.
quadrisulcata

1852. *Report of a Geological Survey of Wisconsin, Iowa, and Minnesota; and incidentally of a portion of Nebraska Territory.* Philadelphia. Pp. i-xxxviii, 39-638, illus.
trentonensis, *quadrisulcata*

.........., and Shumard, B[enjamin] F[ranklin]

1851. *On the number and distribution of fossil species in the Palæozic Rocks of Iowa, Wisconsin, and Minnesota.* American Association for the Advancement of Science, Proceedings of the 5th meeting (Cincinnati), pp. 235-239.
trentonensis, *quadrisulcata*

Owen, Richard (1804-1892)

1861. *Palaeontology, or a systematic summary of extinct animals and their geological relations.* Edinburgh. xvi+463 pp., 174 figs.
quadrisulcata*

Owen, Richard (1810-1890)

1862. *Report of a geological reconnaissance of Indiana, made during the years 1859 and 1860, under the direction of the late David Dale Owen, M. D., State Geologist.* Indianapolis. 368 pp., illus.
CRAWFORDSVILLENSIS

Owodenko, Boris

[1946.] *Mémoire explicatif de la carte géologique du bassin houiller de Djerada et de la region au sud d'Oujda (Maroc oriental français).*

Société géologique de Belgique, Mémoires, tome 70. 163 pp., maps.
crustula

Paekelmann, W[erner]

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acuta*

Page, David

1876. *Advanced text-book of geology, descriptive and industrial. 6th edition.* Edinburgh and London. 536 pp., figs.
quadrisulcata*

Painvin, G. J.

[1939.] *Cahiers de Paléontologie, cinquième embranchement: Mollusques.* Paris. 17 pp., 5 pl.
pyramidata*

Parkinson, James

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quadrisulcata*

1840. *Outlines of oryctology. An introduction to the study of fossil organic remains, &c.* London and Leicester. 350 pp., 10 pl.
quadrisulcata*

Parks, William A[rthur]

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longa, niagarensis

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trentonensis

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formosa

1928. *Faunas and stratigraphy of the Ordovician Black shales and related rocks in southern Ontario.* Royal Society of Canada, Section IV, Transactions, series 3, vol. 22, pp. 39-92, plate.
trentonensis, latior, hudsoni

.........., **and Fritz, M. A.**

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formosa*

Patrunky, H.

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orthoceratophila, *cancellata*

Patte, Etienne

1926. *Études paléontologiques relatives a la géologie de l'Est du Tonkin,*

(Paléozoïque et Trias). Service Géologique de l'Indochine, Bulletin, tome 15, fasc. 1, 240 pp., 12 pl.
continens*

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continens

Patton, Andrew

1885. *Geological observations in the parish of East Kilbride, Lanarkshire. With a list of fossils, compiled by James Coutts.* Geological Society of Glasgow, Transactions, vol. 7, pt. 2, pp. 309-333, pl. 13.
quadrisulcata

Peach, B[enjamin] N[eeve], and Horne, John

1899. *Silurian rocks of Britain, volume 1, Scotland; with petrological chapter and notes by J. J. H. Teall.* Geological Survey of the United Kingdom, Memoir, xviii+749 pp, 27 pl., 120 figs., map.
elongata, *sowerbyi,* bilineata, subtilis, aspersa, monile

1903. *The Canonbie coalfield: its geological structure and relations to the Carboniferous rocks of the north of England and central Scotland.* Royal Society of Edinburgh, Transactions, vol. 40, pt. IV, No. 32, pp. 835-877, 4 pl.
quadrisulcata

.........., ..., **and Macconochie, A[rthur]**

1901. *The Silurian rocks in the south of Scotland,* in, G. F. Scott Elliott, Malcolm Laurie and J. Barcley Murdoch, editors: *Fauna, flora and geology of the Clyde area.* pp. 423-444. Glasgow (Local Committee for the Meeting of the British Association).
elongata, aspersa, bilineata, *sowerbyi,* subtilis

1904. *The Silurian rocks in the south of Scotland,* in, James Barclay Murdoch, editor: *The geology and palaeontology of the Clyde drainage area,* pp. 423-444. Glasgow (Rooms of the Geological Society). This book is a "reissue" of part of the 1901 handbook, with corrections and additions, but with the original pagination retained, i. e., pp. xxx+399-567.

Peale, Albert Charles

1893. *The Paleozoic section in the vicinity of Three Forks, Montana, with petrographic notes by George Perkins Merrill.* United States Geological Survey, Bulletin 110, 56 pp., 6 pl.
C. sp. (Three Forks shale)

Pelseneer, Paul

1889. *Sur un nouveau Conularia du Carbonifère et sur les prétendus "Ptéropodes" primaires.* Société belge de Géologie, de Paléontologie et d'Hydrologie, Mémoires, tome 3, pp. 124-136, pl. 2.
STORMSI

Peneau, Joseph

1928. *Études stratigraphiques et paléontologiques dans le sud-est du massif armoricain (synclinal de Saint-Julien-de-Voucantes).* Société des Sciences naturelles de l'Ouest de la France, Bulletin, série 4, tome 8, pp. 1-300, 24 pl.
C. sp.

Perner, Jaroslav

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ru. Beiträge zur Kenntniss der Böhmischen Silurformation. Česká Akademie Císaře Františka Josefa pro Vědy, slovesnost a umění v Praze, Tř. 2, Dîl 1, 16 pp., plate, 4 figs.
SCULPTA (=insignis), imperialis*

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fritschi

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FRITSCHI (=consobrina)

Petri, Setembrino

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ulrichana, africana, quichua

Phillips, John

1848. *The Malvern Hills, compared with the Palæozoic districts of Abberley, Woolhope, May Hill, Tortworth, and Usk.* Geological Survey of Great Britain and Museum of Practical Geology, Memoirs, vol. 2, pt. 1, pp. 1-330, figs., 3 maps.
sowerbyi

Pictet [de la Rive], F[rancois] J[ules]

1855. *Traité de Paléontologie.* Tome 3. 2e Edition. Paris. 654 pp. (Atlas, 77 pp., 110 pl., 1853-1857).
ornata*

Plews, Henry T.

1858. *On the coalfield of New South Wales.* North of England Institute of Mining Engineers, Transactions, vol. 6, pp. 27-48, 8 plans.
*torta**, levigata*

Plummer, F[rederick] B[yron], and Moore, R. C.

1921. *Stratigraphy of the Pennsylvanian formations of north central Texas.* University of Texas Bulletin 2132, 237 pp., 27 pl.
crustula

Plummer, John T.

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quadrisulcata

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planiseptata

Počta, Filip

1904. *Rukověť Palaeozoologie,* Vol. 1. Prague, 257 pp., illus.
anomala*, bohemica, conferta, nobilis, imperialis

Portlock, J[oseph] E[llison]

1843. *Report on the geology of the County of Londonderry and of parts of Tyrone and Fermanagh.* Dublin and London. xxxii+784 pp., 46 plates of fossils, pl. A-I, 26 figs., map.
quadrisulcata*, ELONGATA

Postlethwaite, John

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DOVERI

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*doveri**, elongata, *cancellata,* subtilis

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doveri*, elongata, *cancellata,* subtilis

Poulsen, Chr[istian]

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*quadrisulcata**

Prado, Casiano de

1860. *Sur l'existence de la faune primordiale dans le chaîne cantabrique.* Société géologique de France, Bulletin, série 2, tome 17, pp., 516-526, 4 figs.
C. sp.

Frantl, Ferdinand

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insignis

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proteica

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proteica

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1840. *On the geology of Coalbrook Dale.* Geological Society of London, Transactions, series 2, vol. 5, pt. 3, pp. 413-495, pl. 35-41. Abstract, 1836, Proceedings, vol. 2, No. 46, pp. 401-406.
*quadrisulcata** (=tubericosta)

Přibyl, Alois

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insignis, grandissima

Price, W[illiam] Armstrong

1914. *Paleontology,* in, Charles E. Krebs and D. D. Teets, Jr.: *Kanawha County.* Pp. 639-653, 2 plates. West Virginia Geological Survey, County Reports.
crustula*

1915. *Paleontology,* in, Charles E. Krebs and D. D. Teets, Jr.: *Boone County.* Pp. 591-619, pl. 42. West Virginia Geological Survey, County Reports. Also issued as: *Notes on the paleontology of Boone County.* 29 pp., plate.
crustula*

1916. *Notes on the paleontology of Raleigh, Wyoming, McDowell and adjacent Counties.* West Virginia Geological Survey, County Reports. Raleigh, McDowell, Wyoming counties, pp. 663-736, pl. 30-31, table.
crustula

Priem, Fernand

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ornata*

Pringle, J[ohn]

1935. *British regional geology: The south of Scotland.* Geological Survey and Museum [Great Britain]. iv+97 pp., 7 pl.
sowerbyi

Prosser, Charles S[mith]

1893. *The Devonian section of central New York along the Unadilla River.* New York State Geologist, 12th Annual Report, pp. 110-142.
undulata

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undulata

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newberryi

.........., **and Kindle, E. M.**

1913. *Systematic paleontology of the Middle Devonian deposits of Maryland,* in, Prosser et al.: *Middle and Upper Devonian,* pp. 115-338, pl. 7-44. Maryland Geological Survey. The plates were issued in an atlas with separately numbered plates for the volume on the Lower Devonian.
undulata*

Prouty, William F[rederick]

1927. *Geology* [*of Hardy County*]. West Virginia Geological Survey, *Report on Hampshire and Hardy counties.* Pp. 202-365, including plates 43-73, fig. 11-17.
C. sp.

Quenstedt, Fr[iedrich] Aug[ust von]

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quadrisulcata*, acuta*

1867. *Handbuch der Petrefactenkunde.* 2 Auflage. Tübigen. viii+982 pp. 86 pl., 183 figs. 3 Auflage. 1885, 1239 pp., 100 pl.
CAPENSIS, i. a.

Raasch, Gilbert O[scar]

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milwaukeensis

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cambria

Raggatt, H. G., and Fletcher, H. O.

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warthi, laevigata, tenuistriata

Range, Paul

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C. sp. (Dwyka)

1912. *Geologie des deutschen Namalandes.* Beiträge zur geologischen Erforschung der Deutschen Schutzgebiete, Heft 2, 104 pp., 11 pl.
C. sp.* (Dwyka)

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C. sp. (Dwyka)

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Raymond, Percy E[dward]

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TRIANGULATA

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triangulata

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triangulata*

1916. *The correlation of the Ordovician strata of the Baltic Basin with those of eastern North America.* Museum of Comparative Zoölogy (at Harvard College), Bulletin, vol. 56, No. 3 (Geological Series vol. 10; Shaler Memorial Series No. 2), pp. 179-286, 8 pl.
wrangeli

1921. *A contribution to the description of the fauna of the Trenton*

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trentonensis*

Read, M[athew] C.

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C. sp.

Reed, Frederick Richard Cowper

1897. *The fauna of the Keisley limestone. Part 2.* Geological Society of London, Quarterly Journal, vol. 53, pt. 1 (No. 209), pp. 67-106, pl. 6.
C. sp.*

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C. sp.*

1899. *The lower Palaeozoic bedded rocks of County Waterford.* Geological Society of London, Quarterly Journal, vol. 55, pt. 4 (No. 220), pp. 718-772, pl. 49, 15 figs.
elongata

1902. *Woodwardian Museum notes: Salter's undescribed species. VI.* Geological Magazine, n. s. decade 4, vol. 9, No. 3, pp. 122-126, pl. 6.
bifasciata, CLAVUS* (=tubericosta)

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quichua*, undulata*, acuta*, africana*

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C. sp.*

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africana, acuta, undulata, quichua

1910. *Sedgwick Museum notes. New fossils from the Dufton shales.* Geological Magazine, n. s., decade 5, vol. 7, No. 5, pp. 211-220, pl. 16-17; No. 7, p. 294-299, pl. 23-24.
plicata

1925. *Revision of the fauna of the Bokkeveld beds.* South African Museum, Annals, vol. 22, pt. 1, p. 27-225, pl. 4-11.
africana*, baini*, quichua*, ulrichana*, GAMKAENSIS, ALBERTENSIS

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SLATERI, MIRIFICA, CUNCTATA, ASTEROIDEA

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linnarssoni

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of the Salt Range. Geological Survey of India, Memoirs, Palaeontologia Indica, n. s., vol. 23, Memoir 1. ii+36 pp., 5 pl.
laevigata*, warthi*, SALARIA, PUNJABICA, CHELENSIS

1949. *The geology of the British Empire.* Second edition. London. ix+764 pp., 26 figs., including 15 folding maps.
africana, laevigata, tenuistriata

Reeds, Chester A[lbert]

1927. *The Arbuckle Mountains, Oklahoma. The fossil collector's Happy Hunting Ground.* Oklahoma Geological Survey, Circular 14, 15 pp., 11 figs. Reprinted from Natural History (New York), vol. 26, No. 5, pp. 463-474, 1926.
trentonensis

Reid, Clement, Barrow, G., and Dewey, Henry

1910. *The geology of the country around Padstow and Camelford; with contributions by J. T. Flett and D. A. MacAlister.* Geological Survey of England and Wales, Memoirs, Sheets 335-336, iv+120 pp., 4 pl., 7 figs.
complanata, subparallela, deflexicosta, subtilis

Reid, J[ohn] H[ector]

1930. *The Queensland Upper Palaeozoic succession.* Queensland Geological Survey, Publication 278, 96 pp., [6] figs., maps and sections.
tenuistriata, inornata

Reisinger, Erich

1938. *Morphologie und Entwicklungsgeschichte der Wirbellosen (excl. Arthropoda).* Fortschritte der Zoologie, n. F., Bd. 3, pp. 35-54.
Note on Kiderlen 1937.

Remelé, Ad[olf Karl]

1885. *Katalog der von Prof. Dr. Ad. Remelé beim internationalen Geologen-Congress zu Berlin im September und October 1885 ausgestellten Geschiebesammlung.* Berlin. 32 pp.
cancellata

Renevier, E[ugène]

1856. *Dates de la publication des espèces contenues dans les planches de la Conchyliologie minéralogique de la Grande-Bretagne, par Mr. James Sowerby, continuée par James de Carle Sowerby.* Société Vaudoise des Sciences naturelles, Bulletin, tome 4, pp. 318-320.

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hollebeni, quadrisulcata, ornata, subtilis, *sowerbyi*

Richards, Horace G.

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crustula*

Richter, R[heinhard]

1865. *Aus dem thüringischen Schiefergebirge, II.* Deutsche geologische

Gesellschaft, Zeitschrift, Bd. 17, Heft 2, pp. 361-376, pl. 10-11.
QUERCIFOLIA, RETICULATA

1866. *Aus dem thüringischen Schiefergebirge. III.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 18 Heft 3, pp. 409-425, pl. 5-6.
*reticulata**

1869. *Das Thüringische Schiefergebirge.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 21, Heft 2, pp. 341-443, pl. 5-6.
reticulata, quercifolia, hollebeni

Richter, Rud[olf], and Richter, E[mma]

1930. *Bemerkenswert erthaltene Conularin und ihre Gattungsgenossen im Hunsrückschiefer (Unterdevon) des Rheinlandes.* Senckenbergiana, Bd. 12, Nr. 2/3, pp. 152-171, 5 figs.
mediorhenana*, BUNDENBACHIA, GEMÜNDINA,*TULIPA* (=tulipina)

1939. *Conularia tulipina, nov. nom.* Senckenbergiana, Bd. 21, Nr. 1/2, p. 168.
TULIPINA

Ries, Heinrich

1897. *Geology of Orange County.* [New York] State Geologist, 15th Annual Report (Senate paper 66), pp. 393-475, 42 pl., 26 figs., maps.
trentonensis

Ringueberg, Eugene N. S.

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MULTIPUNCTA, BIFURCA, TRANSVERSA

1888. *The Niagara shales of western New York; a study of the origin of their sub-divisions and their faunae.* American Geologist, vol. 1, No. 5, pp. 264-272.
bifurca

Robertson, T[homas]

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quadrisulcata

Roch, Édouard

1932. *Les terrains paléozoïques du Pays de Skoura (Haut Atlas marocain).* Société géologique de France, Compte rendu, 1932, No. 16, pp. 223-224.
C. sp.

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C. sp.

1941. *Carte géologique provisoire des régions de Demnat et de Telouet, echelle au 1/200,000e, Notice explicative.* Maroc, Service des Mines, Notes et Mémoires, No. 55 bis 39 pp., 2 figs.
C. sp. (Ordovician)

Roemer, [Carl] Ferdinand von

1844. *Das Rheinische Uebergansgebirge. Ein palaeontologisch-geognostische Darstellung.* Hannover. 96 pp., 6 pl.
gervillei, gerolsteinensis, ornata

1856. In, H. G. Bronn and Roemer: *Lethaea Geognostica,* usw. Third revised edition, Lieferung 11, pp. 433-788 of Bd. 2. Stuttgart.
GRANDIS (=undulata), pyramidata*

1876. *Lethaea geognostica oder Beschreibung und Abbildung der für die Gebirgs-Formationen bezeichnendsten Versteinerungen herausgegeben von einer Vereinigung von Paläontologen, I. Theil, Lethaea palaeozoica, Atlas.* Stuttgart. 2 pp., 62 pl.
ORTHOCERATOPHILA, *grandis**, quadrisulcata*

1885. *Lethaea erratica oder Aufzahlung und Beschreibung der in der norddeutschen Ebene vorkommenden Diluvial-Geschiebe nordischer Sedimentär-Gesteine.* Palaeontologische Abhandlungen, Bd. 2, Heft 5, 173 pp. *(250-420),* 11 pl. (24-34).
orthoceratophila, *sowerbyi,* lanceolata

Roemer, Friedrich Adolf

1842. [*Letter to H. G. Bronn*]. Neues Jahrbuch für Mineralogie, usw., Jahrgang 1842, pp. 820-821.
acuta

1843. *Die Versteinerungen des Harzgebirges.* Hannover. xx+40 pp., 12 pl.
ACUTA

1850. *Beiträge zur geologischen Kenntniss des nordwestlichen Harzgebirges.* Palaeontographica, Bd. 3, Lief 1, pp. 1-52, 55-67, pl. 1-10.
acuta

1852. *Beiträge zur geologischen Kenntniss des nordwestlichen Harzgebirges. II Abtheilung.* Palaeontographica, Bd. 3, Lief 2, pp. 69-111, pl. 11-15.
PINNATA

1866. *Beiträge zur geologischen Kenntniss des nordwestlichen Harzgebirges. V Abtheilung.* Palaeontographica, Bd. 13, Lief. 5, pp. 201-235, pl. 33-35.
BODANA

Rogers, Austin F[lint]

1900. *The Pottawatomie and Douglas formations along the Kansas River,* in, J. W. Beede and Rogers: *Coal Measures faunal studies. I.* Kansas University Quarterly, vol. 9, series A, No. 4, pp. 234-254.
crustula

Rogers, A[rthur] W[illiam]

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africana, quichua, undulata, acuta

Rogers, Henry Darwin

1858. *The geology of Pennsylvania.* Volume 2, pt. 2, pp. 667-1046, 23 pl. New York.
trentonensis*

Rominger, C[arl]

1873. *Upper Peninsula 1869-1873.* Volume I, pt. III. *Palaeozoic Rocks.* Geological Survey of Michigan. 105 pp.
trentonensis

Rotay, A. P. (А. П. Ротай)

1938. *Стратиграфия нижнекаменноугольных отложений кузнецкого бассейна.*
Stratigraphy of the Lower Carboniferous of the Kuznetsk Basin. U.S.S.R., Central Geological and Prospecting Institute, Transactions, fasc. 102, 90 pp., 2 figs., tables.
C. sp.

Roth, Robert [Ingersoll]

1929. *A comparative faunal chart of the Mississippian and Morrow formations of Oklahoma and Arkansas.* Oklahoma Geological Survey, Circular 18, 16 pp., figure, table.
crustula

Roualt, Marie [Mathurin]

1851. *Mémoire sur le terrain paléozoïque des environs de Rennes.* Société géologique de France, Bulletin, série 2, tome 8, pp. 358-399, [4] figs.
MAYERI, NOBLETI, gervillei

Rowley, R[obert] R[oswell]

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C. sp.

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C. sp.*

Roxo, Mathies G[onçalves] de Oliviera

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africana*, ulrichana*

Roy, Sharat Kumar

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MANNI

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trentonensis, asperata

.........., **and Croneis, Carey**

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sowerbyi

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sowerbyi

Ruedemann, Paul

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trentonensis, crustula

Ruedemann, Rudolf

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gracilis

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gracilis

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trentonensis

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trentonensis*

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MULTICOSTA

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papillata, gracilis, trentonensis

1921a. *Report on fossils from the so-called Trenton and Utica beds of Grande Isle, Vt.* Vermont State Geologist, 12th Report, pp. 90-100.
trentonensis

1925. *Some Silurian (Ontarian) faunas of New York.* New York State Museum, Bulletin 265, 134 pp., 24 pl., 41 figs.
rugosa*, CATARACTENSIS, TENUICOSTA, FILICOSTA, PERGLABRA

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papillata, granulata, trentonensis

1926. *The Utica and Lorraine formations of New York,* part 2, *Systematic paleontology. No. 2. Mollusks, crustaceans and eurypterids.* New York State Museum, Bulletin 272, 227 pp., 27 pl., 26 figs.
hudsoni*, LATIOR, granulata*

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trentonensis, multicosta

1934. *Paleozoic plankton of North America.* Geological Society of America, Memoir 2, vii+141 pp., 26 pl., 6 figs.

.........., **and Ehlers, G[eorge] M[arion]**

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latior

Rüger, Ludwig

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cancellata

Růžička, R.

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proteica

Růžička, Vaclav

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exquisita, modesta

Ryckholt, [Philippe François Joseph Adrien de Bounam], Baron de

1854. *Mélanges paléontologiques,* Seconde partie. *Aperçu géognostique des environs de Visé.* Bruxelles. 205 pp., pl. 11-20. Part I of this work was published by the Academie royale de Belgique (Mémoires couronnés et mémoires des savants étrangers, tome 24) but part 2 was withdrawn by the author after being accepted for publication (see the Académie's Bulletin, tome 21, pt. 1, p. 209; pt. 2, p. 138) and was presumably printed privately.
NAMURCANA

Safford, James M[errill]

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trentonensis, gattingeri, missouriensis

Salter, John William

1852. Appendix: *Description of a few species from Wales and Westmoreland, referred to in the foregoing work,* to McCoy 1852. viii pp.
*sowerbyi**, SUBTILIS

1859. *Notes on fossils,* in J. B. Jukes: *The South Staffordshire coalfields.* Second edition. Geological Survey of Great Britain, Memoir. 241 pp.
quadrisulcata, *sowerbyi*

1861. *On the fossils of the south Welsh coal field,* in, E. Rogers et al.: *Iron ores of Great Britain.* Part III. *Iron ores of South Wales,* pp. 219-236, pl. 1-2. Geological Survey of Great Britain, Memoir.
*quadrisulcata**

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sowerbyi, quadrisulcata**

1866. *Appendix on the fossils,* in, A. C. Ramsay: *Geology of North Wales.* Volume 3, part 1. Pp. 239-363, pl. 1-26. Geological Survey of Great Britain, Memoir.
LAEVIGATA (=salteri), HOMFRAYI, MARGARITIFERA, CORIUM

1873. *A catalogue of the collection of Cambrian and Silurian fossils contained in the geological museum of the University of Cambridge. With a preface by the Rev. Adam Sedgwick, LL.D., F.R.S., and a table of genera and index added by Professor Morris, F.G.S.* Cambridge, xlviii+204 pp., figs.
homfrayi, corium, *sowerbyi, clavus, bifasciata,* subtilis

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.........., **and Sowerby, J[ames] de Carle**

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Sandberger, [Karl Ludwig] Fridolin [von]

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acuta

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quadrisulcata

1889. *Über die Entwickelung der unteren Abtheilung des devonischen Systems in Nassau, verglichen mit jener in anderen Ländern. Nebst*

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subparallela

Sandberger, Guido

1842. *Vorläufige Übersicht über die eigenthümlichen bei Villmar an der Lahn auftretenden jüngeren Kalk-Schichten der älteren (sog. Uebergangs-) Formation, besonders nach ihren organischen Einschlüssen, und Beschreibung ihrer wesentlichsten neuen Arten; nebst einem Vorwort über Namengebung in der Naturgeschreibung überhaupt und in der Paläontologie inbesondere.* Neues Jahrbuch für Mineralogie, usw., Jahrgang 1842, pp. 379-402, pl. VIII.
quadrisulcata

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C. n. sp.*

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.........., **and Sandberger, Fridolin**

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subparallela*, deflexicosta*

Sauramo, Matti

1929. *Zur Kenntnis der Geologie von Worms und Nuckö, Estland.* Commission géologique de Finlande, Bulletin 87, 20 pp. (17-36), 2 pl. (1-2), 3 figs.
C. sp.

Savage, T[homas] E[dmund]

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C. sp. (Thebes sandstone)

1913. *Stratigraphy and Paleontology of the Alexandrian Series in Illinois and Missouri. Part One.* Illinois State Geological Survey, Bulletin 23, pp. 67-170, 7 pl. (3-9). Issued separately (pp. 1-124, 7 pl.) in 1913, and in volume form in 1917.
C. sp. (Essex limestone)

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C. sp. (Essex)

1917. *The Thebes sandstone and Orchard Creek shale and their faunas in Illinois.* Illinois Academy of Science, Transactions, vol. 10, pp. 261-275, 2 pl.
DELICATULA, *ORNATA* (=delicatula)

.........., **and Van Tuyl, Francis M.**

1919. *Geology and stratigraphy of the area of Paleozoic rocks in the vicinity of Hudson and James Bays.* Geological Society of America, Bulletin, vol. 30, No. 3, pp. 339-378, pl. 11-13, 4 figs.
C. sp. (Shammattawa limestone)

Schaffer, F[ranz] X[aver]

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anomala*

[Schary, J. M.]

1867. *Catalogue des fossiles du Système Silurien du centre de la Bohême de la collection de J. M. Schary de Prague, envoyés a l'Exposition Universelle de Paris en 1867.* Prague. 17 pp. Note, p. 17: "C'est a la munificence de M. Barrande, que je dois les noms des fossiles non encore publies."
anomala, exquisita, fecunda, *grandis,* simplex

Schauroth, [Karl] v[on]

1853. [*Letter to A. H. E. Beyrich, on Conularia hollebeni, Platysomus striatus.*] Deutsche geologische Gesellschaft, Zeitschrift, Bd. 5, Heft 4, pp. 667-669.
hollebeni*

1854. *Ein Beitrag zur Paläontologie des deutschen Zechsteingebirges.* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 6, Heft 3, pp. 539-577, pl. 20-22.
hollebeni

1865. *Verzeichniss der ersteierungen im Herzogl. Naturaliencabinet zu Coburg (No. 1-4328) mit Angabe der Synonymen und Beschreibung vieler neuen Arten, sowie der letzteren Abbildung auf 30 Tafeln,* Coburg. 327 pp., 30 pl.
irregularis, hollebeni

Schindewolf, O[tto] H[einrich]

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Note on Kiderlen 1937.

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inaequicostata

Schmidt, Fr[iedrich]

1858. *Untersuchungen über die Silurische Formation von Ehstland, Nord-Livland und Oesel.* Archiv für Naturkunde, Liv.-, Ehst.-und Kurlands, ser. 1, Bd. 2, pp. 1-248.
sowerbyi

1859. *Beitrag zur Geologie der Insel Gotland, nebst einigen Bemerkungen über die untersilurische Formation des Festlandes von Schweden und die Heimath der norddeutschen silurischen Geschiebe.* Archiv für Naturkunde, Liv.-, Ehst.- und Kurlands, ser. 1, Bd. 2, Lief. 2, pp. 403-464, map.
sowerbyi

1874. *Miscellanea silurica. II. Über einige neue und wenig bekannte baltisch-silurische Petrefacten.* Académie impériale des Sciences de St. Pétersbourg, Mémoires, série 7, tome 21, No. 11, 48 pp., 4 pl.
TETRADIUM (=Palaenigma) WRANGELI

1881. *Revision der ostbaltischen silurischen Trilobiten nebst geognostischer Übersicht des ostbaltischen Silurgebiets. I. Phacopiden, Cheiruriden und Encrinuriden.* Académie impériale des Sciences de St. Péters-

bourg, Mémoires, série 7, tome 30, No. 1, iv+237 pp., 16 pl.
trentonensis, latesulcata, wrangeli

Schmidt, Hermann

1933. *Der Kellerwaldquarzit, mit einer Beschreibung seiner Fauna und der aus der Tanner Grauwacke.* Geologische und Paläontologische Abhandlungen, n. F., Bd. 19, Heft 5, 55 pp. (297-349), 5 pl. (18-22), 4 figs.
C. sp.*

Schmidt, W[ilhelm] Erich

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acuta

Schmitt, Joseph

1904. *Monographie de l'Ile Anticosti.* Faculté des Sciences de Paris, Thèses, Série A, No. 486, vi+370 pp., 46 pl., map.
trentonensis, splendida, asperata

Schroeder, H[enry Carl]

1909. *Marine Fossilien in Verbindung mit permischem Glazialkonglomerat in Deutsch-Südwestafrika.* Königlich Preussische geologische Landesanstalt zu Berlin, Jahrbuch, Bd. 29, Teil 1, pp. 694-697.
C. sp. (Dwyka)

Schuchert, Charles

1889. *A list of the fossils occurring in the Oriskany sandstone of Maryland, New York and Ontario.* [New York] State Museum of Natural History, 42nd Annual Report of the Trustees (Senate paper 65), pp. 396-400.
lata

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trentonensis

1900a. *Lower Devonic Aspect of the Lower Helderberg and Oriskany formations.* Geological Society of America, Bulletin, vol. 11, pp. 241-332.
pyramidalis, huntiana, lata, undulata

1914. *Notes on Arctic Paleozoic fossils.* American Journal of Science, series 4, vol. 38, No. 227, pp. 467-477. Also issued, with same pagination, as: Contribution from the Paleontological Laboratory, Peabody Museum, Yale University.
trentonensis

1927. *The Pennsylvanian-Permian systems of western Texas.* American Journal of Science, series 5, vol. 14, No. 83, pp. 381-401, 2 figs.
C. sp. (Wolfcamp)

1928. *Review of the late Paleozoic formations and faunas, with special reference to the ice-age of Middle Permian time.* Geological Society of America, Bulletin, vol. 39, No. 3, pp. 769-886, 6 figs., table.
laevigata, tenuistriata, warthi, inornata

1930. *Upper Ordovician and Lower Devonian stratigraphy and paleontology of Percé, Quebec. Part I. Stratigraphy and faunas.* American Journal of Science, series 5, vol. 20, No. 117, pp. 161-176, 4

figs. Also issued, with same pagination, as: Contribution from the Paleontological Laboratory, Peabody Museum, Yale University.
lata

1935. *Correlations of the more important marine Permian sequences.* Geological Society of America, Bulletin, vol. 46, No. 1, pp. 1-46, pl. 1, fig.
inornata, laevigata

1943. *Stratigraphy of the eastern and central United States.* New York. xvii+1013 pp., 123 figs., 78 charts, 3 pl.
triangulata, trentonensis, papillata, gracilis, formosa, cataractensis, newberryi

.........., and Twenhofel, W. H.

1910. *Ordovicic-Siluric section of the Mingan and Anticosti Islands, Gulf of Saint Lawrence.* Geological Society of America, Bulletin, vol. 21, No. 4, pp. 677-716.
[parroquetensis]

.........., et al.

1905. *Catalogue of the type and figured specimens of fossils, minerals, rocks and ores in the Department of Geology, United States National Museum. Part I. Fossil Invertebrates.* United States National Museum, Bulletin, No. 53, pt. 1, v+704 pp.
cambria, crustula, inornata, levigata, missouriensis

Schwartz, G[eorge] M[elvin]

1936. *Geology of the Minneapolis-St. Paul Metropolitan Area.* Minnesota Geological Survey, Bulletin 27. xi+267 pp., 8 pl., 44 figs.
trentonensis*

Schwarz, Ernest H[ubert] L[ewis]

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africana*, PINCHINIANA

1906a. *Geological Survey of the divisions of Tulbagh, Ceres and Worcester.* Cape of Good Hope, Geological Commission, 10th Annual Report, pp. 259-290, 16 figs.
quichua, undulata

1912. *South African geology.* London. 200 pp., illus.
africana*

Schwarzbach, Martin

1949. *Die Fauna des Bug-Karbons, ihre stratigraphische und paläogeographische Bedeutung.* Palaeontographica, Bd. 97, Abt. A, Lief. 1-3, pp. 1-74, pl. 1-4.
C. sp.*

Scott, William Berryman

1932. *An introduction to geology.* Third edition. Volume 2. *Historical Geology.* New York. vii+485 pp., 389 figs.
trentonensis*

Seemann, Fritz

1907. *Das mittelböhmische Obersilur- und Devongebiet südwestlich der Beraun.* Beiträge zur Paläontologie und Geologie Österreich-Un-

garns und des Orients, Bd. 20, Heft 2/3, 46 pp. (69-114), 2 pl. (9-10), fig.
aliena, fragilis, invertens, proteica, simplex

Sharpe, Daniel

1856. *Descriptions of Palaeozoic Mollusca from South Africa.* Geological Society of London, Transactions, series 2, vol. 7, pt. 4, pp. 206-215, pl. 26-27.
AFRICANA

Shaw, E[ugene] W[esley]

1937. *The Guelph and Eramosa formations of the Ontario Peninsula.* Royal Canadian Institute, Transactions, vol. 21, pt. 2 (No. 46), pp. 317-362, pl. 19-24, 3 figs.
rugosa, niagarensis

Sherborn, Charles Davies (Carolo Davies)

1922-1931. *Index animalium sive Index nominum quae ab A. D. MDCCLVIII generibus et speciebus animalium imposita sunt. Sectio secunda, a kalendis ianuariis, MDCCCI usque ad finem decembris MDCCCL.* London. 6808 pp. in 27 parts.
Notes 39 species.

.........., and Blake, J. F.

1902. *List of types and figured specimens in the collection of the Geological Society of London.* London. 100+xxxii pp.
africana

Sherlock, R[obert] L[ionel]

[1948.] *The Permo-Triassic formations. A World review.* London. 367 pp., 15 figs., frontispiece.
laevigata, tenuistriata

Shideler, W[illiam] H[enry]

1914. *The upper Richmond beds of the Cincinnati group.* Ohio Naturalist, vol. 14, No. 3, pp. 229-235.
C. sp.

Shimer, Hervey Woodburn

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JERVISENSIS

1926. *Upper Palæozoic faunas of the Lake Minnewanka section, near Banff, Alberta.* Geological Survey of Canada, Bulletin 42 (Geological Series No. 45), pp. 1-84, pl. 1-8, table.
ALTERNISTRIATA

.........., and Schrock, Robert R.

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trentonensis*, niagarensis*, huntiana*, undulata*, missouriensis*, crustula*, ulrichi*

Shrock, Robert R[akes], and Twenhofel, William H.

1953. *Invertebrate paleontology.* New York. xx+816 pp., illus. A revised and enlarged edition of Twenhofel and Shrock, 1935.
[fecunda*]

Shvetzov, M. S. (М. С. Швецов)

1932. *Общая геологическая карта Европейской части СССР. Лист 58. Северо-западная четверть листа.*
General geological map of the European part of U.S.S.R., Sheet 58, north-western quarter of the sheet. U.S.S.R., United Geological and Prospecting Service, Transactions, fasc. 83, 184 pp., plates, maps.
C. sp. (Lower Carboniferous)

Sinclair, G[eorge] Winston

1940. *The genotype of Conularia.* Canadian Field-Naturalist, vol. 54, No. 5, pp. 72-74.
PARACONULARIA

1940a. *A discussion of the genus Metaconularia with descriptions of new species.* Royal Society of Canada, Section IV, Transactions, series 3, vol. 34, pp. 101-121, 3 pl. Abstract, Proceedings, p. 155.
parroquetensis*, heymani*, ulrichi*, DUBIA, papillata*, CALDERI, delicatula*, GIBRALTARENSIS, multipuncta*, NUDA, manni*, aspersa*, perglabra*, bilineata*, punctata*, solitaria*, longistriata*.

1941. *Notes on Pseudoconularia and P. magnifica (Spencer).* Royal Society of Canada, Section IV, Transactions, series 3, vol. 35, pp. 125-129, plate. Abstract, Proceedings, vol. 35, p. 188.
magnifica*

1942. *A new species of Conularia from Gaspé.* Naturaliste Canadien, vol. 69, No. 6/7, pp. 158-160, fig.
GASPESIA

1942a. *The Chazy Conularida and their congeners.* Carnegie Museum (Pittsburgh), Annals, vol. 29, article 10, pp. 219-240, 3 pl.
CONULARINA triangulata*, UNDOSA, IRRASA, RAYMONDI, NARRAWAYI; CLIMACOCONUS quadratus*, RALLUS, HUMILIS, CLARKI, BROMIDUS, batteryensis*, bottnicus*, scoticus*, lanceolatus*

1943. *Notes on Archaeoconularia Bouček and Eoconularia, new genus.* Royal Society of Canada, Proceedings, series 3, vol. 37, p. 122. Abstract.
EOCONULARIA

[1944.] *A new genus of Conularids.* Canadian Field-Naturalist, vol. 57, No. 7/8, p. 123. Issue for October-November, 1943.
Eoconularia

1944a. *Notes on the genera Archaeoconularia and Eoconularia.* Royal Society of Canada, Section IV, Transactions, series 3, vol. 38, pp. 87-95, plate.
ATTENUATA, AMOENA, MEMBRANACEA, HUMBERIA, SARDINICA, loculata*

1945. *An Ordovician faunule from Quebec.* Canadian Field-Naturalist, vol. 59, No. 3, pp. 71-74, pl. 2.
trentonensis, ulrichi

1946. *Three new conularids from the Ordovician of Quebec.* Naturaliste Canadien, vol. 73, No. 11/12, pp. 385-390, plate.
URBANIS, BUREAUI, FORENSIS

1948. *Aperture of Conularia.* Geological Society of America, Bulletin, vol. 59, No. 12, pt. 2, p. 1352. Abstract.

[1952.] *The occurrence of cystids in the Ordovician of Ontario and Quebec.* Canadian Field-Naturalist, vol. 65, No. 5, pp. 176-179. Issue for September-October, 1951.
triangulata

1952a. *A classification of the Conularida.* Fieldiana. Geology (Chicago Natural History Museum), vol. 10, No. 13, pp. 135-145, fig. 56.
DICONULARIA, EXOCONULARIA, ANACONULARIA, CALLOCONULARIA, CTENOCONULARIA, GLYPTOCONULARIA, STRIMPLEI, OBEX

1953. *Middle Ordovician beds in the Saguenay Valley, Quebec.* American Journal of Science, vol. 251, No. 12, pp. 841-854, 2 figs.
trentonensis

.........., and Rollman, Mary E[lizabeth]

1951. *A forgotten book and its author.* Journal of Paleontology, vol. 25, No. 4, pp. 540-541.
doani

Six, Achille

1887. *Le devonien russe, d'après le Prof. Vénukoff.* Société géologique du Nord, Annales, tome 14, livr. 2/3, pp. 67-126.
inclinata

Skipsey, R. W[hyte]

1865. *On the discovery of Carboniferous limestone fossils in the Upper Coal Measures to the east of Glasgow.* Geological Society of Glasgow, Transactions, vol. 2, pp. 52-53. Notice in: Geological Magazine, vol. 2, No. 10, pp. 186-187.
quadrisulcata

Slater, Ida. L.

1907. *A monograph of British Conulariae.* Palaeontographical Society. 41 pp., 5 pl., fig.
llanvirnensis*, corium*, homfrayi*, *laevigata**, elongata*, linnarssoni*, aspersa*, PUNCTATA, TENUIS, MACULOSA, CORONATA, MICROSCOPICA, *quadrisulcata**, GLOBOSA, HISPIDA, TRIANGULARIS, HASTATA, PLICATA, CRASSA, subtilis*, COMPLANATA, PLANISEPTATA, VESICULARIS, *sowerbyi**, BREVICONVENTA, ELEGANS

Smith, Burnett

1914. *Notes on the fossils of the Paleozoic formations within the Syracuse Quadrangle.* New York State Museum, Bulletin 171 (University of the State of New York Bulletin 571), pp. 57-63.
C. sp. (Niagaran)

Smith, James Perrin

1896. *Marine fossils from the Coal Measures of Arkansas.* American Philosophical Society, Proceedings, vol. 35, No. 152, pp. 213-285, pl. 14-24.
crustula*

Smith, John

[1897]. *On the grasping power of Carboniferous crinoid "fingers" or "Branches", and a speculation as to whether the bulk of the Carboniferous Crinoidea were fixed or floating animals.* Glasgow Natural History Society, Transactions, n.s., vol. 5, pt. 1, pp. 58-61, fig. A-C. This volume is dated 1900.

Solle, Gerhard

1936. *Revision der Fauna des Koblenzquarzits an Rhein und Mosel.* Senckenbergiana, Bd. 18, Nr. 3/4, pp. 154-215, 16 figs.
subparallela

1942. *Neue Einstufung des Oberkoblenz von Oberkleen (Taunus) und ihre paläogeographische Folgerung.* Senckenbergiana, Bd. 25, Nr. 4/6, pp. 255-263, figs.
subparallela

1942a. *Die Kondel-Gruppe (Oberkoblenz) im Südlichen Rheinischen Schiefergebirge. IV-V.* Senckenbergischen Naturforschenden Gesellschaft, Abhandlungen, Heft 464, pp. 95-156, pl. 2-4, fig. 2-3.
subparallela

1942b. *Die Kondel-Gruppe (Oberkoblenz) im Südlichen Rheinischen Schiefergebirge. VI-X.* Senckenbergischen Naturforschenden Gesellschaft, Abhandlungen, Heft 467, pp. 157-240, plate.
subparallela

Sowerby, G[eorge] B[rettingham] (1788-1854)

1852. *A conchological manual.* Fourth edition. London. vi+337 pp., 28 colored plates, figs.
quadrisulcata*

Sowerby, James

1820. *The mineral conchology of Great Britain; or coloured figures and descriptions of those remains of testaceous animals or shells, which have been preserved at various times, and depths in the earth.* Volume 3, part 46. Pp. 107-118, pl. 260-265. London. The complete work was issued in French and German editions, which we have not seen.
CONULARIA QUADRISULCATA, *TERES* (a cephalopod)

Spencer, J[ohn] W[illiam Winthrop]

1875. *Geological sketches of the neighbourhood of Hamilton.* Canadian Naturalist and Quarterly Journal of Science, vol. 7, pp. 463-471.
niagarensis

1879. *A gigantic conularia of the Niagara group of Hamilton, Ontario.* Canadian Naturalist, series 2, vol. 9, pp. 62-63. This note was not signed, but Spencer later claimed it as his.
MAGNIFICA

1882. *Palaeozoic geology of the region about the western end of Lake Ontario.* Canadian Naturalist, n. s., vol. 10, No. 3, pp. 129-171, map.
niagarensis, magnifica, rugosa

1884. *Niagara fossils.* University of the State of Missouri, Bulletin of the Museum, vol. 1, No. 1, 61 pp., 9 pl. Also issued as: Academy of Natural Science of St. Louis, Transactions, vol. 4, No. 4, pp. 555-610, 9 pl.
magnifica*, RUGOSA, WILKINSI

Spriesterbach, Jul[ius]

1925. *Die Oberkoblenzschichten des Bergischen Landes und Sauerlandes.* Preussische geologische Landesanstalt, zu Berlin, Jahrbuch, Bd. 45, pp. 367-450, pl. 10-17.
MONTANA

Sproule, J[ohn] C[ampbell]

1936. *A Study of the Cobourg Formation.* Geological Survey, Canada, Memoir 202, pp. 93-116, pl. 7-9, fig. 4.
trentonensis

Stache, G[uido]

1890. *Die Silurfauna der Ostalpen.* [Austria] Kaiserlich-königlichen geologischen Reichsanstalt, Verhandlungen, Jahrgang 1890, No. 6, pp. 121-126.
C. sp.

Stainier, X[avier]

1892. *Matériaux pour le flore et la faune du houiller de Belgique.* Société géologique de Belgique, Annales, tome 19, Mémoires, pp. 333-359.
destinezi, quadrisulcata

1935. *Matériaux pour la faune du houiller de Belgique, sixième note.* Société belge de Géologie, de Paléontologie et d'Hydrologie, Bulletin, tome 45, fasc. 1, pp. 16-55.
C. sp.

Stauffer, Clinton R[aymond]

1909. *The Middle Devonian of Ohio.* Geological Survey of Ohio, series 4, Bulletin 10, 204 pp., 17 pl.
elegantula

1935. *Conodonts of the Glenwood beds.* Geological Society of America, Bulletin, vol. 46, No. 1, pp. 125-168, pl. 9-12.
C. sp.

.........., **and Thiel, George A[lfred]**

1941. *The Paleozoic and related rocks of southeastern Minnesota.* Minnesota Geological Survey, Bulletin 29, viii+261 pp., plate, 62 figs.
trentonensis, quadrata

Steininger, Johann

1853. *Geognostische Beschreibung der Eifel.* Trier. 143 pp., 10 pl.
EIFELENSIS

Steinmann, G[ustav]

1907. *Einführung in die Paläontologie.* 2 Auflage. Leipzig. 542 pp., figs.
acuta*, quadrisulcata*, quichua*

1929. *Geologie von Perú.* Heidelberg. xii+448 pp., 9 pl., map, 271 figs.
ulrichi*, quichua*

.........., **and Döderlein, Ludwig**

1890. *Elemente der Paläontologie.* Leipzig. 848 pp., figs.
acuta*, quadrisulcata*, QUICHUA

.........., **and Hoek, H.**

1912. *Das Silur und Cambrium des Hochlandes von Bolivia und ihre Fauna. (Beiträge zur Geologie und Paläontologie von Südamerika,*

XVIII.) Neues Jahrbuch für Mineralogie, usw., Beil.-Bd. 34, pp. 176-252, pl. 7-14, 6 figs.
undulata

Stobbs, John T[homas]

1905. *The marine beds in the Coal-Measures of North Staffordshire.* Geological Society of London, Quarterly Journal, vol. 61, pt. 3 (No. 243), pp. 495-527, pl. 34, 3 figs.
quadrisulcata

Stoddart, W[illiam] W[alter]

1865. *On the lowest beds of the Carboniferous series at Clifton near Bristol.* Geological Magazine, vol. 2, No. 2, pp. 83-85.
quadrisulcata

Stose, George W[illis]

1909. *Mercersburg-Chambersburg Folio, Pennsylvania.* United States Geological Survey, Geological Atlas of the United States, No. 170, 19 pp., 18 figs., maps. Field edition, 1910, 144 pp., 18 figs., maps.
quadrata

.........., **and Swartz, Charles K.**

1912. *Pawpaw-Hancock Folio, Maryland-West Virginia-Pennsylvania.* United States Geological Survey, Geological Atlas of the United States, No. 179, 24 pp., 2 pl., 11 figs., maps. Field edition, 176 pp., 20 pl., 11 figs., maps.
pyramidalis, niagarensis

Strahan, Aubrey

1909. *The geology of the South Wales coal-field, Part. I. The country around Newport, Monmouthshire.* Geological Survey of England and Wales, Memoirs, Sheet 249, 2d edition, 115 pp., illus.
microscopica

Strand, Embrick

1928. *Miscellanea nomenclatorica zoologica et palaeontologica. I-II.* Archiv für Naturgeschichte, Jahrgang 1926, Bd. 92, Abt. A, Heft 8, pp. 30-75.

Stromer von Reichenbach, Ernst (Freiherr)

1909. *Lehrbuch der Paläozoologie. I. Wirbellose Tiere.* Leipzig und Berlin x+342 pp., 398 figs.
exquisita*, gracilis*

1944. *Gesicherte Ergebnisse der Paläozoologie.* Bayerische Akademie der Wissenschaften, Mathematisch - Naturwissenschaftlichen Abt. Abhandlungen, Heft 54, n. F, pp. 1-114.
inornata

Suero, Tomas

1952. *Las sucesiones sedimentarias suprapaleozoicas de la zona extraandina del Chubut (Patagonia austral—Republica Argentina).* XIXe Congrès géologique international. Symposium sur les Séries de Gondwana, pp. 373-384, map.
C. sp. (Tepuel system)

Sugiyama, Toshio

1938. *A new Lower Carboniferous Conularia from the Kitakami Moun-*

tainland. Geological Society of Japan, Journal, vol. 45, No. 541, pp. 771-773, 2 figs. Also issued as: Palaeontological Society of Japan, Transactions and Proceedings, vol. 13, No. 13, pp. 103-105, 2 figs.
TYÔANZIENSIS

1942. *Studies on the Japanese Conularida.* Geological Society of Japan, Journal, vol. 49, pp. 390-399, pl. 15.
NEOCONULARIA rectangularis*, CONULARIOPSIS QUADRATA

Šulc, J[aroslav]

1925. *Faunistické seznamy z různých nalezišť Barrandienu, III. Strašnice vosovka.* Praha, Národi Museum, Časopis, Roč. 99, pp. 36-38.
bohemica, linearis, exquisita, fecunda, *modesta,* grandissima, nobilis.

Süssmilch, C[arl] A[dolph] (or Süssmilch)

1922. *An introduction to the geology of New South Wales.* 3d edition. Sydney. xviii+269 pp., 92 figs.
inornata

1935. *The Carboniferous period in eastern Australia.* Australian and New Zealand Association for the Advancement of Science, Report of the 22nd Meeting, pp. 83-118, 4 figs.
laevigata

Svoboda, Josef, and Prantl, Ferdinand

1948. *O stratigrafii a tektonice staršího paleozoika v okolí Chynice. The Stratigraphy and tectonics of the early Palaeozoic Strata in the Vicinity of Chynice (Central Bohemia).* Státního geologického ústavu Československé Republiki, Sborník, Svazek 15, pp. 1-39, pl. 1-4.
proteica

1950. *Stratigraficko-tektoniká studie okolí lomu "Cikánka" v radotínskem udolí. Stratigraphic and Tectonic Study of the Neighbourhood of the Quarry "Cikanka" in the Radotin Valley (Central Bohemia).* Státního geologického ústavu Československé Republiki, Sborník, Svazek 17, oddíl geologický, pp. 1-35 (105-139), pl. 1-3 (4-6).
proteica

Swallow, G[eorge] C[linton]

1860. *Descriptions of new fossils from the Carboniferous and Devonian rocks of Missouri.* Academy of Science of St. Louis, Transactions, vol. 1, pp. 635-660.
MISSOURIENSIS, MARIONENSIS, TRIPLICATA

1863. *Descriptions of some new fossils from the Carboniferous and Devonian rocks of Missouri.* Academy of Science of St. Louis, Transactions, vol. 2, pp. 81-100.
OSAGENSIS

Swartz, C[harles] K[ephart], and Prouty, W. F.

1923. *Gastropoda [of the Silurian of Maryland].* Maryland Geological Survey, Report on the Silurian, pp. 482-494, pl. 29-30.
niagarensis*

Swartz, Frank McKim

1925. *The Devonian fauna of Bolivia.* The Johns Hopkins University Studies in Geology, No. 6 (George Huntington Williams Memorial Publications numbers 20 to 24), pp. 29-68, pl. 1, fig.
striatula, quichua, baini, ulrichana, undulata

.........., and Richardson, Eugene S[tanley], Jr.

1945. *New structures in early Devonian Conularidae.* Geological Society of America, Bulletin, vol. 56, No. 12, pt. 2, p. 1206. Abstract.

Taff, Joseph A[lexander]

1904. *Preliminary report on the geology of the Arbuckle and Wichita Mountains in Indian Territory and Oklahoma.* United States Geological Survey, Professional Paper 31 (Series B. No. 40; Series C, No. 67), 97 pp., 8 pl.
papillata

1928. [*A reprint of Taff 1904.*] Oklahoma Geological Survey, Bulletin 12, 95 pp., including 8 pl., 2 maps.

Tait, David, and Wright, James

1924. *Notes on the structure, character and relationship of the Lower Carboniferous limestones of St Monans, Fife.* Edinburgh Geological Society, Transactions, vol. 11, pt. 2, pp. 165-184, pl. 18, fig.
quadrisulcata

Tansey, V[ivian] O[uray]

1922. *The fauna and correlation of the Bailey limestone in the Little Saline Creek area of Ste. Genevieve County, Missouri.* Missouri Bureau of Geology and Mines, series 2, vol. 17, pp. 166-212, pl. 40-56, table.
huntiana, lata

Teichert, Curt

1947. *Stratigraphy of Western Australia.* Royal Society of New South Wales, Journal and Proceedings, vol. 80, pt. 3, pp. 81-142, pl. 4-7, 10 figs. Reprinted with an additional chapter as: American Association of Petroleum Geologists, Bulletin, vol. 31, No. 1, pp. 1-70, 29 figs.
C. sp. (Liveringa series)

1951. *The marine Permian faunas of Western Australia (an interim review).* Paläontologische Zeitschrift, Bd. 24, No. 1/2, pp. 76-90, map.
warthi

1952. *Carboniferous, Permian, and Jurassic in the Northwest Basin, Western Australia.* XIXe Congrès géologique international. Symposium sur les Séries de Gondwana, pp. 115-135, 2 figs.
C. sp. (Coolkilya sandstone)

Teller, Edgar E[ugene]

1911. *A synopsis of the type specimens of fossils from the Palæozic formations of Wisconsin.* Wisconsin Natural History Society, Bulletin, vol. 11, No. 4, pp. 170-271.
cambria, milwaukeensis

Tennant, James

1847. *A stratigraphical list of British fossils; arranged under the principal divisions of the British strata, with a few elementary remarks on their character and localities.* London. xvi+132 pp.
quadrisulcata, elongata

Termier, Geneviève, and Termier, Henri

1947. *Paléontologie marocaine. I. Généralites sur les invertébrés fossiles.* Maroc, Service géologique, Notes et Mémoires, No. 69, 391 pp., 22 pl. Also issued as: Actualités scientifiques et industrielles, No. 1028. Paris

Erect the class EOPTEROPODA, including conularids.

1950. *Paléontologie marocaine.* Tome II. *Invertébrés de l'ère primaire.* Fasc. IV. *Annélides, Arthropodes, Échinodermes, Conularides et Graptolithes.* Maroc, Service géologique, Notes et Mémoires, No. 79, 279 pp., pl. 184-241. Also issued as: Actualités scientifiques et industrielles, No. 1095. Paris.

margaritifera*, modesta*, maroccana*, insignis*, aliena*, elegans*, proteica*, consobrina*, arcuata*, quadrisulcata*

Termier, Henri

1936. *Études géologiques sur le Maroc Central et de Moyen Atlas septentrional.* Maroc, Service des Mines et de la Carte géologique, Notes et Mémoires, No. 33, 1566 pp., Q+31 pl., 29 tables, 17 charts (in 4 tomes).

MAROCCANA

.........., **and Termier, Geneviève**

1948. *Affinités du genre Conularia.* Société géologique de France, compte rendu, 15 décembre, 1947, pp. 337-338.

Suggest relationship of conularids with pterobranchs.

[1949?] *Position systematique et biologie des Conulaires.* Revue scientifique, Année 86, fasc. 12, No. 3300, pp. 711-722, 25 figs. This number is dated December 1948 but contains reference to papers published as late as November 1949.

ornata*, quadrisulcata*, ARCUATA

1949a. *Affinités des Conularida.* 13e Congrès international de Zoologie, section 9, Communications, pp. 546-547.

Thomas, A[bram] O[wen]

1914. *A new section of the railway cut near Graf, Iowa.* Iowa Academy of Science, Proceedings, vol. 21, pp. 225-229.

trentonensis

Thomas, H[enry] Dighton

1930. *An Upper Carboniferous fauna from the Amotape Mountains, north-western Peru, continued.* Geological Magazine, vol. 67, No. 9, pp. 394-408, pl. 24.

crustula

Thomas, Ivor

1905. *Neue Beiträge zur Kenntnis der devonischen Fauna Argentiniens;* Deutsche geologische Gesellschaft, Zeitschrift, Bd. 57, pp. 233-290. pl. 11-14, 10 figs.

quichua*

Thomson, James

1865. *On the geology of the Campbelton district.* Geological Society of Glasgow, Transactions, vol. 2, pp. 76-88.

quadrisulcata

Thoral, Marcel

1935. *Contribution a l'étude paléontologique de l'Ordovicien inférieur de la Montagne Noire, et Revision sommaire de la faune cambrienne de la Montagne Noire.* Université de Paris, Thèses, serie A, No. 1541, 362 pp., 35 pl.

AZAISI

1935a. *Contribution a l'étude géologique des Monts de Lacaune et des terrains cambriens et ordoviciens de la Montagne Noire.* Paris et Liége. 318 pp., 5 pl., 52 figs., 2 tables.
azaisi

Thorslund, Per

1943. *Gränsen Ordovicium-Silur inom Storsjöormådet i Jämtland. The Ordovician-Silurian Boundary in the Jemtland Storsjön Area, Sweden.* Sveriges geologiska Undersökning, Avhandlingar och uppsatser, ser. C, No. 455 (Årsbok 37, No. 4), 19 pp., 4 figs.
C. sp. (Krykas quartzite).

Tiffany, A. S.

1885. *Geology of Scott County, Iowa, and Rock Island County, Illinois, and the adjacent territory.* Davenport, Iowa. 35 pp. A note says that this paper is from the Proceedings of the [34th meeting of the] American Association for the Advancement of Science, but only the title appears there, p. 259.
continens

Tilton, John L[ittlefield]

1927. *Hampshire County.* West Virginia Geological Survey, *Report on Hampshire and Hardy counties.* Pp. 1-164, including pl. 2-38, fig. 3-9.
pyramidalis, undulata, niagarensis

1927a. *The geological formations above the top of the White Medina.* West Virginia Geological Survey. *Report on Pendleton County.* Pp. 104-226, including pl. 32-44, fig. 20-24.
undulata

1929. *Notes on paleontology, Pocahontas County.* West Virginia Geological Survey. *Pocahontas County Report.* Pp. 365-403.
undulata

Toula, Franz

1906. *Lehrbuch der Geologie.* 2 Auflage. Wien. xi+492 pp., 30 pl., 452 figs., frontispiece, maps.
*grandis**

Treat, Ida Vaillant-Couturier

1933. *Paléontologie de Madagascar. XIX. Le Permo-Trias Marin.* Annales de Paléontologie, tome 22, fasc. 2, 59 pp., (39-95), 6 pl. (5-10), 17 figs.
C. sp.*

Trechmann, Charles Taylor

1918. *The Trias of New Zealand.* Geological Society of London, Quarterly Journal, vol. 73, pt. 3 (No. 291), pp. 165-246, pl. 17-25, 5 figs., table.
laevigata*

Tromelin, Gaston de

1877. *Étude de la faune du grès silurien de May, Jurques, Campandré, Mont-Robert, etc. (Calvados).* Société linnéenne de Normandie, Bulletin, série 3, tome 1, pp. 5-82.
pyramidata*, *SUBPLICOSA, SUBRUGULOSA*

1878. *Étude des terrains paléozoïques de la Basse-Normandie, particulièrement dans les départements de l'Orne et du Calvados.* As-

sociation française pour l'avancement des sciences, Compte rendu, 6e session (Le Havre), pp. 493-501.
exquisita

1880. *Résumé sur la Géologie des terrains Paléozoïques de Normandie.* Société géologique de Normandie, Bulletin, tome 6, pp. 169-178.
exquisita

.........., **and Lebesconte, Paul**

1876. *Observations sur les terrains primaires du Nord du département d'Ille-et-Vilaine et de quelques autres parties du massif breton.* Société géologique de France, Bulletin, série 3, tome 4, pp. 583-623.
pyramidata, plicosa, rugulosa

1876a. *Essai d'un catalogue raisonné des fossiles siluriens des départements de Maine-et-Loire, de la Loire-Inférieure et du Morbihan, avec des observations sur les terrains paléozoïques de l'ouest de la France.* Association française pour l'avancement des sciences, Compte rendu, 4e session, (Nantes), pp. 601-661, tables A-B.
nobilis, exquisita

1876b. *Présentation de fossiles paléozoïques du département d'Ille-et-Vilaine et note additionelle sur la faune silurienne de l'ouest de la France.* Association française pour l'avancement des sciences, Comptes rendu, 4e session (Nantes), pp. 683-687, tables C-D.
proteica, pyramidata

Troost, G[erard]

1840. *Fifth geological report to the twenty-third General Assembly of Tennessee.* 75 pp., map.
sowerbyi

1841. *Sixth geological report to the twenty-fourth General Assembly of the State of Tennessee.* Tennessee, House of Representatives, Document 7, 48 pp., map.
quadrisulcata

Trotter, F[rederick] M[urray], and Hollingworth, S. E.

1927. *On the upper Limestone group and "Millstone Grit" of north eastern Cumberland.* Geological Survey of Great Britain and Museum of Practical Geology, Summary of Progress for 1926, pp. 98-107, fig.
quadrisulcata

1932. *The geology of the Brampton District.* Geological Survey, England and Wales, Memoirs, sheet 18 n.s., xi+223 pp., 9 pl., 17 figs.
quadrisulcata

Twenhofel, W[illiam] H[enry]

1909. *The Silurian section at Arisaig, Nova Scotia. With a correlation note by Charles Schuchert.* American Journal of Science, series 4, vol. 28, No. 164, pp. 143-164. Also issued as: Contribution from the Paleontological Laboratory, Peabody Museum, Yale University.
C. sp. (Arisaig formation)

1914. *The Anticosti Island faunas.* Geological Survey of Canada, Museum Bulletin 3 (Geological Series No. 19), 39 pp., including plate. Also issued in French edition, 1917, 37 pp.
asperata, splendida, niagarensis

1916. *The Silurian and high Ordovician strata of Estonia, Russia, and their faunas.* Museum of Comparative Zoölogy at Harvard College,

Bulletin, vol. 56, No. 4 (Geological Series vol. 10; Shaler Memorial Series No. 3), pp. 289-340, pl. 1-3.
trentonensis

1928. *Geology of Anticosti Island.* Geology Survey, Canada, Memoir 154 (Geological Series No. 135), 481 pp., 60 pl., map.
asperata*, BATTERYENSIS, splendida*, niagarensis*

1938. *Geology and paleontology of the Mingan Islands, Quebec.* Geological Society of America, Special Paper 11, vii+132 pp., 24 pl.
PARROQUETENSIS

.........., **and Shrock, Robert R.**

1935. *Invertebrate paleontology.* New York. 511 pp., 175 figs.
[milwaukeensis]

Ulrich, Arnold

1892. *Palaeozoische Versteinerungen aus Bolivien. (Beiträge zur Geologie und Paläontologie von Südamerika, herausgegeben von G. Steinmann, I.)* Neues Jahrbuch für Mineralogie, usw., Beil.-Bd., 8, Heft 1, pp. 5-116, 5 pl., 2 figs.
africana*, acuta, undulata*, quichua*, BAINI

Ulrich, E[dward] O[scar]

1880. *Catalogue of fossils occurring in the Cincinnati group, of Ohio, Indiana & Kentucky.* Cincinnati. iv+31 pp.
formosa, quadrata, trentonensis

1888. *A correlation of the Lower Silurian horizons of Tennessee and of the Ohio and Mississippi valleys with those of New York and Canada.* American Geologist, vol. 1, No. 2, pp. 100-110; No. 3, pp. 179-190; No. 5, pp. 305-315.
quadrata, formosa, trentonensis

1917. *Formations of the Chester series in western Kentucky and their correlates elsewhere.* Issued with its own pagination (pp. i-iv, 1-272, 11 pl.) as part of a volume entitled *Mississippian Formations of Western Kentucky.* Kentucky Geological Survey.
chesterensis

1927. *Fossiliferous boulders in the Ouachita "Caney" shale and the age of the shale containing them.* Oklahoma Geological Survey, Bulletin 45, 48 pp., including 6 pl., 3 figs.
C. sp. (Viola)

Ure, Andrew

1829. *A new system of geology, in which the great revolutions of the earth and animated nature, are reconciled at once to modern science and sacred history.* London. lv+621 pp., 7 pl., 51 figs.
quadrisulcata*

Ure, David

1793. *The history of Rutherglen and East Kilbride,* &c. Glasgow. vi+334 pp., 20 pl.
Figures "a curious fossil"

Ussher, W[illiam] A[ugustus] E[dmond]

1879. *On the Triassic rocks of Normandy and their environments.* Geological Society of London, Quarterly Journal, vol. 35, pt. 2 (No. 138), pp. 245-267, 6 figs.
gervillei

.........., **Barrow, G. and MacAlister, D. A.**

1909. *Geology of the country around Bodmin and St. Austell; with notes on the petrology of the igneous rocks by J. S. Flett.* Geological Survey, England and Wales, Memoirs, sheet 347, vi+201 pp., 3 pl., 34 figs.
quadrisulcata

Van Tuyl, Francis M[aurice]

1925. *The Stratigraphy of the Mississippian formations of Iowa.* Iowa Geological Survey, vol. 30, pp. 33-349, 6 pl., 16 figs.
byblis, missouriensis

Vanuxem, Lardner

1840. *Fourth Annual Report of the Geological Survey of the Third District.* New York State Assembly Papers, No. 50, pp. 355-383.
quadrisulcata

1842. *Geology of New-York. Part 3. Survey of the Third Geological District.* Albany. 306 pp., 80 figs.
undulata, *quadrisulcata*

Văscăutanu, Th.

1931. *Les formations siluriennes de la rive Roumaine du Dneister.* Inst. Geol. României, Anuarul, vol. 15, pp. 425-663, illus.

Verneuil, [Philippe Edouard Poulletier] de

1840. *Sur l'importance de la limite qui sépare le calcaire de montagne des formations qui lui sont inférieures.* Société géologique de France, Bulletin, tome 11, pp. 166-179.
quadrisulcata

Verrill, A[ddison] E[mory]

1896. *The Opisthoteuthidæ. A remarkable new family of deep sea Cephalopoda, with remarks on some points in molluscan morphology.* American Journal of Science, series 4, vol. 2, No. 1, pp. 74-80, 8 figs.
Erects CONULARIACEA, in Cephalopoda.

Vinassa de Regny, Paolo Eugenio

1902. *Paleontologia.* Milano. xi+510 pp., 356 figs.
anomala*

Vogdes, A[nthony] W[ayne]

1879. *Short notes upon the geology of Catoosa County, Georgia.* American Journal of Science, series 3, vol. 18, No. 108, pp. 475-477.
C. sp.

Vogt, C[arl Christoph]

1846. *Lehrbuch der Geologie und Petrefactenkunde,* &c. Bd. I. Braunschweig. xix+436 pp., 350 figs.
gervillei*

1866. *Lehrbuch der Geologie und Petrefactenkunde,* &c., Bd. I, 3 Auflage. Braunschweig. 728 pp., figs.
ornata*

Voisey, A[lan] H[eywood]

1937. *The Upper Palaeozoic rocks around Yessabah, near Kempsey, New*

South Wales. Royal Society of New South Wales, Journal and Proceedings, vol. 70, pt. 1, pp. 183-204, pl. 6, 5 figs.
[tuberculata]

1938. *The Upper Palaeozoic rocks in the neighbourhood of Taree, N.S.W.* Linnean Society of New South Wales, Proceedings, vol. 63, pt. 5/6, pp. 453-462, pl. 21. Also issued, with same pagination, as: Geology Department, University of Sydney, n. s., Publication No. 28.
tuberculata

Waagen, W[illiam]

1886. *Note on some Palaeozoic fossils recently collected by Dr. H. Warth in the Olive group of the Salt-range.* Geological Survey of India, Records, vol. 19, pt. 1, pp. 22-38, pl. 1.
tenuistriata*, laevigata*, irregularis*

1891. *Salt Range fossils. Geological Results.* Geological Survey of India, Memoirs, Palaeontologia Indica, series 13, vol. 4, pt. 2, pp. 89-242, pl. 1-8, fig. 7-8, table.
laevigata*, tenuistriata*, WARTHI

Wade, Arthur

1911. *The Llandovery and associated rocks of north-eastern Montgomeryshire.* Geological Society of London, Quarterly Journal, vol. 67, pt. 3 (No. 267), pp. 415-459, pl. 33-36, 11 figs.
aspersa, subtilis

1937. *The geological succession in the West Kimberley district of Western Australia.* Australian and New Zealand Association for the Advancement of Science, Report of the 23rd Meeting, pp. 93-96.
C. sp.

Wadia, D[arashaw] N[asarvanji]

1939. *Geology of India.* Second edition. London. xx+460 pp., 19 pl., 45 figs., map.
Notes conularids in calcareous concretions.

Wagner, Georg

1950. *Einführung in die Erd- und Landschaftsgeschichte mit besonderer Berücksichtigung Süddeutschlands.* Öhringen. 664 pp., 200 pl., 565 figs.
pyramidata*, laevigata*

Wagner, P[ercy] A[lbert]

1916. *The Dwyka series in South-West Africa.* Geological Society of South Africa, Transactions, vol. 18, pp. 102-117, pl. 13-15, fig.
C. sp.

1916a. *The geology and mineral industry of south-west Africa.* Union of South Africa Mines Department, Geological Survey Memoir 7, 234 pp., 41 pl., map.
C. sp. (Dwyka)

Walcott, Charles Doolittle

1875. *Descriptions of new species of fossils from the Trenton limestone.* New York State Museum of Natural History, 28th Annual Report (Senate document 71), pp. 93-97.
QUADRATA

1879. *The Utica slate and related formations of the same geological horizon,* and, *Fossils of the Utica Slate.* Albany. 38 pp., 2 pl. Re-

viewed, American Journal of Science, series 3, vol. 18, No. 104 (August, 1879), p. 152. Later printed as: Albany Institute Transactions, vol. 10, pp. 1-38, pl. 1-2, 1883.
hudsonia, quadrata

1884. *Paleontology of the Eureka district.* United States Geological Survey, Monographs, vol. 8, xiii+298 pp., 24 pl., 7 figs.
missouriensis*

1885. *Note on some Paleozoic pteropods.* American Journal of Science, series 3, vol. 30, No. 175, pp. 17-21, 6 figs.
PALAENIGMA

1886. *Second contribution to the studies on the Cambrian faunas of North America.* United States Geological Survey, Bulletin 30 (volume 4), 369 pp. (731-1095), 33 pl., 10 figs.
Palaenigma wrangeli*

1890. *Description of new forms of Upper Cambrian fossils.* United States National Museum, Proceedings, vol. 13 (No. 820), pp. 267-279, pl. 20-21.
CAMBRIA (=a trilobite)

1890a. *The value of the term "Hudson River Group" in geologic nomenclature.* Geological Society of America, Bulletin, vol. 1, pp. 335-355, fig.
trentonensis

Walkom, A[rthur] B[ache]

1913. *Stratigraphical geology of the Permo-Carboniferous system in the Maitland-Branxton district, with some notes on the Permo-Carboniferous palaeogeography in New South Wales.* Linnean Society of New South Wales, Proceedings, vol. 38, pt. 1, pp. 114-145, pl. 8-13, 10 figs.
laevigata

1913a. *The geology of the Permo-Carboniferous system in the Glendonbrook district, near Singleton, N.S.W.* Linnean Society of New South Wales, Proceedings, vol. 38, pt. 1, pp. 146-159, pl. 14 (map), 4 figs.
inornata

1913b. *Notes on some recently discovered occurrences of the pseudomorph Glendonite.* Linnean Society of New South Wales, Proceedings, vol. 38, pt. 1, pp. 160-168, 6 figs.
laevigata

Wallace, R[obert] C[harles]

1925. *The Geological formations of Manitoba.* Natural History Society of Manitoba. 58 pp., including 8 pl., map.
C. sp. (Winnipeg sandstone)

Walther, Johannes

1908. *Geschichte der Erde und des Lebens.* Leipzig. iv+570 pp., 283 figs.
anomala*

Walther, Karl

1903. *Das Unterdevon zwischen Marburg a. L. und Herborn (Nassau).* Neues Jahrbuch für Mineralogie, usw., Beil.-Bd. 17, 66 pp. 1-75, 4 pl., fig.
FIMBRIATA

Ward, Henry A.

1866. *Catalogue of casts of fossils, from the principal museums of Europe and America, with short descriptions and illustrations.* Rochester, N. Y. viii+28 pp., illus.
undulata, C. sp.*

Warth, H.

1897. *Conularien im "Boulder bed" der Salzkette im Pandschab.* Neues Jahrbuch für Mineralogie, usw., Jahrgang 1897, Bd. 1, pp. 211-212.

Way, Harold

MS *The Silurian of Manitoulin Island, Ontario.* University of Toronto, Department of Geology, Thesis (1936).
gibraltarensis, i.a.

Weaver, Thomas

1840. *On the mineral structure of the south of Ireland, with correlative matter in Devon and Cornwall, Belgium, The Eifel,* etc. London. 48 pp. Said to be reprinted from the London and Edinburgh Philosophical Magazine and Journal of Science for 1840, but we have not seen it in that form.
quadrisulcata, *teres*

Weller, Stuart

1897. *The Gurley Collection of fossils. Sixth paper,- Shells, their scientific value and economic significance.* Sunday Inter Ocean (Chicago), vol. 26, No. 213, p. 33, figs. (Anonymous.)
greenei*

1898. *A bibliographic index of North American Carboniferous invertebrates.* United States Geological Survey, Bulletin 153, 653 pp. Notes 27 species.

1900. *Kinderhook faunal studies. II. The fauna of the Chonopectus sandstone at Burlington, Iowa.* Academy of Science of St. Louis, Transactions, vol. 10, No. 3, pp. 57-129, 9 pl.
byblis*

1900a. *The succession of fossil faunas in the Kinderhook beds at Burlington, Iowa.* Iowa Geological Survey, vol. 10, pp. 59-79.
byblis

1903. *The Paleozoic faunas.* Geological Survey of New Jersey, Report on Paleontology, volume 3, xii+462 pp., 53 pl.
trentonensis*

1921. *Geology of the Golconda Quadrangle.* Kentucky Geological Survey, series 6, vol. 4. 148 pp., map.
C. sp. (Glen Dean)

1923. *Geology of the Princeton Quadrangle.* Kentucky Geological Survey, series 6, vol. 10, pp. 1-105, illus.
C. sp. (Menard)

1925. *A new type of Silurian worm.* Journal of Geology (Chicago), vol. 33, No. 5, pp. 540-544, fig.

.........., **and St. Clair, Stuart**

1928. *Geology of Ste. Genevieve County, Missouri.* Missouri Bureau of Geology and Mines, series 2, vol. 22, 352+x pp., 15 pl., 5 figs., maps.
trentonensis

Wetherby, A[lbert] G[allatin]

1880. *Remarks on the Trenton limestone of Kentucky, with descriptions of new fossils from that formation and the Kaskaskia (Chester) group, Subcarboniferous.* Cincinnati Society of Natural History, Journal, vol. 3, pp. 144-160, pl. 5.
quadrata

Whidborne, George Ferris

1896. *Monograph of the Devonian faunas of the South of England.* Volume 3, part 1. Pp. 1-112, pl. 1-16, Palaeontographical Society, volume for 1896.
deflexicosta*

White, Charles A[biathar]

1862. *Description of new species of fossils from the Devonian and Carboniferous rocks of the Mississippi Valley.* Boston Society of Natural History, Proceedings, vol. 9, pp. 8-33, figs. According to Marcou (United States National Museum Bulletin 30, p. 118) this volume did not appear until 1865, although separates were distributed in 1862.
BYBLIS, VICTA

1876. *Description of new species of fossils from Paleozoic rocks of Iowa.* Academy of Natural Sciences of Philadelphia, Proceedings for 1876, [vol. 28] fasc. 2, pp. 27-34. Marcou (see next entry above, p. 138) says this volume appeared in 1877.
MOLARIS

1880. *Fossils from the Carboniferous rocks of the interior states.* United States Geological Survey, Contributions to Paleontology Nos. 2-8, pp. 155-171, 11 plates. Reprinted in the same form in 1883, and also as: United States Geological Survey of the Territories, 12th Annual Report, vol. 1, pp. 151-171, pl. 39-42.
CRUSTULA

1880a. *Fossils of the Indiana rocks.* Indiana Department of Statistics and Geology, 2d Annual Report, pp. 471-522, 11 pl. This report also formed pages 103-154 of a separate publication: Indiana Geological Report, 1879-80, 1881.
missouriensis*

1881. *Report on the Carboniferous invertebrate fossils of New Mexico.* United States Army, Engineer Department, Report upon United States Geographical Surveys west of the one hundredth meridian, volume 3—Supplement—Geology. Appendix, pp. i-xxxvi, pl. 3-4. Marcou says this Appendix (xxxviii pages) was also issued separately.
crustula*

White, Theodore G[reely]

1896. *The faunas of the Upper Ordovician strata at Trenton Falls, Oneida Co., N. Y.* New York Academy of Sciences, Transactions, vol. 15, pp. 71-96., pl. 2-5.
trentonensis, quadrata

1896a. *The original Trenton rocks.* American Journal of Science, series 4, vol. 2, No. 12, pp. 430-432. This is an abstract of White 1896.
trentonensis

1899. *Report on the relations of the Ordovician and Eo-Silurian rocks of*

portions of Herkimer, Oneida and Lewis counties. New York State Museum, 51st Report of the Regents, vol. 1, pp. r21-r54, [6 pl.], 8 figs., 2 maps. Also issued, with same pagination, as: Geology Department, Columbia University, Contributions, vol. 9, No. 66.
trentonensis

1900. *Upper Ordovician faunas in Lake Champlain Valley.* Geological Society of America, Bulletin, vol. 10, pp. 452-462. Volume 10 is dated 1899, but this part (Proceedings of the 11th Annual Meeting of the Paleontological Society, December 1898) is dated January 19, 1900. Also issued, with same pagination, as: Geology Department, Columbia University, Contributions, vol. 9, No. 73.
trentonensis

Whiteaves, J[oseph] F[rederick]

1891. *The fossils of the Devonian rocks of the Mackenzie River Basin.* Geological and Natural History Survey of Canada, Contributions to Canadian Palaeontology, vol. 1, pt. 3, pp. 197-253, pl. 27-32.
SALINENSIS

1897. *The fossils of the Galena-Trenton and Black River formations of Lake Winnipeg and its vicinity.* Geological Survey of Canada, Palaeozoic Fossils, vol. 3, pt. 3, pp. 129-242, pl. 16-22, 15 figs.
asperata*

.........., **and Billings, W[alter] R.**

1883. *Report of the palaeontological branch for the season of 1882.* Ottawa Field-Naturalists' Club, Transactions, No. 4 [vol. 1], pp. 67-69.
trentonensis

Whitehead, T[albot] H[aes], et al.

1928. *The country between Wolverhampton and Oakengates.* Geological Survey of England and Wales, Memoirs, Sheet 153, 244 pp., 8 pl.
quadrisulcata

Whitfield, R[obert] P[arr]

1882. *On the fauna of the Lower Carboniferous limestones of Spergen Hill, Ind., with a revision of the descriptions of its fossils hitherto published, and illustrations of the species from the original type series.* American Museum of Natural History, Bulletin vol. 1, No. 3, pp. 39-97, pl. 6-9.
subulata*

1882a. *Descriptions of new species of fossils from Ohio, with remarks on some of the geological formations in which they occur.* New York Academy of Sciences, Annals, vol. 2, No. 8, pp. 193-244.
elegantula

1883. *List of Wisconsin fossils.* Geology of Wisconsin, Survey of 1873-1879, vol. 1, pt. 2, pp. 362-375.
trentonensis

1891. *Contributions to invertebrate palaeontology.* New York Academy of Sciences, Annals, vol. 5, extra nos. 1, 2, 3, pp. 505-622, pl. 5-16.
elegantula

[1895.] *Contributions to the palaeontology of Ohio.* Geological Survey of Ohio, Report, vol. 7, pp. 407-494, pl. 1-13, fig. Plates 1-12 are headed "Ohio Geol. Survey, Second Ann. Rept.". This paper is a

reprint of Whitfield 1891. Although this volume was dated 1893, only the first 290 pages appeared in that year (see p. xiv), and although on that page the whole volume was said to be published in 1894, it had not yet appeared in January 1895 (see p. 80a).
elegantula

.........., **and Hovey, E[dmund] O[tis]**

1898. *Catalogue of the types and figured specimens in the palaeontological collection of the Geological Department, American Museum of Natural History.* American Museum of Natural History Bulletin, vol. 11, pt. 1, pp. vii+1-72.
trentonensis, gracilis, granulata, papillata

1899. *Catalogue of the types . . . . . Part II. Beginning with the Medina sandstone.* American Museum of Natural History, Bulletin, vol. 11, pt. 2, pp. 73-188.
longa, niagarensis, pyramidalis

1900. *Catalogue of the types . . . . . Part III. Beginning with the Oriskany sandstone.* American Museum of Natural History, Bulletin, vol. 11, pt. 3, pp. 189-356.
crebristriata, desiderata, undulata

1901. *Catalogue of the types . . . . . Part IV. Carboniferous to Pleistocene, inclusive.* American Museum of Natural History, Bulletin, vol. 11, pt. 4, pp. 357-500+xv.
subulata

Whittard, Walter Frederick

1931. *The geology of the Ordovician and Valentian rocks of the Shelve Country, Shropshire.* Geologists' Association, Proceedings, vol. 42, pt. 4, pp. 322-339, pl. 10-11, fig. 43.
C. sp. (Aldress shales)

Willard, Bradford

1936. *The Onondaga formation in Pennsylvania.* Journal of Geology (Chicago), vol. 44, No. 5, pp. 578-603, 5 figs.
undulata

1936a. *A Hamilton coral reef in Pennsylvania.* Pennsylvania Academy of Science, Proceedings, vol. 10, pp. 30-36, fig.
undulata

1939. *Middle and Upper Devonian,* in *The Devonian of Pennsylvania.* Pennsylvania Geological Survey, series 4, Bulletin G 19, pp. 131-307, pl. 15-32, fig. 30-85.
undulata*

Williams, Henry Shaler

1882. *Catalogue of the fossils of the Chemung period of North America.* [Ithaca, New York.] The University Press. 14 pp.
congregata

1913. *Recurrent Tropidoleptus zones of the Upper Devonian in New York.* United States Geological Survey, Professional Paper 79, 103 pp., 6 pl., 18 figs.
C. sp. (Enfield shale)

.........., **and Kindle, E. M.**

1905. *Contributions to Devonian paleontology, 1903.* United States Geological Survey, Bulletin 244 (Series C, No. 69), 144 pp., 4 pl., 3 figs., table.
congregata, newberryi

Williams, James Steele

1938. *Carboniferous invertebrate fossils (except fusulinids) from north central Texas.* University of Texas Publication No. 3801, pp. 149-236.
crustula

[1944.] *Stratigraphy and fauna of the Louisiana limestone of Missouri.* United States Geological Survey, Professional Paper 203, iv+133 pp., 9 pl., 9 figs. Dated 1943.
marionensis*

Williams, M[erton] Y[arwood]

[1915]. *Arisaig-Antigonish district, Nova Scotia.* Canada, Geological Survey, Memoir 60 (Geological Series, No. 47), vi+173 pp., map. Dated 1914. Also issued in a French edition, 1916, paged viii+184.
C. sp. (Ross Brook formation)

1915. *An eurypterid horizon in the Niagara formation of Ontario.* Geological Survey, Canada, Museum Bulletin 20 (Geological Series, No. 29), 21 pp., including 5 pl.
niagarensis*

1919. *The Silurian geology and faunas of Ontario Peninsula, and Manitoulin and adjacent islands.* Geological Survey, Canada, Memoir 111 (Geological Series, No. 91), vi+195 pp., including 34 pl., 6 figs., map.
laqueata, niagarensis

Williamson, W[illiam] C[rawford]

1839. *A notice of the fossil fishes of the Yorkshire and Lancashire coalfields.* Geological Society of London, Proceedings, vol. 3, No. 65, pp. 153-154. Number 65 is wrongly marked "vol. IV".
C. sp.

Wilson, Alice E[velyn]

1913. *A new brachiopod from the base of the Utica.* Geological Survey of Canada, Victoria Memorial Museum Bulletin 1, pp. 81-84, pl. 8. This paper was also issued separately, with the same pagination and (later) considered as Geological Series No. 9. The volume appeared in a French edition in 1915.
trentonensis

1932. *Ordovician fossils from the region of Cornwall, Ontario.* Royal Society of Canada, Section IV, Transactions, series 3, vol. 26, pp. 373-404, 6 pl., [5] tables.
trentonensis

1951. *Gastropoda and Conularida of the Ottawa formation of the Ottawa-St. Lawrence Lowland.* Geological Survey of Canada, Bulletin 17, v+149 pp., including 19 pl. 7 figs.
trentonensis*, narrawayi*, amoena*, dubia*, calderi*

Wilson, Charles W[illiam], Jr.

1949. *Pre-Chattanooga stratigraphy in central Tennessee.* Tennessee Division of Geology, Bulletin 56, 407 pp., including 28 pl., 89 figs., maps.
huntiana

.........., **and Newell, Norman Dennis**

1937. *Geology of the Muskogee-Porum district, Muskogee and McIn-*

tosh Counties, Oklahoma. Oklahoma Geological Survey, Bulletin 57, 184 pp., including 7 pl., 5 figs., map.
crustula

Wiman, Carl

[1893.] *Ueber die Silurformation im Jemtland.* University of Upsala, Geological Institution, Bulletin, vol. 1, No. 2, pp. 256-276, table, fig., Number 2 is dated 1894.
scalaris, pectinata

[1894.] *Paleontologische Notizen 1-2.* University of Upsala, Geological Institution, Bulletin, vol. 2, pt. 11, No. 3, pp. 109-117, pl. 5. Number 3 is dated 1895.
LOCULATA

[1899.] *Eine untersiluriche Litoralfacies bei Locknesjön in Jemtland.* University of Upsala, Geological Institution, Bulletin, vol. 4, pt. 2, No. 8, pp. 133-151, 12 figs. Number 8 is dated 1900.
pulchella

[1900.] *Über die Borkholmer Schicht in Mittelbaltischen Silurgebiet.* University of Upsala, Geological Institution, Bulletin, vol. 5, pt. 2, pp. 149-222, pl. 5-8, 11 figs. Volume 5 is dated 1902.
aspersa*

[1903.] *Paläontologische Notizen 3-6.* University of Upsala, Geological Institution, Bulletin, vol. 6, pt. 1, No. 11, pp. 77-84, pl. 5. Part 1 is dated 1905. Review by G. F. Matthew: American Geologist, vol. 32, no. 3 (September 1903), pp. 189-190.
MUNTHEI

[1906.] *Studien über das Norbaltische Silurgebiet. II.* University of Upsala, Geological Institution, Bulletin, vol. 8, No. 15/16, pp. 73-168, pl. 5-8, 8 tables, 4 figs. Number 15/16 is dated 1908.
HOLMI, RHODINENSIS

Winchell, Alexander

1865. *Descriptions of new species of fossils from the Marshall group of Michigan, and its supposed equivalent, in other states; with notes on some fossils of the same age previously described.* Academy of Natural Sciences of Philadelphia, Proceedings for 1865, pp. 109-133.
NEWBERRYI

1870. *Notices and descriptions of fossils, from the Marshall group of the western states, with notes on fossils from other formations.* American Philosophical Society, Proceedings, vol. 11, pp. 245-260. The sheet starting with page 245 is wrongly marked "A. P. S. —vol. XII-A".
byblis*, newberryi*

1870a. *On the geological age and equivalents of the Marshall group. Part II.* American Philosophical Society, Proceedings, vol. 11, pp. 385-418.
byblis, multicostata, newberryi, whitei

Winchell, N[ewton] H[orace]

1877. *Notes on the fossils of the Trenton limestone in Minnesota.* Minnesota, Geological and Natural History Survey, 5th Annual Report, pp. 51-56.
trentonensis

.........., **and Ulrich, E. O.**

1897. *The Lower Silurian deposits of the Upper Mississippi province: a correlation of the strata with those in the Cincinnati, Tennessee, New York and Canadian provinces, and the stratigraphic and geographic distribution of the fossils.* Geological and Natural History Survey of Minnesota, Final Report, vol. 3, pt. 2, pp. lxxxiii-cxxviii.
quadrata, trentonensis

Windhausen, Anselmo

1931. *Geologïa Argentina. Parte 2. Geologïa histórica y regional del territorio argentino.* Buenos Aires. 645 pp., 68 pl.
africana*, acuta*

Winkler, T[iberius] C[ornelius]

1863. *Handboek der Geologie in verband met Palaeontologie.* Zalt-Bommel. 333 pp., figs.
quadrisulcata*

Wirtgen, [Phillipp Wilhem], and Zeiler, [F.]

1852. *Übersicht der in der Gegend von Coblenz in den unteren Lagen der devonichen Schichten vorkommenden Petrefakten.* Neues Jahrbuch für Mineralogie, usw., Jahrgang 1852, pp. 920-940.
subparallela

Woods, Henry

1891. *Catalogue of the type fossils in the Woodwardian Museum, Cambridge, with a preface by T. McKenny Hughes.* Cambridge. xvi+118 pp.
bifasciata, clavus, homfrayi, llanvirnensis, subtilis

Woodward, Herbert P[reston]

1941. *Silurian system of West Virginia.* West Virginia Geological Survey, vol. 14, viii+326 pp., including 33 pl., 12 figs.
niagarensis

1943. *Devonian system of West Virginia.* West Virginia Geological Survey, vol. 15, xxi+655 pp., including 63 pl., 16 figs.
congregata, huntiana, pyramidalis, jervisensis, rudis, undulata

1951. *Ordovician system of West Virginia.* West Virginia Geological Survey, vol. 21, xi+627 pp., including 39 pl.
ulrichi, trentonensis

Woodward, Samuel P.

1871. *Manual of the Mollusca, 2nd edition.* London. 518 pp., 23 pl., 270 figs., plus 86 pp., 26 figs. in an appendix by Ralph Tate.
*quadrisulcata**

Woolworth, S[amuel] B.

1858. *Catalogue of fossils, from H. C. Grosvenor, of Cincinnati.* New York State, Assembly Paper 163 (11th Annual Report of the Regents of the University of the State of New York on the condition of the State Cabinet of Natural History, &c.), p. 43.
gracilis

Worthen, A[mos] H[enry]

1868. *Alexander County.* Geological Survey of Illinois, volume 3, pp. 20-32.
C. sp. (Thebes)

1868a. *Greene County.* Geological Survey of Illinois, volume 3. pp. 122-133.
verneuiliana

1883. *Description of some new species of fossil shells from the Lower Carboniferous limestones and Coal Measures of Illinois.* Geological Survey of Illinois, volume 7, pp. 323-326.
CHESTERENSIS

1890. *Description of fossil invertebrates.* Geological Survey of Illinios, volume 8, pp. 69-154, pl. 9-28.
chesterensis*

Wright, James, Jr.

1914. *Additions to the fauna of the Lower Carboniferous limestones of Leslie and St Monans, Fife.* Edinburgh Geological Society, Transactions, vol. 10, pt. 2, pp. 132-147.
quadrisulcata

Wurm, Adolf

1925. *Ueber ein Vorkommen von Mittelcambrium (Paradoxidesschichten) im bayerischen Frankenwald bei Wildenstein südlich Presseck.* Neues Jahrbuch für Mineralogie, usw., Beilage-Band 52, Abt. B, Heft 1, pp. 71-93, pl. 3, 2 figs.
SCHLOPPENSIS (an arthropod)

1925a. *Geologie von Bayern, Nordbayern, Fichtelgebirge und Frankenwald.* Erster Theil. *(Handbuch der Geologie und Bodenschätze Deutschlands.* Abt. 2, Bd. 2). Berlin. xiv+374 pp., 8 pl., 109 figs.
schloppensis

Wynne, A[rthur] B[eavor]

1886. *On a certain fossiliferous pebble-band in the "Olive Group" of the eastern Salt Range, Punjab.* Geological Society of London, Quarterly Journal, vol. 42, pt. 3 (No. 167), pp. 341-350. Abstract, Geological Magazine, n. s., decade 3, vol. 3, No. 6, pp. 280-281.
laevigata, tenuistriata, irregularis

1886a. *Notes on some recent discoveries of interest in the geology of the Punjab Salt Range.* Royal Geological Society of Ireland, Journal, n. s., vol. 7, pp. 89-97. Abstract, Geological Magazine, n. s., decade 3, vol. 3, No. 3, pp. 131-134.
laevigata, tenuistriata, irregularis (in abstract, only *ornata*)

1886b. *Discoveries in the Punjab Salt-Range.* Geological Magazine, n. s., decade 3, vol. 3, No. 5, pp. 236-237.

1887. *Recent discoveries in the Salt Range of the Punjab.* Geological Magazine, n. s., decade 3, vol. 4, No. 9, p. 428.

Yandell, Lunsford P[itts], and Shumard, Benjamin F[ranklin]

1847. *Contributions to the geology of Kentucky.* Louisville. 36 pp., plate.
quadrisulcata

Yin, T. H. (Tsan-hsun)

1933. *Cephalopoda of the Penchi and Taiyuan series of North China.* Geological Survey of China, Palaeontologia Sinica, series B, vol. 11, fasc. 3, 52 pp., including 5 pl., 6 figs.
quadrisulcata*

Young, John (1823-1900)

1869. *On the gasteropodous Mollusca of the Carboniferous limestones of*

the west of Scotland. Glasgow Natural History Society, Proceedings, vol. 1, pp. 70-71.
quadrisulcata

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quadrisulcata

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