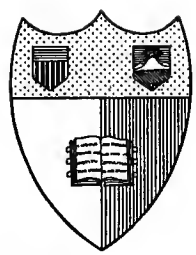


Cornell University Library
Ithaca, New York

FROM

University of Texas

Cornell University Library
QE 807.A5B67
The Permo-Carboniferous ammonoids of the
3 1924 004 586 396
engr

QE
807
A5
B67++

The original of this book is in
the Cornell University Library.

There are no known copyright restrictions in
the United States on the use of the text.

http://www.archive.org/details/cu31924004586396

University of Texas Bulletin
No. 1762: November 5, 1917

THE PERMO-CARBONIFEROUS AMMONOIDS OF THE GLASS MOUNTAINS, WEST TEXAS, AND THEIR STRATIGRAPHICAL SIGNIFICANCE

By
Emil Böse

APPENDIX

On Some New Ammonoids and the Succession of the Ammonoid-Bearing Horisons of the Permo-Carboniferous in Central Texas

BUREAU OF ECONOMIC GEOLOGY AND TECHNOLOGY
DIVISION OF ECONOMIC GEOLOGY
J. A. Udden, Director of the Bureau and Head of the Division

Published by the University six times a month and entered as second-class matter at the postoffice at
AUSTIN, TEXAS

Publications of the University of Texas

Publications Committee:

F. W. Graff	R. H. Griffith
J. M. Bryant	J. L. Henderson
D. B. Casteel	I. P. Hildebrand
Frederic Duncalf	E. J. Mathews

The University publishes bulletins six times a month, so numbered that the first two digits of the number show the year of issue, the last two the position in the yearly series. (For example, No. 1701 is the first bulletin of the year 1917.) These comprise the official publications of the University, publications on humanistic and scientific subjects, bulletins prepared by the Department of Extension and by the Bureau of Municipal Research and Reference, and other bulletins of general educational interest. With the exception of special numbers, any bulletin will be sent to a citizen of Texas free on request. All communications about University publications should be addressed to the Chairman of the Publications Committee, University of Texas, Austin.

B260-618-1m-7747

University of Texas Bulletin
No. 1762: November 5, 1917

THE PERMO-CARBONIFEROUS AMMONOIDS OF THE GLASS MOUNTAINS, WEST TEXAS, AND THEIR STRATIGRAPHICAL SIGNIFICANCE

By

Emil Böse

APPENDIX

On Some New Ammonoids and the Succession of the Ammonoid-Bearing Horisons of the Permo-Carboniferous in Central Texas

BUREAU OF ECONOMIC GEOLOGY AND TECHNOLOGY
DIVISION OF ECONOMIC GEOLOGY
J. A. Udden, Director of the Bureau and Head of the Division

Published by the University six times a month and entered as second-class matter at the postoffice at
AUSTIN, TEXAS

The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of democracy. . . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar

CONTENTS

	Page
Preface	5
List of Literature Cited	9
Stratigraphical Part	12
Stratigraphy of the Permo-Carboniferous in the Glass Mountains. The different beds and their faunas	12
Distribution of the Ammonoids in different Formations	14
Note on the Age of the Gaptank Formation, by J. W. Beede	18
Correlation of the Permo-Carboniferous of the Glass Mountains with other North American Formations	20
Correlation with European and Asiatic Beds	25
Paleontological Part	51
Prolecanitidae Hyatt	51
Prolecanitinae Frech	51
Daraelites Gemm	51
Daraelites texanus n. sp	52
Noritinae Karpinsky	55
Uddenites nov. gen.	55
Uddenites Schucherti n. sp	60
Uddenites minor n. sp	63
Medlicottinae Karpinsky	67
Medlicottia Waagen	67
Medlicottia Whitneyi n. sp	72
Medlicottia Burckhardti n. sp	76
Glyphioceratidae Hyatt	82
Gastrioceras Hyatt	82
Group of Gastrioceras globulosum M. a. W.	83
Gastrioceras modestum n. sp	83
Group of Gastrioceras Zitteli Gemm	85
Gastrioceras roadense n. sp	85
Gastrioceras altudense n. sp	88
Gastrioceras sp. nov. indet	90
Schistoceras Hyatt and J. P. Smith	92
Schistoceras Smithi n. sp	93
Schistoceras diversecostatum n. sp	96
Paralegoceras Hyatt	99
Paralegoceras incertum n. sp	100
Thalassoceratidae Hyatt	102
Prothalassoceras nov. gen.	102
Prothalassoceras Welleri n. sp	104
Tropitidae Mojsisovics	107
Celtitinae Mojsisovics	107
Paraceltites Gemm	107
Paraceltites multicostatus n. sp	108
Paraceltites aff. elegans Girty	110
Arcestidae Mojsisovics	113
Popanoceratinae Hyatt	113
Agathiceras Gemmellaro	113
Agathiceras Frechi n. sp	114
Agathiceras Girtyi n. sp	117

Adrianites Gemm 121
Adrianites marathonensis n. sp..... 123
Staeheoceras Gemmellaro 127
Staeheoceras Bowmani n. sp..... 128
Staeheoceras gilliamense n. sp..... 131
Marathonites nov. subgen. 133
Marathonites J. P. Smithi n. sp..... 135
Marathonites sulcatus n. sp.. 139
Marathonites vidriensis n. sp..... 141
Marathonites Hargisi n. sp.. 144
Vidrioceras nov. subgen. 146
Vidrioceras Uddeni n. sp 149
Vidrioceras irregulare n. sp..... 152
Cyelolobinae Zittel 155
Perrinites nov. gen. 155
Perrinites vidriensis n. sp..... 161
Perrinites compressus n. sp..... 166
Waagenoceras Gemm. 168
Waagenoceras Dieneri n. sp..... 171
Meekoceratidae Waagen 177
Lecanitinae Hyatt 177
Paralecanites Diener 177
Paralecanites altudensis n. sp..... 178
Appendix 182
Medlicottia n. sp..... 184
Perrinites n. sp..... 187
Staeheoceras n. sp..... 190
Agathiceras n. sp..... 193
Medlicottia n. sp. I 194
Medlicottia n. sp. II. 197
Perrinites n. sp. 201
Gastrioceras n. sp..... 204
Conclusions 206
Index to plates 216

THE PERMO-CARBONIFEROUS AMMONOIDS OF THE GLASS MOUNTAINS, WEST TEXAS, AND THEIR STRATIGRAPHICAL SIGNIFICANCE

By Emil Böse

PREFACE

Permo-carboniferous fossils have been first collected in the Glass Mountains, or Sierra del Vidrio, by R. T. Hill. These were described and listed by G. H. Girty[1] in 1908. They contained a number of Foraminifera, Bryozoa, Corals, Brachiopoda, Pelecypoda, and Gastropoda, but no Cephalopoda. Hill did not try to subdivide the beds, but most of the fossils seem to have come from our Word formation, although some may have been collected in lower horizons. It is impossible to ascertain the exact localities where those collections were made, Hill's references being altogether indefinite.

In 1904 and again in 1911, Dr. J. A. Udden made a brief visit to Marathon, Brewster County, and collected a number of fossils in the region of Altuda Mountain, and among them several ammonoids. In 1914 he spent three months in the Glass Mountains and constructed a series of cross sections through the Permo-Carboniferous, collecting at the same time numerous fossils, carefully noting their position and locality. In the course of this work he discovered many rich fossil localities, which later on proved to be of the greatest importance. In 1915, Dr. Udden asked me to make a general cross-section through the Permo-Carboniferous of the Glass Mountains, beginning at the Cretaceous where it overlies the youngest portion of the Palaeozoic, and ending in the oldest beds at the foot of the mountains bordering the Marathon basin. He proposed to make this section along the Gilliam Canyon, as this region seemed to offer the greatest facilities for observation, and to continue it in the same general direction south of the head of the canyon.

I executed this work in part of September and October, 1915, with the assistance of Mr. W. F. Bowman, who did the necessary topo-

[1]Girty, Guadalupian Fauna, p. 27.

graphical work and helped me to collect fossils. The section was made following generally the eastern side of the Gilliam Canyon and an affluent in its upper part, crossing the Road Canyon,[1] the mountains south of it, the valley between these and Leonard Mountain, ending at the southern foot of this last-named mountain.

After having finished this work I began to study Dr. Udden's collections and found that there existed strata older than those I had seen, that there existed quite a number of localities rich in ammonoids, and that the Glass Mountains probably would prove one of the richest localities of the earth, with respect to Permo-Carboniferous cephalopods.

The first fruit of these preliminary studies was a paper on the Richthofenias found until that time in the Glass Mountains and in the region of the Shafter Mine (Presidio County) which was published as Bulletin of the University of Texas No. 55, 1916.

As these first studies of Dr. Udden's collection and my own clearly showed that our material for a palaeontological subdivision was still very incomplete, and that especially the lower part of the Permo-Carboniferous was not sufficiently represented, Dr. Udden kindly enabled me to make a second excursion to the Glass Mountains, this time accompanied by Mr. Charles Laurence Baker, who in the year 1915 had studied the older Palaeozoic and the Anthracolitic in the Marathon basin, and who desired to obtain some additional data and to acquaint himself with the subdivision of the Permo-Carboniferous north of the Southern Pacific Railway, and to try to correlate it with the strata south of that railroad, which he had studied the previous year. We made this excursion during September and part of October of the year 1916, and studied principally the lower portion of the Permo-Carboniferous, although several localities of the Word formation were also visited, and the upper part of the Pennsylvanian, the Gaptank formation of Udden. We also made a short excursion south of the Southern Pacific Railway in the Mt. Ord range, where I had the opportunity of seeing that the different Permo-Carboniferous divisions of the Glass Mountains continue there with slight changes in their lithological character.

[1]On the map of Plate 1, in Univ. of Texas Bull. No. 1753, the Road Canyon is erroneously called Word Canyon, while on the geological map accompanying that paper, the right name has been used.

The chief object of our excursion, to collect as many ammonoids as possible, was entirely attained; at the same time many fossils of other classes were brought together, some of them from entirely new localities. In the present paper I am able to describe 29 species of Permo-Carboniferous ammonoids belonging to 16 genera and subgenera. This list will certainly be much augmented by later discoveries, because on the whole the fossil treasures of the Glass Mountains have been barely touched, and several months of collecting would be necessary to obtain a reasonably complete fauna from all the different horizons.

In the present publication, only the ammonoids will be described, because they enable us to subdivide the enormous mass of the Permo-Carboniferous sediments; while the other classes of fossils and especially the brachiopods, pelecypods and gastropods, are generally not limited to certain horizons. To the description of the Permo-Carboniferous forms is added that of a *Schistoceras* from the Pennsylvanian of the same region, on account of its relation to a *Schistoceras* found in the lowermost Permo-Carboniferous.

But the cephalopod fauna of the Glass Mountains is not only interesting in so far as it enables us to establish local stratigraphical horizons in the West Texas Permo-Carboniferous. Its significance is much more far reaching! It enables us to correlate certain strata of Central Texas and their northern continuation and it makes it also possible to correlate our beds with European and Asiatic localities and even may allow us to determine the relative age of several disconnected beds of Permo-Carboniferous age in different parts of the earth. The lower part of our beds contains a number of cephalopods entirely unknown until now, which apparently represent the oldest marine Permo-Carboniferous fauna described up to the present date.

All this will be still more emphasized when the fossils belonging to other classes shall be described, but then it will be demonstrated also that a fauna composed of brachiopods, pelecypods, and gastropods may show a decidedly Pennsylvanian character and yet belong to the Permo-Carboniferous and not even to the oldest part of it; an observation which has been made by several other authors, especially Carl Diener.

Before we enter into the discussion of our problems it remains to express my warmest thanks to Dr. J. A. Udden, Director of the Bureau of Economic Geology, for the great liberality which he showed in allowing me to make use of his important and detailed field notes, as well as of his collections; for his assistance in obtaining the necessary literature and his ever-ready willingness to further my studies. Neither should I forget to extend my sincerest thanks to the gentlemen who have helped me to collect the fauna here described—Mr. Charles Laurence Baker and Mr. W. F. Bowman; without whose assistance I probably would not have been able to amass the necessary material.

I also wish to thank Mr. Carl Christianson at Austin for the great pains he has taken in making the photographs of the fossils which have been used for the compilation of the plates which accompany this work.

All the sutures reproduced here have been photographed with the apparatus described by me about ten years ago.[1] This apparatus can be further improved by setting it on another slide working at right angles with the one described in the article mentioned; this allows of centering the fossils with flattened sides, and of using a common Penny Picture Camera or holder. The circumstance that between two and twenty-four pictures can be made on a plate of 5 by 7 inches, results in saving plates and at the same time avoids movement of the camera during the changing of the plateholders.

Austin, Texas, January, 1918.

[1]E. Böse, Ein verbesserter Apparat zur photographischen Reproduktion von Ammonitensuturen und Ambulakren von Seeigeln. Centralblatt f. Min. Geol. u. Pal., 1907, p. 422.

LIST OF ABBREVIATIONS OF LITERATURE CITED IN THIS PAPER

1. Abich, Djulfa.—H. Abich, Geologische Forschungen in den Kaukasischen Ländern. I Theil, Eine Bergkalkfauna aus der Araxesenge bei Djulfa in Armenien. Wien, 1878.
2. Boehm, Jüngeres Palaeozoicum v. Timor.—G. Boehm, Geologische Mitteilungen aus dem Indoaustralischen Archipel. VI b. Jüngeres Palaeozoicum von Timor. N. Jahrb. f. Min. Beilagebd. 25, 1907.
3. Caralp, Le Permien de l'Ariège.—J. Caralp, Le Permien de l'Ariège, ses divers faciès, sa faune marine. Bull. Soc. géol. France, 4e sér., t. 3.
4. Diener, Permocarb. fauna of Chitichun No. I.—C. Diener, The Permocarboniferous fauna of Chitichun No. I. Mem. Geol. Surv. India. Palaeontologia Indica, Ser. XV Himalayan Fossils, vol. 1, part 3, Calcutta, 1897.
5. Diener, Amm. u. Orth. i. südtirol. Bellerophonkalk.—C. Diener, Ueber ein Vorkommen von Ammoniten und Orthoceren im südtirolischen Bellerophonkalk. Sitz. Ber. K. Ak. d. Wiss. Wien, vol. 106, 1897.
6. Diener, Syst. Stell. d. Amm. d. südalp. Bellerophonkalkes.—C. Diener, Ueber die systematische Stellung der Ammoniten des südalpinen Bellerophonkalkes. Centralbl. f. Min., 1901.
7. Diener, Perm. foss. of the Central Himalayas.—C. Diener, Permian fossils of the Central Himalayas. Mem. Geol. Surv. India. Palaeontologia Indica; Ser. XV, part 5, Calcutta, 1903.
8. Frech, Palaeozoische Faunen aus Asien und Nordafrika. N. Jahrb. f. Min., 1895, II.
9. Frech, Lethaea palaeoz. II 3.—F. Roemer und Fr. Frech, Lethaea palaeozoica, Bd. II Lief. 3, Stuttgart, 1904.
10. Frech, In Riehthofen, China V.—Fr. Frech, Obere Neodyas, in Richthofen, China. Ergebnisse Eigener Reisen und darauf gegründeter Studien, Bd. V. Berlin, 1911.
11. Gemmellaro, Calc. e. Fusulina.—G. G. Gemmellaro, La fauna dei calcari con Fusulina della valle del Fiume Sosio nella Provincia di Palermo. Fasc. I. Palermo, 1888, App. 1888.
12. Girty, Guadalupian fauna.—G. H. Girty, The Guadalupian Fauna. U. S. Geol. Surv., Prof. Papers 58, 1908.
13. Haack, Permfauna a. Nordmexico.—W. Haack, Ueber eine marine Permfauna aus Nordmexiko nebst Bemerkungen über Devon daselbst. Zeitschr. d. deutsch. geol. Gesellsch., Bd. 66, 1914 (1915).
14. Haarmann, Coahuila.—Erich Haarmann, Geologische Streifzüge in Coahuila. Zeitschr. d. deutsch. geol. Gesellsch., 1913, Monatsber.

15. Haug, Les Amm. du Perm. et du Trias.—E. Haug, Les Ammonites du Permien et du Trias. Remarques sur leur classification. Bull. Soc. géol. France, IIIe sér., t. 20, 1894.
16. Haug, Et. s. l. Goniatites.—E. Haug. Etudes sur les Goniatites. Mém. Soc. géol. France. Paléontogie, mém. 18, t. 7, fasc. IVe, 1898.
17. Hyatt, Gen. of foss. Ceph.—A. Hyatt, Genera of fossil cephalopoda. Proc. Boston Soc. Nat. Hist., vol. 22, 1884.
18. Hyatt and Smith, Triass. ceph. gen. of America.—A. Hyatt and J. P. Smith, The Triassic Cephalopod Genera of America. U. S. Geol. Surv., Prof. Papers, No. 40, 1905.
19. Karpinsky, Amm. d. Artinsk-Stufe.—A. Karpinsky, Ueber die Ammoneen der Artinsk-Stufe und einige mit denselben verwandte carbonische Formen. Mém. de l'Acad. I. Sc. de St. Pétersbourg, VIIe sér., t. 37 No. 2, St. Pétersbourg, 1889 (1888).
20. Mojsisovics, Arkt. Trias-Amm.—E. v. Mojsisovics, Ueber einige arktische Trias-Ammoniten des nördlichen Sibirien. Mém. Acad. Imp. Sc. St. Pétersbourg, VIIe sér., t. 31, 1888.
21. Noetling, Beitr. z. Geologie der Salt Range.—Fr. Noetling, Beiträge zur Geologie der Salt Range, insbesondere der permischen und triassischen Ablagerungen. N. Jahrb. f. Min., Beilagebd. XIV, 1901.
22. Noetling, Medlicottia u. Episageceras.—Fr. Noetling, Ueber Medlicottia Waag. und Episageceras n. g. aus den permischen und triasischen Schichten Indiens. N. Jahrb. f. Min., Beilagebd. 19, 1904.
23. Rothpletz, Perm., Trias. und Jura auf Timor und Rotti.—A. Rothpletz, Die Perm-, Trias-, und Jura-Formation auf Timor und Rotti im indischen Archipel. Palaeontographica Bd. 39, 1892.
24. Smith, Carb. Amm. of America.—James Perrin Smith, The Carboniferous Ammonoids of America. Mon. U. S. Geol. Surv. Vol. 42, 1903.
25. Smith, Cephalopoda in Zittel-Eastman.—James Perrin Smith, Cephalopoda in Zittel-Eastman, Textbook of Paleontology, 2nd edition, vol. I, London, 1913.
26. Smith, Middle triass. marine invert. faunas of N. A.—James Perrin Smith, The Middle Triassic Marine Invertebrate Faunas of North America. U. S. Geol. Surv., Prof. Papers 83, 1914.
27. Tchernow, L'étage d'Artinsk.—A. Tchernow, L'étage d'Artinsk. I. Ammonoidés des bassins de Jaïva, de Kosva et de Tchoussovaïa. Livr. 1. Bull. de la Soc. Imp. des Natur. de Moscou. Année 1906, Moscou, 1907.
28. Tschernyschew, Obercarb. Brach. d. Ural u. d. Timan.—Th. Tschernyschew, Die obercarbonischen Brachiopoden des Ural und des Timan. Mém. Com. géol. Russie, t. XVI, No. 2, St. Petersburg, 1902.

29. Tzwetaev, Ceph. d. Calc. Carb. de la Russie Cèntrale.—Marie Tzwetaev, Cephalopodes de la section supérieure du Calcaire Carbonifère de la Russie Centrale. Mém. Com. géol. Russie, t. V, No. 3, St. Pétersbourg, 1888.

30. Udden, Baker and Böse, Review of the Geology of Texas.—J. A. Udden, Ch. L. Baker, and E. Böse, Review of the Geology of Texas. Bull. Univ. of Texas, No. 44, Austin, Tex. 1916.

31. Verneuil, Géol. de la Russie.—R. J. Murchison, E. de Verneuil et A. de Keyserling, Géologie de la Russie d'Europe et des montagnes de l'Oural. Vol. II, Paléontologie. Londres-Paris, 1845.

32. Vogl, Palaeodyas v. Mrzla-Vodica.—Victor Vogl, Die Palaeodyas von Mrzla-Vodica in Kroatien (Karstgebiet). Jahrb. d. k. Ungar. geol. Reichsanstalt, Bd. 21, Budapest, 1913.

33. Waagen, Productus limestone fossils.—W. Waagen, Salt-Range fossils. I. Productus-Limestone fossils. 1. Pisces Cephalopoda. Mem. Geol. Surv. India. Palaeontologia Indica Ser. XIII, Calcutta, 1879.

34. Wanner, Geol. Ergebn.—J. Wanner, Einige geologische Ergebnisse einer im Jahre 1909 ausgeführten Reise durch den östlichen Teil des indo-australischen Archipels. Centralbl. f. Min., 1910.

35. Wanner, Perm-, Trias-, und Jura-Formation d. Indo-australischen Archipels. J. Wanner, Neues über die Perm-, Trias-, und Jura-Formation des indo-australischen Archipels. Centralbl. f. Min., 1910.

36. White, C. A. The Texan Permian.—The Texan Permian and its mesozoic types of fossils. Bull. U. S. Geol. Surv., No. 77, 1891

STRATIGRAPHICAL PART

Stratigraphy of the Permo-Carboniferous in the Glass Mountains

STRATIGRAPHICAL PART

STRATIGRAPHY OF THE PERMO-CARBONIFEROUS IN THE GLASS MOUNTAINS

THE DIFFERENT BEDS AND THEIR FAUNAS

One may divide all the Permo-Carboniferous of the Glass Mountains into four horizons. The highest part is then the Tessey formation; below it follows the Gilliam formation, which overlies the Vidrio formation, below which exists some more richly fossil-bearing sediments. This subdivision is mainly based on the lithological character of the beds, the Tessey formation being a rather unstratified or thick-bedded dolomite, the Gilliam a medium and thin-bedded limestone and dolomite, the Vidrio a thick-bedded gray dolomite, the lowest formation a sequence of sandstones, shales and limestones, which are quite generally fossiliferous. This portion includes a sequence of dolomite, shales and sandstones in its upper part, then follows a larger member of sandstone and below this a heavy mass of limestone, which overlies a considerable quantity of thinly laminated sandstone with beds of thick-bedded limestone. Below this series which we call the *Word formation,* there is a mass of shales alternating with rather thin or medium-bedded gray limestones and thinly bedded cherts which we call the *Leonard formation.* This series is underlain by a mass of rather medium to thin-bedded, whitish gray, rarely conglomeratic limestone, which we have called the *Hess formation.* At the bottom of this series was discovered an erosional unconformity, which although being of quite a considerable importance to the east of the Glass Mountains (near Gap Tank) becomes more and more pronounced farther to the west, and has been followed by Baker also south of the Southern Pacific Railway in the Mt. Ord Range. We recognized the great importance of this unconformity and found that the greater part of the underlying formation belonged to the Pennsylvanian; these beds, mostly shales, limestones and sandstones, are called the *Gaptank formation.* The natural idea would have been to suppose that this unconformity

represented the upper limit of the Pennsylvanian, but Udden observed in an unnamed place which we afterwards used to call the Wolf Camp (between Gap Tank and Leonard Mountain) that there were certain strata below the unconformity, mostly shales and limestones, which contained fossils similar to those in the Word formation—as for example, Lyttonia,—and which did not seem to confirm the idea that the Gaptank formation really belonged to the Pennsylvanian. Near the Wolf Camp, Udden also found a few small cephalopods, apparently belonging to new species. By studying Dr. Udden's collections and those that were made by Mr. Charles L. Baker, and myself, at the same locality, and which contained several hundred ammonoids, I was able to demonstrate that the Gaptank formation really contained two different horizons, an upper one only preserved near the Wolf Camp which represents the lowermost Permo-Carboniferous, and which I shall call the *Wolfcamp formation;* and a lower one which contains a characteristic Upper Pennsylvanian fauna, for which we preserve the name *Gaptank formation.** The unconformity thus does not constitute the boundary between the Carboniferous and the Permian, but belongs to the lower part of the Permian, notwithstanding that in most parts it forms the limit between the Pennsylvanian and the Permo-Carboniferous. In the eastern region the unconformity separates the Hess formation from the Gaptank formation (Gap Tank and some miles farther west) although in one place there it has eroded the upper limestones of the Gaptank formation. At Wolf Camp we find the unconformity between the Hess and the Wolfcamp formation, but farther west, this latter one and even the whole Gaptank formation are entirely eroded and the uncon-

*Editor's Note: The undersigned has inadvertently in his "Notes on the Geology of the Glass Mountains," (Univ. of Tex. Bull. No. 1753), himself taken the credit of having named the Wolfcamp formation. I wish to state here that the discovery of the Wolfcamp could hardly have been made except by a paleontologist of such accomplishments as Dr. Böse. The classification and subdivision of the entire anthracolitic section in the Glass Mountain country was to a large extent the joint work of the three authors of University of Texas Bulletin No. 44. It so happened that the writer of this note had done most of the field work on the Permo-Carboniferous rocks in the Glass Mountains; Baker had no doubt the best information on the general geology of the surrounding region; while Dr. Böse was relied upon for that critical paleontological knowledge which is decisive in all work of this kind—a circumstance particularly fortunate for our studies in this region.

J. A. UDDEN.

formity brings the Hess formation in contact with the older and strongly folded member of the Pennsylvanian called the Dimple formation, or with somewhat younger beds, equally much-folded and belonging to the Pennsylvanian, called Haymond formation by Baker,[1] or still other strata. This shows that the unconformity discovered by Udden is of great importance for the local geological history but that it does not constitute the boundary line between the Upper Pennsylvanian and the Permo-Carboniferous.

This is not the place for the discussion of the geological and stratigraphical conditions of the Glass Mountains, which have been described by Dr. Udden in a separate publication,[2] but it is necessary to explain the stratigraphical local names introduced by us, so that we may be able to use them in the following text.

DISTRIBUTION OF THE AMMONOIDS IN THE DIFFERENT FORMATIONS

The upper formations—the Tessey, Gilliam and Vidrio dolomites—do not seem to be very fossiliferous and no cephalopods have been found in them at the places where I could study them.

Our ammonoids have been found only in the lower part of our Permo-Carboniferous: in the Word, Leonard, Hess and Wolfcamp formations. The richest in genera and species are the highest and lowest of these—the Word and Wolfcamp formations; while the Leonard formation is extremely rich in specimens which belong to few genera and species. The Hess formation has given only two species up to this time; one of which is even not entirely without doubt as to its age; but the Hess formation has been less studied than any of the other divisions and there is the possibility that richer localities may yet be found. The species of our fauna are distributed in the different formations in the following manner:

Wolfcamp formation:

Daraelites texanus, n. sp.
Uddenites Schucherti, n. g. n. sp.
Uddenites minor, n. sp.
Gastrioceras modestum, n. sp.
Schistoceras diversecostatum, n. sp.

[1]Cf. Udden, Baker and Böse, Review of the Geology of Texas, p. 46.
[2]University of Texas Bulletin, No. 1753.

Paralegoceras incertum, n. sp.
Agathiceras Frechi, n. sp.
Marathonites vidriensis, n. sp.
Marathonites sulcatus, n. sp.
Marathonites, J. P. Smithi, n. g. n. sp.
Vidrioceras Uddeni, n. g. n. sp.
Vidrioceras irregulare, n. sp.

Hess formation:

Prothalassoceras Welleri, n. g. n. sp.
Marathonites Hargisi, n. sp.

Leonard formation:

Medlicottia Whitneyi, n. sp.
Gastrioceras altudense, n. sp.
Perrinites vidriensis, n. g. n. sp.
Perrinites compressus, n. sp.
Paralecanites altudensis, n. sp.

Word formation:

Medlicottia Burckhardti, n. sp.
Gastrioceras roadense, n. sp.
Gastrioceras sp. nov. indet.
Paraceltites multicostatus, n. sp.
Paraceltites aff. elegans Girty.
Agathiceras Girtyi, n. sp.
Adrianites marathonensis, n. sp.
Stacheoceras Bowmani, n. sp.
Stacheoceras gilliamense, n. sp.
Waagenoceras Dieneri, n. sp.

This list demonstrates that the formations distinguished here are real paleontological zones; not one species passes from one formation to the other and there are even very few genera which occur in several of our subdivisions.

Every one of our formations is characterized by the great development of some genera and this permits us to establish stratigraphical zones which may be used instead of the meaningless local geographical names whenever a comparison with beds of other localities can be made. We can thus establish the following four zones:

Zone of Waagenoceras=Word formation.
Zone of Perrinites=Leonard formation.
Zone of Prothalassoceras=Hess formation.
Zone of Uddenites=Wolfcamp formation.

When we compare the fauna of each of these divisions we find that they may be united into two groups on account of the paleontological relations existing between them. One group would be formed by the Zone of Waagenoceras and that of Perrinites; while the other natural group would consist of the Zone of Prothalassoceras and that of Uddenites.

The correctness of this view can be easily demonstrated for the first group. We find that in both these zones occurs the genus *Medlicottia;* that both contain *Gastrioceras* belonging to the group *Gastrioceras Zitteli* Gemm., and that the highly developed forms of the *Cyclolobinae* are represented by *Perrinites* in the lower zone and by *Waagenoceras* in the upper one.

It is a little more difficult to show relations between the two lower divisions, on account of the scarcity of ammonoids in the zone of *Prothalassoceras,* but still there are some features which separate this zone from that of *Perrinites,* and others which connect it with the zone of Uddenites. Both the zones of *Waagenoceras* and *Perrinites* contain in general quite highly developed ammonoids like *Perrinites, Waagenoceras, Medlicottia, Adrianites,* and species belonging to the group of *Gastrioceras Zitteli* Gemm., while both of the two lower zones contain less highly developed forms. Instead of the higher developed *Medlicottia* we find in the zone of *Uddenites* the new genus *Uddenites* which is not a precursor of *Medlicottia,* though also a branch of *Pronorites,* but which has not developed in the same degree of the first-mentioned genus. Instead of *Stacheoceras* with many lobes, we find *Marathonites* and *Vidrioceras* with a very small number of lobes. In the lowermost zone there occurs even the genus *Schistoceras* which has been known only from the Pennsylvanian. In the upper zone of the lower group we find a less developed member of the *Thalassoceratidae,* and although the higher developed forms of this genus do not occur in the zone of *Waagenoceras,* we shall see that in Europe and Asia these higher forms occur in beds of the same age, and associated with forms that are also found in our highest zone. The two zones of the lower group are united with each other to a certain degree by the occurrence of *Marathonites* in both of them and they show a certain difference from the zones of the higher group in the degree of development of the ammonoids contained in them.

At the present time it is difficult to decide how near the relationship is between the zone of *Uddenites* and that of *Prothalassoceras,* because so few ammonoids have been found in the latter one. According to my provisional observation also the brachiopods and gastropods of these two zones have more affinities with the Pennsylvanian than those from the two upper zones, although in the zone of *Perrinites* occur some gastropods of entirely carboniferous aspect.

We have to take into account also that we do not know how much material of the zone of *Uddenites* was removed by erosion before the zone of *Prothalassoceras* was deposited. Near the Wolf Camp the conglomerate is about 45 feet thick and indicates considerable erosion; therefore quite a number of beds may be unknown to us because they have been carried away and are not preserved anywhere else in this region.

Thus we arrive at the following conclusions: There is a certain affinity between the zones of *Waagenoceras* and of *Perrinites,* while the ammonoids of the two lower zones show a distinct and somewhat older character; the degree of relationship between these two latter zones cannot be exactly determined, on account of the scarcity of ammonoids in the upper one and because we do not know how much material has been destroyed during the erosional period which separates the zones from each other.

We have already mentioned that the dolomites on top of the Word formation do not seem to be very fossiliferous and that an exact determination of their age cannot be made; the fossils only show that these beds belong still to the Permian, but it is impossible to say where the Permo-Carboniferous ends.

Somewhat different are the conditions below our fossiliferous series. The shales and limestones which carry the ammonoids of the Wolfcamp formation rest on the very characteristic gray limestone which may be followed to the east as far as Gap Tank. This limestone contains a small fauna of brachiopods, pelecypods, gastropods, etc., of decidedly Pennsylvanian character. At Gap Tank the rocks underlying the afore-mentioned limestone are well developed; they consist of shales alternating with rather thick-bedded whitish-gray limestones similar to the upper one, and farther below of sandstones, limestones, shales and several conglomerates. In the continuation of this series

southward the shales which belong to its upper portion are very well exposed and enormously fossiliferous. They contain a characteristic Pennsylvanian fauna. Ammonoids are rare; the principal species which was found and which will be described in the palaeontological part of this work is *Schistoceras J. P. Smithi* n. sp., similar to *Sch. Hyatti* Smith. Furthermore, we collected a small globose involute ammonite which seems to belong to *Stacheoceras* or *Marathonites,* and a fragment of a large ammonoid with simple sutures which belongs apparently to a new genus but is too incomplete for a description.

Lately Dr. J. W. Beede has made a provisional study of the faunas contained in the Gaptank formation and to him I am indebted for the following review, which I reproduce verbatim:

"A cursory review of the invertebrate fossils of the Gaptank formation, with provisional identifications, shows an interesting succession of forms from the base upward, and shows also that the formation covers a large span of the Pennsylvanian system of rocks. From the lowest part of the formation—really series—we have such fossils as *Cryptacanthia* cf. *compacta* W. and St. J., *Chonetes mesolobus* N. and P., and *Pugnax rockymontanus* (Marcou) with fossils usually associated with this fauna; to these it is important to add others belonging to the lower and middle part of the formation, such as species of *Heterocoelia, Coelocladia,* and *Wewokella?;* three species of *Composita,* two of which have Guadalupian affinities, *Spirifer* aff. *musakheylensis* Dav., *Uncinulus* aff. *Wangenheimi* Tschern., *Chaenomya leavenworthana* Meek, *Porcellia,* and others. Many additional species are common to the rocks of the Kansas section or are closely related to them. The *Fusulinae* of the lower part of the formation (however much of it this may include) seem to be those of the "Upper Coal Measures" below the top of Stage G of the Kansas section. The basal part of the formation, however, must go as low as the vicinity of the Pawnee or Fort Scott limestone of the Kansas section as is shown by the first four species named. The upper limit of the lower part of the formation, as represented by the collections, probably reaches up to or into Stage G of the Kansas section.

"The upper part of the formation contains a species of *Schwagerina* probably identical with the Kansas species, *Fusulina* sp. very closely related to *F. longissimoidea* Beede, of the same horizon as the *Schwag-*

erina in both states, *Omphalotrochus?* sp. and a variety of *Euomphalus pernodosus* M. and W.

"The associated fauna is such as to force the conclusion that the upper Gaptank formation reaches as high as the base of the Lower Permian (Permo-Carboniferous) if it does not slightly penetrate it. The evidence of the faunas of the overlying formation is perfectly consistent with this conclusion.

"While a large percentage of the species of fossils found in the Gaptank formation is identical with or related to species from the Pennsylvanian of the Mississippi Valley, yet many have very close relationships with forms described from the Pennsylvanian and even Permo-Carboniferous of Eurasia, especially the southern part of the continent.

"Among the species with southern Asiatic affinities may be mentioned *Spirifer* cf. *musakheylensis* Dav., *Productus* group of P. *giganteus* Waagen, *Enteletes hemiplicatus* Hall? aff. (Syntrialasma) *hemiplicatus* of Keyserling from Lo Ping, and *Productus guadalupensis comancheanus* Girty, group of *P. humboldti;* three of those with northern Eurasian affinities are *"Pleurotomaria"* group of *P. altaica* de Vern., *Uncinulus* aff. *wangenheimi* Tschernyschew, and *Euphemus nodocarinatus* (New Harmony variety) White, with E. *carbonarius* Stuckenberg (Kart. Géol. Russ. 127); of species related to the Permo-Carboniferous of the Alps and Sicily we have *Enteletes* aff. *waageni* Gemm., *Geyerella* aff. *Geyerellae* of Schellwien from the Trogkofelschichten.

"Even from this brief review it is evident that during the Pennsylvanian time at least an intermittent connection was maintained between the waters of this part of west Texas and the Mississippi Valley sea, as well as with the southern Eurasian region during the later Pennsylvanian.

"The fauna of the formations above the Gaptank—Wolfcamp to Gilliam—show little if any evidence of a connection with the Mississippi Valley region after the close of the Gaptank. While these higher formations contain some species common to the Mississippi Valley region or related to them, yet they may all be accounted for as survivors of the earliest migration."

With these remarks of Dr. Beede should be compared his list of fossils from the Gaptank formation published by Udden in his "Notes on the Geology of the Glass Mountains," University of Texas Bulletin No. 1753, 1917, p. 38 et. seq.

Together with the ammonoids of our zone of *Uddenites,* we have found some fossils of carboniferous aspect, but at the same time we found intimately associated with the cephalopod-bearing beds several Richthofenia and a little higher several Lyttonia and other brachiopods of Permo-Carboniferous character, all far below the conglomerate of the erosional unconformity at the beginning of the zone of *Prothalassoceras.*

It seems therefore that we are justified in considering as the uppermost Pennsylvanian the light gray limestones which follow the foothills from Wolf Camp to Gap Tank, and to regard our cephalopod-bearing dark shales and gray limestones as the lowest portion of the Permo-Carboniferous. For the time being, this is certainly the best solution of the problem, because it is easy to follow the upper limit of the gray masses of limestone. If later detailed studies should demonstrate that part of these limestones belongs to the Permo-Carboniferous this would not have great influence on the main subdivision of the beds.

CORRELATION OF THE PERMO-CARBONIFEROUS OF THE GLASS MOUNTAINS WITH OTHER NORTH AMERICAN FORMATIONS

The Permian of North America is still very little known. This makes correlation difficult, especially in those regions where no marine fauna has been described. Most of the fossils cited are pelecypods, which do not make it possible to distinguish well limited palaeontological zones. Nevertheless, there are some regions which permit a more exact correlation.

The nearest place where a marine Permo-Carboniferous fauna has been found is the Guadalupe Mountains in Culberson County, West Texas. The detailed description of this fauna by G. H. Girty should allow an exact correlation, but unfortunately the ammonoids described are few and badly preserved. Nevertheless, the occurrence of *Waagenoceras* (not "Waagenoceras" Cumminsi White) seems to

be certain and this would correlate the Delaware Mountain beds with our Word formation (zone of *Waagenoceras*). This is confirmed by the existence of a form described as *Gastrioceras* sp., which has most intimate relations with our *Gastrioceras* n. sp. indet. With the exception of the *Gastrioceras serratum* Girty, the rest of the ammonoids have been found in higher strata; nothing similar to them seems to occur in any of our beds. The brachiopod fauna of the Word formation contains a number of species also found in the Delaware Mountain beds and therewith confirms our supposition that both are contemporaneous; but we must not forget that many of those species occur frequently also in our lower horizons.

A further, although negative proof for our assumption is afforded by the fauna of our Leonard formation (zone of *Perrinites.*) None of the characteristic *Perrinites* seems to have been found in the Guadalupe Mountains. The *Perrinites Cumminsi* White figured by Girty certainly does not belong to this genus, but in part at least to *Waagenoceras.* Nor have there been found in the Guadalupe Mountains any of the very large Producti of the group of *Productus sino-indicus* Frech, so common in our Leonard formation. This negative proof is of course not conclusive, but tends to bear out our supposition that the Delaware Mountain beds are younger than our Leonard formation, and contemporaneous with our Word formation. Girty had already found that the fauna from the Glass Mountains collected by R. T. Hill had a great similarity with that of the Delaware Mountain beds. It has to be kept in mind that his collections may have come from different horizons and this may at least in part account for the differences Girty found.

Much more certain are the relations between our fauna and that of some localities on the western border of the great central carboniferous area, developed in Kansas, Oklahoma and Texas. Most of the Permian existing in this region has not yielded any ammonoids, but there are some localities in Texas where ammonoids have been described and where these even seem to be quite plentiful. These are the Old Military Crossing of the Big Wichita in Baylor County; the falls on Salt Croton Creek, Kent County; Quanah, Hardeman County, and a place near San Angelo, Tom Green County. In the last named locality, only a

species of *Medlicottia* was found, which White[1] identified with his *Medlicottia Copei.* The locality near the falls on Salt Croton Creek has furnished *Perrinites Hilli* Smith and a number of undescribed species of *Popanoceras* (probably *Stacheoceras*) and *Medlicottia* which are supposed to be identical with similar forms found at the third locality, the Military Crossing of the Big Wichita. The ammonoids discovered at this last place are: *Medlicottia Copei* White, *Paralegoceras baylorense* White sp., *Stacheoceras Walcotti* White sp., and *Perrinites Cumminsi* White sp. White recognized the fact that his ammonoids showed some very near relation to those of the Sosio beds of Sicily and of the Productus limestone of India, but notwithstanding this he expressed the somewhat surprising belief that those beds of Sicily and India might perhaps belong to the Upper Coal Measures, strata that he found below his Texan Permian. As we shall see later on, he reversed the real conditions. White did not know the works of Murchison, Verneuil and Keyserling, Karpinsky[2] and Krotow, or he would have perceived that those forms which he thought to be Mesozoic types are in reality typical Permian genera and that there was no commingling of Mesozoic and Carboniferous types at all.

When we study the fauna described by White we see that the most important fact is the occurrence of highly developed Cyclolobinae in the form of *Perrinites,* while other decidedly Permian forms are *Medlicottia* and that group of *Stacheoceras* which is represented by *St. Walcotti.* The occurrence of *Perrinites* is of special significance as it is by far the most common of all the species found at the Military Crossing, the same as is the case with *Perrinites* in our Leonard formation.

Perrinites has been found also at the falls of the Salt Croton Creek, Kent County; but this species, *P. Hilli* Smith, is very different from *P. Cumminsi* and exceedingly similar to *P. vidriensis;* so much so that for some time I doubted if it were not the same species. This resemblance justifies us in supposing that the beds of *P. Hilli* and our Leonard formation are of the same age. The former ones belong to the middle part of the Double Mountain formation while the beds at the

[1]White, The Texan Permian, p. 21.

[2]He received this work after his paper had gone to the printer.

Military Crossing belong to the upper Wichita, or perhaps the lower Clear Fork.

The fauna of the beds at the Military Crossing shows that they cannot be much different in age from the Leonard formation and may possibly be an equivalent of the lower part of the zone of *Perrinites.* The beds at Salt Croton Creek certainly correspond to the upper part of the Leonard formation where *P. vidriensis* is the most common fossil. The result is somewhat surprising because the thickness of the Clear Fork formation is about 1900 feet, and that of the lower half of the Double Mountain about 700 feet, while that of the Leonard formation is probably not much over 700 feet. This may possibly be explained by the difference of facies as there cannot be much doubt that paleontologically the beds at the Military Crossing cannot be much older that the Leonard formation, while the middle part of the Double Mountain certainly corresponds to the upper part of the Leonard formation. Both localities of Central Texas are certainly older than our Word formation and of course also older than the Delaware Mountain formation. These latter zones may be represented by the upper part of the Double Mountain formation.

The locality at Quanah, Hardeman County, was apparently discovered by Ch. N. Gould. On a recent trip to this place which I made, accompanying Dr. J. W. Beede, we collected quite a number of generally badly preserved specimens of *Perrinites.* Some of the better preserved individuals show the details of the suture, which are quite different from those of *Perrinites Hilli* as well as *Perrinites vidriensis,* the saddles being much more slender and deeper scalloped, although the branches are in general simpler of outline. The species is more evolute than the other two mentioned, and has to be considered as new, the external form being entirely different from that of *P. Cumminsi.* The only other ammonoid observed by us at the same locality was a very large *Gastrioceras,* larger than any other one so far described, but so badly preserved that it is practically undeterminable. The locality is north of the Acme Cement Mills west of Quanah, and a little south of the first wagon road running east and west.

The locality near San Angelo where *Medlicottia Copei?* was found must be above the Albany formation which is considered as an equiva-

lent of the Wichita formation of northern central Texas. It belongs possibly to the Clear Fork division, but no details are known.

Below the Clear Fork division we find in northern Texas the Wichita formation composed of red, bluish and gray-white sandstones, red concretionary clays, occasional blue shales and clay-ball conglomerates. Further south these beds are supposed to be represented by the blue-black and gray shales and clays and the hard compact and thick-bedded limestone of the Albany formation. This member of the Central Texas series thus would correspond to the lower part of our Leonard formation, the Hess formation, the unknown strata destroyed by the Permo-carboniferous erosion, and the Wolfcamp formation. The invertebrate fauna of the lower Wichita-Albany has never been described and the ammonoids are not known. No nearer comparisons can be made with other Permian localities of North America. In the Appalachian region the Permian consists of plant-bearing beds of lower Permian character, while in Nova Scotia this series probably corresponds to higher beds of the Permian (Saxonian and Franconian). Unfortunately, no detailed studies about the Permian in the Basin Ranges and the Rocky Mountains are available, although the Permian seems to be well represented there. The fossils found by Frech near Fort Douglas near the Great Salt Lake seem to represent principally an upper Permian fauna. Very little is known about the shales which represent the Permian in California; especially in the southern part of the Sierra Nevada, they seem to be entirely sterile.

Very little can be said about the interesting locality discovered by Haarmann[1] at Las Delicias near Torreon, Coahuila, in northern Mexico. The small fauna which has been described by W. Haack[2] belongs undoubtedly to the upper Anthracolitic and may very well represent one of our Permo-Carboniferous zones, but it is impossible to make a more exact determination of its age.

Still less is known about the upper Anthracolitic existing in Chiapas, southern Mexico, Guatemala and British Honduras, although a list of the fossils from the last two countries has been made by E. Stolley and published by Carl Sapper.

[1]Haarmann, Coahuila.

[2]Haack, Permfauna a. Nordmexico.

CORRELATION WITH EUROPEAN AND ASIATIC BEDS

The main marine lower Permian beds of Europe, in which ammonoids have been found, are the Sosio beds of Sicily; the Trogkofel beds of the Carnian Alps, and the Karawanken; the sandstones of Mrzla-Vodica in Croatia; the beds of St. Girons in the Pyrenees; and perhaps the cherty beds of Spitzbergen and Barent Island; the Artinsk beds of eastern European Russia. Of all these the Sicilian Sosio beds are by far the richest, containing twenty genera and subgenera, with sixty-eight species of ammonoids; while the next richest fauna, that of the cephalopod-bearing strata of the Artinsk in Russia, has fourteen genera with forty-two species of ammonoids (not counting the species which have been cited but not described, or which are doubtful).

It has been the opinion of most of the authors that the cephalopod-bearing Artinsk is a little older than the Sicilian Sosio beds. Karpinsky gives a short comparison of the faunas and reaches the conclusion that the Sicilian fauna is a little younger, but that it is very similar to that of the Artinsk; that one form even is identical, while others are very nearly related. He adds that the occurrence of the complicated Arcestidae (*Waagenoceras* and *Hyattoceras*) could be explained if one supposed that such forms belong to more southern regions.

It appears to me that Karpinsky has paid more attention to the similarity of the two faunas than to the discrepancies. I do not give much importance to the circumstance that the species are not identical in both faunas, because it is not to be supposed that many forms could have such an enormously wide distribution without undergoing specific changes. Much more important seems to me the occurrence of the same subgenera or genera and also of groups of species wherever these have not been united into special subgenera. Karpinsky tries to demonstrate that practically the greatest part of the Artinskian fauna is autochthonic because their ancestors were living in the upper Carboniferous of Russia. This appears to be a very dangerous proceeding, because if we apply this rule to American occurrences, we can easily show that those ancestors lived in America also in the Carboniferous. I do not believe that it is often possible to prove in what special place on the earth a certain genus originated. Our knowledge of the distribution of ammonoids is far too limited yet, and every day

may prove our conclusions to be wrong. Whatever may seem today to be a type which was developed in a certain locality, tomorrow may prove to be much more plentiful in a far distant locality. The modern studies about the ammonites of the Mesozoic seem to demonstrate that most of the genera, subgenera and even groups of species occur all over the earth, at least during the period before the Upper Cretaceous; that they succeed each other in one region in the same manner as in the other; and that only very few types developed locally. I do not doubt that similar conditions existed in the Permian, the first formation where ammonoids begin to occur very frequently.

If we compare the genera, subgenera and groups of species which occur both in the Artinsk and in the Sosio beds, we find that there is really a great similarity between the two faunas. The genera, etc., which occur in both faunas are: *Parapronorites, Medlicottia, Propinacoceras, Daraelites, Gastrioceras* (group of *G. Zitteli*), *Agathiceras, Adrianites, Popanoceras, Stacheoceras,* and perhaps *Thalassoceras, Paraceltites* and *Sicanites.* Part of these genera are not of great importance as they occur also in younger or older formations. *Medlicottia,* for example, occurs certainly in different parts of the Permian; *Gastrioceras, Agathiceras* and *Stacheoceras* (in the wider sense) are even found in the Carboniferous. But *Parapronorites, Propinacoceras, Daraelites, Adrianites, Popanoceras, Thalassoceras, Paraceltites,* and *Sicanites* certainly appear to be limited to the lower part of the Permian, where also the typical *Medlicottia* and *Stacheoceras* seem to have attained their greatest development. The occurrence of these types in both faunas tends to prove that the difference in age must be comparatively small, but that such a difference exists is proved by the occurrence of genera in the Artinsk which are generally of an older type, and of others in the Sosio beds which belong to a younger type. We shall discuss these particularities here a little more fully.

In the Artinsk we find *Pronorites,* a genus which is most frequent in the Carboniferous, and which is entirely missing in the Sosio beds. *Parapronorites* which is nearly related to *Pronorites,* but shows a higher developed suture, is very frequent in the Artinsk (nine species) while in the Sosio beds it is represented by only one species. On the other hand, *Propinacoceras,* which has perhaps a little more highly developed suture than *Parapronorites,* is represented by three species

in the Sosio beds and only by one in the Artinsk. Among the *Gastrioceras* of the Artinsk there are yet forms which are nearly related to Carboniferous forms (*Gastrioceras Fedorowi, G. Nikitini*) while others like *G. Sucssi* belong to the group of *G. Zitteli.* In the Sosio beds the older forms seem to be absent and all the species described belong to the younger group of *G. Zitteli.* The species described by Gemmellaro as *Glyphioceras* have nothing to do with the Carboniferous *Glyphioceras.*

Agathiceras is about equally frequent in both faunas but the genus changes very little in the different horizons from the upper Carboniferous to the different stages of the Permo-Carboniferous and is therefore of no importance at all except on account of its greater frequency in the younger formation. A higher stage is represented by *Adrianites* and it is quite characteristic that from the Artinsk only one species has been described (Tchernow cites a second one) while ten are known to occur in the Sosio beds. Among these are two belonging to the subgenus *Hofmannia* altogether unknown in the Artinsk.

The genera *Doryceras* and *Clinolobus* seem to be limited to the Sosio beds and are not known with certainty elsewhere.

Very characteristic is the distribution of the different groups and perhaps subgenera of *Stacheoceras* in both faunas. In the Artinsk we find not only the type with very few lobes, similar in its external appearance and in its suture to those which occur in the Carboniferous and which may all be nearly related to our subgenus *Marathonites;* but also the type with a higher development of the suture. In the Sosio beds only these latter forms (represented by twelve species) are known to occur. *Popanoceras* s. s., is represented by only one species in the Artinsk, while in the Sosio beds four species occur; *Popanoceras* certainly represents a higher stage of development than *Stacheoceras* does.

Very important is the occurrence of the highly developed Cyclolobinae (*Hyattoceras* and *Waagenoceras*) in the Sosio beds. They are nearly related to the evidently younger form of *Cyclolobus.* None of this kind has been described from the Artinsk.

In the Sosio beds, *Thalassoceras* is represented by four species, while in the Artinsk only one or two occur, and the only one figured may

even belong to a less highly developed precursor of that genus. (*Prothalassoceras.*)

The occurrence of *Paraceltites* in the Artinsk is extremely doubtful, while this genus is represented by four species in the Sosio beds. This is important in so far as the sculpture of the genus is very similar to that of the real ammonites, while the suture is somewhat archaic.

The genus *Daraelites* was first described from the Sosio beds where it occurs in only one species, represented by numerous specimens. Another and seemingly rather rare species has been described from the Russian Artinsk by Tchernow. The genus has apparently a wider range in age than has been thought. It occurs in our lowermost Permo-Carboniferous of the Glass Mountains, Texas, although in only two specimens. There it is represented by a new species which differs from those of the Artinsk and the Sosio beds by the broad first lateral lobe. Another species is known to occur in the Permo-Carboniferous of St. Girons in the Pyrenees.

A very interesting feature is the occurrence of *Medlicottia* in both the Sosio limestone and the Artinsk sandstone. In the latter beds the genus is represented by at least one species, while the Sosio beds contain four species different from those of the Artinsk. Karpinsky had thought that *M. Orbignyana* was possibly identical with *M. Trautscholdi* Gemm., or that this latter one only represented a variety of the Russian form; but Noetling has already indicated a number of differences in the sutural line and we may add that the form of the external saddle and of the adventive lobe A is very different in both forms, and that also the lateral lobes have an evidently very different outline. This is especially evident when we compare Gemmellaro's figure with that of nearly the same size of *M. Orbignyana* given by Karpinsky on his plate II, fig. l, g, h and k. It seems also that the furrow on the ventral part is much wider in *M. Trautscholdi* than in the Russian form.

Noetling has tried to determine the age of certain beds through the development of the sutural line of *Medlicottia.* He supposes that the geologically older species have a smaller number of auxiliary lobes and also of rudimentary lobes on the external saddle than the younger ones; that the adventive lobe A is shallower in the older species than in the younger ones, etc. But he supposed also that the cephalopod-bear-

ing sandstones of the Artinsk are younger than the Sosio beds. I have tried to show in our chapter on *Medlicottia* that Noetling over-estimates the value of certain details in the sutural line. The differences between the species of *Medlicottia* are in reality so small that a determination of age based on the development of the sutural line is certainly out of the question until we get to know more material in different horizons.

Sicanites has been found in Sicily in only two species, one of which is somewhat doubtful, and the type species appears to have been found in only a very few specimens. Karpinsky even doubts that *Sicanites* represents a final stage of development and thinks that the specimens described as *Sicanites* may be nothing more than young individuals or inner whorls of *Medlicottia*. If *Sicanites* is really a genus it probably occurs both in the Russian Artinsk (*Medlicottia Karpinskyana* Krotow) and in the Sosio beds of Sicily.

This comparison of the ammonoid fauna of the Artinsk and the Sosio beds shows us quite clearly that the Artinsk contains a number of rather archaic genera unknown in the Sosio beds or represented by an occasional species. On the other hand, the Sicilian fauna contains some highly developed forms, especially those belonging to the Cyclolobinae (*Hyattoceras, Waagenoceras*) which are absolutely unknown in the Artinsk and which find their nearest relations in higher strata of the Permian.

These facts can be deduced from the table B published by Karpinsky (l. c., pp. 88, 89), and they are still more evident if we add to it those species described by Tchernow and make the necessary corrections of generic determinations for some of the species described by Karpinsky. They can only be explained by supposing that the Artinsk and the Sosio beds represent paleontological zones of different age, and that the Artinsk is decidedly older than the Sosio beds.

Karpinsky obtained quite similar results. He also believes that the Artinsk is somewhat older than the Sosio beds but he does not think that the difference is very great (Karpinsky, loc. cit., table C on page 94); and Tschernyschew even thinks the difference in age is entirely inconsiderable (Tschernyschew, Die obercarbonischen Brach. d. Ural u. d. Timan, p. 720-721).

As I have said above, Karpinsky seems to pay more attention to the similarities of the two faunas than to the discrepancies, although these latter are evidently by far greater than the similarities.

It is of course extremely difficult to decide how great the difference in age is because the two faunas are found in localities separated from each other by an enormous distance; but the paleontological character of the Sosio beds makes it very probable that they correspond in age at least to the Kungur dolomites of the Ural which cover the cephalopod-bearing sandstones of the Artinsk. This is only a supposition, because the Kungur dolomites do not contain ammonoid forms and a direct paleontological comparison is therefore impossible. It may even be that the Sosio beds are still a little younger than the Kungur dolomites but they are certainly not nearly of the same age as the Artinsk sandstone.

This will appear more evident yet when we compare the faunas of the Artinsk and of the Sosio beds with those of the Glass Mountains.

A comparison between the fauna of our zone of *Waagenoceras* (Word formation) and that of Sicily shows at once the intimate relations between the two. There is not one genus in our fauna which does not also exist in the Sosio beds, and most of the species have some near relative even in the Sicilian beds, as is shown by the following table:

SPECIES FROM THE WORD FORMATION OF THE GLASS MOUNTAINS	CORRESPONDING FORMS FROM OTHER LOCALITIES	
Medlicottia Burckhardti n. sp.	*M. Verneuili* Gemm.	Sosio beds
Gastrioceras roadense n. sp.	*G. sosiense* Gemm.	Sosio beds
Gastrioceras sp. nov. indet.	*G.* sp. Girty	Delaware beds
Paraceltites multicostatus n. sp.	*P. Hoeferi* Gemm.	Sosio beds
Paraceltites aff. *elegans* Girty.	*P.* plicatus Gemm.	Sosio beds
Agathiceras Girtyi n. sp.		
Adrianites marathonensis n. sp	*A. insignis* Gemm.	Sosio beds
Stacheoceras Bowmani n. sp.		
Stacheoceras gilliamense n. sp.	*St. globosum* Gemm.	Sosio beds
Waagenoceras Dieneri n. sp.	*W. Nikitini* Gemm.	Sosio beds

The occurrence of *Waagenoceras* at both localities is of the greatest importance. While this genus has never been found anywhere else, it is extremely frequent in the Glass Mountains and in the Sosio beds. The occurrence of this genus alone would make it highly probable that

both faunas are synchronous. The rest of the genera in our zone of *Waagenoceras* confirms this opinion, especially *Medlicottia, Gastrioceras* of the *G. Zitteli* group, *Paraceltites, Adrianites* and *Stacheoceras.* Our fauna is much poorer in species than that of the Sosio beds and that explains, perhaps, why a number of genera that occur in the Sosio beds have not yet been found in the Word formation. The principal ones of these genera are: *Hyattoceras, Popanoceras* (possibly represented by some forms that have been taken for *Stacheoceras*), *Propinacoceras, Parapronorites, Sicanites, Daraelites, Thalassoceras, Doryceras*, and *Clinolobus.* While many of these genera are very rare also in the Sicilian deposits, the absence of some of them, such as *Hyattoceras, Popanoceras, Propinacoceras* and *Thalassoceras,* is somewhat surprising; although some of them may be found in the future. If, according to Gemmellaro, *Hyattoceras* had not been found together with *Waagenoceras,* we might suppose that it is represented in the Glass Mountains by *Perrinites;* but this latter genus always occurs below the strata with *Waagenoceras!*

In another chapter we have tried to show that the fauna of the zone of *Waagenoceras* is intimately related to that of the zone of *Perrinites.* At the same time it appears that the fauna of this latter zone does not show very great differences from that of the Sosio beds, although a comparison is made difficult by the reduced number of species collected until now in the zone of *Perrinites.* The following table will explain those relations:

SPECIES FROM THE LEONARD FORMATION OF THE GLASS MOUNTAINS	CORRESPONDING FORMS FROM OTHER LOCALITIES	
Medlicottia Whitneyi n. sp.	*M.* bifrons Gemm.	Sosio beds
Gastrioceras altudense n. sp.	*G. Waageni* Gemm.	Sosio beds
Perrinites vidriensis n. sp.	*Hyattoceras* (?)	Sosio beds
Perrinites compressus n. sp.		
Paralecanites altudensis n. sp.		

Perrinites is so nearly related to *Hyattoceras* that we might take it for its precursor, but unfortunately the evolution of the suture of the latter genus is unknown, so that we do not know if it passes through some stage similar to the suture of *Perrinites.* We might also suppose that this latter genus vicariates for *Hyattoceras,* and that the zone thus simply represents a certain phase of the Sosio beds.

The other forms found are mostly very similar to some from the Sosio beds. *Medlicottia Whitneyi* is not only very nearly related to *M. Burckhardti* from our zone of *Waagenoceras,* but also to *M. bifrons* Gemm. from the Sosio beds. *Gastrioceras altudense* belongs without doubt to the group of *G. Zitteli. Paralecanites altudensis* cannot easily be compared with any other form described.

We may add that *Perrinites* is much more highly developed than anything found until now in the cephalopod-bearing sandstones of the Artinsk; which indicates that this latter horizon is still older and that our *Perrinites* beds represent perhaps a zone between the cephalopod-bearing sandstones of the Artinsk and the Sosio beds. The fauna of the *Perrinites* beds is more nearly related to that of the latter horizon.

We shall now try to show the relations between our lower horizons (the zone of *Prothalassoceras* and zone of *Uddenites*) and the Artinsk and Sosio beds. This comparison is somewhat hampered by the extreme scarcity of ammonoids in the zone of *Prothalassoceras* and also by the circumstance that a certain part of the zone of *Uddenites* has been destroyed by erosion during the Permo-Carboniferous time.

The only two ammonoids so far found in the zone of *Prothalassoceras,* both of which show intimate relations to forms from the Artinsk sandstone, are *Prothalassoceras Welleri* n. sp. and *Marathonites Hargisi* n. sp. The only relatives of these forms seem to exist in the cephalopod-bearing sandstone of the Artinsk. *Prothalassoceras Welleri* with its characteristic simple suture, has a great similarity to *Thalassoceras Gemmellaroi* Karp., although it is certainly specifically different. The resemblance of the suture in both species is really surprising, but as we shall explain in the description of our new species, it is possible that *Thalassoceras Gemellaroi* represents an immature stage of a real *Thalassoceras* and that larger specimens may show a more complicate suture, in which case it would be proven that our *Prothalassoceras* is a real precursor of *Thalassoceras.* Just at present we do not know the development of the suture of this latter genus.

Marathonites Hargisi n. sp. has its nearest relative in *Popanoceras* sp. indet. (cfr. *Parkeri* Heilpr.) Karpinsky, but a complete comparison cannot be made because in the Russian form the auxiliary saddles and lobes are unknown.

The small number of ammonoids found in the lowest part of the zone of *Prothalassoceras* and the imperfect knowledge we have about those Russian forms which appear to be their nearest relatives, impedes us in drawing accurate conclusions with respect to the age of our horizon. Nevertheless, the circumstance that upon that zone rests one whose fauna has intimate relations with that of the Sosio beds, and which for its part is covered by another zone the fauna of which without doubt is synchronous with that of the Sosio beds, makes it very probable that our Hess limestone is a representative of the cephalopod-bearing sandstone of the Artinsk. This opinion is confirmed to a certain degree by the fauna of the zone which is found below the Hess limestone.

The ammonoids contained in the Wolfcamp formation or zone of *Uddenites* have an entirely archaic character and are different from any fauna so far described. The following table shows these features more clearly and will serve as a base for further discussion.

SPECIES FROM THE WOLFCAMP FORMATION, GLASS MOUNTAINS	CORRESPONDING FORMS AT OTHER LOCALITIES
Daraelites texanus n. sp.	*D. elegans* Tchernow, Artinsk, Russia
Uddenites Schucherti n. sp.	———
Uddenites minor n. sp.	———
Gastrioceras modestum n. sp.	*G. subcavum* M. a. G., Cisco formation, Texas.
Schistoceras diversecostatum n. sp.	*Sch.* Hyatti Smith, Cisco formation, Texas.
Paralegoceras incertum n. sp.	———
Agathiceras Frechi n. sp.	*A. uralicum* Karp., Artinsk, and Upper Carb., Russia.
Marathonites J. P. Smithi n. sp.	? *Stacheoceras Romanowskyi* Karp., Artinsk, Russia.
Marathonites sulcatus n. sp.	? *Stacheoceras Ganti* Smith, Cisco formation, Texas.
Marathonites vidriensis n. sp.	? *Stacheoceras Ganti* Smith, Cisco formation, Texas.
Vidrioceras Uddeni n. sp.	———
Vidrioceras irregulare n. sp.	———

We recognize at once how little similarity there is between our fauna and any other. Forms like *Uddenites, Paralegoceras incertum,* and *Vidrioceras* are types unknown from any other locality, and it is

still very doubtful if any of our species belonging to *Marathonites* have anything to do with *Stacheoceras Romanowskyi* and *St. Ganti.* Of the first of these species we do not know the internal suture and in the second the internal lobes seem to be entirely different from those of *Marathonites.* On the other hand, *Agathiceras Frechi* is not of great importance, because the species of this genus change very little from the Carboniferous up to the Permian.

More interesting is the occurrence of *Daraelites* as this genus so far has only been found in the Permo-Carboniferous; but the species is very different from those described from the Artinsk and the Sosio beds.

Most interesting is also the genus *Uddenites.* There is no doubt that it represents a branch of *Pronorites,* as the inner whorls show the typical *Pronorites* suture. *Pronorites* is known to exist in the upper Carboniferous as well as in the Permo-Carboniferous, but it seems that not before this latter period does it begin to split up into different branches. *Uddenites* apparently represents the oldest of these branches which developed from the type genus as a side branch because the type continued to exist until the Artinsk stage. No branch of the *Pronorites* tribe seems to have developed during the upper Carboniferous.

Only two forms in our list are strongly related to upper Carboniferous forms; namely, *Gastrioceras modestum* and *Schistoceras diversecostatum,* but their relatives also have only been found in the very highest part of the Pennsylvanian.

The absence of all more highly developed ammonoids, especially *Medlicottia,* the presence of types that are nearly related to such as have been found only in the highest Pennsylvanian and others that are exclusively from the Permo-Carboniferous, the occurrence of genera that are different from anything so far discovered in the Carboniferous and the Permo-Carboniferous, makes our fauna a unique one and shows at the same time that it represents one older than the oldest Permo-Carboniferous so far known, but younger than the highest Carboniferous. Our fauna would thus range between the Uralian and the Artinsk; or, as we take this latter expression as the name of a stage, we might say that our fauna belongs to the Artinsk but is older than the cephalopod-bearing sandstones of this stage. This also

confirms our opinion expressed above, i. e., that the cephalopod-bearing sandstone of the Artinsk is most probably represented by the Hess limestone as it is certainly older than the zone of *Perrinites* and younger than that of *Uddenites.*

The faunas so far discussed here are those which contain a great number of ammonoids, but there is known quite a number of localities where at least a few ammonoids have been found, and it will be interesting to see if we can establish the relation in age between these strata and those of the Glass Mountains.

The most important of these is probably that of Mrzla-Vodica in Croatia. The sandy, micaceous, argillaceous shales of that locality contain the following ammonoids:

Gastrioceras Roemeri Gemm.(?)
Adrianites elegans Gemm.
Adrianites isomorphus Gemm.
Adrianites Haueri Gemm.
Stacheoceras sp.
Medlicottia (?) *croatica* Vogl.
Propinacoceras Galilaei Gemm. sp.
Paraceltites Hoeferi Gemm.

There can be no doubt that the fauna corresponds to some part of the Sosio beds although the highly developed Cyclolobinae are missing; the presence of three *Adrianites,* of a *Gastrioceras* belonging to the group of *G. Zitteli,* and of *Paraceltites* is quite decisive. It is thus nearly certain that this horizon corresponds to our zone of *Waagenoceras* (Word formation).

Kossmat[1] has already pointed out the somewhat surprising circumstance that those strata which contain an undoubtedly Permo-Carboniferous fauna are developed in a sandy-shaly facies quite similar to that of the Auernigschichten of the upper Carboniferous in the Carnian and Julian Alps, while in these latter parts the Permo-Carboniferous is represented by the light-colored Trogkofel limestones. The brachiopod fauna of these limestones described by Schellwien makes it evident that they really belong to the Permo-Carboniferous although it does not allow the exact determination of the horizon; but the occurrence of *Popanoceras* and *Thalassoceras* in the Trogkofel limestone

[1]N. Jahrb. f. Min., 1915, I, p. 413.

indicates that these strata may also correspond to some part of the Sosio beds.

Kossmat has also indicated that there seems to be a great similarity between the strata of Mrzla-Vodica and the cephalopod-bearing shales of St. Girons in the Pyrenees which are known to contain *Daraelites*, *Gastrioceras* and *Paraceltites*. Unfortunately, these fossils are not well preserved and the fauna might as well correspond to that of the cephalopod-bearing sandstone of the Artinsk as to that of the Sosio beds.

Very little is known about the cherty beds of Spitzbergen and Barent Island, which are considered by Frech as belonging to the Permo-Carboniferous. The only ammonoid known from that part is *Agathiceras* and as this genus occurs as well in the uppermost Carboniferous as in the Permian, it does not prove anything.

Some ammonoids have been described by Diener from the uppermost Permian (Bellerophon limestone) of the Alps. All these belong to the genus *Paralecanites* which is found also in the Triassic of California. Haug has pointed out the near relationship between *Paralecanites* and *Nomismoceras* and we have been able to show that a form from our Leonard formation may also belong to *Paralecanites*. Thus this tribe probably begins in the Carboniferous and ends in the Triassic. There is no doubt that the main bed of *Paralecanites* belongs to the uppermost Permian.

We shall now turn our attention to the relation which might exist between our faunas and those of the Permian of Asia. There are several localities known where ammonoids have been described. These are Darwas and Woabjilga in Central Asia, the Himalayas, the Salt Range of India, several localities in China, the Island of Timor, and Djulfa in Armenia. The faunas described from these localities range from the Permo-Carboniferous to the uppermost Permian. We shall try to discuss their relations to the European and American faunas beginning with the oldest of them.

Karpinsky established the fact that the fauna of Darwas is synchronous with that of the cephalopod-bearing sandstones of the Artinsk. The fauna is composed of the following species:

Pronorites praepermicus Karp.
Propinacoceras darwasi Karp.
Agathiceras uralicum Karp.

Stacheoceras Romanowskyi Karp.
Thalassoceras sp. ind.

This list does not leave any doubt that the fauna really corresponds in age to that of the Artinsk sandstone. If our conclusions are right, the Darwas fauna would correspond to that of our Hess limestone or zone of Prothalassoceras.

A very similar fauna seems to have been found by Wanner[1] at Bitaunu in the district Maubesi on the island of Timor. These strata contain hundreds of *Agathiceras,* large *Gastrioceras, Popanoceras, Propinacoceras,* and *Parapronorites* aff. *Koninckı* Gemm. The fauna is apparently very similar to that of the Sosio beds and probably synchronous with it.

The Chinese localities which carry ammonoids seem to belong mostly to the Permo-Carboniferous, but the few cephalopods so far found do not allow the exact determination of the horizon.

The famous fossil-bearing strata of Lo Ping only yielded *Gastrioceras* (?) *Richthofeni* Frech, a not very characteristic form, on which a conclusion as to the age of the beds cannot be based.

In the lower part of his section of Ta-Pa-Shan, near Tshau-Tien, province of Sz'-Tshwan, Richthofen discovered a number of spiral tests which have been determined by Frech as *Agathiceras* cf. *Suessi* Gemm. and *Gastrioceras* cfr. *Zitteli* Gemm. These fossils do not leave much room for doubt that those strata correspond either to the Sosio beds or the Artinsk sandstone.

Some very peculiar ammonoids have been found by Richthofen near Ning-Kwo-hsein, province of Nyan-hwei. Frech has described one of them as *Paraceltites pseudo-opalinus* Frech and thinks that the other form is a new genus similar to *Gastrioceras.* He supposes that the strata are more or less of Artinskian age.

A very interesting fauna from the Himalayas has been described by Diener. The fossils were collected in the Productus shales near Lilinthi by F. H. Smith. Diener describes the following species:

Hyattoceras nov. sp. ex. aff. *H. Cumminsi,* White.
Adrianites (*Hofmannia*) sp. ind.
Gastrioceras sp. ind. ex aff. *G. Marianum,* Vern.
Pericyclus sp. ind.
Lilinthiceras nov. gen. sp. ind.

[1]J. Wanner, Geol. Ergebn., p. 143-144.

Aganides sp. ind.
Nomismoceras Smithi n. sp

Most of these ammonoids show a very characteristic and well developed sculpture but extremely simple sutures, with the exception of the so called *Hyattoceras* aff. *Cumminsi.* This interesting form apparently belongs to a genus related to *Hyattoceras,* but certainly has nothing to do with *Perrinites Cumminsi.* I have compared a specimen of *Perrinites vidriensis* of about the same size as the *Hyattoceras* aff. *Cumminsi* Diener and I have been able to state that the character of the suture is very different. In *Perrinites* the saddles are stout, of pyramidal form, with shallow secondary lobes; and they end in a broad, rounded leaf like those of the large specimens, only that the phylloid end is relatively much broader. The saddles of *Hyattoceras Cumminsi* Diener are much more slender and the incision deeper, and there does not exist the well rounded terminal phyllum. While *Perrinites* shows even in the younger stages a very high median saddle which divides the siphonal lobe into two parts, the Indian species has a very low median saddle in the rather shallow siphonal lobe. The Indian form differs also generically from *Hyattoceras* by its rather evolute form, the smaller number of saddles, and lobes, and the less phylloidal terminals of the saddles. But it has to be taken into consideration that Diener's shell is very small and that one cannot quite know the final form of the suture. It seems that the genus belongs to the Cyclolobinae and that its position is nearer the less developed forms (*Perrinites, Hyattoceras*) than the higher ones (*Waagenoceras, Cyclolobus*). The occurrence of this form may indicate that the Productus shales of Lilinthi correspond more or less to our zone of *Perrinites,* or to some part of the Sosio beds, but a real proof for this supposition does not exist.

The other ammonoids described from Lilinthi do not give any indication of the age of those strata. I doubt very much that Diener's *Adrianites* (*Hofmannia*) sp. has really anything to do with *Hofmannia.* The suture is entirely different on account of the enormously high median saddle in the siphonal lobe and of the rather tongue-shaped saddles; those of *Adrianites* showing always a distinct constriction above their base.

Somewhat surprising is the occurrence of the new genus *Lilinthiceras* with its complicate sculpture which, as Diener justly remarks, recalls the upper Triassic *Clionites;* unfortunately the suture is only imperfectly known.

The remaining ammonoids have a rather archaic character; they could very well come from the Upper Carboniferous. It is therefore impossible to decide with any amount of certainty the exact age of the Productus shales of Lilinthi.

For a long time a controversy has been going on with regard to the age of the Productus limestone of the Salt Range of India. Notwithstanding the astonishing number of fossil species discovered in and described from these strata, the most different opinions have been expressed with regard to their age. There is no necessity to enter into the details of this controversy as its history has been given by Fr. Noetling in his "Beiträge zur Geologie der Salt Range."

The fossils of the Productus limestone were first regarded as Carboniferous (Verneuil, Davidson, Koninck); an opinion which was accepted by Wynne and, at first, also, by Waagen. Waagen, however, little by little changed his views until at last he came to regard the Speckled sandstone, the lower and part of the middle Productus limestone (Katta beds) as the equivalent of the Permo-Carboniferous, while the rest of the middle Productus limestone is considered as the equivalent of the Rotliegendes and Weissliegendes (Virgal and Kalabagh beds), and the upper Productus limestone as the representative of the rest of the Zechstein.

Noetling gets to a somewhat different result. Like Waagen he believes that the Carboniferous does not exist in the Salt Range and that the strata above the important unconformity on top of the Cambrian belong to the Permian. But he does not recognize the existence of the Permo-Carboniferous in the Salt Range, and believes that only the Rotliegendes or Penjabien, and Zechstein or Thuringien are represented. He considers his three lower groups, the Talchir, Dandote and Warcha groups, as representing the Rotliegendes; and the three upper, i. e., the Amb, Virgal and Chideru group, as synchronous with the Zechstein. The three lower groups correspond to Waagen's middle and lower Speckled sandstone, while the upper three groups are the same as Waagen's Productus limestone; the Amb group being the

lower, the Virgal groups the middle, and the Chideru group the upper Productus limestone. In another paper, Noetling[1] says he considers that the Sicilian Fusulina limestones (Sosio beds) are older than the Russian Artinsk and this older than the Productus limestone. Thus neither the Artinsk nor the Sosio beds would be represented in the Salt Range.

An entirely different opinion is held by Tschernyschew. He thinks that the Talchir, Dandote and Warcha groups represent the middle Carboniferous, that the lower and middle Productus limestones are equivalent to the upper Carboniferous, and that only the highest part of the middle and the lower part of the upper Productus limestone are of Permo-Carboniferous age, while the rest of the upper Productus limestone would correspond to the lowest part of the Russian Permian. Tschernyschew based his views principally on the character of the brachiopods contained in the Salt Range deposits, which he compared with those of the Russian Carboniferous.

Tschernyschew's views have not been accepted by most of the authors who had an opportunity to compare the Indian faunas with those of other parts of the world; neither Noetling, nor Frech, nor Diener, nor Haug, are inclined to adopt the opinion of the Russian scholar. Haug (Traité de géologie, p. 808) says that if the base of the deposits is Uralian, the Artinskien is probably represented by the lower part of the middle Productus limestone, while the upper part of the middle Productus limestone would be equivalent to the Saxonian and the upper Productus limestone correspond to the Thuringien.

Most of the modern authors base their classification of the Salt Range on the cephalopods contained in them. Unfortunately ammonoids have been found only from the upper part of the Middle Productus limestone (Kalabagh beds) upwards, but practically all the modern authors concede that the ammonoids contained in those beds are of a very highly developed Permian type.

The upper part of the middle Productus limestone carries the genus *Xenaspis,* which has its nearest relatives in the Triassic; and *Xenodiscus,* which occurs much more frequently in the Triassic than in the Permian. Its ancestors in the Permo-Carboniferous are not well known,

[1]Noetling, Medlicottia u. Episageceras, p. 354.

but as J. P. Smith thinks, may be found in the Prolecanitidae. These genera suggest at once the conclusion that the strata in which they are found imbedded must belong to a higher division of the Permian and certainly not to the Permo-Carboniferous where similar forms are entirely unknown. This conclusion is confirmed by the circumstance that at Chitichun I in the Himalayas, *Xenaspis carbonaria* has been found together with *Krafftoceras*, a near relative of *Cyclolobus* or possibly a subgenus of the latter group. The form has a much more highly developed suture than even *Waagenoceras* or *Perrinites,* and Diener has very justly sustained the opinion that Chitichun I and the upper portion of the middle Productus limestone are of the same age and that they are certainly younger than the Permo-Carboniferous.

The upper portion of the middle Productus limestone contains also *Medlicottia primas.* This species has also been found in the upper Productus limestone in the zone of *Episageceras Wynnei* (Chideru group). But the fossil which is most characteristic for the upper Productus limestone is *Cyclolobus Oldhami.* The genus *Cyclolobus* has a much more highly developed sutural line than any of those described until now from the Permo-Carboniferous, and certainly indicates that the strata in which it occurs are younger than the Artinsk or the Sosio beds. *Cyclolobus* and its near relative *Krafftoceras* have been found by Diener in the Kuling shales of Spiti (Himalaya). *Cyclolobus* has also been described by Rothpletz from the Permian strata of Ajer Mati near Kupang on Timor (*Cyclolobus persulcatus*).

Wanner[1] has made known another locality where *Cyclolobus* exists on Timor. In a collection made by Lieutenant v. Grube, Wanner found a number of species described from the Ajer Mati and among them the *Cyclolobus.* But possibly there exist different horizons in the collection; it contains at least two species of *Medlicottia,* one of which has been determined as *M. magnotuberculata* Tchernow, a very characteristic form from the Artinsk. Possibly the whole series from the Artinsk to the Permian may be developed in that place and it may very well be possible that the true relations between the Artinsk, Sosio beds and upper Productus limestone can be ascertained in that region of Timor.

[1]J. Wanner, Perm-, Trias-, und Jura-Formation des indo-australischen Archipel, p. 737.

The upper Productus limestone contains also *Stacheoceras antiquum* and *Popanoceras priscum*, probably the youngest and last members of these long living genera. *Stacheoceras* occurs also in the Permian strata of Timor described by Rothpletz (*Stacheoceras tridens*) and in the Chitichun I limestone of the Himalaya (*Stacheoceras Trimurti* Diener).

Very little is known about the strata of Woabjilga (Karakorum Pass) where Stoliczka collected ammonites with ceratitic sutures which may belong to *Xenodiscus*. These strata may not even be Permian, but if they are, they certainly correspond to the upper part of the Productus limestone.

There is another Permian locality of Asia which contains a great number of ammonoids and which has been known for a long time: Djulfa in Armenia. The fauna has first been described by Abich and later on revised first by Möller and again by v. Arthaber. The fauna contains the following species of ammonoids:

Gastrioceras Abichi Möller.
Gastrioceras sp. ind.
Hungarites Raddei Arth.
Hungarites pessoides Abich.
Hungarites nov. form. spec. ind.
Otoceras djoulfense Abich.
Otoceras tropitum Abich.
Otoceras Fedoroffi Arth.
Otoceras trochoides Abich.

While both *Hungarites* and *Otoceras* are very frequent also in the Triassic, *Gastrioceras* is a distinctly anthracolitic genus. It is remarkable that one of the species described from Djulfa seems to be much nearer related to the upper Carboniferous and the lowest Permocarboniferous species than to those which constitute the group of *G. Zitteli*. The other species may belong to this last named group. It is of some interest that a species which seems to belong either to *Hungarites* or to *Dalmatites* has been found by Udden in a limestone near Shafter, Presidio County, Texas, which certainly is synchronous with our Word formation; it corresponds to some part of the Sosio beds. The species has been determined by James Perrin Smith; through the courtesy of Dr. Smith, I have been able to study the specimen and

I do not doubt that the determination is exact. This shows that the genus ranges still lower than has been supposed.

Arthaber has convincingly shown that the fauna of Djulfa belongs to the upper Permian, that it is certainly younger than the Sosio beds, and that it is synchronous with the Kund-Ghat and Jabbi beds of the Upper Productus limestone in the Salt Range of India.

The preceding review of Permian cephalopod-bearing strata demonstrates that a correlation of the beds is extremely difficult on account of the enormous distance between the different localities, the circumstance that nearly nowhere a succession of different faunas exists at the same place, and the incomplete descriptions of several of the faunas.

Notwithstanding these difficulties, I have tried to make the apparent relations between the different faunas more evident by uniting our results in the following comparative tables, following in the second one the method used by Frech.

Up to the present time, the question of marine communications between the Trans-Pecos Permo-Carboniferous and the Asiatic and European localities of a similar facies, remains a matter of pure speculation. Our data are still extremely incomplete. The Trans-Pecos Permo-Carboniferous is known to exist in a facies that changes relatively little in the Guadalupe Mountains, the Glass Mountains, and the Shafter region near the Rio Grande; it is very probable that it continues toward the south into Mexico, and that the locality near Las Delicias northeast of Torreon, Coahuila, is the southernmost place where it has been discovered so far. This locality, which was discovered by Haarmann while its fauna was described by Haack, is the only one found in Mexico, so far. In general, the lowest strata of northern Mexico are known to belong to the upper Jurassic or even possibly in some localities in Chihuahua and Sonora, to the Liassic or the Dogger. Marine Triassic has been found by Carl Burckhardt at Zacatecas, where it rests unconformably on older, possibly Paleozoic, schists. It may be possible that older strata than the upper Jurassic could be found some day in the Sierra de Catorce in the state of San Luis Potosi; where according to Joseph Burkart, the rocks of the Jurassic rest unconformably on older shales. Burkart, of course, did not recognize those strata as Jurassic when he described them in 1836, and thought they represented the Carboniferous, but apparently he can-

TABLE 1

APPROXIMATE CORRELATION OF THE AMMONOID BEARING BEDS OF THE PERMOCARBONIFEROUS AND THE PERMIAN

		NORTH AMERICA				EURASIATIC MEDITERRANEAN REGION	URAL	CENTRAL ASIA	HIMALAYAS		SALT RANGE OF INDIA			ISLAND OF TIMOR
		GLASS MOUNTAINS	SHAFTER REGION	GUADALUPE MOUNTAINS	CENTRAL TEXAS						CERATITE BEDS	LOWER TRIASSIC		
OVERLYING BEDS		CRETACEOUS	CRETACEOUS		TRIASSIC RED BEDS	LOWER TRIASSIC								
PERMIAN OR DYAS	PERMOCARBONIFEROUS UPPER	THURINGIAN				BELLEROPHON LIMESTONE OF THE ALPS HUNGARITES OTOCERAS BEDS OF DJULFA ARMENIA	BRACKISH AND INLAND SEA DEPOSITS				ZONE OF EPISAGECERAS WYNNEI	CHIDERU GROUP	UPPER PRODUCTUS LIMESTONE	CYCLOLOBUS BEDS OF AUER MATI
		SAXONIAN			RED BEDS			KARAKORUM PASS CEPHALOPOD BEARING BEDS OF WOABJILGA	CHITICHUN I LIMESTONE	KULING SHALES OF SPITI	ZONE OF CYCLOLOBUS OLDHAMI			
		UNCONFORMITY									ZONE OF XENASPIS CARBONARIA	VIRGAL GROUP	MIDDLE PRODUCTUS LIMESTONE	
		GILLIAM BEDS												
		VIDRIO BEDS	UNCONFORMITY YELLOW LIMESTONE	CAPITAN LIMESTONE	DOUBLE MOUNTAIN DIVISION	ST. GIRONS BEDS (PYRENEES) SOSIO BEDS OF SICILY MRZLA VODICA BEDS OF CROATIA	KUNGUR BEDS (UPPER ARTA BEDS)		PRODUCTUS SHALES OF LILINTHI		NO AMMONOIDS KNOWN	AMB GROUP	LOWER PRODUCTUS LIMESTONE	CEPHALOPOD BEARING BEDS OF BITAUNU
		ZONE OF WAAGENOCERAS (WORD BEDS)	ZONE OF DALMATITES (THIN BEDDED ZONE)	ZONE OF WAAGENOCERAS (DELAWARE BEDS)								WARCHA GROUP	MIDDLE AND	
		ZONE OF PERRINITES (LEONARD BEDS)	ZONE OF PERRINITES (BRECCIATED ZONE)		ZONE OF PERRINITES CLEAR FORK DIVISION							DANDOTE GROUP	LOWER SPECKLED SANDSTONE	
	LOWER	ZONE OF PROTHALASSOCERAS (HESS LIMESTONE AND CONGLOMERATES)	TRANSITION BEDS	HUECO BEDS	ALBANY WICHITA DIVISION	TROGKOFEL BEDS OF THE CARNIAN ALPS	CEPHALOPOD BEARING SANDSTONE (LOWER ARTA BEDS)	CEPHALOPOD BEARING BEDS OF DARWAS (BOKHARA)				TALCHIR GROUP		
		UNCONFORMITY												
		ZONE OF UDDENITES (WOLF CAMP BEDS)	YELLOW SANDSTONE				UNCONFORMITY				UNCONFORMITY			
UNDERLYING BEDS		CISCO BEDS (HIGHEST CARBONIFEROUS)	SHALES CIENEGUITA BEDS (UPPER CARBONIFEROUS)	?	CISCO BEDS (UPPERMOST CARBONIFEROUS)	SCHWAGERINA BEDS AUERNIG BEDS (UPPERMOST CARBONIFEROUS)	SCHWAGERINA BEDS CORA BEDS	URALIEN	BARUS BEDS OF KASHMIR		CAMBRIAN			

TABLE II

Correlation table of Cephalopod-bearing Permian Beds.

		Name of strata	Genera of ammonoids
Triassic		Lower Triassic	Otoceras, Episageceras, Hungarites, etc.
Permian or Dyas.	Thuringian	4. Bellerophon limestone of the Alps	Paralecanites.
		3. Djulfa beds in Armenia.	Otoceras, Hungarites, Gastrioceras.
		2. Upper Productus limestone of the Salt Range of India.	Episageceras, Medlicottia, Cyclolobus Popanoceras, Stacheoceras, Xenodiscus, Xenaspis.
		Limestone of Ajer mati in Timor.	Cyclolobus, Stacheoceras.
	Saxonian	1. Upper part of the middle Productus limestone of the Salt Range of India.	Xenaspis.
		Kuling shales of Spiti, Himalaya.	Xenaspis, Cyclolobus, Krafftoceras.
		Limestone of Chitichun I, Himalaya.	Xenaspis, Stacheoceras, Krafftoceras.
		Limestone of Woabjilga, Karakorum.	Xenodiscus (?)
	Permo-Carboniferous. Upper.	2. Sosio limestone of Sicily.	Waagenoceras, Hyattoceras, Popanoceras, Stacheoceras, Adrianites, Hofmannia, Medlicottia, Propinacoceras, Parapronorites, Sicanites, Daraelites, Thalassoceras, Paraceltites, Agathiceras, Doryceras, Clinolobus, Gastrioceras, Nomismoceras. (?)
		Word beds of the Glass Mountains, West Texas.	Medlicottia, Gastrioceras, Paraceltites, Agathiceras, Adrianites, Stacheoceras, Waagenoceras.
		Delaware Mountain beds, West Texas.	Waagenoceras, Agathiceras, Gastrioceras, Paraceltites, Peritrochia,
		Thin-bedded limestone of Shafter, West Texas.	Dalmatites.
		Beds of St. Girons, Pyrenees.	Daraelites, Gastrioceras, Paraceltites.
		Sandstone of Mrzla-Vodica, Croatia.	Gastrioceras, Adrianites, Stacheoceras, Paraceltites, Medlicottia.
		Trogkofel limestone of the Carnian Alps (ex parte?)	Popanoceras, Thalassoceras.
		Beds of Lo Ping, China?	Gastrioceras.
		Beds of Tshau-Tien, China?	Gastrioceras, Agathiceras.
		Productus shales of Lilinthi, Himalaya?	Hyattoceras?, Hofmannia?, Gastrioceras, Pericyclus, Lilinthiceras, Aganides, Nomismoceras.
		Cephalopod-bearing beds of Bitaunu in Timor.	Agathiceras, Gastrioceras, Popanoceras, Propinacoceras, Parapronorites, Medlicottia.
		1. Leonard beds of the Glass Mountains, West Texas.	Medlicottia, Gastrioceras, Perrinites, Paralecanites.
		Brecciated zone of Shafter, West Texas.	Perrinites.
		Cephalopod-bearing beds of Central Texas, Double Mountain division.	Perrinites, Gastrioceras, Stacheoceras, Medlicottia.
		2. Hess limestone and conglomerate of the Glass Mountains, West Texas.	Prothalassoceras, Marathonites.
		Cephalopod-bearing beds of Central Texas (upper Wichita and Clear Fork).	Perrinites, Paralegoceras, Stacheoceras, Medlicottia.
		Cephalopod-bearing sandstones (lower Arta beds) of the Ural.	Pronorites, Parapronorites, Propinacoceras, Gastrioceras, Agathiceras, Adrianites, Stacheoceras, Marathonites?, Popanoceras, Medlicottia, Paraceltites?, Prothalassoceras?, Goniatites?, Daraelites.
		Cephalopod-bearing limestones of Darwas, Bokhara.	Pronorites, Propinacoceras, Agathiceras, Stacheoceras, Thalassoceras.
		1. Wolfcamp beds of the Glass Mountains, West Texas.	Daraelites, Uddenites, Gastrioceras, Schistoceras, Paralegoceras, Agathiceras, Marathonites, Vidrioceras.
Carboniferous.		Upper Carboniferous.	Schistoceras, Stacheoceras?, Paralegoceras, Gastrioceras, etc.

not mean anything other than those rocks which yielded the rich fauna described by J. G. Aguilera.

Thus the data we possess at the present day do not furnish any proof for the hypothesis that a marine communication existed from the Torreon region toward the east, connecting the Trans-Pecos Permo-Carboniferous sea with that of the European Mediterranean. But neither do they exclude the possibility of the existence of such a waterway; the ammonoids of our Trans-Pecos Permo-Carboniferous make it evident that some kind of a marine communication must have existed at least at the time of our zone of *Waagenoceras*. It does not seem that this communication went through the northern states of the Union, because the Permo-Carboniferous strata of those parts indicate the existence of a shallow sea or even brackish water, while the fauna of the Trans-Pecos beds must have lived in deeper water or at least farther from a coast. Directly east from the Trans-Pecos region, no fauna like that of our zone of *Waagenoceras* has been discovered so far, but the zone of *Perrinites* seems to be well represented in the middle part of the Double Mountain formation and in the Clear Fork and Wichita-Albany beds. Unfortunately, *Perrinites* is known only in Texas and even related forms have not been found anywhere else, if we do not consider *Perrinites* as a form vicariating for *Hyattoceras*. But the other fossils which accompany the former genus are very similar to those found near Palermo in Sicily, and make it probable to a certain degree that the Permo-Carboniferous of Central Texas was in direct communication with the European Mediterranean. This communication may not have existed in the northern part of the state, but rather farther to the south; because the character of the beds in north Texas indicate very shallow littoral waters in the lower formations as well as in the upper, while to the south (Runnels and Coleman counties), at least the lower strata (Albany formation) have the character of deposits in waters that were somewhat farther from the coast. It may even be that the marine communication did not exist in Texas at all, but in Northern Mexico.

That a marine communication has existed also between the Trans-Pecos and the Indian Permo-Carboniferous sea appears to be very probable. There are no ammonoids known in the Salt Range strata which seem to correspond to ours in age, but the brachiopod fauna es-

pecially of our Leonard beds (zone of *Perrinites*) seems to have very intimate relations with that of the lower and middle Productus limestone. Especially characteristic seems to be the frequency of the group of *Productus sino-indicus* Frech, represented by extremely large individuals, as well as of the group of *Productus gratiosus* and of *Rhipidomella corallina* Waagen sp.; which, with the exception of the second one, do not seem to be well represented in the European Permo-carboniferous of the Alps and Sicily. Significant to a certain degree is also the frequent occurrence of a *Camarophoria* very similar to *C. mutabilis* Tschern., of the Schwagerina limestone of the Ural. Not less important is the existence of numerous specimens of *Lyttonia, Oldhamina,* and *Richthofenia,* the latter one being much more similar to those of India than those of Sicily, as has been shown in another publication.[3]

Thus there is no doubt about a direct marine communication with the Asiatic Permo-Carboniferous sea; but again, we do not know in which direction and at what place the channel existed, little or nothing being published about the Permo-Carboniferous strata west of the Trans-Pecos region, especially in Arizona and California; although a direct communication through these two states and New Mexico, with Asia, seems to be extremely probable.

Thus it seems that there existed an uninterrupted marine communication between Europe and Asia through the actual American continent during the Permo-Carboniferous, at least at the time of the zone of *Waagenoceras,* and probably also during the zone of *Perrinites.* The brachiopod fauna, however, seems to be more nearly related to that of Asia than to the European fauna, while the principal ammonoid genus *Perrinites* is not known anywhere else than in Texas.

I am not able to give more than a few slight indications with respect to marine communications between the Trans-Pecos sea and those of Asia and Europe, because ammonoids are rather scarce in most parts of the earth during the Permo-Carboniferous; but a study of the complete fauna of the Glass Mountains will certainly show much more clearly how more or less intimate are the relations between it and the other faunas of the same age known in different parts of the world.

PALEONTOLOGICAL PART

PALEONTOLOGICAL PART

PROLECANITIDAE Hyatt

PROLECANITINAE Frech

Daraelites Gemm.

This genus was established by Gemmellaro[1] for moderately involute, smooth forms, with elliptical cross-section and a suture consisting of entire rounded saddles and slightly serrated lobes. The siphonal lobe is very wide and divided into three branches, the median of which is extremely narrow, while the two lateral ones are broad and serrated at the bottom. The external saddle is club-shaped, constricted at the base, and rounded at the top. The first lateral lobe is less wide than the preceding one, but deep and has a serrated bottom. The first lateral saddle has the same form as the external one, but is much higher. The second lateral lobe is much narrower and shallower than the first one, but also serrated at the bottom. The second lateral saddle is a little higher than half the first one, club-shaped, somewhat constricted at the base, entire and rounded at the top. The rest of the lobes and saddles are entire, rounded and directed obliquely backward.

Gemmellaro compared his genus with *Xenodiscus, Meekoceras* and *Hungarites* from the Permian of the Salt Range and Armenia, but at the same time recognized that it had some relationship to *Paraprononites.*

Although the evolution of the suture in *Daraelites* was unknown at that time, *Karpinsky*[2] demonstrated at once that this genus could only be derived from *Paraprolecanites.* That his supposition was absolutely correct has been shown much later by Tchernow[3] who was able to study the development of the suture. According to the figures given by this author it is evident that the suture of *Daraelites* develops from that of the so called *Ibergiceras* stage and passes through that of *Paraprolecanites*[4] and what by Tchernow is called the *Prodaraelites* stage, and finally ends in the *Daraelites* stage.

---

[1]Gemmellaro, Calc. c. Fusulina, p. 63.

[2]Karpinsky, Amm. d. Artinsk-Stufe, p. 42, fig. 27.

[3]Tchernow, L'Etage d'Artinsk, p. 371, et. seq., p. 297, pl. 1, fig. 9.

[4]Tchernow calls this (explanation of his fig. 9-k) the beginning of the *Daraelites* stage.

Karpinsky regards *Daraelites* as belonging to the tribe of the *Lecanitinae,* in which he unites *Ibergiceras*[1], *Prolecanites, Paraprolecanites, Lecanites,* and as a side branch, *Daraelites.* J. P. Smith[2] regards *Daraelites* as belonging to the *Noritinae,* but the suture line shows that this genus does not pass through the Pronorites stage. It would therefore be preferable to unite this genus provisionally with the *Prolecanitinae,* although we do not know its predecessors during the later time of our Carboniferous.

Daraelites has a wide distribution, although very few species are known. It was first described from the Sicilian Sosio beds (*Daraelites Meeki* Gemm.). The genus has been found also in the Permian of the Pyrenees[3], together with *Gastrioceras* and *Paraceltites,* unfortunately all specifically undeterminable. Another species (*Daraelites elegans*) has been described by Tchernow[4] from the Artinsk of Russia. We can add to this list our discovery of *Daraelites* in the lowermost part of the Permo-Carboniferous of Texas. The species found there is rare and fragmentary but its genus cannot be doubted and specifically it is evidently different from any other *Daraelites* so far described.

Daraelites texanus, n. sp.
Pl. I. Fig. 1-8

Shell discoidal, moderately involute, with compressed flanks and rounded venter. Cross section elliptical higher than broad in the adult whorls, nearly as broad as high in the younger whorls. Umbilicus moderately narrow, but shallow; the flank curves down into the umbilical wall without forming a shoulder, the umbilical wall not being well limited. No ornamentation and no constrictions are visible on the cast. The body chamber is unknown.

The septa are well separated from each other (pl. I, fig. 4). The siphonal lobe is large and is divided into three branches, the middle one being very narrow, prominent and pointed, while the lateral ones are rounded and finely serrated at the bottom; the siphonal lobe is much narrower at its upper part than above the bottom. The first lateral

[1]Holzapfel has shown that *Ibergiceras* is not an independent genus, but only an immature form of *Pronorites cyclolobus.*

[2]J. P. Smith, in Zittel-Eastman, Textbook of Paleontology, 2nd ed., Vol. i, p. 633.

[3]Caralp, Le Permian de l'Ariége, etc.

[4]Tchernow, l'Etage d'Artinsk, p. 374, pl. 1, fig. 9,

lobe is extremely broad, and somewhat oblique, the bottom being a little nearer to the siphon than the upper part. The bottom is finely serrated. The second lateral lobe is narrow, having only about one-third of the width of the first one. It is curved with the convexity toward the siphonal region, and the bottom is finely serrated. The first and second auxiliary lobes are slightly curved similarly to the preceding one, but seem to be rounded at the bottom and not serrated. The third and fourth auxiliary lobes are very small, straight and less deep than the preceding ones; the fourth lobe is on the umbilical border. All the lobes from the second lateral to the fourth auxiliary are a little oblique, the upper part being somewhat nearer to the siphonal region than the bottom. All the saddles are entire and rounded at the top. The external saddle is moderately high and much constricted a little below the middle. The first lateral saddle is much higher than the external, constricted above the base, but much less than the preceding one. The second lateral saddle is only about half as high as the first, and constricted above the base. The first auxiliary saddle has only about two-thirds of the height of the preceding one and is constricted above the base. From the first to the fourth auxiliary saddle, the height decreases steadily, the second and perhaps even the third show very slight constriction above the base. The fourth, which lies on the umbilical wall, is of a very simple form, broader below than above, and rounded at the top.

The internal suture (pl. I, fig. 8) could only be observed in the whorl preceding the outer one on which the external suture appears as described above. This inner whorl shows only five external lateral lobes and five saddles. The internal suture shows a rather deep, lanceolate antisiphonal lobe, the lower part of which touches the inner walls of the internal saddles belonging to the next smaller septum. The first lateral lobe it not quite as deep as the antisiphonal one, slightly curved with the convexity toward the antisiphonal region, and rounded at the bottom. A second and very small lobe lies on the umbilical seam so that one of its flanks belongs to the internal, the other to the ex-high and slender, rounded at the top, but not constricted. The first ternal suture. It is only a slight indentation. The internal saddle is lateral saddle is somewhat tongue-shaped, oblique and very small.

Dimensions:

Height of the last whorl.....	5.6 mm	(1)
Width of the last whorl.....	4.2	0.75
Height of the preceding whorl.....	2.1	(1)
Width of the preceding whorl.....	1.9	0.90

Relation to other species:

As we have only two fragments, it is difficult to compare their shape to that of the species described from other localities. It seems that our form has the flanks more flattened and the ventral part somewhat broader than *Daraelites Meeki,* as well as *Daraelites elegans.* The real distinguishing characteristic is to be found in the suture line. In our species, the first lateral lobe is nearly as broad as the siphonal, while in *D. Meeki* it is about half as wide, and in *D. elegans* much less than half as wide, as the siphonal. Our species has seven saddles while *D. Meeki* has only six. *D. elegans* has apparently the same number of saddles as our species.

Age:

Wolfcamp formation, lower Permo-Carboniferous.

Number of specimens examined:

Two fragments. The species is evidently very rare at the locality.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

NORITINAE Karpinsky

Uddenites nov. gen.

Type: Uddenites Schucherti Bose

While the Noritinae in the Russian Artinsk are well represented by numerous species of *Pronorites* and especially *Parapronorites,* and in the Sicilian Sosio beds by an abundance of specimens of at least one *Parapronorites,* this sub-family has very few representatives in the Permo-Carboniferous of the Glass Mountains and even these few belong exclusively to the very lowest horizon, the Wolfcamp formation. The only member of the Noritinae in our region is the new branch, *Uddenites,* which is represented by two species.

Karpinsky[1] has shown that the Prolecanitidae developed during the end of the Carboniferous and the Permian, three different branches: the Medlicottinae, the Noritinae, and the Lecanitinae. Most of these forms have a discoidal shape with strongly compressed flanks, but while the Noritinae and Lecanitinae show a rounded ventral region, the Medlicottinae develop a more or less deep furrow in this part.

Our new genus unites to a certain degree the characters of the Noritinae and the Medlicottinae; it shows the typical sutures of *Pronorites* (pl. I, fig. 26) on the inner whorls and later on develops a suture which, though different from that of *Pronorites,* is still intimately related to it; and while the inner whorls show the general form of *Pronorites* with its rounded ventral region (pl. I, fig. 33, 36) the larger ones develop a deep furrow (pl. I, fig. 37, 38) in that place, so that the outer form somewhat resembles that of *Propinacoceras,* although it does not have the tubercles on the ventral region. *Uddenites* cannot be considered as a stage in the development of *Medlicottia, Sicanites* or *Propinacoceras,* as such a stage is not observed in the evolution of the suture of these genera, and we have to consider our genus as an independent, although possibly local, branch developed from *Pronorites,* parallel to *Parapronorites* and belonging to the same subfamily, the Noritinae.

The characters of our new genus are:

[1]Karpinsky, Amm. d. Artinsk-Stufe, p. 41-45.

Shell discoidal, involute, with flat flanks and flattened ventral region, which in the inner whorls is somewhat rounded, while later on it develops a deep furrow somewhat narrower than the lateral flattened and elevated portions of the ventral region. The cross-section of the adult whorl is nearly rectangular if we do not consider the furrow on the ventral region; the small whorls have a similar cross-section only with slightly curved flanks and ventral region, so that there the cross-section is rounded subrectangular.

The inner whorls are absolutely smooth and very evolute; where the *Pronorites* suture is visible the flanks show fairly strong transversal ribs slightly curved backward, with the convexity toward the front, beginning at the umbilicus and disappearing before they reach the ventral shoulder. (Pl. I, fig. 32.) They are separated by shallow interstices with rounded bottom, nearly twice as wide as the ribs. At the stage where the furrow begins to develop, the umbilical border shows very fine radial lines of growth, slightly bent backward; the rest of the cast does not show any ornamentation.

The septa are very near together but without touching each other in the largest whorl, while on the inner whorls they are farther separated. The suture is nearly straight. On those inner whorls which have a rounded although flattish ventral region, the suture corresponds to that of the typical *Pronorites*. There the siphonal lobe appears to be divided into three different parts, by the appearance of two secondary saddles on the sides; the middle part is open below, on each side is a small secondary saddle, and a pointed secondary lobe. The siphonal lobe is deep and much narrower at the upper end than below the middle, at the height of the secondary lobes. The first lateral lobe is very broad and divided into two branches by a small secondary saddle. Both branches, as well as the secondary saddle, are rounded. The second lateral lobe is about half as broad as the first one, rounded at the bottom and much narrower at the upper part than below. The first and second auxiliary lobes are much smaller and less deep than the two lateral ones. The saddles are all entire and rounded at the top. The external saddle is not very high and bends slightly toward the sipho; the first lateral saddle is higher than the external, and constricted above the base; the second lateral saddle is similar to the first, but a little lower; the first auxiliary saddle is much lower than

the preceding one, and also much narrower and not constricted; the second auxiliary saddle, which is on the umbilical wall, is an insignificant saddle.

The suture described above is visible still near the point where the furrow on the ventral region begins. From here on, the suture begins to change materially. The secondary saddle in the first lateral lobe develops a slight bulge on its inner side and so becomes asymmetrical; at the same time the number of auxiliary saddles and lobes on the flank near the umbilical region increases rapidly and constantly. The umbilical portion of the secondary saddle in the first lateral lobe then begins to grow much quicker than the siphonal one. At about the fourth part of a whorl from the point where the furrow begins, this secondary saddle becomes still farther subdivided. Its siphonal portion, which has developed into an independent secondary saddle, shows a slight notch which divides it into two equal parts, while the umbilical portion of the original secondary saddle has grown so far that it can almost be considered as an independent lateral saddle. If we still consider this saddle as a secondary one, we count in this part eight saddles and eight lateral and auxiliary lobes. This is apparently the final stage of development. In the largest whorl there is only one more change, insofar as the notch on the siphonal part of the secondary saddle deepens so much as to cause two little secondary saddles, the umbilical one of which is a little higher than the siphonal one.

Before continuing, I shall try to describe the final stage of the suture in our genus. The evolution of the suture proves that the highest saddle has to be considered as the first lateral one, and that all the protuberances between it and the external saddle must be regarded as secondary saddles of the broad first lateral lobe. In the final stage, the siphonal lobe is extremely narrow and deep. It occupies only the width of the furrow on the ventral part. It is narrower at its upper part than below the middle, and its bottom is divided into three branches by two lateral, relatively long and pointed, saddles which lean over towards the sipho. The middle branch does not seem to be closed and is much longer than the lateral branches. The first lateral lobe lies on the ventral shoulder, is extremely broad, and is divided into four branches by three secondary saddles. The deepest of these branches is the outer one (counting always the part toward the sipho as the

inner, and those toward the umbilicus as the outer ones). It is not nearly so deep as the siphonal lobe, but deeper than the second lateral one. This branch is leaning toward the outside; i. e., the bottom is nearer to the sipho than its top. It is separated from the next secondary lobe by a relatively high secondary saddle which leans over to the outside. It is entire and rounded at the top. The other three secondary lobes are very small and shallow and together with the two saddles which separate them, resemble the teeth of a saw. The second lateral lobe is nearly symmetrical, tongue-shaped, narrower at the top than below the middle, and ending in a point. The first auxiliary lobe is asymmetrical and curved with the convexity toward the inner side, pointed at the lower end. The second and third auxiliary lobes are again symmetrical, pointed, narrower at the upper part than below the middle. The fourth and fifth auxiliary lobes are symmetrical, pointed, but about equally wide in their upper half. The fifth auxiliary lobe lies near the umbilical border and there follow still two more lobes on the umbilical border and wall. The sixth is similar to the fifth, but smaller; while the seventh is extremely small and rather like an indentation.

The saddles are all entire and rounded, but differ in height. The external saddle is moderately high and leans over toward the sipho. It is not constricted. All the lateral saddles on the flank are of the same shape; i. e., rounded at the top and more or less constricted above the base. The first and second lateral saddles are higher than the external and very similar to each other in width and length. The first auxiliary is considerably shorter. From the first to the fifth (on the umbilical shoulder) the saddles decrease steadily in length and width, but all are more or less of the same shape. The sixth and seventh auxiliary saddles, which lie on the umbilical wall, reach with their top to the continuation of the line formed by the upper end of the preceding saddles, but their base lies much higher than that of the saddles on the flank.

The internal sutures could be studied only in a specimen whose furrow on the ventral part is not yet developed, but in an adult whorl the general outline of the internal suture is visible and it does not materially differ from the one we are about to describe.

The internal suture shows a very deep antisiphonal lobe of lanceolate form, much narrower at the top than below the middle. The

first lateral lobe is not even half as long as the antisiphonal one; it is slightly asymmetrical and somewhat curved with the convexity toward the antisiphonal side. Then follows a second and quite insignificant lateral lobe, the top of which is about as high as that of the first lobe, while the depth is about one-fourth of that of the preceding one. This lobe lies near the umbilical seam.

The internal saddle is high, slender, slightly curved with the convexity toward the antisiphonal region, and a little constricted. The first lateral saddle is very small and narrow, rounded at the top and constricted near the base; it leans a little over toward the antisiphonal region. A second insignificant saddle develops on the umbilical seam and forms the internal flank of the seventh auxiliary saddle of the external suture. While the lateral saddles and lobes are far apart in two suture lines following each other, the antisiphonal lobe touches the inner flanks of the internal saddles of the next older septum.

The development of the sutures in our genus shows clearly that it was derived from *Pronorites,* the inner whorl still showing the general form and the suture of that genus. The later developmnt is entirely different, somewhat similar to *Propinacoceras,* but the suture is entirely different. If we regard the general features of the adult suture, we find that it shows a certain relation to *Parapronorites* on one side, and to *Daraelites* on the other. Characteristic is the low external saddle and the excessively broad first lateral lobe. The short external saddle occurs in both those genera named above, while the broad first lobe is especially pronounced in *Parapronorites,* although in *Daraelites* this element is certainly wider than any of the following ones. The first lateral lobe has very different secondary elements in our genus, while in *Parapronorites* they consist more or less of little sawtooth-like saddles and lobes and in *Daraelites* we observe only a very minutely serrate first lobe. All the rest of the lobes in *Parapronorites* are bifid with the exception of the last ones, which end in a point. In *Daraelites* they are serrated or rounded.

These relations show that our genus holds a position similar to that of *Parapronorites* and *Daraelites,* which latter one has also similar internal lobes; and that *Uddenites* is to be regarded as an independent branch of the Noritinae.

Uddenites so far has been found only in the Wolfcamp formation, the very lowest part of our Permo-Carboniferous.

Uddenites Schucherti nov. sp.
Pl. I. Fig. 9-23

Shell discoidal, involute, with flat flanks and flattened ventral region, the latter with a median furrow in the adult whorls, and slightly rounded in the juvenile ones. The furrow is slightly narrower than each of the flattened parts on its side; flanks and ventral part form a right angle but the ventral border is somewhat rounded. The cross-section of the adult whorl is nearly rectangular, with the exception of that part which embraces the next smaller whorl, and not taking into account the furrow on the ventral part. The cross-section of the smaller whorls is rectangular, but the ventral part is slightly curved. The umbilicus is very narrow, its border is rounded, its wall is narrow but steep. No ornamentation is visible on the cast. The body chamber is unknown.

The septa are very near together but without touching each other. The suture forms a nearly straight line. The final stage of the suture consists of a siphonal and eight lateral and auxiliary lobes, the last one on the umbilical shoulder, and a ninth on the umbilical wall. These are separated by eight saddles on the ventral part and flank, and two or more on the umbilical wall.

The siphonal lobe is deep and trifid, the middle part most prominent but apparently not closed. The lateral points are small and sharp. The lobe is much narrower at its top than near the base; it occupies about the width of the furrow on the ventral part. The first lateral lobe is extremely broad; it occupies part of the ventral region, the ventral shoulder and part of the flank; it is subdivided into four branches by three secondary saddles, the outer one of which is large and bent over toward the umbilicus. The branch between this secondary saddle and the first lateral one is not nearly as deep as the siphonal lobe, but deeper than any of the lateral lobes. It is curved with the convexity toward the umbilicus. The other two secondary saddles with their three lobes form a saw-tooth-like line, the outer secondary saddle being a little higher than the other one. The second lateral lobe is symmetrical, not as deep as the first one, some-

what pointed, narrower at the top than below the middle. The first auxiliary lobe is asymmetrical, pointed, curved with the convexity toward the ventral side. The second and third auxiliary lobes are again symmetrical, pointed, narrower in the upper part than below the middle. The fourth and fifth auxiliary lobes are symmetrical, pointed, but about equally wide in their upper half. The fifth lobe lies near the umbilical border and there follow still two more lobes on the umbilical border and wall. The sixth is similar to the fifth, but smaller; while the seventh is extremely small and not more than a slight indentation.

The saddles are all entire, and rounded at the top, but they differ in height. The external saddle is moderately high and leans over toward the sipho; it is constricted. The lateral and auxiliary saddles are of equal shape, rounded at the top and more or less constricted above the base. The first and second lateral saddles are of equal length and higher than the external and the rest of the saddles on the flank; they are also similar in shape and width. The first auxiliary saddle is considerably shorter than the two preceding ones. From the first to the fifth auxiliary (on the umbilical shoulder) the saddles decrease in length and width, but have more or less the same shape. A sixth and seventh which lie on the umbilical wall reach with their top to the prolongation of the line formed by the upper ends of the preceding saddles, but their base is much higher than that of the saddles on the flank.

The seventh auxiliary saddle reaches with its flank over to the internal suture. This (pl. I, fig. 23) consists of a very deep antisiphonal lobe of lanceolate form, much narrower at the top than below the middle. Its bottom reaches far down and touches the upper and inner sides of the internal saddles of the next suture. The first lateral lobe is not quite half as long as the antisiphonal one; it is slightly asymmetrical and somewhat curved with the convexity toward the anti siphonal side. There follows a second and quite insignificant lateral lobe, the top of which is about as high as that of the first lobe, but its depth is only about one-fourth of that of the preceding one. This lobe lies near the umbilical seam. The internal saddle is high, slender, slightly curved with the convexity toward the antisiphonal region, and a little constricted. The first lateral saddle is very small and narrow,

rounded at the top and constricted near the base; it leans a little over toward the antisiphonal region. A second and very insignificant saddle begins on the umbilical seam and is really not more than the flank of the seventh auxiliary saddle on the umbilical wall.

The internal sutures described above were observed on a whorl which does not yet show the furrow on the ventral region.

Dimensions:

Diameter	15.2 mm	(1)
Width	4.5 mm	0.30
Height of the last whorl	8.2 mm	0.54
Diameter of umbilicus, about	2.5 mm	0.16

Relation to other species:

The only species the present one can be compared with is *Uddenites minor* n. sp., but this latter species is much more evolute. I have been somewhat in doubt if there are really two different species, because there is the possibility that *U. minor* represents only inner whorls of *U. Schuchcrti;* but the difference in evolution is so great, especially in the fragments of both species which are nearest in size, that I have come to the decision to distinguish both forms by different names, especially as the larger specimen of *U. minor* shows an entirely adult suture. I do not ignore the fact that in some species of *Pronorites* the larger whorls show a tendency to cover not only the preceding whorls, but also part of the umbilicus; but I have no proof that this is the case in *Uddenites,* although in *U. minor* the last whorl covers at least the entire preceding whorl. Later finds will have to decide this question.

Age:

Wolfcamp formation; lowermost Permo-Carboniferous.

Number of specimens examined:

Two.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

Uddenites minor n. sp.
Pl. I, Fig. 24-40

Shell discoidal, moderately involute, with flat flanks and flattened ventral region, the latter with a median furrow in the adult whorls, and slightly rounded in the younger ones. The furrow is a little narrower than each of the flattened parts on either side. The flanks and ventral region form a right angle, but the ventral shoulder is somewhat rounded. The cross-section of the adult whorl is nearly rectangular, if we do not consider that part which embraces the next smaller whorl and the furrow on the ventral portion. The cross-section of the next smaller whorls without a furrow is rectangular, with a somewhat rounded ventral region; and the still smaller whorls seem to have an elliptical cross-section. The whorls grow very rapidly in height from that point where the furrow on the venter begins to develop. They even embrace the entire preceding whorl. The umbilicus is moderately narrow. The flank curves down to the umbilical seam in a regular curve. The inner whorls are exceedingly evolute, each one embracing only a small part of the preceding one. The body chamber is unknown.

The adult whorls do not present any trace of ornamentation. The innermost whorls are also absolutely smooth, but at the part where the *Pronorites* suture is visible, and the furrow not yet developed, the flanks show fairly strong transversal ribs slightly curved with the convexity toward the front, beginning at the umbilicus and disappearing before they reach the ventral shoulder. (Pl. I, fig. 32.) They are separated by shallow interstices with rounded bottoms, nearly twice as wide as the ribs. At the stage where the furrow begins to develop, the umbilical border shows very fine radial lines of growth, slightly bent backward.

The septa are not very near together and never touch each other. On the inner whorls they are still farther separated than on the adult ones. The suture is nearly straight. On the inner whorls which have a rounded and flattened venter without a median furrow, the suture is entirely like that of *Pronorites* and shows the following character (pl. I, fig. 26): The siphonal lobe appears to be divided into three different parts by the appearance of two secondary saddles on the sides. The middle branch is open below; on each side is a small

secondary saddle and a pointed secondary lobe; the siphonal lobe is deep and much narrower at the upper end than below the middle, at the height of the secondary lobes. It is relatively much broader and shorter than in the adult suture. The first lateral lobe is very broad and divided in two branches by a small secondary saddle; both branches, as well as the secondary saddle, are rounded. The second lateral lobe is about half as broad as the first one, rounded at the bottom and much narrower at the upper part than below. The first and second auxiliary lobes are much smaller and less deep than the two lateral ones. The saddles are all entire and rounded at the top. The external saddle is not very high and bends slightly toward the sipho; the first lateral saddle is higher than the external and constricted above the base; the second lateral saddle is similar to the first, but a little lower; the first auxiliary is much lower than the preceding one; also much narrower and not constricted; the second auxiliary, which lies on the umbilical wall, is an insignificant saddle.

From the point where the median furrow on the venter develops, the suture begins to change materially. The secondary saddle in the first lateral lobe bulges slightly on its side nearest to the siphonal region and becomes asymmetrical; at the same time the number of auxiliary lobes and saddles on the flank near the umbilical region increases rapidly. Afterwards, the exterior portion of the secondary saddle in the first lateral grows much quicker than the interior one; at about the fourth part of a whorl from the point where the median furrow begins, the aforesaid secondary saddle becomes still further subdivided. Its inner bulge has developed into an independent secondary saddle and now becomes indented and divided in two equal parts, while the outer portion of the original secondary saddle has grown so far that it could almost be considered as an independent lateral saddle; but its development shows that it has to be regarded as a secondary one, belonging to the first lateral lobe. Here the suture has reached its adult stage and consists now of eight saddles and eight lateral and auxiliary lobes between the umbilical border and the sipho.

This ulitimate stage of the suture has the following character (pl. I, fig. 24-25). The siphonal lobe is deep and very narrow, and occupies about the width of the median furrow on the venter. It is

narrower at its upper end than above its bottom, and is divided into three branches, of which the middle one is the longest and not closed, while the two others are short and pointed. The first lateral lobe lies on the ventral shoulder, is exceedingly wide, and is divided into four very unequal branches by three secondary saddles. The deepest of these branches is the one nearest the umbilical side; it is not nearly so deep as the siphonal lobe, but deeper than the second lateral one. This branch is curved with the convexity toward the umbilicus. It is separated from the next secondary lobe by a high secondary saddle strongly bent over toward the umbilicus. It is entire and rounded at the top. The next secondary lobe is funnel-shaped, pointed and very small. The third secondary lobe is only a slight indentation, while the last secondary lobe is deeper and rounded. The intervening saddles are not well separated by the indentation mentioned, but rather appear as a larger secondary saddle with an indentation on the inner flank. The second lateral lobe is not quite symmetrical, but rather curved with the convexity toward the ventral region. It is narrower at the top than below the middle and slightly pointed at the bottom. The first auxiliary lobe is curved with the convexity toward the ventral region. It is a little narrower at the top than below the middle, quite asymmetrical and pointed. The second, third and fourth auxiliary lobes are symmetrical, pointed and somewhat narrower at the top than below the middle. The fifth auxiliary lobe, near the umbilical border, is similar to the preceding ones, but is more or less of the same width in its upper as in its lower half. The sixth auxiliary lobe on the umbilical wall is very small but similar in outline to the fifth.

The saddles are all entire and rounded. The external saddle is moderately high and bends over toward the siphonal region; it is not constricted. All the lateral saddles on the flank are of the same shape, rounded at the top and more or less constricted above the base. The first and second lateral saddles are higher than the external and very similar to each other with respect to length and width. The first auxiliary saddle is considerably shorter, and from this on to the fifth on the umbilical shoulder, the saddles decrease steadily in length and width. The form of the saddles on the umbilical wall could not be distinguished but they certainly resemble those of *Uddenites Schucherti* nov. sp.

The internal sutures could not be made visible in this species, but there is no doubt that they resemble those of the preceding species.

Dimensions:	I		II	
Diameter	10.0 mm	(1)	9.8 mm	(1)
Width	3.1	0.31	3.1	0.32
Height of the last whorl	4.7	0.47	4.3	0.44
Diameter of umbilicus.	3.3	0.30	3.0	0.31

Relation to other species:

This species is very similar to *Uddenites Schucherti* nov. sp., but is much more evolute. We have already indicated why we do not consider *U. minor* as juvenile forms of the other species; at least not until this can be proven by actual observation.

Age:

Wolfcamp formation, lowest Permo-Carboniferous.

Number of specimens examined:

Three.

Locality:

Immediately northwest of Wolf Camp, on foothill of the Glass Mountains.

MEDLICOTTINAE Karpinsky

Medlicottia Waagen

The genus *Medlicottia* has been established by Waagen for a number of involute discoidal species with a median furrow on the venter, but later on it was shown that several forms included should be separated and belonged in reality to other genera. Waagen[1] originally (1879) described *Goniatites primas,* his type for *Medlicottia,* as *Sageceras primas,* and introduced the new genus *Medlicottia* later (1880) in a supplement[2] without giving a real diagnose of the genus. He included in it the following species:

Medlicottia Orbignyana Verneuil.
Medlicottia artiensis Gruenewaldt.
Medlicottia primas Waagen.
Medlicottia sakmarae Karpinsky.
Medlicottia Wynnei Waagen.

In 1888 Gemmellaro described a number of new species belonging to *Medlicottia,* the existence of which forms, in loose blocks of the Sicilian Permian, had been proven already in 1882 by Mojsisovics. At the same time Gemmellaro[3] established his new genus *Propinacoceras* and expressed the opinion that the so called *Medlicottia sakmarae* probably belonged to this new genus.

Nearly at the same time (1889) Karpinsky[4] published the first detailed study of the genus *Medlicottia,* separating from it *Propinacoceras sakmarae.* He distinguishes three different groups; that of *M. Orbignyana,* including *M. Trautscholdi* Gemm., *M. primas* Waag., *M. Verneuili* Gemm., *M. Marcoui* Gemm., and *M. bifrons* Gemm.; that of *M. Wynnei* Waag., including only this species; and that of *M. artiensis* Gruenew., including *M.* indeterm. Karp., and *M. Karpinskyana* Krotow. He regards *M. Schopeni* Gemm. as a form of passage from the third group to *Propinacoceras.*

Karpinsky also is the first one to show the development of the suture in *Medlicottia.* He is able to show that the septa pass from the *Iber-*

[1]Waagen, Productus limestone fossils, I, p. 39.
[2]Waagen, loc. cit., p. 83.
[3]Gemmellaro, Calc. c. Fusulina, p. 53.
[4]Karpinsky, Amm. d. Artinsk-Stufe, p. 21-26, 41, 45.

giceras to the *Pronorites,* then to the *Sicanites* and at last to the *Medlicottia* stage.

In 1904, Noetling[1] showed that Karpinsky's group of *M. Wynnei* cannot be regarded as a simple group of *Medlicottia,* but that it has to be considered as a different genus, to which he gave the name of *Episageceras,* and in which he included a species *M. Dalailamae* described by Diener and considered by him as being of Triassic age, while Noetling regards it as Permian; and a new species, *Episageceras latidorsatum,* from the lower Triassic of the Salt Range. Noetling also indicates that *Medlicottia artiensis* Gruenewaldt differs essentially from the real *Medlicottia,* which resemble the type species *M. primas* Waag., on account of its sculpture as well as the form of the suture. *Medlicottia Schopeni* Gemm. should be entirely separated from the genus, according to Karpinsky as well as Noetling.

So Noetling would regard as belonging to *Medlicottia* only the following species:

Medlicottia primas Waag.
Medlicottia Orbignyana Vern.
Medlicottia bifrons Gemm.
Medlicottia Marcoui Gemm.
Medlicottia Trautscholdi Gemm.

Noetling gives a very detailed diagnosis of the genus *Medlicottia* (including only the six species mentioned above) which we do not reproduce here. The most important characters are the following: Shell discoidal, very involute, flattened on the flanks, narrow venter with two lateral keels and a deep median furrow, sometimes crossed by numerous transverse plications. Umbilicus very small in the adult specimens, but wider in the younger whorls. Sculpture consisting apparently only of sigmoidal lines of growth.

The suture consists of a very narrow, deep, bifid or trifid siphonal lobe, with parallel sides, a series (up to twelve) of rudimentary adventive lobes, an adventive lobe, two lateral lobes and up to ten auxiliary lobes. All the lobes are bifid with exception of the rudimentary adventive lobes and the last auxiliary lobes which are pointed or rounded.

There is an external saddle divided into two unequal parts by the adventive lobe. The part nearest to the sipho is high, narrow and

[1]Fr. Noetling, Medlicottia u. Episageceras.

notched on its sides by the rudimentary adventive lobes. The other part of the external saddle is much shorter and resembles the lateral saddles in form. The lateral saddles are long, narrow at the base, broadening forward, rounded and often deeply notched on both sides at the middle of their height.

To this definition we can add that the internal suture (pl. I, fig. 49, 50) shows a deep bifid antisiphonal lobe occupying the whole breadth of the dorsal part which corresponds in width to the venter of the next smaller whorl. The internal saddle is very narrow and high. The first and second lateral lobes are bifid, while the bottom of the five auxiliary lobes is rounded. The lateral saddles are all high, entire and rounded at the top.

The internal suture of *Medlicottia* has been unknown up to the present time; we shall show its outline on an immature specimen of *M. Burckhardti.* According to what could be observed in some larger specimens, the suture does not change essentially, with exception, perhaps, of the number of auxiliary lobes.

To the six species cited by Noetling another one *Medlicottia Copei* White[1] should be added; its suture resembles that of *M. Orbignyana* more than any other.

Medlicottia magnotuberculata Tchernow[2] probably belongs to the group of *M. artiensis;* at least the sculpture is very similar. Unfortunately, the suture is not known. This group should certainly be separated from *Medlicottia* and the species described by Gruenewaldt, Karpinsky and Tchernow should be united in a new genus.

Another species, *Medlicottia* (?) *croatica,* has been described by Vogl.[3]

To the species listed as belonging to *Medlicottia* we can add two more from the Permo-Carboniferous of the Glass Mountains. One has been found in the Leonard formation (*M. Whitneyi*) and the other is frequent in the Word formation (*M. Burckhardti*). Both are entirely different from the other North American species, *M. Copei;* and even belong to other groups.

Noetling[4] contends that (1) in geologically older species the adven-

[1]White, The Texan Permian, p. 21, pl. 1, fig. 1-3.
[2]Tchernow, L'Etage d'Artinsk, p. 366, 397; pl. 1, fig. 7-a, b.
[3]D. V. Vogl, Palaeodyas von Mrzla-Vodica.
[4]Noetling, Medlicottia u. Episageceras, p. 354.

tive lobe is very little pronounced, while in geologically younger species it reaches a considerable width and depth, and seems to represent a lateral lobe; (2) that in geologically older species the number of rudimentary adventive lobes is smaller than in geologically younger species; (3) that in geologically older species all the lateral lobes with exception of the first one are asymmetrically bifid in such a manner that the finger nearer to the umbilicus is longer and stronger than the other: geologically younger species begin to show symmetry and it even appears as if in the geologically youngest species the reversed arrangement is taking place.

Noetling bases this hypothesis on the supposition that the Sicilian Sosio beds are older than the Russian Artinsk, and that this horizon for its part is older than the Productus limestone of the Salt Range of India. But this succession is by no means universally recognized. On the contrary, by far the majority of the authors considers the Russian Artinsk to be somewhat older than the Sicilian Sosio beds, and while the upper and part of the middle Productus limestone is generally considered as being younger than the Sosio limestone, all the lower Productus limestone is considered as being older than those beds.

Noetling says that if it should be proven that his supposition with respect to the relative age of the horizons mentioned is wrong, all his conclusions would be untenable, but it would also be shown that the ontogenetic development of the suture cannot be used for any kind of conclusions with respect to geological age.

I do not think that in this case the consequences would be so terrible as Noetling paints them. I would rather suppose that this author overestimates the value of an adventive lobe and does not always take into account the influence of size on the development of the suture.

Most of the Sicilian species are rather small, but we know nothing about the real size of the complete specimen because, apparently, none with a body chamber has been found. At least, Gemmellaro, who always pays great attention to the length of the body chamber, does not even mention its size in his description of the different *Medlicottia*. The only species from the Artinsk is not very large, and a comparison with that from the Productus limestone is rather difficult.

In his first paragraph Noetling asserts that the adventive lobe is much less conspicuous in the older forms than in the younger ones.

Certainly it is much deeper in *M. primas* than in any of the other species described, but I cannot see any essential difference in the adventive lobes of *M. Orbignyana* and *M. Verneuili.* If the depth of the adventive lobe really had some relation to the age of the species, then *M. Verneuili* would have to be considered as much younger than *M. Marcoui, M. bifrons* and *M. Trautscholdi.* Karpinsky himself remarked that the whole difference between *M. Orbignyana* and *M. Trautscholdi* may be only one of size, and justly indicates that the suture of the small specimen of *M. Orbignyana* figured in his pl. 2, fig. 1, g, h, k, is extremely similar to that of *M. Trautscholdi.* Noetling recognizes this fact but thinks that Karpinsky overlooks the smaller number of adventive lobes (Noetling, loc. cit., p. 362); but I must say that I am unable to see any such difference between the suture in pl. 2, fig. 1 k, of Karpinsky, and pl. 8, fig. 31, of Gemmellaro. The number of these rudimentary adventive lobes simply increases with the size of the animal.

Noetling thinks also that in the geologically older species the lateral lobes, with exception of the first one, have a longer finger on the umbilcal side than on the side nearer to the venter. But he himself remarks that this can only be seen in *M. Marcoui* and *M. Trautscholdi.* This observation, made by Noetling himself, shows at once that this character cannot be of any importance at all, because all the Sicilian species come from the same bed, the "Calcare compatto"!

I think that Noetling's assertion that the depth of the adventive lobe and the number of rudimentary adventive lobes or the relative length of the branches of the lateral lobes can be used to determine the geological age of a species, cannot be sustained. These characteristics depend mostly upon the size of the individual or are altogether insignificant.

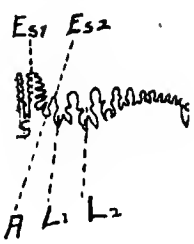
Tchernow's proposition to divide *Medlicottia* into two groups, one with two keels or an angular ventral side, and another with a ventral part limited by rows of tubercles, cannot very well be accepted. This would again place *M. artiensis* in the genus *Medlicottia* from which it certainly should be separated. On the other hand the principle could not be applied to our *M. Whitneyi,* which on the inner whorls shows a row of tubercles on both sides of the median groove, while it has sharp keels on the outer whorl (pl. I, fig. 42, 43, 45, 45a).

I cannot see any necessity for a further sub-division of the genus *Medlicottia* in the sense that this has been limited by Noetling. All the species described are more or less intimately related to each other; even the circumstance that in some species the siphonal lobe is trifid, while in others it is bifid, does not seem to be of essential importance.

The genus *Medlicottia* in the restricted sense is entirely limited to the Permian, while the nearly related *Episageceras* is found both in the Permian and in the Triassic.

Fig. 1. *Medlicottia Whitneyi* nov. sp. Mature external suture.

Medlicottia Whitneyi nov. sp.
Pl. I, Fig. 41-45a



Shell discoidal, very involute, flattened on the flanks, with a sharp keel on both sides of the narrow venter and a deep median groove between them. The cross-section is sagittate but truncated and hollowed at the ventral part and profoundly incised on the dorsal side by the next smaller whorl. The whorls are deeply embracing, the umbilicus is very small, the umbilical border is slightly rounded, the umbilical wall is vertical but narrow.

On the exterior whorl we observe a very shallow, broad, spiral depression at about two-thirds of the height of the flank. It does not seem to run parallel to the ventral keel, but to get nearer to it on the inner part of this same whorl. At the end of the last whorl the ventral keels are very sharp, and even slightly elevated above the ventral portion which slopes down toward the median groove; and is separated from it by a rounded edge. The flanks in this part of the whorl are absolutely smooth. About half a whorl's length farther inward, the uppermost part of the flank shows a series of low rounded ribs or plications, leaning strongly forward; counting from the ventral shoulder these ribs cover about one-fifth of the breadth of the flank;

on the keels of the venter they cause slight tubercle-like swellings. While four-fifths of the flank (counted from the umbilicus) is quite flat, the shell bends suddenly over to the venter from the spiral line where these ribs begin to appear. Farther inward the ribs get shorter but yet stronger, and the keels form rows of well-marked tubercles, which are visible on the cast (pl. I, fig. 45, 45a).

The septa are not much separated and the lateral lobes and saddles even nearly touch each other. The suture follows a sigmoidal line. It consists of a great number of saddles and lobes in the description of which we adopt the nomenclature established by Noetling (compare text figure 1, and pl. I, fig. 41).

The siphonal lobe (S) is very deep with parallel sides and extremely narrow. It occupies the width of the median groove on the venter and ends in two points. The two lateral lobes, L_1 and L_2, are divided in two branches, the first lobe being symmetrical, the second nearly so. The first lateral lobe is much deeper than the siphonal lobe; the second is deeper than the first lateral lobe. On the flank there follow still ten auxiliary lobes, the last of which lies on the umbilical shoulder. At least the first five auxiliary lobes are divided into two branches by a high median saddle but also in the rest we find at least such a division indicated with the possible exception of the last one, which seems to be rounded. The fourth auxiliary lobe is very asymmetrical, the branch nearer to the umbilicus being much larger than the other one. The last two auxiliaries are somewhat dim, and could not be represented in our figure.

The external saddle is divided into two unequal parts, Es_1 and Es_2 by the adventive lobe A. The part Es_1, which is nearer to the sipho, is high and asymmetrical; it is deeply scalloped by four rudimentary adventive lobes on the siphonal side and five more on the umbilical side. These latter five lobes are much deeper than the other four and consequently the rudimentary adventive saddles between them are much longer and more slender than those on the siphonal side which are short and rounded. The eighth rudimentary adventive lobe (a_5) is divided by a low median saddle; the first seven are simply rounded at the bottom, while the ninth is strongly curved. The branch Es_1 is slightly notched at the top. The other branch of the external saddle Es_2 is much smaller and forms an angle of some 30° with the main

branch; in shape it resembles the lateral saddles but is much smaller. It is high and bulges on both sides, in the middle. The adventive lobe A between the two branches of the external saddle has a simply rounded bottom.[1]

The two lateral saddles have in general the form of asymmetrical trilobate leaves; that is to say, near the middle they bear lateral protuberances which are directed obliquely above. In the first lateral saddle, the protuberance on the siphonal side has a higher position than that on the umbilical side; in the second lateral saddle the conditions are reversed. The first auxiliary saddle is similar to the second lateral; in the second and third auxiliary saddle the protuberances are greatly reduced, and the rest of the auxiliary saddles are more or less tongue-shaped and somewhat constricted near the base.

From the first lateral until the last auxiliary the height of the saddles diminishes gradually.

Dimensions:

Diameter	41.8 mm	(1)
Width	9.2	0.21
Height of the last whorl	25.5	0.61
Diameter of umbilicus	1.3	0.03

Relations to other species:

The shape and sculpture of our species are very similar to those of *M. Orbignyana* Vern.[2] the latter one showing also in the younger whorls tubercles on the keels, while in the later whorls these become entirely smooth and sharp. Especially the figures given by Tchernow demonstrate how similar the sculpture is. But the suture in both species is entirely different, *M. Orbignyana* having generally tongue-shaped saddles, while those of our species resemble trilobate leaves. The siphonal branch of the external saddle is in *M. Orbignyana* much less asymmetrical than in *M. Whitneyi.*

[1]We have treated A and a_0 as two diferent adventive lobes, following the example of Noetling; but it seems to me much more natural to consider these lobes together as A, divided by an adventive saddle. In *M. Orbignyana*, Noetling considers as A what would correspond to a rudimentary adventive lobe and the adventive lobe A if the dividing saddle were not so extremely small. Genetically there is certainly no difference.

[2]Verneuil, Geol. of Russia, II, p. 375, pl. 26, fig. 6.
Karpinsky, Amm. d. Artinsk-Stufe, p. 35, pl. 2. fig. 1 a-n.
Tchernow, L'Etage d'Artinsk, p. 367, pl. 1, fig. 8 a-c.

With regard to the suture, our species resembles *M. bifrons* Gemmellaro.[1] There we find the same kind of trilobate saddles, the very asymmetrical siphonal branch of the external saddle, and the inclined umbilical branch of this saddle, although the number of rudimentary adventive lobes and of auxiliary lobes is much smaller,—a fact which might be explained by the size, if the suture (Gemm., pl. 9, fig. 19) has not been taken from the specimen figured in Gemm., pl. 9, fig. 18. Another difference may be found in the lesser length of the umbilical branch of the external saddle in *M. bifrons* and the generally broader lobes. The Sicilian species does not show the rows of tubercles on the ventral keels, it is broader in the ventral part, and the ratio of dimensions is somewhat different from that of *M. Whitneyi.*

The suture of our species has a certain similarity also to that of *M. primas* Waagen[2]. There we find the same trilobate saddles, and the inclined umbilical branch of the external saddle, but the adventive lobe is much deeper and of different shape and the siphonal branch of the external saddle is much less asymmetrical.

A certain resemblance exists also between *M. Whitneyi* and *M. Burckhardti* n. sp. In this latter one, we find the same kind of trilobate lateral saddles, but they are longer and more slender. The umbilical branch of the external saddle, Es_2, is very little inclined and nearly parallel to the lateral saddles and not very much smaller. In a specimen a little larger than that of *M. Whitneyi,* the siphonal branch of the external saddle shows only seven rudimentary adventive lobes instead of nine. Small specimens of *M. Burckhardti* show sharp ventral keels and not a trace of tubercles.

The other species found in Texas, *M. Copei* White[3], resembles our species much less. It is broader at the venter, the saddles are not trilobate but tongue-shaped, the adventive lobe A has an entirely different form, and the lobes are more asymmetrical.

The circumstance that *M. Copei* is so entirely different from *M. Whitneyi* is of some interest, because apparently they come from beds of nearly the same age; but we have to take into account the fact that the fossils in both localities are very insufficiently known and that the

[1]Gemmellaro, Calc. c. Fusulina, p. 51, pl. 9, fig. 16-19.

[2]Waagen, Saltrange fossils, Productus limestone fossils, I, p. 39, pl. 2, fig. 7.
Noetling, Medlicottia und Episageceras, p. 355, pl. 17, fig. 1-a, 1-b, pl. 19, fig. 1.

[3]White The Texan Permian, p. 21, pl. 1, fig. 1-3.

beds with *M. Copei* are probably a little older than those with *M. Whitneyi.*

Age:
Leonard formation, Permo-Carboniferous.

Number of specimens examined:
One.

Locality:
About two miles W N W from Iron Mountain, at the foot of an extensive clay slide, Glass Mountains.

Fig. 2. Mature external suture of *Medlicottia Burckhardti* nov. sp.

Medlicottia Burckhardti nov. sp.

Pl. I, Fig. 46-52; Pl. II, fig. 1-3

Shell discoidal, very involute, flattened on the flank, and with sharp keel on both sides of the very narrow venter and deep median groove between them. The cross-section is sagittate, slightly excavated and truncated at the ventral portion and profoundly incised at the dorsal side by the next smaller whorl. The flanks are not completely flat but very slightly and evenly convex; keels on the venter are very sharp in younger individuals. Their highest part is at the ventral shoulder and from there the shell slopes in a slight curve down to the border of the median groove. In the largest specimens the keels become entirely rounded. The whorls are deeply embracing. The umbilicus is very small, the umbilical border is slightly rounded, and the umbilical wall is narrow but steep.

All of our specimens are casts and not a trace of sculpture is visible. There were certainly no tubercles on the keels, or ribs on the flanks, even of the inner whorls.

There exists a certain difference in the form of the largest and the smallest specimens. While the flanks of the large whorls are evenly convex, those of the small ones (20 mm. diameter) are almost perfectly flat on the four-fifths of the flank nearest to the umbilicus and they then bend rather suddenly over toward the siphonal region, as is shown in our cross section on pl. I, fig. 48.

The septa are not very near together but the lobes almost touch the saddles of the next smaller septum. The suture follows a sigmoidal line. The mature suture (compare text fig. 2 and pl. II, fig. 2) consists of a very great number of lobes and saddles. The siphonal lobe, S, is very deep, with parallel sides, and extremely narrow. It occupies about the width of the median groove on the venter and ends in two points. The two lateral lobes, L_1 and L_2, are divided in two branches by a high secondary saddle; the first lobe is asymmetrical, the branch on the umbilical side being longer than that on the other one, and straight; while the branch on the siphonal side is curved with the convexity toward the venter. The second lateral lobe is almost symmetrical. There are ten auxiliary lobes, the first one of which (a_1) is at least as deep as the second lateral lobe and entirely similar in shape. The first six auxiliary lobes, a_1-a_6, resemble in general shape the second lateral lobe, although they decrease rapidly in depth and the dividing secondary saddle becomes quickly lower and broader; in the seventh and eighth, and even in the ninth, the division in two branches is at least still indicated, while the tenth lobe shows a rounded bottom.

The external saddle, Es, is divided in two parts, Es_1 and Es_2, by the adventive lobe, A. The branch Es_1 is very asymmetrical and strongly scalloped by nine rudimentary adventive lobes; those on the umbilical side are much deeper than those on the siphonal side. All the rudimentary lobes form a right angle with the direction of Es_1, with the exception of a_9, which is in an oblique position. As I have already said, in the description of *M. Whitneyi,* I would prefer to consider this lobe, a_9, as a part of A than as an independent rudimentary adventive lobe. The umbilical branch, Es_2, of the external saddle is nearly parallel to Es_1. Its form is slightly trilobate like the lateral

saddles, but smaller; the adventive lobe A, which divides the two branches is deep, and parallel to the branch Es_1. The lateral saddles L_1 and L_2 are strongly trilobate; that is, while their general form could be called tongue-shaped, they show near the middle two lateral protuberances, of which those directed toward the second lateral lobe are pointed downward, while those directed toward the first lateral and the first auxiliary lobes are pointed upward. The saddles are somewhat constricted below these protuberances. The second lateral saddle is higher than the first one. Of the ten auxiliary saddles the first eight resemble in shape the lateral saddles. Their length and the size of the lateral protuberances decrease rapidly while the width does not change materially, which gives the last of them a stouter form than the first ones show. The ninth and tenth auxiliary saddles are simple and rounded. The tenth saddle lies on the umbilical border.

In smaller specimens the sutures do not differ essentially. The number of rudimentary adventive lobes on the siphonal branch of the external saddle is reduced to seven, and the number of auxiliary lobes decreases; but the shape of the saddles and lobes, and especially of the external saddle, and its dividing adventive lobe A, does not change materially.

The internal suture could be seen only on a small specimen (III of our list of dimensions), but it belongs really to the next larger whorl which should have a diameter of at least 40 mm. As internal sutures up to now have not been found in any *Medlicottia* it is perhaps well worth while to describe these (pl. I, fig. 49, 50).

The antisiphonal lobe is clearly bifid, a short triangular median saddle causing the division in two points. The lobe is relatively broad and occupies nearly the whole breadth of the venter of the next smaller whorl; it is wider above than below. The first lateral lobe is almost as deep as the antisiphonal one; it is narrower at the top than near the bottom, and is bifid, the two points being divided by a very low saddle. The second lateral lobe is similar in general shape to the first one, but it is shorter and the dividing saddle between the points is still lower. The auxiliary lobes, five in number, are all simple and rounded at the bottom; they decrease gradually in depth.

The internal saddle is high, slender, and somewhat club-shaped. The first and second lateral saddles are a little higher than the internal

one, but broader and slightly constricted near the base. The first auxiliary saddle is similar to the lateral ones, and still slightly constricted at the base, although a little less long; while the following three auxiliary saddles decrease gradually in length and are not constricted. A fifth auxiliary saddle probably exists on the umbilical seam.

Dimensions:

Most of the specimens found are only fragments, especially the larger ones. Dimensions can be given, therefore, only for smaller individuals; but there are fragments which show that the complete shell would have a diameter of at least 130 to 140 millimeters. This proves it to be the largest species of *Medlicottia* so far found, the largest fragments of *M. primas* indicating a diameter of about 120 mm.

Dimensions:	I	II		III	
Diameter	?	55.0 mm	(1)	19.1 mm	(1)
Width	26.8 mm	11.4	0.21	4.7	0.25
Height of the last whorl..	76.0	32.0	0.58	11.2	0.59
Diameter of umbilicus....	Small	Small	...	1.5	0.07

Relation to other species:

M. Burckhardti has certain affinities with *M. Verneuili* Gemm.[1] This refers only to the suture, because our species does not show any of the shallow grooves on the flank nor any of the transversal folds that are characteristic for the Sicilian species; but we have to consider that our species is only known by casts and that a faint sculpture is not always preserved on these. The general character of the suture is very similar in both species, although the Sicilian species has a smaller number of auxiliary lobes. Extremely characteristic is the shape of the external saddle and especially the form and position of its umbilical branch, Es_2, and the deep adventive lobe A, but in general the lateral and auxiliary saddles are higher and more slender in *M. Burckhardti* than in *M. Verneuili* and the secondary saddles which divide the lobes in two branches are shorter.

Much more different is *M. primas Waag.*,[2] although it has the trilobate saddles. The shape of the external saddle is entirely different and the lateral saddles are more strongly trilobate and lower.

[1]Gemmellaro, Calc. c. Fusulina, p. 48, pl. 5, fig. 4-8; pl. 8, fig. 5 (Not 26, as is said in Gemmellaro's text).

[2]Waagen, Productus limestone fossils, I, p. 39, pl. 2, fig. 7.

Noetling[1] does not think that the trilobate form of the saddles is of fundamental importance and tries to explain their origin simply through the greater number of septa. He says that the points of the lobes often reach to near the protuberance on the saddle of the next following septum. This is certainly not the case in our species. The points of the first lateral lobe touch only the upper part of the two lateral saddles in the next septum, and in *M. Whitneyi* they do not even touch those saddles. The trilobate form, therefore, cannot be explained simply by the crowding of the septa. I would rather suppose that these different shapes of the saddles indicate different tribes or sections of the genus.

Our species can be easily distinguished from *M. Whitneyi* nov. sp., by its deep adventive lobe A, and the position of Es_2; there is also a smaller number of rudimentary adventive lobes of the external saddle in our species on specimens of the same size. In general, the saddles in *M. Burckhardti* are higher and more slender than in *M. Whitneyi.*

The other species found in Texas, *M. Copei* White[2], belongs to an entirely different group. Its saddles are tongue-shaped and not trilobate, the form of the adventive lobe, A, is entirely different, and the umbilical part of the external saddle, Es_2, is much lower. The suture of *M. Copei* has a very great similarity to that of *M. Orbignyana* Vern., although the external shape, especially the width of the venter and the convexity of the flanks, is certainly different; but the character of the suture may prove to be more important in *Medlicottia* than the external shape. *M. Copei,* by the way, furnishes another proof that the trilobate form of the saddles is not simply caused by the crowding of the septa, because in this species the septa are very near each other, and the saddles are simply tongue-shaped.

Age:

Word formation, Permo-Carboniferous.

Number of specimens examined:

About twenty. The species is very common in the lower limestone

[1]Noetling, Medlicottia und Episageceras, p. 358.

[2]White, The Texan Permian, p. 21, pl. 1, fig. 1-3.

of the Word formation, but it is generally difficult to collect, on account of its occurring in large blocks of hard limestone.

Locality:

Near the junction of Road and Gilliam Canyons; on the hills north of Leonard Mountain, Glass Mountains.

GLYPHIOCERATIDAE Hyatt

Gastrioceras Hyatt

The genus *Gastrioceras* was established by Hyatt[1] for evolute forms with a wide umbilicus, ribs or tubercles on the flanks, trapezoidal or semilunar cross-section with a high median saddle of the siphonal lobe, two lateral lobes, and two saddles. Later on Karpinsky[2] published his beautiful studies about the limitation of the genus, showing that there is not really a great difference between it and *Glyphioceras* if the extreme forms are taken into account. According to Karpinsky, the suture is entirely identical and the principal differences should be found in the trapezoidal cross-section, the presence of ribs or tubercles on the flanks, and a wide umbilicus, in *Gastrioceras*. With respect to the cross-section, we shall show how different this is in the different stages of age of the same species.

With respect to the ornamentation, J. P. Smith[3] has shown that some species of *Gastrioceras* lack those ribs altogether, as *G. globulosum* Meek and Worthen, "while some species of *Glyphioceras* have umbilical ribs, and, in their youth, also the elliptical cross-section, as *Glyphioceras diadema* Goldfuss."

Thus there remains only the wide umbilicus to distinguish *Gastrioceras* from *Glyphioceras,* certainly not a very good character to base the distinction of genera on; but as it refers only to the very extremes of both groups, the distinction between *Glyphioceras* and *Gastrioceras* might be justified. Unfortunately even this character does not hold good when we take *Glyphioceras* in the sense Haug[4] and Smith[5] regard it, and include, for example, *G. calyx* Phill., which is an evolute form.

Karpinsky evidently doubted the validity of the genera *Glyphioceras,* and *Gastrioceras,* and has not been able to separate them satisfactorily. Neither have Haug and J. P. Smith; but as it certainly is desirable to divide these forms and as generally only extreme cases are doubtful

[1]Hyatt, Gen. of Foss. Ceph., p. 327.
[2]Karpinsky, Amm. d. Artinsk-Stufe, p. 45, et. seq.
[3]Smith, J. P. Carb. Amm. of America, p. 83.
[4]Haug, Et. s. l. Goniatites, p. 26.
[5]Smith, J. P., Carb, Amm. of America, p. 62.

it may be best to let the question rest as it is until some author can review all the paleozoic forms which belong to these groups.

Tchernow evidently thought that something would be gained by further subdividing Gastrioceras and thus he united the species from the Artinsk under the name of *Paragastrioceras.* I have not been able to find if the author ever gave a definition of this new genus and the new species he considered as belonging to it.

If there is to be a subdivision of *Gastrioceras,* there should certainly be established at least a subgenus for the group of *G. Zitteli* Gemmellaro[1]; that is to say, relatively evolute forms with strong transversal ribs at the umbilical shoulder, and strong spiral ribs on the ventral portion and often also on the flanks, the transverse ribs often disappearing in the outer whorls. This group is very well characterized, seems to exist only in the Permian, and has a very wide distribution.

Our material is not rich enough to allow us a subdivision of the genus, but we shall see that two very different groups are represented: one without strong transversal and spiral ribs, but with delicate transversal and spiral lines in our lowermost beds, and another one represented by several species and clearly belonging to the group of *Gastrioceras Zitteli.*

Group of Gastrioceras globulosum M. a. W.

Gastrioceras modestum n. sp.

Pl. II, Fig. 4-27

Shell discoidal, composed of a great number of not very deeply embracing whorls, moderately evolute, flanks and ventral portion broadly rounded. Cross-section nearly semilunar. The umbilical shoulder is very sharp, especially in the younger individuals, a little more rounded but well-marked in the older ones; the umbilical wall is slightly convex and very broad, and the umbilicus is moderately wide. The whorls are much wider than high; the greatest width lies at the umbilical shoulder; from there the shell suddenly bends down, forming a rather sharp edge; the umbilical shoulder, flanks and ventral portion form a single curve, and cannot be distinguished from each other. Each whorl shows three not very deep constrictions; these begin at the umbilical

[1]Gemmellaro. Calc. c. Fusulina, p. 85, pl. 6, fig. 18-23; pl. 7, fig. 14.

seam and at the umbilical shoulder they turn suddenly forward so as to form a curve, the convexity of which is directed toward the front. The body chamber is unknown.

In none of our specimens is the shell well enough preserved to show the ornamentation entirely, but the moulds prove that the principal ornamentation is composed of broad and flat, very low, radial ribs (pl. II, fig. 13). These at the umbilicus are narrow, but widen considerably on the ventral portion, where they are separated by narrow and shallow interstices. The same kind of ornamentation shows also in the interior part of a whorl but there we observe also traces of very fine, spirally revolving lines. The umbilical shoulder seems to have possessed a number of very faint nodules or tubercles.

The septa are well separated from each other. The suture (pl. II, fig. 24-27) is nearly straight on the external part of the whorl and very simple. It consists of a siphonal lobe, divided in two branches by a moderately high median saddle, and of two saddles and two lateral lobes. The branches of the siphonal lobe are lanceolate; the first lateral lobe is funnel-shaped, symmetrical and ends in one single point; the second lobe is very wide and shallow. It lies a little below the umbilical border on the umbilical wall, and also ends in a point. The median sadde of the siphonal lobe is about half as high as the external saddle; it is broad at the base and narrow at the upper end, where it is notched by an indentation. The external saddle is tongue-shaped, high, entire, and nearly symmetrical. The first lateral saddle is much broader but lower than the preceding one. The internal lobes could not be ascertained.

The suture is the common one of *Gastrioceras* or *Glyphioceras.*

Dimensions:	I		II		III		IV	
Diameter	21.0 mm	(1)	16.8 mm	(1)	11.4 mm	(1)	8.2 mm	(1)
Width.	?15.2	0.72	12.2	0.73	10.8	0.95	7.6	0.93
Height of last whorl	7.7	0.37	6.3	0.38	4.5	0.39	3.5	0.43
Diameter of umbilicus, between the umbilieal shoulders..	?	....	6.5	0.39	4.5	0.39	3.4	0.41

Relation to other species:

The present species is not a very characteristic one. It is somewhat similar to *Gastrioceras subcavum* Miller and Gurley[1] but has a narrower umbilicus, and the umbilical shoulders are a little more rounded.

Another species which resembles ours is *Gastrioceras subglobulosum* Meek and Worthen[2] but its umbilical shoulders are a little more rounded, the umbilicus is narrower and the ventral region is much flatter.

Both species have been found in the Cisco formation; it is thus not very surprising that related species should occur in the next higher zone, the base of the Permo-Carboniferous. But in general it is not possible to give much importance to this kind of simple forms which show no characteristic ornamentation and which present a suture line that is general in practically all the species of the genus from the Carboniferous to the Permian.

Age:

Wolfcamp formation, Permo-Carboniferous.

Number of specimens examined:

Thirteen. The species is quite frequent at the locality.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

Group of Gastrioceras Zitteli Gemm.

Gastrioceras roadense nov. sp.

Pl. II, Fig. 28-47

Shell discoidal, evolute, compressed on the flanks, ventral portion rounded in the adult specimens. In the adolescent stages the flanks are less flattened and the ventral portion more rounded; in the young specimens the flanks and ventral portion are evenly curved. The umbilicus is moderately large, forming a very sharp umbilical shoulder in the adult specimens (pl. II, fig. 41), while in the adolescent and young ones (pl. II, fig. 28-41) it is more rounded. The umbilical wall

[1]J. P. Smith, Carb. Amm. of America, p. 97, pl. 17, fig. 15-17.

[2]J. P. Smith, Carb. Amm. of America, p. 89, pl. 6, fig. 1; pl. 21, fig. 7-9.

is broad and very steep. On the cast each whorl shows several moderately deep constrictions which on the flanks have a radial position, but on the ventral portion curve strongly forward. The cross section of the adult specimens is subtrapezoidal, the flanks being flat (pl. II, fig. 41-42) and the ventral portion not very strongly rounded. The height is much greater than the width; the greatest width exists near the umbilical border. In the adolescent stage the flanks are not quite so much flattened (pl. II, fig. 38-40) and the ventral portion more rounded, the whorl being broader than high. In the young specimens (pl. II, fig. 32, 36) the cross-section is semilunar, flanks and ventral region forming an uninterrupted curve, the greatest width still at the umbilical shoulder; but the whorl is much broader than high.

Several specimens preserve the ornamentation. As does everything else in this species, this ornamentation changes with the stages of age. A very small specimen (pl. II, fig. 28, 29) with about 7.5 mm. diameter shows about twenty-two transversal ribs on the umbilical shoulder. These are broad at their base, sharper but rounded at the top; they are strongest below the umbilical shoulder and disappear on the flanks, and are separated by deep interstices about as broad as the ribs. The flanks and ventral portion show about sixteen to seventeen fine spiral ribs between the umbilical shoulder and the sipho; similar ribs also pass at least over the upper part of the transversal ribs and are best visible in the interstices. The spiral ribs are rounded and separated by narrow furrows.

On a specimen of about 26.5 mm. diameter (pl. II, fig. 38-40), the transversal ribs on the umbilical shoulder begin to disappear; they are slightly inclined forward, are very short, show only on the umbilical shoulder and on the upper part of the umbilical wall, and disappear at the beginning of the flank. They are low, rounded and separated by rounded furrows which are narrower than the ribs. These latter appear to be about thirty-five on the whorl. On the umbilical shoulder, the flank and the ventral region, we count between the umbilical border and the sipho, thirty-one spiral ribs. The first two of these at the umbilical shoulder are separated by a wider interstice; all the others are practically at equal distances from each other. The ribs are rounded and separated by very narrow furrows. These spiral ribs cross the transverse ones in their whole length. The spiral ribs are

crossed by a great number of lines of growth strongly inclined forward. This gives them the aspect of twisted cord.

In a larger whorl (pl. II, fig. 41) which must have had a diameter of at least 50 mm., and which belongs to the specimen described immediately above, the ornamentation changes again. The transversal ribs have disappeared entirely, the spiral ribs are very low, rounded and broad. Another and still larger specimen (pl. II, fig. 42) shows that there are sixteen ribs between the umbilical border and the ventral shoulder and about seven or eight more between this and the sipho, so that some of the spiral ribs must have disappeared too. They are separated from each other by shallow interstices with rounded bottom as wide as the ribs.

The septa practically form a straight line and are well separated from each other The external suture (pl. II, fig. 43-46) consists of the siphonal lobe, two lateral lobes and two saddles. The siphonal lobe is divided into two branches by a comparatively high tapering median saddle, notched at the top. Both branches are very narrow in the young individuals, but broader at the upper side in adults. The external saddle is high and narrow even in the adult specimen. The first lateral lobe is long, tongue-shaped, well pointed and narrow, in the younger individuals; but only a little less wide than the external saddle, in adults. The first lateral saddle is much lower than the external one and also broader. The second lobe is on the umbilical wall; it is broad, shallow, pointed, and funnel-shaped.

The internal suture (pl. II, fig. 47) is known only in a small specimen (diameter, about 14 mm.) It consists of a funnel-shaped, not sharply pointed antisiphonal lobe, a tongue-like internal saddle, a first lateral lobe similar in form to the antisiphonal one, but a little shorter, and a first lateral saddle about as high as the internal saddle, but about twice as broad.

Dimensions:

	I	II		III		IV		V	
Diameter. . . .	.?	26.5 mm	(1)	11.6 mm	(1)	8.8 mm	(1)	6.2 mm	(1)
Width.	24.3 mm	13.4	0.51	7.3	0.63	5.8	0.66	4.3	0.69
Height of last whorl.	28.2	11.6	0.44	5.0	0.43	3.5	0.41	2.4	0.39

Diameter of umbilicus (between umbilical shoulders. . .	?	7.7	0.29	3.9	0.34	3.0	0.34	2.4	0.39

Relation to other species:

Our species belongs without doubt to the group of *G. Zitteli* Gemm.[1] but is certainly much less evolute. It resembles, perhaps still more *Gastrioceras sosiense* Gemm.[2] but also in this species the umbilicus is relatively larger while the transversal ribs at the umbilical shoulder are shorter and less conspicuous.

None of the *Gastrioceras* from the Russian Artinsk is very similar to our species, *G. Jossae* Vern.[3] being much more evolute; while *G. Suessi* Karp.[4] lacks the strong transversal ribs on the umbilical shoulder. The other species of *Gastrioceras* of the Artinsk apparently belong to entirely different groups.

None of the carboniferous *Gastrioceras* much resembles our species. Much more similar than any other one is perhaps *G. altudense* n. sp., but it has a smaller number of spiral ribs and the umbilical ribs are quite different.

Age:

Word formation, Permo-Carboniferous

Number of specimens examined:

Ten. The species is by no means very rare, but generally not very easy to collect.

Locality:

Junction of Road and Gilliam Canyons; hill north of Leonard Mountain, Glass Mountains.

Gastrioceras altudense n. sp.

Pl. III. Fig. 1-6

Shell discoidal, evolute, compressed on the flanks, rounded on the ventral region; cross-section parabolical, greatest width at the um-

[1]Gemmellaro, Calc. c. Fusulina, p. 85, pl. 6, fig. 18-20; pl. 7, fig. 17.
[2]Gemmellaro, loc. cit., p. 88, pl. 7, fig. 17-19.
[3]Verneuil, Géol. de la Russie, II, p. 370, pl. 26, fig. 2 (not 3).
[4]Verneuil, Géol. de la Russie, II, p. 371, pl. 26, fig. 3.
Karpinsky, Amm. d. Artinsk-Stufe, p. 52, pl. 3, fig. 3.

bilical shoulder; whorl not much broader than high. Umbilicus moderately wide and shallow, umbilical wall not very steep, umbilical shoulder not very sharp but rather rounded. No constrictions visible on the shell (cast unknown).

The ornamentation of this species (pl. III, fig. 1, 3) is very characteristic. There are about twenty-five transversal ribs which begin at the upper end of the umbilical wall, cross the umbilical shoulder and disappear rather suddenly a little below the middle of the flank. These ribs are all slightly inclined forward, and are crossed by some spiral ribs which cause about three tubercles on each of them. The transversal ribs are comparatively high and sharp but not very broad; they are separated from each other by wide and deep furrows with round bottom. The spiral ribs mentioned appear not only on the transversal rib but on the whole flank and the ventral region. There are seven ribs on each flank; they are relatively thin and high, sharp, and separated from each other by wide and round furrows. On the ventral part there are about six ribs (three on each side of the sipho) which stand much nearer together than those on the flanks. Near the last part of the whorl a new rib begins between the fifth and sixth rib on the flank (counted from the umbilicus), which indicates that larger specimens would show a larger number of spiral ribs.

The septa of this species are unknown.

Dimensions:[1]

Diameter	25.7 mm	(1)
Width	10.0	0.39
Height of last whorl	9.5	0.37
Diameter of umbilicus:		
From seam to seam	8.5	0.33
From shoulder to shoulder	11.8	0.46

Relation to other species:

Although it was not possible to find the suture of this species there does not remain any doubt about its belonging to *Gastrioceras* and especially to the group of *G. Zitteli* Gemm. None of the species so far described is very similar to ours, the nearest being perhaps *Gastrio-*

[1]The dimensions were not measured at the place of the largest diameter, because the specimen is somewhat crushed there.

ceras Waageni Gemm.[1] but in this latter species the transversal ribs are much more numerous, the spiral ribs are finer, and the umbilicus is wider.

The transversal ribs in our species are rather similar to those of *G. Jossae* Vern.[2] but the spiral costae are much finer in this species.

From our *G. roadense* n. sp., the present species is easily to be distinguished by its wider umbilicus, the longer transversal ribs and the smaller number of spiral costae.

Age:

Leonard formation, Permo-Carboniferous. The horizon is not absolutely certain. The species was found by Dr. J. A. Udden. Judging from the rock, it comes from the Leonard formation. The second specimen, collected also by Udden, probably comes from a place about three miles south of Bird's Mine, in the Altuda Mountain region; at least, it was kept together with fossils from the Leonard formation of that place.

Number of specimens examined:

Two. According to Dr. Udden the species is rather frequent at one of the localities, but most of the specimens were poorly preserved.

Locality:

About two miles southwest of Altuda station (Southern Pacific Railway), South of Bird's mine near the instrusive plug on Capt. James's ranch.

Gastrioceras sp. nov. indet.

Pl. III. Fig. 7-8

Shell discoidal, very evolute, compressed on the flanks, rounded on the ventral region; cross-section parabolical, greatest width a little above the umbilical border; whorl very little broader than high. Umbilicus very wide and shallow, no umbilical shoulder developed, the flank curving down to the umbilical wall which is narrow and not well limited. No constrictions are visible on the shell of the fragment, the cast being unknown.

[1]Gemmellaro, Calc. c. Fusulina, app. p. 25, pl. D. fig. 24-26.

[2]Verneuil, Géol. de la Russie, II, p. 370, pl. 26, fig. 2 a-c (not fig. 3).

The ornamentation of this species is extremely characteristic; it consists of a great number of transversal ribs on the flank. These begin at the umbilical seam, and are slightly bent forward. They are straight on the lower two-thirds of the flank and then curve strongly forward and end at the ventral shoulder. These ribs are high and sharp, steeper on the back side than on the fore side. On the ventral region we observe six spiral ribs, three on each side separated by a somewhat broader furrow along the sipho. Another very faint rib shows where the transversal ribs end. The spiral ribs are low and rounded, separated by relatively narrow furrows.

A remnant of the suture line is visible on one flank and as far as it goes, corresponds to that of *Gastrioceras.*

Dimensions:

Diameter	33.6 mm	(1)
Width	10.3	0.31
Height of last whorl	9.0	0.27
Diameter of umbilicus between the seams	17.7	0.53

Relation to other species:

There does not remain much doubt that the present species belongs to *Gastrioceras* although the suture line is very imperfectly known; especially the form of the siphonal lobe could not be observed.

Among the Russian and Sicilian species there is none which could be confounded with our form. It may perhaps be related to *Gastrioceras Waageni* Gemm.[1], but the transversal ribs are not by far as high in that species as in ours, and the spiral ribs are not limited to the ventral portion but cross over the transversal ribs as in our *G. altudense.*

There is only one species very similar to ours and that is *Gastrioceras* sp., described by Girty[2] from the Delaware Mountain formation. This species shows the transversal ribs passing over a great part of the flanks, while spiral ribs cover the ventral portion. Girty's species is much less evolute than ours and the number of transversal ribs is much smaller so that there is no doubt about their being specifically different.

Our species is certainly a new one and possibly even the representative of a new group, as the relationship to that of *G. Zitteli* is not a

[1]Gemmellaro, Calc. c. Fusulina, App., p. 25, pl. D, fig. 24-26.

[2]Girty, Guadalupian fauna, p. 500, pl. 29, fig. 22.

very near one. I wish to indicate that if it were not for the spiral costae on the ventral part, one might be inclined to place the species in *Paraceltites;* but in this latter genus the ventral portion is nearly smooth and the transversal ribs disappear gradually between the ventral shoulder and the sipho.

On account of the imperfect state of preservation we avoid naming this species.

Age:
Word formation, Permo-Carboniferous.

Number of specimens examined:
One.

Locality:
Junction of Road and Gilliam Canyons, Glass Mountains.

Schistoceras Hyatt emend. J. P. Smith

The genus *Schistoceras* was established by Hyatt[1] for an undescribed and unfigured species with a suture similar to that of *Prolecanites* but differing from it by its large, bottle-shaped, median saddle of the siphonal lobe. It has three pairs of lateral lobes and a small umbilical lobe with two pairs of dorsal lobes, the two branches of the siphonal lobe being widely separated. The lobes are hastate and the saddles more rounded and club-shaped.

J. P. Smith[2] was the first to figure the type species (*Schistoceras Hyatti* Smith) although Haug[3] had already illustrated another species (*Sch. Hildrethi* Mort.) of this genus, but considered it to belong to *Agathiceras.* J. P. Smith recognized the difference between this latter genus and *Schistoceras* and explained it in the following manner: "This genus undoubtedly resembles *Agathiceras,* but appears to differ in the constant number of lobes and saddles; one external lobe divided deeply by a bottle-shaped siphonal saddle, three lateral lobes decreasing in length toward the umbilicus; a short pointed lobe

[1]Hyatt, Gen. of foss. Ceph., p. 336.
[2]J. P. Smith, Carb. Amm. of North America, p. 104.
[3]Haug, Etudes sur les Goniatites, p. 105, pl. 1, fig. 40.

on the umbilical shoulder; and the internal lobes consisting of a long tongue-shaped, undivided dorsal or antisiphonal lobe and two pairs of lateral lobes. There are, then, in all, ten external and five internal lobes four more than are possessed by *Paralegoceras,* and two more than in *Agathiceras.* . . . The ontogeny of *S. Hyatti* shows unmistakably that the genus is derived from *Gastricoceras* through *Paralegoceras,* and is thus not a member of the Prolecanitidae. It may possibly be an ancestor of the Arcestidae, but that question can be settled only by a study of the ontogeny of the primitive Permian member of this group."

J. P. Smith united in this genus four species: *Sch. fultonense* Miller and Gurley, *Sch. Hildrethi* Morton, *Sch. Hyatti* Smith, and *Sch. missouriense* Miller and Faber, all from the Upper Coal Measures of America. In his excellent study of *Sch. Hyatti* the author shows how the suture of the genus develops from the Gastrioceran through the Paralegoceran stage to that of *Schistoceras,* thus demonstrating that this genus is the most complex member of the *Glyphioceratidae.*

So far, *Schistoceras* only has been known from the Upper Coal Measures (Uralian) where it does not seem to be very rare, especially in the upper part (Cisco formation). In the western part of Texas (Glass Mountains) we have found two new species, one in the Carboniferous and another one in strata perhaps about 1000 feet higher in the lowest Permo-Carboniferous, our Wolfcamp formation. The first of those species, *Sch. Smithi* nov. sp., occurs in shales with a rich fauna of Pennsylvanian forms; it is relatively rare, one specimen having been found by Dr. J. A. Udden, another one and a fragment by Mr. C. L. Baker. The other species, *Sch. diversecostatum* n. sp., is very frequent near Wolf Camp in the lowermost Permian, Mr. Baker and the writer having been able to collect twenty-four specimens in a short time. It occurs in a marly limestone and shales together with a rich fauna of ammonoids, very few Gastropods, Pelecypods, Brachiopods and a Trilobite.

No *Schistoceras* has been found in any of the higher beds

Schistoceras Smithi nov. sp.
Pl. III, Fig. 9-16

Shell discoidal, involute, compressed laterally, with flanks flattened, venter rounded. Cross-section parabolical, about as broad as high (

even a little broader, the greatest width being at the umbilical shoulder. The involution is one-third of the height of the whorl. The umbilicus is moderately narrow, and deep; the umbilical shoulder is somewhat rounded but fairly distinct; the umbilical wall is broad and perpendicular. No constrictions are visible on the mould. In none of the specimens could any trace of the ornamentation be observed. The body chamber is unknown.

The septa are very near together but do not touch each other. The suture (pl. III, fig. 12, 16) follow a straight line between the sipho and the umbilicus. The siphonal lobe is divided into two branches by a high median saddle. Each of the branches is broad and long, asymmetrical on account of the umbilical side being sinuous, while the siphonal side is only slightly curved; the branch ends in a sharp point. The first lateral lobe is symmetrical, tongue-shaped, pointed, wider at the top than in the middle, much shorter than the branches of the siphonal lobe. The second lateral lobe is broader than the first one but less deep; it is also tongue-shaped and pointed. A small tongue-shaped, or perhaps rather funnel-shaped, pointed auxiliary lobe exists near the umbilical shoulder.

The median saddle of the siphonal lobe is extremely high and very slender, it is broader at the base than at the top, where it is deeply notched by an indentation; the sides are slightly concave, but do not show a constriction. The saddles are all spatulate, rounded above and not constricted. The external saddle is high and narrow, a little higher than the median saddle of the siphonal lobe. The first lateral saddle is comparatively stouter than the external one and about as high as the median saddle of the siphonal lobe. The second lateral saddle is still a little stouter than the first one and also somewhat lower. A small rounded and simple auxiliary saddle lies on the umbilical border, part of its umbilical flank remaining on the umbilical wall. It was impossible to uncover the suture on the umbilical wall and on the dorsal part of the shell.

Dimensions:

Diameter	79.9	(1)
Width	38.0	0.48
Height of last whorl	40.8	0.51
Involution	13.7	0.17
Diameter of umbilicus	14.8	0.19

The dimensions refer to the largest specimen found; the second one is only slightly smaller, but a little crushed. The ratio of dimensions seems to be the same. Both specimens are septate throughout so that the original size must have been much larger.

Relation to other species:

All the species of *Schistoceras* so far described are very similar to each other. This circumstance cannot surprise us much, because the only difference could be in the ratio of dimensions and perhaps slight details of the suture.

Our species is very similar to *Sch. Hyatti* Smith[1], the type species of the genus, but it has a different cross-section, the flanks of our species being more decidedly flattened, while those of the type species are rather rounded (Smith, pl. 20, fig. 8). The ratio of dimensions is not very different, being in our species 1 :0.48 :0.51 :0.17 :0.19 and in *Sch. Hyatti*, 1 :0.51 :0.51 :0.17 :0.20. There are slight differences in the suture. The median saddle of the siphonal lobe is comparatively higher in our species. The saddles are stouter and not constricted, the branches of the siphonal lobe are more asymmetrical, the shape of the second lateral saddle is very different, the greater part of the auxiliary saddle is on the flank, etc.

From all the other species so far described our species apparently differs still more, especially by the greater height of the whorls.

There is no very great difference between the species described here and *Sch. diversecostatum* from the Permo-Carboniferous. This latter one has more rounded flanks and a wider umbilicus; the sutures resemble each other very much, but that of *Sch. Smithi* seems to have stouter saddles.

Age:

Gaptank formation, Pennsylvanian (Uralian).

Number of specimens examined:

Three. The species is rare at the locality.

Locality:

About 2 miles south of Gap Tank, Glass Mountains.

[1]J. P. Smith, Carb. Amm. of North America, p. 108, pl. 20, fig. 1-8; pl. 21, fig. 10-13.

Schistoceras diversecostatum nov. sp

Pl. IV, Fig. 1-36

Shell discoidal, involute, laterally compressed, with slightly rounded flanks and strongly convex venter. Cross-section helmet-shaped, a little broader than high, having the greatest width near the umbilical shoulder. The involution is a little less than one-third of the height of the whorl. The umbilicus is moderately wide and deep; the umbilical shoulder is rounded; the umbilical wall is steep and broad. No constrictions are visible on the casts.

The sculpture changes with the age. A specimen with a diameter of 6 mm. seems to be entirely smooth; a larger one (diameter 9.5 mm.) shows traces of strong spiral ribs, but is not well preserved. Another one (11 mm.) as well as some a little larger (pl. IV, fig. 20-25, 27-31) shows at the umbilical shoulder a row of strong and radially prolonged, rounded nodules separated by broad and shallow interstices with a rounded bottom; both nodules and interstices, as well as the rest of the surface, are covered by fine but very distinct ribs. These lean forward at the umbilical shoulder and on the lower part of the flank, then curve strongly forward with the convexity towards the front where the flank passes into the venter, and then curve again backward, with the convexity backward. These lines are crossed by still finer spiral ribs, especially on the ventral portion, while on the flanks they seem to be missing. They are strongest in the interstices between the sinuous transversal ribs. In a specimen with a diameter of 21 mm. the umbilical nodules are still well developed, but the spiral ribs cover also the flanks and cause slight swellings on the transversal ribs, especially on the venter and the upper part of the flanks. A still larger specimen (diameter, 28.5 mm.) shows the row of umbilical nodules, but they are more numerous, narrower and more elongated as well as fainter. The spiral ribs show strongly on the whole flank, producing distinct swellings on the transversal ribs; on the median portion of the venter they are much stronger and separated by wider interstices. There they are real spiral ribs that pass over interstices as well as transversal ribs without producing considerable swellings on these latter ones. On a still larger specimen (diameter, 36.5 mm.) the spiral lines are no longer visible and the sinuous transversal ribs are more numerous and fainter on the smaller portion of the whorl, while

on the last portion the sculpture seems to disappear entirely and the shell appears entirely smooth, with faint undulated lines of growth.

The body chamber is unknown. All the specimens are septate throughout.

The septa are near together and in the smaller whorls almost touch each other in certain places. The suture (pl. IV, fig. 26, 36) follows a straight line between the sipho and the umbilicus. In a specimen with a diameter of 12 mm. the paralegoceran stage of the suture is still visible in the lower half of the whorl, while in the largest portion we find already the schistoceran stage. From here on, the suture does not change materially, as is shown in our pl. IV, fig. 26, 36; one figure representing a suture at a diameter of 26.0 mm. and another one at a diameter of 45.0 mm.

The siphonal lobe is divided into two branches by a high median saddle. Each of the branches is broad and long, asymmetrical on account of the umbilical side being sinuous while the siphonal side shows a simple curve; the branch ends in a sharp point, and it is a little narrower at the top than in the middle. The first lateral lobe is also asymmetrical, the lateral convexity being higher on the siphonal than on the umbilical side; it is generally tongue-shaped, pointed, a little narrower at the top than in the middle, and slightly shorter than the branches of the siphonal lobe. The second lateral lobe is about as wide as the first one and similarly shaped but considerably shorter. A small funnel-shaped, pointed auxiliary lobe exists still on the lower part of the flank.

The median saddle of the siphonal lobe is very high and slender, broader at the base than at the top, where it is notched by an indentation; it is slightly constricted above the base. The saddles are all spatulate, rounded above and slightly constricted (with exception of the auxiliary saddle). The external saddle is much higher than the median saddle of the siphonal lobe and very narrow. The first lateral saddle is a little lower than the external one and a little higher than the median one of the siphonal lobe; it is a little narrower than the external saddle. The second lateral saddle is lower than the first one, but of about the same width. In general it may be said that the length of the saddles decreases very gradually from the external to the second lateral saddle. An auxiliary saddle exists near the umbilical shoulder, but is completely visible on the flank. It is considerably lower than the second lateral

saddle although about as broad or even broader. It was impossible to observe the suture on the umbilical wall.

The internal suture (pl. IV, fig. 35) has been observed on a relatively small specimen. The antisiphonal lobe is long, narrow and funnel-shaped. The first lateral lobe is at least as broad as the antisiphonal one, and more than one-half deeper; it is also funnel-shaped. The second lateral lobe is funnel-shaped, broad, and only half as deep as the first one.

All the internal saddles are rounded at the top and tongue-shaped. The internal saddle is only very little higher than the first lateral. The second lateral saddle is much lower; one of its flanks is on the umbilical wall.

	I		II		III		IV		V	
Diameter:	48.3mm	(1)	36.5mm	(1)	26.0mm	(1)	16.7mm	(1)	4.2mm	(1)
Width:	23.8	0.49	19.3	0.53	15.0	0.58	11.7	0.70	3.4	0.81
Height of last whorl:	23.1	0.48	17.6	0.48	12.3	0.47	7.5	0.45	1.8	0.43
Diameter of umbilicus:	11.4	0.24	8.7	0.24	6.5	0.25	4.1	0.25	1.1	0.26
Involution:	8.3	0.17	6.0	0.16	4.4	0.17	2.0	0.12	0.5	0.12

Even the largest specimen found is septate throughout; the complete shell therefore would be much larger than our number 1.

Relation to other species:

All the species of *Schistoceras* resemble each other externally very much. The principal differences are found in the ratio of dimensions, the figure of the cross-section and in the details of the suture. *Sch. diversecostatum* n. sp. differs from *Sch. Smithi* n. sp. principally by its larger umbilicus and the more rounded flanks; further, the saddles of the suture are more slender and slightly constricted, the auxiliary saddle is broader and entirely on the flank, while in the older species it is partly on the umbilical wall.

From *Sch. Hyatti* Smith[1] it differs principally by its wider umbilicus in the mature stage, while in the immature stages the umbilicus is much wider in *Sch. Hyatti*. At a diameter of 42 mm. we find the ratio between diameter and umbilicus in this latter species to be 1:0.23, while in one of ours (I) it is 1:0.24; in a specimen with a diameter of 21 mm. it is in *Sch. Hyatti* 1:0.28, while in a specimen of ours with a diameter of 16.7 mm. it is still 0.25; in a specimen of *Sch. Hyatti*

[1]J. P. Smith, Carb. Amm. of North America, p. 108, pl. 20, fig. 1-8; pl. 21, fig. 10-13.

with a diameter of 10.5 mm. it is 1 :0.38, and in a still smaller one with a diameter of 7.75 mm. it is 1 :0.35, while in our smallest specimen with a diameter of 4.2 mm. it is 1 :0.26. A similar difference can be shown to exist in the ratio of width and height of the last whorl; in general the height of the whorls is always comparatively greater than in similar specimens of *Sch. Hyatti.* A great difference exists between the two species with regard to the internal suture, the first lateral lobe being much longer than the antisiphonal lobe in our species, while in *Sch. Hyatti* it is much shorter.

The other species of *Schistoceras* so far described seem to be much more different yet, although some of them are still imperfectly known.

Age:

Wolfcamp formation, lowest Permo-Carboniferous. The present species is of certain interest insofar as it represents the first *Schistoceras* found in the Permo-Carboniferous.

Number of specimens examined:

Twenty-five. The species is rather common at the only locality where it has been found.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

Paralegoceras Hyatt

Hyatt established this genus for forms similar to *Gastrioceras,* but with higher arched whorls, narrower umbilicus and less prominent ornamentation, but with sutures similar to *Gastrioceras.*

Karpinsky later on has shown that the suture line offers a possibility of distinguishing both genera, *Paralegoceras* having ten lobes against eight of *Gastrioceras,* counting the two branches of the siphonal lobe as a single lobe. The pair of lobes which *Paralegoceras* has in excess of *Gastrioceras* is the second lateral one, which is visible on the flank, while in *Gastrioceras* only one lateral lobe is visible on the flank. Thus those forms which show two lateral lobes on the flank should be considered as belonging to *Paralegoceras.* But sometimes, in *Gastrioceras,* the auxiliary lobe which generally lies on the umbilical

wall, appears on the flank; such is the case of *Gastrioceras russiense* Tzwetaev[1], but Karpinsky[2] has shown that this species has only eight lobes and that it thus belongs to *Gastrioceras.*

We shall show that we have a form in our fauna which possibly belongs to *Paralegoceras* but that as it has not been possible to uncover the internal suture the genus cannot be determined with certainty.

Paralegoceras incertum nov. sp.

Pl. V, Fig. 1-13

Shell subglobose, involute, rounded on the flanks and on the ventral region; cross-section of the whorl nearly hemispherical, greatest width at the umbilical border, whorl much broader than high. Umbilicus very narrow, apparently deep and with a steep umbilical wall. The umbilical border shows a thickened portion which could almost be considered as a broad, rounded, spiral rib that accompanies the umbilical shoulder. No constrictions are seen on the cast. The body chamber is unknown.

The septa are very simple (pl. V, fig. 6, 13). The siphonal lobe is divided in two branches by a median saddle; each of the branches is narrow and pointed. The first lateral lobe is f unnel-shaped and pointed, a little deeper than the branches of the siphonal lobe and much broader than either of them. A second lateral lobe is visible on the flank; it reaches nearly as far down as the first one, but its umbilical flank is much lower. The median saddle of the siphonal lobe is high and slender, slightly constricted near the middle and notched at the top. The external saddle is high, tongue-like but not very broad. The first lateral saddle is not quite as high as the external saddle, but much broader at the base. A second very low and rounded saddle is visible on the spiral swelling along the umbilical border, so that possibly an auxiliary lobe may exist on the umbilical wall, but this could not be observed.

On one of the casts traces of radial, wave-like, low ribs can be distinguished. They seem to be strongly curved forward on the ventral region.

[1]Marie Tzwetaev, Ceph. d. Calc. Carb. de la Russie Centrale, p. 42, pl. 6, fig. 30-34.
[2]Karpinsky, Amm. d. Artinsk-Stufe, p. 47, fig. 28-a.

Dimensions:

	I		II	
Diameter	13.3 mm	(1)	6.8 mm	(1)
Width	13.0	0.98	7.2	1.06
Height of last whorl	6.7	0.50	3.1	0.46
Diameter of umbilicus	1.7	0.13	0.7	0.10

Relation to other species:

We have already remarked in our discussion of *Paralegoceras* that the generic position of the present species is not quite certain. For *Gastrioceras* as well as for *Paralegoceras,* the form is too involute, but the suture evidently places it in one of the two genera. I do not know any species which could be compared with the present one.

Age:

Wolfcamp formation, Permo-Carboniferous.

Number of specimens examined:

Three. The species seems to be very rare at the locality; it is not quite certain that the third specimen belongs to it.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

THALASSOCERATIDAE Hyatt

Prothalassoceras nov. gen.

Type, Prothalassoceras Welleri Böse

Gemmellaro's genus *Thalassoceras* shows a very simple suture line which consists of an extremely wide siphonal lobe divided in two branches by a high median saddle; two lateral lobes, strongly digitate or dentated; and two saddles broad at the base, dentated on the flanks, rounded at the top, and with simple outline.

Among the species described by Gemmellaro is *Th. varicosum*[1] which shows a peculiar but simple suture at a diameter of 7 mm. It is so different from the mature suture of the other species that it probably has to be considered as a stage in the development of *Thalassoceras.*

Karpinsky[2] has described from the Russian Artinsk a *Thalassoceras Gemmellaroi* which shows a similar, although perhaps still a little simpler, suture. The specimen has a diameter of 11 mm. The suture is made visible at the front end of the last whorl; at the back end it is still somewhat simpler.

As Karpinsky's specimens are still relatively small, the largest one having a diameter of 11 mm. and the smaller one of 6 mm., one might be inclined to take that suture also only for a stage in the development of *Thalassoceras,* but we find in our Texas Permo-carboniferous a species which is certainly adult, having a diameter of more than 47 mm., and which shows in general the same suture as *Th. Gemmellaroi* and as the immature *Th. varicosum.* As this form is certainly older than the Sicilian species, we have to consider it as a new genus and as an antecessor of *Thalassoceras;* its suture line being passed through by *Thalassoceras* in its first stages. Until now only one specimen has been found, so that it was impossible to prepare the sutures of the smaller whorls.

Our new genus (pl. V, fig. 14-18) shows the following character: Shell discoidal, extremely involute, with compressed flanks and rounded

[1]Gemmellaro, Calc. c. Fusulina, p. 72, pl. 5, fig. 20-22; pl. 7, fig. 33, 34.
[2]Karpinsky, Amm. d. Artinsk-Stufe, p. 80, pl. 4, fig. 3a-d.

venter. The cross section is more or less parabolical, much higher than broad, the greatest width being found near the umbilical border. Umbilicus practically closed. Ornamentation consists apparently only of very fine lines that from the umbilicus curve strongly backward; on the upper part of the flank and on the venter no shell is preserved and nothing can be said about the further course of these lines. The body chamber is only partly known; what is preserved of it has the length of about one-third of the last whorl.

The septa are well separated from each other. The suture (pl. V, fig. 17, 18) forms a nearly straight line between the sipho and the umbilicus. It is extremely simple, being composed only of a siphonal lobe, a lateral lobe (a second one probably on the umbilical wall) and two saddles.

The siphonal lobe is extremely broad like that in *Thalassoceras* and divided in two branches by a high median saddle. Each of the branches is broad, and shows seven teeth at the bottom; the size of these increases from the sides to the bottom. The highest one can barely be distinguished. The first lateral lobe is narrow and about as deep as each of the branches of the siphonal lobe and is a little less symmetrical than the last one. It also has seven teeth at the bottom, but while in the siphonal branch the largest one is practically in the middle, it is nearer to the umbilical side in the first lateral lobe. A second lobe which must be very small and which could not be made entirely visible, must exist in the umbilical region.

The median saddle in the siphonal lobe is high, not very broad, slightly notched at the top, a little broader at the base than above. The external saddle is narrow, higher than the median saddle of the siphonal lobe, and rounded at the top. The first lateral saddle is much lower than the external saddle, but broader; it is rounded from the base up to the top, and its outer flank disappears in the umbilical region.

Comparing this sutural line with that of *Thalassoceras Gemmellaroi* Karp.[1] we see that there is no essential difference between the two, but that the suture of the typical *Thalassoceras,* as for example, *Th. Phillipsi*[2] or *Th. subreticulatum,*[3] is entirely distinct through its digitate lobes, which are divided into two dentate halves by a deeper indenta-

[1]Karpinsky, Amm. d. Artinsk-Stufe, p. 80, fig. 3, a-d.

[2]Gemmellaro, Calc. c. Fusulina, pl. 10, fig. 15 (not 12, as indicated in the text).

[3]Gemmellaro, ibid., pl. 10, fig. 6.

tion in the middle, by the presence of a second lateral lobe on the flank, and by the strongly scalloped saddles, which are rounded only at the upper end. The suture of the typical *Thalassoceras* is much more developed than that of *Prothalassoceras,* which is easily explained by their different age.

Judging by the suture alone, *Th. Gemmellaroi* Karp. should be included in our new genus, but as there is only a very small specimen known, the generic position of that species will remain to a certain degree doubtful until the examination of a larger one will show if the suture develops to that of the Sicilian *Thalassoceras* or retains the outline figured by Karpinsky; which latter case I think to be the more probable.

Prothalassoceras has been found only at the base of our Hess formation, a horizon which has yielded but one other cephalopod until now, and which in general contains only a great number of Fusulinidae and a few brachiopods. The bed where the new genus was found is far below those strata which correspond in age to the Sosio beds of Sicily.

Prothalassoceras Welleri nov. sp.

Pl. V, Fig. 14-18

Shell discoidal, extremely involute, with compressed flanks and rounded venter, but without a development of ventral shoulders; cross-section more or less parabolical, much higher than broad, the greatest width being found in the umbilical region. Umbilicus practically closed, no umbilical shoulder developed, the flank bending gradually down towards the umbilicus. The only ornamentation which could be discovered is found on some of the shell preserved on the flank near the umbilical region and consists of fine lines that from the umbilicus curve strongly backward; on the upper part of the flank and on the venter the shell is not preserved and nothing can be said about the further course of those lines. The body chamber is only in part known; what is preserved of it has the length of about one-half of the last whorl.

The septa are well separated from each other and the suture is straight between the sipho and the umbilicus; it is extremely simple (pl. V, fig. 17, 18), being composed of the siphonal lobe, a lateral one

and two saddles. The second lateral lobe may perhaps exist on the umbilical wall, but could not be observed.

The siphonal lobe is extremely broad. A median saddle divides it in two branches which are broad, wider above than below, with a bottom that has the general outline of a half circle, but which is serrated by seven teeth, the size of which increases from the upper side of the lobe toward the bottom. The first lateral lobe is narrower but about as deep as the siphonal lobe, though less symmetrical; its deepest part on which the longest tooth shows, lies nearer to the umbilical side, and there are more teeth on the ventral side than on that near the umbilicus, while in the branches of the siphonal lobe the longest tooth is about in the middle of the bottom and the number of teeth is more or less the same on both sides. No second lobe appears on the flank, but it may exist on the umbilical wall, which is covered.

The median saddle in the siphonal lobe is high, not very broad, slightly notched at the top, a little broader at the base than at the upper end. The external saddle is narrow, higher than the median saddle of the siphonal lobe, and rounded at the upper end. The first lateral saddle is much lower than the external, but broader; it is rounded from the base up to the top, and its outer flank disappears in the umbilical region.

Dimensions:

Diameter	47.5 mm	(1)
Width	23.7	0.50
Height of the last whorl	28.7	0.60
Diameter of umbilicus	Umbilicus practically closed	

Relation to other species:

The only species which seems to be nearer related to ours is *Thalassoceras Gemmellaroi* Karp.[1] The external shape is very similar to that of *Proth. Welleri,* if we take into account that it is a very small specimen. The ratio of diameter, width and height of the last whorl is 1:0.55:0.55, but it is extremely probable that larger specimens will have whorls that are higher than broad. The suture is very similar to that of our species in its general outline, although there are differences in the details. For example: the first lateral saddle is much broader in the Russian species, the teeth in the lobes are comparatively

[1]Karpinsky, Amm. d. Artinsk-Stufe, p. 80, pl. 4, fig. 3, a-d.

larger, the first lateral lobe is broader than the branches of the siphonal, the sides of the saddles still show teeth in places where they are entirely smooth in our species. Some of these differencs may disappear in larger specimens, but others, for example, the relative width of the branches of the siphonal lobe of the first lateral, are probably permanent. The Russian species may consequently belong to *Prothalassoceras,* but it is certainly specifically different from ours.

Age:

Conglomerate at the base of the Hess formation, Permo-Carboniferous.

Number of specimens examined:

One. Together with Mr. C. L. Baker, I have searched for a long time at the locality without being able to find any other Cephalopod, although other fossils were present.

Locality:

About 2½ miles N 20° E from the old oil derrick on Wedin's ranch at the foot of the first range of hills, Glass Mountains.

TROPITIDAE Mojsisovics

CELTITINAE Mojsisovics

Paraceltites Gemm.

The genus *Paraceltites* has been established by Gemmellaro[1] for discoidal, very evolute shells, with transversal straight ribs ending before they reach the venter and becoming more numerous and sigmoidal on the larger whorls; body chamber longer than one whorl, simple lobes consisting of an undivided siphonal lobe, one lateral lobe and a second one on the umbilical wall, and two saddles, all of them rounded and simple.

The type of the genus is *P. Hoeferi,* from the Sosio beds.

Gemmellaro considered *Paraceltites* as belonging to the *Tropitidae* and as being especially similar to *Celtites,* although the latter one has a divided siphonal lobe. This view has been accepted by J. P. Smith[2] who regards *Paraceltites* as the oldest member of the subfamily Celtitinae.

Frech[3] does not share this opinion but tries to unite *Paraceltites*[4] with *Paralecanites* Diener[5] but this view is opposed by Diener,[6] Hyatt and J. P. Smith[7], who base their objections on the difference in the form of the siphonal lobe which in *Paraceltites* is undivided while in *Paralecanites* it has a median saddle; and on the difference in ornamentation.

Paraceltites is a widely spread genus. It was originally described from the Sicilian Sosio beds, but later on it has been found in the Pyrenees.[8] The species, however, could not be determined. It was also shown to exist in Croatia[9] where *Paraceltites Hoeferi* occurs in a sandstone and is associated with a number of ammonoids identical with

---

[1]Gemmellaro, Calc. c. Fusulina, p. 73.

[2]J. P. Smith, Middle Triass, Marine Invert. Faunas of N. A., p. 33; J. P. Smith in Eastman-Zittel, Textb. of Paleontology, 2nd ed., p. 640.

[3]Fr. Frech, Palaeozoische Faunen a. Asien u. Nordafrika, p. 56.

[4]Fr. Frech, Lethaea paleoz., Bd. II Lief 3, p. 552.

[5]Diener, Amm. u. Orth. i. südtirol, Bellerophonkelk, p. 66, pl. 1, fig. 3-8.

[6]Diener, Stell. d. Amm. d. südalp. Bellerophonkalkes, p. 436-440.

[7]A. Hyatt and J. P. Smith, Triass. ceph. gen. of America, p. 136.

[8]Caralp, Le Permien de l'Ariège.

[9]D. V. Vogl, Paläodyas v. Mrzla-Vodica, i. Kroatien.

species from the Sosio beds. Girty[1] described a *Paraceltites elegans* from the Guadalupian of West Texas.

A somewhat doubtful species, *Paraceltites* sp. indet., has been described from the Russian Artinsk by Karpinsky[2] and another species, *Paraceltites pseudo-opalinus,* has been cited and figured from China by Frech.[3] The suture of this latter species is not known and its sculpture is a little different from the other species belonging to the genus, although it cannot be denied that a certain similarity in the ground plan of the ornamentation exists.

In our fauna, *Paraceltites* is represented by two species, both from the same horizon and locality. They were found by Mr. Bowman, but all the specimens are rather fragmentary. The suture could be studied only in one of them and seems to be the same as described by Gemmellaro; unfortunately it does not show on the outside of the silicified shell and could be seen only imperfectly on the interior side. The sculpture is like that of the typical *Paraceltites* and there is no doubt that our species belong to that genus.

Paraceltites multicostatus n. sp.

Pl. V, Fig. 19-32

Shell discoidal, very evolute, much compressed on the flanks, rounded on the venter, cross-section of the whorl elliptical, much higher than broad; umbilicus very wide, no sharp umbilical shoulder developed, umbilical wall not very steep, flank curving gradually onto it. The outer whorl covers only part of the venter of the next one.

The sculpture consists of numerous transversal ribs, about forty on the outer whorl, while the next one has not quite thirty. These ribs on the largest whorl are low, broad, rounded on the surface, beginning at the umbilical seam where they are narrow and sharp, widening rapidly on the flank and disappearing when they reach the venter. They are radial or even slightly directed backward at the umbilical wall and border, and from there on bend strongly forward. On the body chamber the ribs become very indistinct and nearly obliterated,

[1]Girty, Guadalupian fauna, p. 499, pl. 25, fig. 12-14.

[2]Karpinsky, Amm. d. Artinsk-Stufe, p. 82, pl. 4, fig. 7.

[3]Fr. Frech, Palaeoz. Faunen a. Asien u. Nordafrika, p. 56, fig. 3-a, b.
Idem, In Richthofen, China, V, p. 190.

but are extremely numerous. On the inner whorl the ribs are very prominent especially at the umbilical border where they develop almost a kind of tubercle; they are also less inclined forward. In the innermost whorls the ribs are practically radial, not very numerous, and much more thickened at the umbilical border and on the lower part of the flank. The interstices between the ribs have a rounded bottom and on the outer whorl are narrower than the ribs while on the inner whorls they are wider. The venter is entirely smooth.

The septa are well separated from each other. The suture could not be made out in its details, it being visible only on the interior side of a half open whorl. It consists of a siphonal lobe, a lateral lobe and two saddles. The siphonal lobe is undivided, as far as could be observed. The lateral lobe is broad, rounded at the bottom and much wider above than below. Both the saddles are rounded and entire; the external saddle seems to be much narrower and higher than the first lateral one.

The internal sutures consist only of an undivided, funnel-shaped, antisiphonal lobe and a rather broad, high, rounded, entire internal saddle.

Dimensions:	I		II	
Diameter[1]	16.8 mm	(1)	12.8 mm	(1)
Width	3.2	0.19	2.8	0.22
Height of the last whorl	5.8	0.35	3.5	0.27
Diameter of umbilicus	6.6	0.39	5.7	0.45

Relation to other species:

P. multicostatus is very similar to *P. Hoeferi* Gemm.[2] but in this latter species the ribs are more sigmoidal and more numerous than they are in ours. The Sicilian species is perhaps even somewhat more evolute than that from the Glass Mountains.

Very similar to our species is also *P. Münsteri* Gemm.,[3] but the ribs appear to be less numerous, especially on the inner whorls, and more sigmoidal on the outer one; it is also much more evolute.

[1]There are fragments among our material which must have had a diameter of at least 25 mm., or more.

[2]Gemmellaro, Calc. c. Fusulina, p. 75, pl. 7, fig. 6-10; pl. 10, fig. 44-46. (Gemmellaro indicates in the text, fig. 1 and 2; while in the explanation of plate 10, he gives the right numbers).

[3]Gemmellaro, ibidem, app., p. 21, pl. D, fig. 17, 18.

Paraceltites elegans Girty[1] has a lesser number of ribs, which on the outer whorl seem to become more sigmoidal. It is somewhat difficult to compare both species because Girty gives only an enlarged figure, but there are some features which distinguish our species well from that of the Guadalupian. The cross-section is entirely different; it is much more elliptical in *P. elegans* than in ours, and there seems to be a comparatively sharp umbilical border developed, at least in the last whorl; which is not the case in any of our specimens.

All the other species of *Parceltites* described so far are still more different than those cited.

Age:

Word formation, Permo-Carboniferous.

Number of specimens examined:

Seven.

Locality:

Two and a half miles N 70° E from the second tank above the headquarters ranch of the Hess Ranch, Glass Mountains.

Paraceltites aff. elegans Girty

Pl. V, Fig. 33-38

1908 *Paraceltites elegans* Girty, Guadalupian Fauna, p. 499, pl. 25, fig. 12-14.

Among our material there is a fragment which is specifically different from all others but which is not complete enough to be described as a new species. Its character is the following:

Shell discoidal, very evolute, much compressed on the flanks, rounded on the venter; cross-section of the whorl elliptical, much higher than broad. Umbilicus wide without a sharp umbilical border; umbilical wall not very steep, flanks curving gradually down to the umbilical seam. The outer whorl covers only the smooth part of the venter.

The sculpture consists of numerous transversal ribs, about twenty-five on the largest whorl and probably about twenty on the next smaller one. The ribs on the largest whorl are prominent, rounded on

[1]Girty, Guadalupian fauna, p. 499, pl. 25, fig. 12-14.

the surface, broad, beginning at the umbilical seam where they are narrow and rounded, widening and flattening on the flank and disappearing when they reach the venter. They are practically straight but lean forward from the umbilicus on. On the next smaller whorl the ribs are similar to those on the largest whorl, with the single exception that they lean a little less forward and that they are still more prominent. On the whorl which follows the second one, the ribs look nearly like broad, elongated, radial tubercles. Interstices with a rounded bottom, and about as wide as the ribs, separate these from each other.

The venter is smooth. The suture is unknown.

Dimensions:

Diameter: about	21.0 mm	(1)
Width	4.0	0.19
Height of the last whorl	6.2	0.30
Diameter of umbilicus, about	9.0	0.43

Relation to other species:

Our specimen has a great general resemblance to the inner whorls of *P. elegans* Girty, although it does not seem to have any sigmoidal ribs. The cross-section is certainly different from that of the Guadalupian form, which is rather more parabolical than elliptical, thus causing a pretty steep umbilical wall at least in the largest wall, while in our specimen the umbilical wall is not steep at all. The ventral portion of *P. elegans* is much more broadly rounded than in our species.

Girty compares his species with *P. Hoeferi* and *P. Halli* but it seems to resemble still more *P. plicatus* Gemm.[1] although in this latter species the ribs are still wider apart. That Gemmellaro's specimen does not show the finer ribbing on the outer whorl does not prove that it does not exist in the largest whorl, because the figured specimen is very small and certainly does not represent more than inner whorls. Its cross-section is similar to that of the Guadalupian form and quite different from that of our outer whorl, although a little more like that of our next smaller whorl. The number of ribs in the Sicilian species is probably equal to that of our species, but smaller than that of *P. elegans* when counted on the whorls corresponding in size.

Our species is certainly different from *P. elegans* as well as from *P. plicatus* but belongs to the same group.

[1]Gemmellaro, Calc. c. Fusulina, app. p. 21, pl. D, fig. 22, 23.

Age:
Word formation, Permo-Carboniferous.

Number of specimens examined:
One.

Locality:
Two and a half miles N 70° E from the second tank above the headquarters ranch of the Hess Ranch, Glass Mountains.

ARCESTIDAE Mojsisovics

POPANOCERATINAE Hyatt

Agathiceras Gemmellaro

The genus was created by Gemmellaro in 1887 for discoidal involute shells with rounded ventral portion showing an ornamentation consisting of spiral striae, a sutural line showing externally three constricted entire saddles and one broad one near the umbilicus, and a siphonal lobe divided by a bottle-shaped saddle notched at the top. In addition there are three lateral lobes of spatulate form in the external sutures.[1] Later on, Gemmellaro[2] was also able to show the outline of the internal lobes. These lobes, according to him, consisted of an antisiphonal lobe; one asymmetrical lateral lobe ending in a sharp point; a high, slender and pointed internal saddle and a first lateral one, very low and very broad.

Mojsisovics[3] and also Karpinsky[4] had united *Adrianites* Gemm. with *Agathiceras,* but other authors, like Haug,[5] J. P. Smith[6] and Tchernow[7] recognized the validity of the genus *Adrianites*, the latter one showing that Karpinsky's *Agathiceras Stuckenbergi* belongs to *Adrianites.* We shall discuss the difference between the two genera later on in our paragraph on *Adrianites.*

Agathiceras has been found in the highest Carboniferous of North America (*A. ciscoense* Smith) and Russia (*A. cfr. uralicum*) but it seems to be very rare in those strata. In the Permo-Carboniferous, on the contrary, *Agathiceras* is exceedingly common. Karpinsky, Krotow and Tchernow evidently found quite a number of specimens in the Russian Artinsk. Gemmellaro, who describes three different species, says that *A. Suessi* is the most common of all the ammonoids of the Sicilian Permo-Carboniferous. Frech says that *A.* cfr. *Suessi* is not

[1]Gemmellaro, Calc. c. Fusulina, p. 76, et. seq.
[2]Idem, ibid, App., p. 23, pl. C, fig. 20 (not mentioned in the explanation of the plate).
[3]Mojsisovics, Arkt. Trias-Amm., p. 19.
[4]Karpinsky, Amm. d. Artinsk-Stufe, p. 63, 84.
[5]Haug, Les Amm. du Perm. et du Trias., p. 394.
[6]J. P. Smith, Carb. Amm. of America, p. 130.
[7]Tchernow, L'ètage d'Artinsk, p. 288, et. seq.

very rare at Tsan-tien in China. Wanner found hundreds of *Agathiceras* at Bitaunu on the island of Timor. In the Glass Mountains we have found numerous specimens of *Agathiceras* in two different strata: the Wolfcamp formation, and the Word formation. In the first one, hundreds of specimens can be collected in a very limited locality, while in the second horizon another species of *Agathiceras* occurs by the thousand in certain beds. It often nearly covers the surface of some limestone beds.

Agathiceras Frechi nov. sp.

Pl. V, Fig. 39-54; Pl. VI, Fig. 1-26

Shell discoidal, with somewhat compressed flanks and rounded ventral part. Whorls numerous and deeply embracing, cross-section nearly hemispherical in very young individuals, and parabolic in the older ones, the height of the whorl being generally less than the width. The difference is very small in the largest specimens but very great in the smallest; that is to say, the height grows much more rapidly than the width of the whorl. The greatest width lies a little above the umbilicus; at this place the surface of the flanks bends down rather abruptly, although in a curve, toward the umbilicus. The umbilicus is nearly closed; in the largest one (No. 1 of our table of dimensions, pl. V, fig. 39-41) it has a diameter of only 1.0 mm. so that the ratio to the diameter would be only 0.045. Each whorl shows about four deep constrictions in the larger whorls; in the smaller ones (Nos. IX to XI of the dimensions table below) there are even five, but on the innermost (Nos. XII to XIV) they disappear altogether. They are slightly curved forward on the flanks and backward on the ventral region. The body chamber is unknown.

On several specimens the shell is preserved and shows the common spiral ornamentation of *Agathiceras*. In No. XI of our dimension table the spiral ribs are sharp and as broad or even broader than the furrow-like interstices (pl. VI, fig. 9, 14). We count about twenty-six spiral ribs between the umbilicus and the sipho. On No. III of our dimension table (pl. V, fig. 49-54) the spiral ribs are very thin and separated by broad and flat interstices; there are probably not more than thirty ribs between the umbilicus and the sipho. The ribs are

frequently visible also on the casts but generally they disappear with the shell material so that the casts become entirely smooth.

The septa are widely separated from each other even in the innermost whorls. The suture (pl. V, fig. 42, 47; pl. VI, fig. 2) forms a straight line from one umbilicus to the other. The external suture consists of a siphonal lobe divided by a median saddle; of three lateral and auxiliary lobes on each side, connected by three saddles; and of a fourth one in the umbilical region. Each branch of the siphonal lobe is a little broader than the first lateral lobe. These branches, as well as the three lateral lobes, are all of the same form—pointed below, widest below the middle, and narrower at the upper end. They decrease in width and depth from the first lateral to the first auxiliary. The siphonal saddle is high and slender, well constricted in the middle and notched at the top. The external and the first lateral saddle are similar in outline but the first lateral one is lower and narrower than the external; both are nearly symmetrical, entire, rounded at the top and constricted in the middle. The second lateral saddle is a little asymmetrical, showing a deeper constriction on the inner side. It is narrower and lower than the two preceding ones. The first auxiliary saddle is a little lower than the second lateral, but very broad and asymmetrical, the inside flank being much steeper than the outer one.

The internal sutures (pl. VI, fig. 3) are very simple; they consist of a narrow antisiphonal lobe, of triangular form, ending in one single point, and of one lateral lobe, similar in form to the antisiphonal but asymmetrical. These lobes are connected by a tongue-shaped, high internal saddle, and a broad and low first lateral saddle, which unites on the umbilical seam with the first external auxiliary saddle by means of a wide and rather shallow lobe.

The suture corresponds in every detail to that of the type of the genus, *Agathiceras Suessi,* as it was figured by Gemmellaro.[1]

The character of the septa is very constant in our species, even as small a specimen as No. XIII of our dimension table having exactly the same external suture as the largest one.

[1]Gemmellaro, Calc. c. Fusulina, app., pl. C, fig. 20.

Dimensions:

	I	II	III
Diameter	22.0 mm (1)	18.0 mm (1)	16.8 mm (1)
Width	14.0 mm 0.64	11.7 mm 0.65	11.3 mm 0.67
Height of last whorl	13.6 mm 0.61	11.0 mm 0.61	10.2 mm 0.61
Diameter of umbilicus	1.0 mm 0.045	nearly closed	nearly closed

	IV	V	VI
Diameter	14.8 mm (1)	14.3 mm (1)	12.6 mm (1)
Width	10.1 mm 0.68	10.1 mm 0.71	8.8 mm 0.71
Height of last whorl	9.1 mm 0.61	7.8 mm 0.55	7.0 mm 0.56
Diameter of umbilicus	nearly closed	nearly closed	nearly closed

	VII	VIII	IX
Diameter	11.8 mm (1)	10.6 mm (1)	8.2 mm (1)
Width	8.7 mm 0.74	7.8 mm 0.74	6.2 mm 0.67
Height of last whorl	6.6 mm 0.56	5.8 mm 0.54	4.5 mm 0.55
Diameter of umbilicus	nearly closed	nearly closed	nearly closed

	X	XI	XII
Diameter	8.0 mm (1)	7.6 mm (1)	5.9 mm (1)
Width	6.0 mm 0.75	5.7 mm 0.75	4.5 mm 0.76
Height of last whorl	4.4 mm 0.55	4.1 mm 0.54	3.1 mm 0.53
Diameter of umbilicus	nearly closed	nearly closed	nearly closed

	XIII	XIV
Diameter	5.2 mm (1)	2.6 mm (1)
Width	4.1 mm 0.79	2.2 mm 0.85
Height of last whorl	2.7 mm 0.52	1.3 mm 0.50
Diameter of umbilicus	nearly closed	nearly closed

Relation to other species:

Our species is distinct from every other that has been described. In its outer form it resembles most *A.* cfr. *uralicum* Karp.[1] from the upper Carboniferous of Russia, but that species is still more compressed than ours. By taking the dimensions from the figure we get diameter 1, width 0:56, height of the last whorl, 0.51; while at that same height the ratio in our species would be 1:0.65:0.61. The type of *A. uralicum* Karp. from the Artinsk shows a much greater difference. If we take his specimen with a diameter of 23. mm.[2] we find the ratio of 1:0.54: 0.61, while our nearest specimen with 22 mm. diameter has the ratio 1:0.64: 0.61. The umbilicus is nearly closed in *A. uralicum* as well as in ours. The ornamentation of the Russian form is probably a little coarser than in ours.

[1]Karpinsky, Amm. d. Artinsk-Stufe, pl. 4, fig. 4, b, c, d.

[2]Abich, Djoulfa, p. 120.

Similar to our species is also *A. anceps* Gemm.[1] from the Sosio beds of Sicily. The ratio there is in a diameter of 17 mm. equal to 1:0.65: 0.59, while a similar specimen of ours (diameter 16.8 mm.) would have 1:0.67:0.61; but in the Sicilian species the umbilicus is much wider (2 mm.).

Still less similar is *A. Suessi* Gemm.[2] likewise from the Sosio beds, it being much more compressed and having a comparatively wide umbilicus.

All these species show relatively strong transversal striae which are not visible on any of our specimens; but that may depend on the state of preservation.

Our species resembles somewhat *A. ciscoense* Smith[3] but its ornamentation seems to be much finer than that of the Carboniferous species. The dimensions cannot very well be compared as there is only a large specimen of *A. ciscoense* known, with a diameter of 35 mm., which would give a ratio of 1:0.54:0.40. The umbilicus is entirely closed, while in our species it would at that diameter certainly have at least 1.5 mm. Also the sutures are different, *A. ciscoense* showing only a small part of the fourth saddle.

The somewhat doubtful *Agathiceras texanum* Girty[4] has nothing to do with our species; we shall discuss it a little more in detail in our description of *Agathiceras Girtyi* n. sp.

Age:

Wolfcamp division, Permo-Carboniferous.

Number of specimens examined:

More than one hundred.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

Agathiceras Girtyi nov. sp.

Pl. VI, Fig. 27-46

Shell subglobose, rounded on the flanks as well as on the ventral side, very involute. Whorls numerous and deeply embracing, cross-

[1]Gemmellaro, Calc. c. Fusulina, p. 79, pl. 7, fig. 20-22.
[2]Gemmellaro, ibid., p. 77, pl. 6, fig. 1-4; pl. 7, fig. 36.
[3]J. P. Smith, Carb. Amm. of America, p. 131, pl. 21, fig. 17-19.
[4]Girty, Guadalupian Fauna, p. 501, pl. 25, fig. 8.

section nearly hemispherical, broader than high. The greatest width lies in the umbilical region, a little above the umbilicus. The height of the whorls increases much more rapidly than the width, as is shown in our table of dimensions. The flanks curve rapidly down to the umbilicus, which is very small. The outside of the shell does not show any constrictions or varices but on the few moulds collected we observe several deep constrictions, which evidently correspond to the internal varices of the shell. These constrictions are slightly bent backward on the flank and form a deep curve backward on the ventral portion of the shell; this latter curve is much deeper and narrower on the larger specimens than on the small ones. Their number could not be ascertained. The body chamber is unknown.

On most of the specimens the shell is preserved but to it adheres nearly always the inner part of the shell of the next larger whorl so that they show not only the internal ornamentation of the shell but also the internal suture line, which gives the species a very remarkable aspect. Only in some specimens (pl. VI, fig. 39-42) is the external surface of the shell preserved. The ornamentation consists of strong and high spiral ribs separated by wide and flat interstices; we count about thirty-three ribs between the umbilicus and the sipho. On the internal side of the shell the ribs appear as narrow and deep furrows and the interstices as broad and slightly rounded ribs. No lines of growth are visible.

The septa form a straight line and are widely separated from each other. The external suture (pl. VI, fig. 43-45) consists of the siphonal lobe divided by a median saddle, three lateral and auxiliary lobes and four saddles. Each branch of the siphonal lobe is about as broad as the first lateral lobe but is also a little deeper. The two lateral lobes are of a similar form, being wider in the middle than above, and pointed in the lower part. The first auxiliary lobe is a little wider than the other two and broadens towards the upper part. The three lobes decrease in depth from the first toward the third. The median saddle of the siphonal lobe is high, slender, constricted near the middle and notched at the top by an indentation. The external and the two lateral saddles are similar in outline but decrease in height from the external toward the second lateral. They are high, slender, entire, rounded at the top and constricted above their base; the first auxiliary

saddle is very broad, low, asymmetrical, much steeper on the inner flank than on the outer one. In the larger specimens the lobes are slightly pointed and the auxiliary saddle is a little higher

The internal lobes (pl. VI, fig. 46) are very simple. They consist of a deep funnel-shaped, antisiphonal lobe, a very similar but shallow first lateral one, a triangular internal saddle, and a very broad and low lateral saddle. Between this and the first auxiliary external saddle there must exist a broad but shallow lobe with its deepest point immediately upon the umbilical seam; but it could not be observed directly. The internal lobes do not change materially in the larger specimens.

Dimensions:[1]

	I		II		III	
Diameter	14.8 mm	(1)	14.4 mm	(1)	14.3 mm	(1)
Width	?12.3 mm	0.84	11.1 mm	0.77	11.1 mm	0.78
Height of last whorl	9.2 mm	0.62	8.0 mm	0.56	8.0 mm	0.56
Diameter of umbilicus	1.0 mm	0.068	?1.0 mm	0.069	1.0 mm	0.07

	IV		V		VI	
Diameter	11.8 mm	(1)	11.6 mm	(1)	10.5 mm	(1)
Width	9.1 mm	0.77	9.1 mm	0.78	8.6 mm	0.82
Height of last whorl	6.8 mm	0.58	6.1 mm	0.53	5.8 mm	0.55
Diameter of umbilicus	?		0.8 mm	0.069	?0.7 mm	0.067

	VII		VIII		IX	
Diameter	8.3 mm	(1)	8.0 mm	(1)	7.5 mm	(1)
Width	7.0 mm	0.84	7.1 mm	0.89	?6.2 mm	0.83
Height of last whorl	4.5 mm	0.54	4.5 mm	0.56	4.3 mm	0.57
Diameter of umbilicus	?		0.5 mm	0.063	0.4 mm	0.053

	X	
Diameter	6.4 mm	(1)
Width	5.6 mm	0.88
Height of last whorl	3.1 mm	0.48
Diameter of umbilicus	0.3 mm	0.047

Relation to other species:

The nearest relative of our form is probably *Agathiceras Frechi* n. sp., but it is easily distinguished by its finer spiral ribs, and less subglobose form and the narrower umbilicus.

[1]There are still larger specimens at the same localities, but no specimen could be found well enough preserved to show the exact dimensions. One of these specimens was at least 28 to 30 mm. in diameter; it shows that the height of the last whorl is only a little less than the width. The measurements of the umbilicus in the table above are not quite exact with the exception of the first one.

All the species from the Russian Artinsk and the Sicilian Sosio beds are much more compressed on the flanks and do not show more than a general generic resemblance. The only exception is *A. Krotowi* Karp.[1] which is much broader than our species, and has an entirely different cross-section and a much wider umbilicus. Its suture line also shows a much lower fourth saddle.

The species from the upper Carboniferous of America (*A. ciscoense* Smith) and of Russia (*A.* cfr. *uralicum* Karp.) are much more compressed on the flanks.

Girty[2] has described an *Agathiceras texanum*[3] and this species must be of some interest to us as it comes from a horizon about synchronical to the one in which our species has been found. It is difficult to compare both forms as Girty does not figure the aperture nor the ventral part: as no dimensions are given a comparison is nearly impossible. The general form seems to resemble that of our species, but the umbilicus is certainly wider. Entirely different is the suture line, which in *A. texanum* is curved, and consists of only three saddles. The ornamentation is also certainly different, but its details are not made very clear by Girty's description, although he refers to *Adrianites Stuckenbergi Karp,* as having a somewhat similar one.

The generic position of *A. texanum* is extremely doubtful. The form of the second lateral saddle is different from anything I have seen in typical *Agathiceras,* and there exists evidently one saddle less than in the type of the genus. Girty cites *A. Krotowi* Karp. as having also one saddle less than the type, but Karpinsky says only that the auxiliary or umbilical saddle is narrow and in his figure 7-c, it is clearly shown, while in Girty's species the next saddle seems to belong to the internal suture.

Age:

Word formation, Permo-Carboniferous.

Number of specimens examined:

More than fifty. The species is one of the most common at the different localities.

---

[1]Karpinsky, Amm. d. Artinsk-Stufe, p. 66, pl. 5, fig. 7.

[2]Girty, Guadalupian fauna, p. 501, pl. 25, fig. 8 and 8-a.

[3]Girty changes the name into *Agathoceras,* but I cannot see a reason why that should be done.

Locality:

Junction of Road and Gilliam Canyons; half a mile southeast of the latter point, especially frequent on the hill east of the first locality; mountain north of Leonard Mountain—Glass Mountains.

Adrianites Gemm.

Gemmellaro[1] created the genus *Adrianites* for some more or less globose forms with reticulate ornamentation, with broad ventral part, narrow or closed umbilicus, strong constrictions, long body chamber, curved suture composed of numerous claviform or lanceolate lobes, and saddles constricted at the base, the siphonal lobe being divided into two branches by a median saddle.

Mojsisovics[2] and Karpinsky[3] tried to show that these forms could not well be separated from *Agathiceras,* because the general character of the saddles and lobes is the same, although they are much more numerous in *Adrianites.*

Gemmellaro[4] answered Mojsisovics in the appendix to his work, demonstrating that the internal sutures of both groups were entirely different, *Adrianites* possessing at least five to six internal saddles while *Agathiceras* has only two of an entirely different form.

Karpinsky does not seem to give much importance to these characters, because in an appendix to his work he insists that both groups belong together; but Haug[5], J. P. Smith[6], Diener[7] and Tchernow[8] recognized the validity of the genus *Adrianites* and Smith justly remarks that *Adrianites* represents a much higher stage of development than *Agathiceras* does.

Among our material *Adrianites* is very rare, and none of the specimens could be prepared in such a manner as to show the nature of the internal suture. But the number and form of the lobes and saddles of the external suture line correspond exactly to those of the typical

[1]Gemmellaro, Calc. c. Fusulina, p. 39.
[2]Mojsisovics, Arktische Trias-Amm., p. 19.
[3]Karpinsky, Amm. d. Artinsk-Stufe, p. 63, 84.
[4]Gemmellaro, loc. cit., app. p. 23.
[5]Haug, Les Amm. d. Perm. et. du Trias, p. 394.
[6]J. P. Smith, Carb. Amm. of America, p. 130.
[7]Diener, Perm. foss. of the Central Himalayas, p. 117.
[8]Tchernow, L'étage d'Artinsk, p. 288, etc.

Adrianites. Our species has a certain importance on account of being the first one which has been described from American strata.

Adrianites is much less related to *Agathiceras* than Mojsisovics and Karpinsky thought. The external suture of the first one is certainly composed of the same simple elements as *Agathiceras,* but the internal suture of the latter one is as simple as that of *Glyphioceras,* while *Adrianites* shows a very well subdivided internal suture. A great difference certainly exists also in the form of the aperture. Gemmellaro[1] has shown that *Agath. Suessi* has the ventral part of its mouth bent upwards and the lateral portion inward, while a small depression between both produces two lateral prolongations in the form of beaks. In *Adrianites* the ventral part of the margin of the aperture is convex while on the sides are long prolongations which imitate those of some real ammonites (*Oppelia, Perisphinctes*). The same difference is indicated by the form of the constrictions, which to a certain degree must be parallel to the aperture. *Agathiceras* shows constrictions bent slightly backward in the ventral part, while in *Adrianites* these constrictions in the same place are strongly curved forward. Both genera preserve still the simple ornamentation of the earlier *Goniatites,* but the development of the other elements, sutures as well as form, aperture and length of body chamber, is certainly higher in *Adrianites* than in *Agathiceras.*

I have shown in the description of *Adrianites marathonensis* nov. sp. that even in specimens where the internal suture is not visible, the genus *Adrianites* can be easily distinguished from *Agathiceras* by some features of the external suture. One of these is, of course, the greater number of saddles and lobes generally, although this difference does not exist in all of the species of *Adrianites.* Much more important and characteristic is the form of the siphonal lobe; the two branches of this lobe are always curved and narrow, nearly in the form of a half moon, half as broad as the first lateral lobe, in *Adrianites;* while in *Agathiceras* they are always broad, nearly symmetrical, and about of the size and width of the first lateral lobe. I have shown that this is persistent in every species so far described of *Adrianites,* even where the number of saddles and lobes in the external suture is extremely reduced.

[1]Gemmellaro, loc. cit., p. 78, pl. 6, fig. 2, 4.

Adrianites seems to occur first in the Permo-Carboniferous. The oldest species is probably *Adrianites Stuckenbergi* Karp. from the Artinsk. *Agathiceras* has been found in the Permo-Carboniferous and in the upper Carboniferous of Russia and America.

Adrianites marathonensis nov. sp.

Pl. VI, Fig. 47-56

Shell subglobose, with rounded flank and somewhat flattened ventral part, very involute; whorls numerous and deeply embracing; cross-section almost semi-circular in the younger specimens and a little more sub-trapezoidal in the larger ones. The width of the whorls is much greater than the height, the greatest width lying a little above the umbilical region. At this place the surface of the flank curves gradually down toward the steep but not very broad umbilical wall. The umbilicus is narrow and deep. Each whorl shows about three moderately deep constrictions. These are sinuous on the flanks, in the form of an open S, and from the ventral shoulder begin to curve forward, forming a convexity on the ventral part. The body chamber is unknown.

None of the specimens shows a trace of shell material, so that the ornamentation remains entirely unknown.

The septa do not stand very near together; the external sutural line is slightly curved between the sipho and the umbilicus. It consists (pl. VI, fig. 52, 53) of seven lobes and six saddles, a seventh saddle existing on the umbilical seam. The siphonal lobe is divided into two branches by a low median saddle. Both branches are exceedingly narrow and asymmetrical, ending in a blunt point; they curve from the top outward and then again inward in their lower part. The first lateral lobe is more than twice as broad as each of the branches of the siphonal lobe. The first and second lateral lobes are very similar in shape, being symmetrical and a little narrower at the top than in the middle, and ending below in a somewhat rounded point. Both are nearly of the same depth, the second a little shallower than the first; but both are much less deep than the branches of the siphonal lobe. The first auxiliary lobe is a little less symmetrical than the first two laterals and much shallower, but about as broad. The second auxiliary is not quite as

deep as the first one and much narrower. The third auxiliary lobe, which lies on the umbilical shoulder, is small, funnel-shaped, and ends in a point. Very similar to it is the fourth auxiliary lobe which lies on the umbilical wall.

The median saddle of the siphonal lobe is short, relatively broad, very slightly constricted near its middle, deeply notched at the top by an indentation. The external and the first lateral saddles are of a very similar shape. Like all the rest of the saddles they are entire and rounded at the top; they are about of the same height, symmetrical, slender, and nearly double as high as the median saddle of the siphonal lobe; the first lateral saddle is much narrower than the external one. The second lateral saddle is similar in shape to the first and the external, but much lower. The first, second, and third auxiliary saddles show practically no constriction and decrease gradually in height. They are all lower than the second lateral. The third auxiliary saddle lies on the umbilical wall.

Dimensions:

Diameter	13.3 mm	(1)
Width	10.5	0.79
Height of last whorl	6.3	0.47
Diameter of the umbilicus	1.6	0.12

Generic position:

In its external shape our species is very similar to *Agathiceras Girtyi* n. sp., although its ventral part is decidedly flattened, while that of the latter species is rounded. Unfortunately, no trace of the ornamentation is preserved, but we know that the difference in ornamentation between *Agathiceras* and *Adrianites* is not very great. In general our species has the same type of lobes and saddles as *Agathiceras*, but their number is much greater and the shape of the siphonal lobe and its median saddle is certainly different. The median saddle is much lower and relatively broader than that of any known species of *Agathiceras*. In this latter genus the two branches of the siphonal lobe are similar in shape and size to the first lateral lobe. This is not the case in our species, those branches being very narrow and curved with the convexity toward the outside. This is the form of the siphonal lobe of every *Adrianites* described until now, not only the Sicilian ones, but also the Russian. Different from it is only *Adrianites* sp. ind., de-

scribed by Diener[1], but this species must be regarded as belonging to an entirely different genus, as it shows only three lateral saddles and a median saddle which is much higher than the external one.[2] We can therefore leave it out of consideration.

The shape of the siphonal lobe of *Adrianites* is extremely characteristic, but this circumstance seems to have escaped most of the authors. Karpinsky only refers to the difference between the median saddles of the siphonal lobe but overlooks entirely the fact that however the form of this saddle may change, the two branches of the siphonal lobe are always narrow and curved, while in *Agathiceras* they are of nearly the same form and size as the first lateral lobe. Karpinsky (loc. cit., p. 85) says that *Adrianites isomorphus* Gemmellaro (loc. cit. app., pl. B, fig. 7) has the median saddle characteristic of *Agathiceras,* while *Agathiceras anceps* Gemmellaro (loc. cit., pl. 7, fig. 22) has a median saddle like that of the typical *Adrianites.* By comparing in these cases the form of the siphonal lobe we find that *A. isomorphus* has the typical siphonal lobe of *Adrianites,* the branches of which are narrow and strongly curved, while *A. anceps* has the typical siphonal lobe of *Agathiceras,* the branches being of about the same size and shape as the first lateral lobe and not curved at all. Karpinsky also says that *Adrianites ensifer* Gemmellaro (loc.. cit., pl. VI, fig. 11-13; pl. VII, fig. 25) which has only four lateral lobes, should be compared with *Agathiceras Suessi* Gemmellaro (loc. cit., pl. VI, fig. 1-4; pl. VII, fig. 36); but this comparison proves once more the absolute reliance we can put in the form of the branches of the siphonal lobe. *A. ensifer* has only four lateral lobes and therefore is more similar to *Agathiceras* than any other species, but the branches of the siphonal lobe are strongly curved, while in *Ag. Suessi* they are broad and straight and of the same figure as the first lateral lobe.

In our discussion of the genus we have already shown that *Adrianites* cannot under any circumstances be united with *Agathiceras* on account of the different aperture and internal suture. But we had to be somewhat prolix here with regard to those characters that allow us to distinguish both genera, even where the aperture is not preserved

[1]Diener, Perm. Foss. of the Central Himalayas, p. 117, pl. 5, fig. 26.

[2]Diener's figure 26-c has been erroneously printed in a reversed position, as is shown by the description of the author, but not noted in either the text or the explanation of the plate.

and the internal sutures cannot be studied; and we had to show that there is an external character which can generally be observed and at the same time is absolutely reliable.

We see that our species shows the characteristic median saddle and siphonal lobe of *Adrianites* and that the number of its lobes is larger than in *Agathiceras,* although the general character of the lateral lobes and saddles is the same; consequently, there is no room for doubt that our species is a typical *Adrianites.*

Relation to other species:

The only species which is very nearly related to ours is *Adrianites insignis* Gemm.,[1] but it is still relatively broader and the sutural line has one saddle more than ours. A certain similarity exists also between our species and *Adrianites elegans* Gemm.[2] but this species is somewhat higher than ours and more rounded on the ventral part. The sutural line is more strongly curved than in ours, but has the same number of lobes and saddles. The ratio of diameter to width, height of the last whorl, and diameter of umbilicus is, in the smallest of Gemmellaro's specimens, 1:0.6:0.45:0.23; which shows that the width is relatively less, and that the umbilicus is much larger, than in our species.

Much more similar is the ratio in *Adrianites insignis,* which, according to the measurements given by Gemmellaro, is 1: 0.87: 0.48: 0.12. These are nearly the same as those of our species; i. e., 1: 0.79: 0.47: 0.12.

There has been another very broad species described—*Adrianites Stuckenbergi* Karp. sp.[3]—which has about the same number of lobes, but its external form is entirely different.

G. Boehm[4] has described a very broad form of *Adrianites* under the name of *Adrianites timorensis,* but it is easily distinguished by its wider umbilicus.

Age:

Word formation, Permo-Carboniferous.

---

[1]Gemmellaro, loc. cit., p. 42, pl. 6, fig. 8-10.

[2]Gemmellaro, loc. cit., p. 41, pl. 6. fig. 14-17; pl. 7, fig. 23, 24.

[3]Karpinsky, Amm. d. Artinsk-Stufe, p. 65, pl. 5, fig. 4, a-e.

[4]G. Boehm, Jüngeres Palaeozoicum v. Timor, p. 321, pl. 11, fig. 3, a-c; text, fig. 1 a, b.

Number of specimens examined:

Two. The species seems to be rare, but as it externally resembles somewhat the small individual of *Waagenoceras Dieneri* n. sp., it may easily be confounded with them where the suture cannot be made out.

Locality:

Near junction of Road and Gilliam Canyon, Glass Mountain.

Stacheoceras Gemmellaro

Gemmellaro[1] in 1888 created the new genus *Stacheoceras* for discoidal forms with more or less rounded flanks, and numerous saddles and lobes; the saddles being entire, high and rounded, the lobes bifid or trifid. As Mojsisovics[2] did not think it possible to separate *Stacheoceras* from *Popanoceras* Hyatt, Gemmellaro[3] in an appendix to his work, proceeded to defend his opinion, showing the differences between the two genera, demonstrating that such not only exist in the external sutures, but also in the internal ones. In 1889, Karpinsky[4] accepted the opinion of Mojsisovics and included all the forms from the cephalopod-bearing Artinsk in the genus *Popanoceras* Hyatt. Later on Haug,[5] in 1894, recognized the genus *Stacheoceras,* placing it in the family of Joannitidae, while he considers *Popanoceras* as belonging to the Arcestidae. In 1897, Diener[6] accepts *Stacheoceras* as a subgenus of *Popanoceras.* In 1903, James Perrin Smith[7] clearly accepts Stacheoceras as a genus distinct from *Popanoceras,* but includes his forms with entire saddles and bifid and trifid lobes (*P. Ganti, P. Parkeri, and P. Walcotti*) in the genus *Popanoceras;* later on, in 1913, he[8] considered at least one of these species as belonging to *Stacheoceras* (*St. Ganti*).

In 1907, Tchernow[9] also recognized the validity of the genus *Stacheoceras.* He considers *Popanoceras Sobolevskyi* Vern. as the repre-

[1]Gemmellaro, Calc. c. Fusulina, p. 24.

[2]Mojsisovics, Arktische Trias-Amm., p. 18.

[3]Gemmellaro, loc. cit., app., p. 11.

[4]Karpinsky, Ammoneen d. Artinsk-Stufe, p. 67, 84.

[5]Haug, Les Amm. du Perm. et du Trias., p. 394.

[6]Diener, Permocarb. fauna of Chitichun No. I, p. 9.

[7]J. P. Smith, Carb. Amm. of America, p. 25, 128, 135.

[8]J. P. Smith, in Zittel-Eastman, Text-book of Paleontology, Vol. I, 2nd ed. p. 641, fig. 12-13.

[9]Tchernow, L'étage d'Artinsk, I., p. 287, 303, etc.

sentative of the genus *Popanoceras,* which was also considered as the type species by Gemmellaro, and places Karpinsky's *P. Krasnopolskyi* in the genus *Stacheoceras* identifying it with *St. subinterruptum* Krot.

It seems thus that the older genus *Popanoceras* Hyatt has been definitely subdivided in two: *Popanoceras* with saddles divided by marginal lobes, and *Stacheoceras* with entire saddles. The Triassic species which had been considered as belonging to *Popanoceras,* universally have been placed in *Parapopanoceras* Haug.

Our material from the Permo-Carboniferous of the Glass Mountains contains eight species which would have to be considered as belonging to *Stacheoceras,* if we take this genus in the sense of Gemmellaro, but they show such surprising difference in form as well as suture, and the greater part present so well-defined natural groups, that we had to separate these under new subgeneric names. It is even possible that these groups may be considered as genera, when our knowledge of the lowermost Permo-Carboniferous and Pennyslvanian Popanoceratidae shall be increased by new species.

For the moment being, we have described under the generic name of *Stacheoceras,* two new species which differ widely in their external form, but which, with respect to their suture, resemble the Sicilian species of *Stacheoceras* more than any of those belonging to our subgenera *Marathonites* and *Vidrioceras.* The difference between the two species *Stacheoceras Bowmani* and *St. gilliamense* is so great that I would consider them as belonging to two different genera, if it were not for our imperfect knowledge of their suture.

Stacheoceras Bowmani nov. sp.

Pl. VI, Fig. 57-69

Shell discoidal with flat flanks and rounded ventral portion composed of deeply embracing whorls. The greatest width lies a little above the umbilical shoulder. The whorls are much higher than broad. The flanks curve slightly down toward the umbilical shoulder, the wall of the umbilicus is steep but extremely narrow, the umbilicus itself is narrow and shallow. There are no constrictions on the whorls, either on the shell or on the cast.

On the cast of a younger specimen (pl. VI, fig. 66) we observe very faint, radiating, low, flat, and very broad elevations, perhaps

thirty to the whorl, which begin at the umbilicus but disappear before reaching the external part. These elevations, which cannot very well be called ribs, do not show on the shell of the larger whorls and cannot be seen on every cast; but that depends probably on the stage of preservation. The ornamentation of the shell is very characteristic (pl. VI, fig. 61, 62, 68). It is composed of fine radial ribs flattened on the upper surface which slants backward into a furrow and breaks down steeply toward the front into the next furrow. The furrows or interstices between the ribs are much narrower than these ribs themselves. The ribs form a double curve on the flanks; from the umbilicus they bend forward and from above the middle of the flank they curve slightly backward and bend again forward until the shoulder of the ventral region, forming thus on the flank an **S**-like figure. On the shoulder of the ventral part they suddenly bend strongly backward until the region of the sipho, thus forming a deep curve backward on the ventral part. In smaller specimens the ribs are entirely straight on the flanks but show also the deep backward curve on the ventral portion.

The suture (pl. VI, fig. 60, 66) could not be entirely made clear, but enough of it could be traced to make sure of the generical position of the species. The septa are not very near together; they never touch each other. The siphonal lobe is divided in two branches by a high siphonal saddle. Each of the branches is asymmetrical and bifid, the inner point being much longer than the outer. The first lateral lobe is bifid but shows an additional point at each side of the principal and most prominent ones. The second lateral and the first and second auxiliary lobes are trifid and symmetrical, while the rest of the lobes on the flank, about five in number, seem to be funnel-shaped and to end in one single point; but these lobes could not be seen very clearly. The siphonal saddle is moderately high, constricted below the middle and notched at the top by a shallow indentation. The saddles are all entire, high, relatively broad, rounded at the top, and at least the external and the two lateral saddles are more or less constricted near their base, while the auxiliary saddles are more tongue-like, or are even only simple undulations. Their height decreases steadily from the external saddle to the last auxiliary near the umbilicus. The internal sutures are unknown.

Dimensions:

	I		II		III		IV	
Diameter:	19.1 mm	(1)	20.6 mm	(1)	23.7 mm	(1)	33.3 mm	(1)
Width.	6.8	0.36	7.4	0.36	?8.0	0.34	?7.7	0.23
Height of last whorl. . . .	10.2	0.53	10.6	0.51	12.5	0.53	17.3	0.52
Diameter of umbilicus. . .	2.2	0.12	2.4	0.12	?3.2	0.14	4.0	0.12

These dimensions are measured on relatively small specimens; there are fragments the diameter of which must reach at least 36 mm.

Relation to other species:

If only the outer form and the ornamentation had to be considered, this species would have to be regarded as a typical *Popanoceras* similar to the younger individuals of *P. Moelleri* Gemm.[1] or *P. clausum* Gemm.[2] But the suture does not leave any doubt that the species belongs to *Stacheoceras*. It is true that the suture could be seen only on specimens which do not show even a trace of ornamentation, but on one of the individuals with preserved shell a few of the entire and rounded saddles show up rather clearly, and the relations of dimensions are so similar (compare especially No. 1, with suture line but without ornamentation; and No. 11, with ornamentation but not showing the septa) that I do not doubt that all the specimens belong to the same species.

Among the fauna of the Russian Artinsk we find a form which in its outline and in the form of the ribs somewhat resembles our species. It is *Stacheoceras Lahuseni* Karpinsky,[3] but the prominent ribs which are so very characteristic are missing in our specimens.

Among the Sicilian species there is *Stacheoceras Karpinskyi* Gemmellaro[4] which, although much more subglobose than our species, shows a strong curving backward of its ribs on the ventral part.

Our species consequently is not entirely an exception but it does not resemble very much any of the species described until now. A somewhat extraordinary feature might be found in the circumstance that the first lateral lobe of our species ends in four points; the suture on a small specimen shows that this lobe there is simply bifid. We notice a similar development in the first lobe of *Stacheoceras Krasnopolskyi* Karp.,[5] but the character of the suture of this species is entirely dif-

[1]Gemmellaro, Calc. c. Fusulina, p. 21, pl. 3, fig. 6-16.
[2]Gemmellaro, ibid., p. 22, pl. 3, fig. 17-21.
[3]Karpinsky, Amm. d. Artinsk-Stufe, p. 67, pl. 5, fig. 1 a-h, 2 a-c, 3.
[4]Gemmellaro, Calc. c. Fusulina, p. 30, pl. 8, fig. 6-8.
[5]Karpinsky, Amm. d. Artinsk-Stufe, p. 73, pl. 5, fig. 10.

ferent from ours. Much more similar is the suture of *Stacheoceras Trimurti* Dien.,[1] which also shows a bifid first lateral lobe in the younger stages and one ending in four points in older specimens; but the form of this latter species is entirely different from that of *St. Fowmani.*

A little more similar in general form is *Stacheoceras Walcotti* White[2] but the ornamentation is different and the suture line shows only trifid lobes (even on the branches of the siphonal lobe) and thus to a certain degree resembles *Stacheoceras tridens* Rothpl.[3]

Age:

Word formation, Permo-Carboniferous.

Number of specimens examined:

Twelve. The species is not very rare at the principal localities.

Locality:

Junction of Road and Gilliam Canyons and the mountains near it; also on the mountain north of Leonard Mountain, Glass Mountains.

Stacheoceras gilliamense nov. sp.

Pl. VI, Fig. 70-76

Shell small, globose, with rounded flanks and ventral part; very involute, composed of deeply embracing whorls. The greatest width is on the umbilical shoulder. The whorls are much broader than high and of a semilunar cross-section. The umbilicus is narrow and deep, the umbilical wall is nearly vertical and relatively broad, but slightly curved. No constrictions and no ornamentations are visible although the shell is preserved.

The sutural line is not entirely known. What is visible on the external surface turns out to be the internal suture of the next whorl. We have shown in the descriptions of our *Agathiceras Girtyi* n. sp. that this case is quite frequent in the same zone. The fossils are silicified throughout, and the inner side of one whorl is pressed so closely

[1]Diener, Permocarb. fauna of Chitichun No. 1, p. 10, pl. 1, fig. 1-af.

[2]Ch. A. White, The Texan Permian, etc., p. 21, pl. 1, fig. 9-11.

[3]Rothpletz, Perm., Trias., und Jura auf Timor u. Rotti, p. 87, pl. 9, fig. 4.

against the next one that, while the outside is completely destroyed, the inner part of the whorl then appears to be the external side of the next one, but shows the internal sutures of the larger whorl.

We have the same case in the present species (pl. VI, fig. 73). We distinguish an antisiphonal lobe, somewhat similar to that of *Marathonites;* it is divided into three branches by two relatively long and slender saddles, but while these are nearly parallel in *Marathonites,* they are strongly inclined toward the middle branch and much shorter in this species. The middle branch is lanceolate, while the side branches seem to be a little asymmetrical and to end in a single point which lies nearer to the inner side. The first lateral lobe is asymmetrical and bifid, the outer point being longer than the inner one; the second lateral and the first, second and third auxiliary lobes appear to be all trifid, the middle point being considerably more prominent than either of the two lateral ones. There appears to be a fourth auxiliary lobe on the umbilical seam, but its figure could not be made clear. The lobes decrease in depth from the first lateral to the third auxiliary. The saddles are all very high, slender, entire, rounded at the top and constricted near their base. There are one internal, two lateral and three auxiliary saddles visible, the first one being a little bent over toward the sipho. The saddles decrease gradually in height from the first to the last one.

The septa are well separated from each other.

Although the external sutures are not known, there does not exist any doubt that the species belongs to *Stacheoceras* or a new subgenus of it. The antisiphonal lobe is certainly different from those figured by Gemmellaro (loc. cit., app., pl. C, fig. 6, 8) but we shall see that in *Marathonites* exists a similar one. For the moment being, we have to leave our species with *Stacheoceras* on account of our imperfect knowledge of the suture, but we may already state that the species belongs either to *Marathonites* or more probably to another subgenus, with a greater number of lobes and a somewhat different antisiphonal lobe.

Dimensions:

Diameter	10.2 mm	(1)
Width	10.1	0.99
Height of last whorl	4.5	0.44
Diameter of umbilicus	1.1	0.11

Relation to other species:

There does not seem to be any other species known which could be compared to ours. The only one which resembles it somewhat is *St. globosum* Gemm.,[1] but this differs by its less globose form. A nearer comparison cannot be made because the suture of the Sicilian species has not been figured and that of ours is only imperfectly known.

Age:

Word formation, Permo-Carboniferous.

Number of specimens examined:

Two.

Locality:

Junction of Road and Gilliam Canyons, Glass Mountains.

Marathonites nov. subgen.

Type: Marathonites J. P. Smithi Böse

When we contemplate the species which have been united under the name of *Stacheoceras* we observe that most of the Sicilian species have a very great number of lobes between the sipho and the umbilicus. They vary from six (*St. perspectivum*) to ten (*St. mediterraneum, St. Gaudryi*). Only the *St. pygmaeum* shows not more than five, but this species is a very small one and may even be composed of younger individuals of other species. On the contrary, the species from the Russian Artinsk in general have not very many lobes with the exception of *St. Kingianum* and *St. Lahuseni,* which also distinguish themselves from all the rest by their outer form. Of *St.* sp. ind. (cf. *Parkeri* Heilpr.) we do not know how many lobes exist, but *St. Romanowskyi* shows only four (5) lobes and *St. Krasnopolskyi* six (7) lobes.

Similar conditions we find in the *Stacheoceras* described from the Pennsylvanian of North America. *Stacheoceras Parkeri* Heilpr. has only four lobes, the last of which is on the umbilical shoulder. *St. Ganti* J. P. Smith has five lobes.

In our lowermost strata of the Permo-Carboniferous the genus *Stacheoceras* is represented by five species, while a sixth one has been

[1]Gemmellaro, Calc. c. Fusulina, p. 31, pl. 4, fig. 13, 14.

found loose on Pennyslvanian strata near the boundary of the Permo-Carboniferous and may also belong to this latter horizon. All of them show only five to six lobes, while another species in the higher part of our Permo-Carboniferous (Word formation) shows about seven lobes; and another one, of an entirely different form and externally similar to the Sicilian *Popanoceras,* shows about ten lobes.

If we compare not only the external lobes of the group represented here but also the internal ones which could be very well observed in *M. Smithi,* we find that they are absolutely different from those of the Sicilian type, which are known in *St. mediterraneum*[1] and in *St. Benedictinum.*[2] While we see that the trifid antisiphonal lobe in the Sicilian species is not much, if at all, deeper than the following lateral lobes, we observe in *M. Smithi* (pl. VI, fig. 79, 80) a very deep lanceolate antisiphonal lobe that ends in a quite sharp point. At both sides of it, we see a low and slender rounded saddle, after which follows a much broader and much higher saddle, separated from the smaller one by a narrow, pointed, asymmetrical lobe which is much less deep than the central antisiphonal lobe. We may probably consider these three central lobes with their two small dividing saddles as a very broad and deep, trifid, antisiphonal lobe. The same arrangement of the internal lobes has been observed in *Marathonites vidriensis* n. sp. (pl. VII, fig. 31, 32). This antisiphonal lobe resembles the totality of the internal lobes of *Gastrioceras.* We shall also see that there is another new subgenus of *Stacheoceras* from the same locality and the same horizon which shows a similar form of the antisiphonal lobe, although the rest of the internal lobes are somewhat different.

J. P. Smith[3] has drawn the internal suture of *Stacheoceras Ganti* but he has not been able to distinguish the details. At least, nothing is shown there of the characteristic antisiphonal lobe of *Marathonites.* Our species have a great external resemblance to those mentioned above from the Russian Artinsk and those from the Pennsylvanian of America, not only in the form of the shell but also in the limited number of lobes between the sipho and the umbilical shoulder; but owing to our imperfect knowledge of the inner lobes of the species mentioned,

[1]Gemmellaro, loc. cit., app., pl. C, fig. 8.
[2]Gemmellaro, loc. cit., app., pl. C., fig. 6.
[3]J. P. Smith, loc. cit., p. 132, pl. 21, fig. 16.

there is no possibility of actually proving that they belong also to our new subgenus.

Marathonites shows the following characters:

Shell discoidal, of rather globose form, generally not much flattened on the flanks, with semilunar transversal section, very involute. Umbilicus small and deep. Whorls deeply embracing and slowly growing. Length of body chamber unknown. The surface is ornamented with fine transversal striae slightly curved toward the back. The whorls show transversal constrictions on the mould, corresponding to internal varices; these show generally a slight sinuosity open towards the forepart. These constrictions show also on the surface of the shell.

The sutural line (pl. VI, fig. 79, 80) consists of nine lobes and ten saddles between the umbilical shoulders (the entire external surface), one lobe on the umbilical wall, nine lobes and eight saddles on the internal side, while another saddle is on the umbilical seam; so that the whole suture consists of twenty lobes and twenty saddles. The suture forms always a nearly straight line and curves only very little toward the forepart. The siphonal lobe is broad, divided into two branches by a high saddle, somewhat constricted in the middle. Each of the two branches of the antisiphonal lobe is bifid, the interior point being somewhat longer than the exterior on the umbilical side. The antisiphonal lobe is divided into three parts by two relatively high and slender saddles, the middle branch being much deeper than the two lateral ones.

All the rest of the lobes are either trifid or bifid on the external side as well as on the internal. All the saddles are high, slender, rounded, entire, slightly constricted near the base. The median saddle of the siphonal lobe is notched by a shallow indentation.

Marathonites J. P. Smithi nov. sp.

Pl. VI, Fig. 77-89

Shell of subglobose form with rounded flanks, very involute, slightly compressed on the flanks and broadly rounded on the external side. The greatest breadth is a little above the umbilical border. The spire is formed by a great number of slowly-growing whorls much broader than high. The whorl curves slightly down toward the umbilical border, forming a very steep but narrow umbilical wall between the

shoulder and the seam. In the larger whorls this steep wall becomes still narrower and tends to disappear. The umbilicus is narrow and very deep. All the whorls show moderately deep constrictions on the cast, which correspond to internal varices on the shell; about three to each whorl, slightly curving backward. The body chamber is unknown. The inner whorls are a little different from the outer ones, being still broader with respect to their height.

In none of our specimens is the shell preserved, so that no trace of ornamentation could be observed; but in a fragment of the interior surface there is a very distinct ornamentation preserved on the mould. It consists of very fine transversal lines slightly curved backward, especially in the middle, similar in direction to the constrictions on the whorls. These fine elevated lines are separated by flat inter-spaces much broader than those lines. These striae are very near together on the umbilicus, but the interstices widen considerably toward the ventral part.

The suture (pl. VI, fig. 77-80) is nearly straight, only a little bent backward near the siphonal region in the external side and still more in the antisiphonal region on the internal part. The septa are moderately close without ever touching each other. All the saddles are entire, high, relatively broad, rounded, slightly constricted near their base. The siphonal lobe is divided into two branches by a median saddle. Each of the branches is bifid, the inner point (on the siphonal side) being much longer than the outer one (on the umbilical side). The first and second lateral and the first auxiliary lobes are trifid, the middle point being much longer than the lateral ones, while these are of about equal length; although the inner one seems to be sometimes slightly longer. The second auxiliary lobe is practically bifid, the outer point being much longer than the inner one, but on the outer side the line of the outer point bulges a little, thus indicating a tendency toward becoming trifid. A simple pointed lobe is visible on the umbilical wall; it ends in one sharp point. The first lateral lobe is much narrower than the siphonal one as a whole, but broader than either of the branches. The second lateral lobe is a little broader than the first, the first auxiliary still a little more so than the second lateral, but the second lateral and the first auxiliary one decrease steadily in depth compared with the first lateral; the second auxiliary is much

shallower and narrower than the others while the next one is very narrow and funnel-shaped.

The median saddle of the siphonal lobe is slightly notched by a shallow indentation and constricted near the base. The external and the two lateral saddles are very similar to each other, the external one being the highest, the others gradually decreasing in height. The first auxiliary saddle is a little broader than the preceding ones; the second auxiliary saddle, near and on the umbilical shoulder, is very broad and much lower than the other, and is not constricted at its base.

The internal suture (pl. VI, fig. 79, 80) is very characteristic. It consists of an antisiphonal lobe divided in three parts by two slender and long saddles. The middle branch is lanceolate, symmetrical, ending in a rather sharp point. It is much deeper than the two lateral branches; these are asymmetrical, ending in a point which is near the inner side of the branch. The two saddles which divide the antisiphonal lobe are long and slender, rounded, somewhat constricted above their base, and leaning a little toward the median branch lobe. The first lateral lobe is much narrower than the antisiphonal one, but broader than either of its branches. It is asymmetric and bifid, the outer point (on the umbilical side) being longer than the inner one. The second lateral lobe is asymmetrical and trifid, the middle point being the deepest, while the outer one is shorter than the inner one. This lobe is somewhat broader and less deep than the first one. The first auxiliary lobe is again asymmetrical and bifid, the inner point being a little longer than the outer one. This lobe is nearly as broad as the first lateral lobe and a little deeper than the second one. The second auxiliary lateral lobe is nearly symmetrical and bifid, both prongs being about the same length. The internal saddles are all high, slender, rounded, and slightly constricted at their base. The internal saddle is the highest, the first and second lateral are of equal height, but a little lower than the internal saddle; the first auxiliary is broader and a little lower than either of the others. A second auxiliary saddle exists on both sides of the umbilical seam. It is somewhat asymmetrical, of pyramidal form and slightly notched by a shallow indentation of its upper part.

Dimensions:

	I		II		III	
Diameter	24.0 mm	(1)	20.0 mm	(1)	12.2 mm	(1)
Width	14.8 mm	0.60	?11.5 mm	0.58	8.7 mm	0.71
Height of last whorl.....	11.9 mm	0.49	?7.8 mm	0.39	6.0 mm	0.49
Diameter of umbilicus...	2.8 mm	0.12	?2.0 mm	0.10	2.0 mm	0.16

Relation to other species:

Marathonites J. P. Smithi is very nearly related to *M. sulcatus* n. sp. but the latter one is still more involute, its umbilicus is much narrower, and its septa are much nearer together so that they almost touch each other; also the form of the lobes is different. In *M. Smithi* the central one of the three points of the lateral lobes is much longer than the others, while in *M. sulcatus* the three points are of nearly equal length; saddles and lobes are generally broader in the latter species than in the former one. *M. sulcatus* has apparently four constrictions to the whorl and these are much deeper than in *M. Smithi.*

From *M. vidriensis* n. sp. our species is easily distinguished by the broad interstices between the transversal striae, by the much more involute form and narrower umbilicus and by the different internal suture. *M. Hargisi* n. sp. has an absolutely different suture and may even belong to a different subgenus.

From *Stacheoceras Ganti* Smith our species is easily distinguished by its wider umbilicus and the less numerous and straighter constrictions, also by higher saddles. *St. Parkeri* has an entirely different suture.

Very similar to our species seems to be *Stacheoceras Romanowskyi* Karpinsky,[1] at least in the character of the septa, but it shows only three lateral and auxiliary lobes, while our species has four (five).

A certain resemblance has also *St. pygmaeum* Gemm.[2] at least in the form of the lobes; but there are only three of them as against four in our species, and the branches of the siphonal lobe are simple instead of bifid.

Age:

The species has been found only in the Wolfcamp division, the lowermost part of the Permo-Carboniferous.

[1]Karpinsky, Ammoneen d. Artinsk-Stufe, p. 77, pl. V, fig. 6, a-b.
[2]Gemmellaro, Calc. c. Fusulina, p. 39, pl. 8, fig. 15-17.

Number of specimens examined:

Fourteen. The species is quite common at the locality.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

Marathonites sulcatus n. sp.

Pl. VII, Fig. 1-4

Shell of subglobose form, slightly flattened on the flanks, rounded on the ventral side, very involute; the greatest breadth is very little above the umbilical shoulder. The spire is formed by a great number of slowly growing whorls which are much broader than high. The flank curves slightly down to the umbilical border, the umbilical wall being very steep but narrow. The umbilicus itself is extremely narrow and very deep. On the last whorl of the cast four deep transversal constrictions are visible. They are slightly bent backward and on the ventral part show a broad curve open (concave) toward the forepart. The body chamber is not preserved. Our specimen being a cast, no ornamentation could be observed.

The sutural line (pl. VII, fig. 4) is nearly straight, only bent a very little backward in the siphonal region. The septa are very close and even touch each other on the flank of the inner part of the whorl. All the saddles are entire, high, relatively broad, rounded at the top, and constricted near their base. The siphonal lobe is divided into two branches by a median saddle. Each of the branches is bifid, the inner point being much longer than the outer one. The first and second lateral and the first auxiliary lobes are trifid, the middle point being very little longer than the two lateral ones, which in the first and second lateral lobe are of about equal length. The first auxiliary lobe is decidedly asymmetrical, the middle point being longer than the internal lateral one, and this one much longer than the external one. The second auxiliary lobe is apparently bifid but could not be well observed. The first lateral lobe is much narrower than the siphonal one, but broader than each of the branches; the second lateral lobe is a little narrower and much shallower than the first one, while the first auxiliary is broader than the second lateral but much shallower, although its points reach as deep down as those of the first lateral. The median saddle of the siphonal lobe is high and slender; it is slightly notched at

the top by a shallow indentation and constricted near the base. The external and the two lateral saddles are very similar in form, the first one being the highest, while the others rapidly decrease in length. Their width is nearly the same. The second auxiliary saddle is much broader and lower than the rest. The internal sutures are unknown.

Dimensions:

Diameter	19.9 mm	(1)
Width	14.7	0.74
Height of last whorl	10.0	0.50
Diameter of umbilicus	0.8	0.04

Relation to other species:

Our species is very similar to *Marathonites J. P. Smithi* n. sp., but differs in many respects. It is still more involute, the flanks are a little more flattened, the umbilicus is much narrower and the septa are much nearer together. A great difference exists in the form of the trifid lobes. While the points are nearly equal in length in our species, the middle point is very prominent in *M. J. P. Smithi.* Also saddles and lobes are generally broader in our species and especially the first auxiliary saddle is much wider and lower. The transversal constrictions in our species are much deeper and apparently also more numerous.

M. vidriensis n. sp. is easily distinguished from the present species by its much less involute form and wider umbilicus, the flatter flanks and the less rounded ventral portion. The suture is also different, the trifid lobes showing a very prominent middle point, and the first auxiliary saddle being nearly of the same form and size as the external and the two lateral saddles.

M. Hargisi n. sp. has a somewhat similar but more globose form and its suture is entirely different.

Stacheoceras Ganti Smith[1] of the Pennsylvanian is much more involute and lobes and saddles are much broader and shorter.

Stacheoceras Parkeri Heilprin[2] from the Pennsylvanian seems to be somewhat similar in form and the septa are also very near each other, but the suture is entirely different, the first lateral lobe being bifid.

[1]Smith, Carb. Amm. of America, p. 132, pl. 21, fig. 14-16.

[2]Heilprin, Proc. Acad. Nat. Sci. Phila., 1884, p. 53, fig. 1, 2.

Age:

Wolfcamp division, lowest Permo-Carboniferous.

Number of specimens examined:

One. The only one which has been found so far.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

Marathonites vidriensis nov. sp.

Pl. VII, Fig. 5-32

Shell small, of discoidal but rather globose involute form, with somewhat flattened flanks which curve into the not very convex ventral portion; the cross-section is more rounded trapezoidal than semilunar. The greatest width lies a little above the umbilical border. The spire is formed by numerous and very slowly growing whorls about twice as broad as high. The flank curves slightly down to the border of the umbilicus, from there the shell bends sharply into the nearly vertical umbilical wall, which is relatively broad. The umbilicus is moderately narrow and very deep. All the whorls show deep transversal constrictions on the cast, about four in number on each of them. These constrictions are nearly straight on the inner whorls and only bend very slightly backward on the larger ones; on one of the specimens the shell is preserved. There the constrictions show also on the outer surface, but are accompanied by slight varices on their forward border.

The shell shows an ornamentation composed of very thin elevated transversal striae separated from each other by rather broad flat interstices which taper toward the umbilicus and become very narrow there. The same ornamentation shows also on the interior surface of one of the whorls.

The sutural line (pl. VII, fig. 8, 15, 19, 26, 30) is nearly straight, and only bent a little backward near the siphonal region on the ventral side, and much so in the antisiphonal portion of the internal side. The septa are moderately near together, without touching each other. All the saddles are entire, very high, slender, rounded at the top and slightly constricted near their base. The lobes are generally broader

than the saddles. The siphonal lobe is divided in two branches by a median saddle. Each of the branches is asymmetrical and bifid, the inner point on the siphonal side being much longer than the outer one. The first and second lateral and the first auxiliary lobes are trifid, the middle point being considerably longer than the two lateral ones; these latter are of nearly equal length; the inner one seems to be very slightly longer. These three lobes are almost of equal width, while the depth diminishes somewhat from the first to the third one. The second auxiliary lobe is asymmetrical and bifid, the outer point being much longer than the inner one. It is much shallower and narrower than the first three. A third auxiliary lobe exists on the umbilical wall; it ends in one point, is funnel-shaped, and much smaller than any of the others.

The siphonal saddle is relatively high and slender; it is slightly notched at the top by a shallow indentation and constricted near the base. The external and the two lateral saddles are very similar in shape; their height decreasing very little from the first to the third while their width is practically equal. The saddles are generally narrower than the intervening lobes. The first auxiliary saddle is much shorter and narrower than the external and the laterals. The second auxiliary, which exists on the umbilical shoulder, is very broad and low, and is not constricted at its base. A third auxiliary saddle lies in its greater part on the umbilical wall; it is still lower than the preceding one but not quite as broad.

The internal suture (pl. VII, fig. 31, 32) is very characteristic. It shows a broad antisiphonal lobe divided into three parts by two slender and long saddles. The middle branch is lanceolate and symmetrical, ending in a sharp point, and is much deeper than the two lateral branches. These are asymmetrical, ending in a point which is near the inner side of the branch. The two saddles which divide the antisiphonal lobe are long and slender, rounded, entire, somewhat constricted above their base and leaning a little toward the central branch lobe. The first lateral lobe is much narrower than the antisiphonal one, but broader than each of its branches. It is about as deep as the lateral branches, and is asymmetrical and bifid, the outer point being much longer than the inner one. The second lateral lobe is practically symmetrical and trifid, the middle point being much longer than the

others, while the inner lateral point seems to be a little more prominent than the outer one. The first auxiliary lobe is very little asymmetrical and trifid, the middle point being much longer than the other two, the outer one of which is a little shorter than the inner one. These three lobes decrease in width and depth from the first one to the third. The second auxiliary lobe is very narrow, funnel-shaped, and symmetrically bifid; the connection between it and the following saddle on the umbilical wall could not be made quite clear.

The internal saddles are all high, slender, rounded, entire, and, with the exception of the fourth, conspicuously constricted at their base. They decrease steadily in height, but the fourth is a little wider than the first three and not constricted.

Dimensions:

	I		II		III	
Diameter	12.9 mm	(1)	11.7 mm	(1)	11.7 mm	(1)
Width	9.9 mm	0.77	9.3 mm	0.79	9.3 mm	0.79
Height of last whorl.....	5.8 mm	0.45	5.0 mm	0.43	5.0 mm	0 43
Diameter of umbilicus...	2.8 mm	0.22	2.8 mm	0.24	2.8 mm	0.24

	IV		V		VI	
Diameter	11.3 mm	(1)	10.2 mm	(1)	8.7 mm	(1)
Width	9.6 mm	0.85	8.6 mm	0.84	7.3 mm	0.84
Height of last whorl.....	4.7 mm	0.42	4.3 mm	0.42	3.3 mm	0.38
Diameter of umbilicus....	2.8 mm	0.25	2.4 mm	0.24	2.3 mm	0.26

Relation to other species:

M. vidriensis is easily distinguished from *M. J. P. Smithi* n. sp. by its larger umbilicus, the more trapezoidal than semilunar cross-section, the deeper constrictions, the narrower interstices between the transversal striae of the ornamentation, by the different inner septa, and especially by the narrower first auxiliary saddle and the less irregular form of the trifid lobes.

From *M. sulcatus* n. sp., it differs through the much larger umbilicus, the more trapezoidal cross-section, the straighter constrictions, the flatter flanks and less rounded ventral portion, the different form of the trifid lobes, which in *M. sulcatus* do not show the prominent middle point, the narrow fourth lateral saddle, and generally the narrower saddles and wider lobes.

M. Hargisi n. sp. has an entirely different suture, and is also of a much more globose form.

Stacheoceras Ganti[1] Smith is a much more involute form and *St. Parkeri* Heilprin[2] has an entirely different suture, the first lateral lobe being bifid, instead of trifid, as in our species.

With respect to *Stacheoceras Romanowskyi* Karp. and *St. pygmaeum* Gemm., we could only repeat what we have said about them in our paragraph on *M. J. P. Smithi* n. sp., adding solely that the external form of the Sicilian species is entirely different from that of our species.

Age:

M. vidriensis has only been found in the Wolf Camp division, the lowest Permo-Carboniferous.

Number of specimens examined:

Nine. The species is quite frequent at the locality.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

? Marathonites Hargisi nov. sp.

Pl. VII, Fig. 33-39

Shell globose, with rounded flanks and ventral portion; involute, with the greatest width at the umbilical border. The spire is formed by a great number of very slowly growing whorls which are much broader than high. The umbilicus is relatively narrow and deep, its border is very sharp, its wall is broad and vertical. On the last whorls three deep transversal constrictions are visible; they are slightly bent backward, in the flanks a little more than on the ventral portion. The body chamber is unknown. No ornamentation is visible on the cast.

The septa are not very near together and nowhere touch each other. The sutural line (pl. VII, fig. 36, 39) is practically straight with a slight inflection in the siphonal region. All the saddles are entire, high, relatively broad, rounded at the top, and the first three are slightly constricted near their base. The siphonal lobe is divided in two branches by a high median saddle. Each of the branches is bifid and

[1]Smith, Carb. Amm. of America, p. 132, pl. 21, fig. 14-16.

[2]Heilprin, Proc. Acad. Nat. Sci. Phila., 1884, p. 53, fig. 1, 2.

asymmetrical, the inner point being much longer than the outer one. The first lateral lobe is also bifid but the outer point is very little longer than the inner one. The second lateral lobe is trifid, the middle point being much more prominent than the two lateral ones. The first auxilary lobe is again bifid, the two points being nearly of the same length. The second auxiliary lobe is funnel-shaped and ends in a single point. The third auxiliary lobe, which lies on the umbilical wall, is also funnel-shaped and ends in a single point. The two lateral and the first auxiliary lobes are much narrower than the siphonal one and not much broader than each of the branches of the latter one; they are more or less of the same width, but decrease slightly in depth from the first to the third.

The siphonal saddle is relatively high, slender, a little constricted near the middle and notched at the top by an indentation. The external and the two lateral saddles resemble each other very much; they are high, slender and constricted near the base. The first auxiliary saddle is a little broader and not constricted. The second auxiliary, which lies on the umbilical shoulder, is as high as the first, but somewhat asymmetrical and broader. The internal suture is unknown.

Dimensions:

Diameter	12.0 mm	(1)
Width	10.3	0.86
Height of last whorl	5.0	0.42
Diameter of umbilicus	3.0	0.25

Relation to other species:

The present species is different from all the other ones that have been found in the Glass Mountains. It distinguishes itself through its first lateral lobe, which is bifid instead of trifid. This character gives it a certain similarity to the ammonoid described by Karpinsky[1] as *Popanoceras* sp. indet. (cfr. *Parkeri* Heilpr.) This species has also a bifid first lateral lobe, while the second one is trifid but unfortunately, the first auxiliary is not well known, although Karpinsky says that it seems to resemble the second lateral. This would distinguish it from our species where the first auxiliary lobe is bifid.

Our species is certainly different from *Stacheoceras Parkeri* Heilpr.,[2]

[1]Karpinsky, Ammoneen d. Artinsk-Stufe, p. 75, pl. 5, fig. 5, a-c.
[2]Heilprin, Proc. Acad. Nat. Sci. Phila., 1884, p. 53, fig. 1, 2.

because there the first auxiliary lobe is on the umbilical shoulder, while in ours the second auxiliary lobe occupies that place. *St. Parkeri* seems to differ also from the Russian species mentioned above. According to Karpinsky's Fig. 5a, there are probably more lobes on the ventral side and the flanks than in the American species, and the septa are certainly less near together.

Smith[1] remarks that the bed in which *St. Parkeri* has been found belongs to the middle Coal Measures (Strawn formation), and that Frech wrongly refers these beds to the Permian. Frech probably followed Karpinsky, who, in his Table C (loc. cit., p. 94, and on p. 92, 93), places these beds in the Permo-Carboniferous.

Age:

The only specimen was found by myself on the ranch of Mr. Hargis near Marathon. It was found loose on rocks of shale of the Pennsylvanian age, near the boundary line with the lower Permo-Carboniferous. The specimen is preserved as limonite, formed by the oxidation of pyrite. There were no more limonite shells found in the Pennsylvanian; I suppose, therefore, that this specimen rolled down from the Permian which probably belongs in the Hess formation. In the Wolfcamp formation, fossils composed of limonite are common, but they are also found in the Hess formation (Leonard Mountain.)

Number of specimens examined:

One.

Locality:

Anticline on Hargis's ranch near railroad milepost 580, about three miles west of Marathon.

Vidrioceras nov. subgen.

Type: Vidrioceras Uddeni Böse

In our description of the new subgenus *Marathonites,* we have tried to show briefly how the original genus *Popanoceras* Hyatt was divided into two genera by splitting off those species with entire saddles, for which the name *Stacheoceras* was given by Gemmellaro. Furthermore,

[1]J. P. Smith, Carb. Amm. of America, p. 133.

we tried to show that in our lowest Permo-Carboniferous, and possibly in the Pennsylvanian, there are certain species which show the general form of the saddles and lobes of *Stacheoceras* but which distinguish themselves by a much smaller number of lobes on the external side, and which have very characteristic internal lobes that are entirely different from those of the typical *Stacheoceras*. In our material there are two more species, the septa of which show a marked difference from those of *Marathonites*. The differences are so great that I propose a subgeneric name for this group, which is easily distinguishable from *Marathonites,* even where the form of the internal sutures cannot be ascertained.

The new subgenus *Vidrioceras* shows the following features:

Shell of rather globose form, flattened on the flanks of the inner whorls, but rounded on the outer ones; cross-section rather trapezoidal in youth, semilunar in an advanced stage; very involute in the adult stage while younger specimens are much less so; umbilicus wide in the inner whorls and narrow in the outer ones. Whorls deeply embracing and very slowly growing. Surface ornamentation composed of faint transversal undulations decidedly curved toward the front. Each whorl shows on the cast two to three deep constrictions equally curved toward the front.

The suture (pl. VII, fig. 60, 61) consists of nine lobes and ten saddles on the external part between the two umbilical shoulders; of two lobes and one saddle on each side of the umbilical wall (together, four lobes and two saddles); of seven lobes and eight saddles on the internal side. The whole suture line is therefore composed of twenty lobes and twenty saddles. All the saddles are entire, rounded at the top, and the first three lateral saddles of the external side as well as those on the internal side, are slightly constricted. The siphonal lobe is divided in two branches by a high median saddle; the first lateral lobe is bifid, the second ends in one point; the first auxiliary is again bifid in the type species, while in the other species the second lateral and the first auxiliary lobes develop each a small secondary point. The antisiphonal lobe is divided in three branches by two relatively high and slender saddles, the middle branch being much deeper than the lateral ones. The internal first lateral lobe is bifid, the second is symmetrical, and ends in one point, while the first auxiliary does the same, but is asym-

metrical. The rest of the saddles and lobes (near the umbilicus) are simple, asymmetrical undulations.

The suture is nearly straight, slightly curved toward the front, with an inflection backward in the siphonal and antisiphonal regions.

Vidrioceras resembles in many respects *Marathonites*. The principal difference is to be found in the details of the suture line. The siphonal and antisiphonal lobes are very similar in both subgenera, but while *Marathonites* has nine lobes and eight saddles on the internal side, *Vidrioceras* has only seven lobes and eight saddles; and while the former has one lobe on the umbilical wall, the latter has two. Another difference is to be found in the shape of the first auxiliary saddle. In *Marathonites,* this is very similar to the external and lateral, while in *Vidrioceras,* it is of the common *Glyphioceras* type; and while in the first-mentioned subgenus the second auxiliary lobe is decidedly bifid, in the other subgenus it is a simple and very shallow notch between two auxiliary saddles. The greatest difference, perhaps, exists in the form of the lobes, which in *Vidrioceras* never become really trifid.

On account of the small number of specimens I have not been able to study the entire development of the suture in *Vidrioceras,* but in a specimen of about 7.5 mm. diameter, I could trace the suture in the lower half. It is much simpler than in the larger whorls. The branches of the siphonal lobe end in one point, being still very asymmetrical, but the first lateral lobe is practically rounded and has lost its two points. The same is the case with the first auxiliary lobe, while the second lateral shows still its only sharp point. The external saddle is much higher than the two laterals, the first lateral is very low and narrow, while the second one is about as high as the first one, but much broader. The first auxiliary saddle is much higher than the second lateral, but is about as broad. The second auxiliary lobe disappears almost entirely.

When we compare this suture with that of a *Marathonites vidriensis* of about the same size, we find that in the latter one the suture is still entirely the same as in the larger whorls.

Vidrioceras Uddeni nov. sp.

Pl. VII, Fig. 40-61

Shell globose in the younger stages, with somewhat flattened flanks and flattened ventral portion. In the larger specimens both these parts are more rounded; very involute in the later stages, but much less so in the inner whorls. The greatest width is a little above the umbilical border. This latter one is not sharp but slightly rounded; the umbilical wall is vertical but not very broad. The umbilicus is narrow and very deep in the larger whorls and rather broad in the younger stages. The height of the whorls increases somewhat with the advancing age, but in general the whorls grow very slowly and are deeply embracing. On each whorl we count two to three deep constrictions (on the cast) strongly curved toward the front region. The body chamber is unknown.

In none of our specimens is the shell preserved, but on the cast we often observe the trace of an ornamentation which consists of very low transversal undulations, bent slightly backward near the umbilicus, but curving energetically toward the front part on the flanks and especially in the ventral region. The broad ribs are separated by much narrower interstices. The same kind of ornamentation shows on the inner side of one of the whorls, the ribs being generally parallel to the constrictions mentioned above.

The sutural line (pl. VII, fig. 43, 47, 60, 61) is nearly straight with only a slight inflection backward in the siphonal and antisiphonal regions. The septa are not very near each other. All the saddles are entire, high, slender, and rounded at the top. The siphonal lobe is divided in two branches by a high and slender median saddle. Each of the branches is asymmetrical and ends in one point which lies entirely on the inner side of the branch. The first lateral lobe is nearly symmetrical and bifid; it is not much broader than each of the branches of the siphonal lobe. The second lateral lobe is also practically symmetrical, but ends in only one point and is a little broader and deeper than the first one. The first auxiliary lobe is similar in shape to the first lateral and also bifid; it is in its upper part wider than the second lateral, which is in that part much narrower than in the middle. The second auxiliary lobe is very shallow and funnel-shaped. The third auxiliary lobe, which lies on the umbilical wall, is relatively

deep, ends in one point, and is funnel-shaped. The fourth auxiliary lobe, which is also on the umbilical wall, is quite insignificant and only a slight notch, still shallower and smaller than the third one.

The median saddle of the siphonal lobe is slightly notched at its top by a shallow indentation and very little constricted near its base. The external saddle is very slightly bent over toward the median saddle and well constricted near the base. The first lateral saddle is similar to the external but constricted only on its outer side, while the inner one is nearly straight; the second lateral saddle is somewhat asymmetrical, the inner side being constricted while the outer one forms a straight line. It is a little broader than each of the preceding ones. The first auxiliary saddle is broader and lower than the other three; the second auxiliary is still more insignificant, the highest point lying well over to the inner side; the third auxiliary is on the umbilical wall, very low and small, but symmetrical.

The internal suture (pl. VII, fig. 60, 61) is very characteristic. The broad antisiphonal lobe is divided into three parts by two long and slender saddles inclined toward each other. The middle branch is lanceolate and much deeper than the lateral ones; these are asymmetrical, curved and end in a point which lies near the inner side. The first lateral lobe is slightly asymmetrical and bifid, the inner point being stouter but shorter than the outer one. The second lateral lobe is nearly asymmetrical and ends in one sharp point. It is narrower in its upper part than in the middle. The first auxiliary lobe is very asymmetrical, showing a very long inner point and only a slight bulging at the outer side. It is shorter and narrower than the first two and in its general outline is funnel-shaped. The internal saddles are all high, entire, and rounded at the top, and the first three are constricted below the middle. Their height decreases slightly from the first to the third; this latter one is also much narrower than the first two. The first auxiliary saddle is extremely broad but low and asymmetrical. It has about the width of the first and second lateral together with the intervening second lateral lobe. The greatest part of the first auxiliary saddle still lies on the internal side of the whorl, but a portion of its outer flank is on the umbilical wall.

In smaller specimens the suture becomes somewhat simpler. In one of a diameter of about 7.5 mm. we see that the flanks become very flat and the ventral part very slightly rounded; between both a remarkably sharp shoulder begins to appear. In this part the siphonal lobe is still similar to that of the larger whorls, but the first lateral lobe becomes entirely rounded (compare sutural line on fig. 58, pl. VII) and does not show the two points as in the larger whorls. The second lateral lobe still ends in one point but its upper part is here wider than the middle portion.

The first auxiliary lobe is entirely rounded, instead of being bifid, and lies on the flat flank (compare sutural line on right side of fig. 57, pl. VII). The second auxiliary lobe nearly disappears and is only indicated by a slight inflection of the outer flank of the first auxiliary saddle. The second lateral lobe is much deeper than the first lateral and the first auxiliary.

The median saddle of the siphonal lobe (compare fig. 58, pl. VII) is relatively lower than in the larger whorls. The external saddle is high, broad, and well constricted near the middle. The first lateral saddle is much narrower and lower than the external; it is not constricted. The second lateral saddle is a little higher and much broader and not constricted, while the first auxiliary is similar to the second lateral in size and form. The second auxiliary saddle is only indicated by a slight bulging of the outer flank of the preceding one.

Dimensions:

	I[1]		II		III	
Diameter	23.2 mm	(1)	14.6 mm	(1)	13.7 mm	(1)
Width	18.0 mm	0.78	13.2 mm	0.90	12.7 mm	0.93
Height of last whorl	9.8 mm	0.42	7.7 mm	0.53	6.9 mm	0.50
Diameter of umbilicus	2.7 mm	0.12	2.5 mm	0.17	2.2 mm	0.15

	IV		V		VI	
Diameter	11.5 mm	(1)	10.9 mm	(1)	8.7 mm	(1)
Width	11.2 mm	0.97	10.6 mm	0.97	8.7 mm	1.00
Height of last whorl	5.1 mm	0.44	4.7 mm	0.43	3.8 mm	0.44
Diameter of umbilicus	1.8 mm	0.16	1.9 mm	0.17	2.0 mm	0.18

Relation to other species:

There is only one species nearly related to ours, that is *V. irregulare* n. sp. The differences exist in the form of the inner whorls and in

[1]Specimen I is slightly crushed, therefore the measurements may not be quite correct.

the sutures. While our species shows in the inner whorls a rather flattened ventral portion and flattened flanks, *V. irregulare* has a very round external side and rounded flanks. Much greater are the differences in the sutures. In *V. irregulare,* the second lateral lobe is decidedly asymmetrically bifid and the first auxiliary asymmetrically trifid. This difference is not a question of age only, because those specimens of *V. Uddeni* which are as large and larger than those of *V. irregulare* show the same suture as the adults that are smaller, while the interior whorls of this latter species seem to have a suture more or less identical with that of *V. Uddeni.* The final stage in the adults of both species is therefore entirely different.

It does not seem that any other species has been described which resembles ours.

Age:

This species has been found only in the Wolfcamp formation, lowest Permo-Carboniferous.

Number of specimens examined:

Nine. The species is rather common at the locality.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

Vidrioceras irregulare nov. sp.

Pl. VII, Fig. 62-73

Shell rather globose, very involute, with slightly flattened flanks and strongly rounded ventral sides. The umbilicus is very narrow and deep; the umbilical wall is vertical and very broad; the umbilical shoulder is relatively sharp. The cross-section of the whorls is semilunar. The numerous whorls grow very slowly in height and are much broader than high. On each exist about three deep transversal constrictions which are strongly curved toward the front. In one of the specimens traces of the ornamentation are preserved on the cast. It consists of broad but very low and somewhat indistinct transversal undulations parallel to the constrictions mentioned above; these undulations or broad and low ribs, are separated by narrow interstices. The body chamber is unknown.

The septa are well separated and never touch each other. The sutural line (pl. VII, fig. 65, 67, 72, 73) inclines from the umbilicus backward toward the siphonal region. All the saddles are entire, rounded at the top, high, slender and the first three are constricted near their base. The lobes are much broader than the saddles. The siphonal lobe is divided in two branches by a median saddle. Each of the branches is asymmetrical and ends in one point which is near the inner side; on the outer side the bottom of the lobe bulges slightly and thus shows a tendency to form a second and shorter point. The first lateral lobe is nearly symmetrical and bifid; the second lateral lobe is decidedly asymmetrical and bifid, the outer point being much longer than the inner one. The first auxiliary lobe is asymmetrical and trifid, the middle and the outer point being of equal length while the inner one is much shorter than either of the others. A second auxiliary lobe is very shallow, funnel-shaped, and ends in one point. A third seems to exist on the umbilical wall; its exact figure could not be clearly seen, but it appears to be deeper than the second, to be funnel-shaped and to end in a sharp point. The first and second lateral lobes seem to be of nearly the same width, while the first auxiliary is broader. The depth of these three lobes decreases gradually.

The median saddle of the siphonal lobe is relatively high and slender; it is slightly notched at the top by a shallow indentation. The external saddle is very high and slender, and well constricted a little below the middle. The first lateral saddle is a little lower and less constricted, while the second is somewhat asymmetrical. The first auxiliary saddle is very broad, low and asymmetrical, while the second auxiliary is still lower, relatively broad and yet more asymmetrical. The internal sutures of the species are unknown.

Dimensions:

Diameter	19.7 mm	(1)
Greatest width	16.5	0.84
Height of last whorl	9.4	0.48
Diameter of umbilicus	1.9	0.10

Relation to other species:

The present species cannot very well be compared with any of those belonging to *Marathonites* on account of its suture line. It resembles more our *Vidrioceras Uddeni* n. sp., but the outer form is somewhat

different because the ventral portion of this latter species is much more flattened. This cannot be explained by different age, because the inner whorls of *V. irregulare* n. sp. show a decidedly rounded external part. The suture is also different, *Vidrioceras Uddeni* showing no trifid lobes at all, even in a specimen larger than any one of the present species; but the general arrangement of the external part of the septa is very similar, although the details are different. It seems that the inner whorls of our species have a suture identical to that of *V. Uddeni*, which would make it probable that our species belongs to the same genus.

No other species seem to be known which could be compared with ours.

Age:

V. irregulare n. sp. has been found only in the Wolfcamp division, of the lowest Permo-Carboniferous.

Number of specimens examined:

Two; the only ones found, so far.

Locality:

Immediately northwest of Wolf Camp, Glass Mountains.

CYCLOLOBINAE Zittel

Perrinites nov. gen.

Type: Perrinites vidriensis Böse

There has been described from the Texas Permo-Carboniferous at least one, but probably two, species under the generic name of *Waagenoceras* which certainly do not belong to this genus. One of these is *Waagenoceras Hilli* Smith[1] and the other *Waagenoceras Cumminsi* White.[2] Waagen,[3] Frech,[4] and Diener,[5] have considered this latter species as belonging to *Hyattoceras*; and Smith acknowledged that the septa of his *Waagenoceras* Hilli more resemble those of *Hyattoceras* than of *Waagenoceras,* but he thought that it should be rather considered as belonging to this latter genus, because *Hyattoceras* has a closed umbilicus.

There is no doubt that the shape and suture place the two Texan species in the vicinity of *Hyattoceras* and *Waagenoceras,* but the very circumstance that some authors consider them to belong to one genus and others to the other, shows that there must be some difference of importance.

Before we discuss the difference between the Texas forms and those of Sicily, we must first make clear the difference betwen *Waagenoceras* and *Hyattoceras.* With respect to shape *Waagenoceras* is generally subglobose, while *Hyattoceras* is more discoidal; the first genus is involute but shows an open umbilicus, while the second one has a closed umbilicus. These differences, of course, would not be sufficient to separate both groups generically. The principal difference exists in the form of the sutures. In *Hyattoceras,* the suture follows a straight line, while in *Waagenoceras* it is strongly curved between the sipho and the umbilicus. In the first genus the saddles in general are broad at the base and taper upward, while in the second one, they are extremely narrow at the base and become rather narrower than

[1] J. P. Smith, Carb. Amm. of North America, p. 140, pl. 27.
[2] Ch. A. White, The Texan Permian, p. 20, pl. 1, fig. 4-8.
[3] W. Waagen; Productus limestone fossils, Geological results, p. 203.
[4] Fr. Frech, Lethaea geognostica; die Dyas, p. 512.
[5] Diener, Permian fossils of the Central Himalayas, p. 115.

broader toward the top. In *Hyattoceras* the external saddle ends in two phylloid points and the lateral and auxiliary saddles in one. In *Waagenoceras* all the saddles end in one phylloid point of remarkable size. In *Hyattoceras* all the saddles are parallel to each other, while in *Waagenoceras* the external saddle is strongly bent over toward the siphonal region. The median saddle of the siphonal lobe is higher in *Waagenoceras* than in *Hyattoceras* and the number of lateral and auxiliary lobes is larger in the first genus than in the latter.

These differences permit of distinguishing both genera at once. Especially characteristic is the line which is followed by the suture, straight in one genus and curved in the other; the form and position of the external saddle; and the form of the saddles in general.

When we now compare the Texas forms with those of Sicily we must take into consideration that *W. Cumminsi* is known only in small individuals and that the suture is apparently not quite well preserved, while *W. Hilli* is a large specimen the septa of which are of course much farther divided. In both species the median saddle of the siphonal lobe is very high, all the saddles end in one phylloid point, but are much broader at the base than at the upper end; while the lobes, including the branches of the siphonal one, decidedly end in one long point.[1] All the saddles are parallel to each other and the external ones do not lean over toward the sipho; the suture follows a straight line.

Thus the Texan forms distinguish themselves from *Waagenoceras* by their smaller number of lobes, the form of the saddles broad below and narrow above and that of the lobes, ending in a prominent point and broad above; while in *Waagenoceras* the saddles and lobes, generally speaking, are equally broad in the whole length. Furthermore, the Texan species do not show, like *Waagenoceras,* an external saddle leaning over toward the sipho; on the contrary, it stands erect and is parallel to the lateral saddles. The lobes of the Texan species end in one prominent point while those in *Waagenoceras* are rather digitate. The suture of the Texan species follows a straight line while that of *Waagenoceras* follows a strongly convex line.

[1]This is not as evident in the figure of *W. Hilli* given by J. P. Smith as it can be seen to be in the original, which is in my hands.

As Waagen, Frech, Diener and Smith have asserted, the suture of the Texan species resembles much more that of *Hyattoceras;* but notwithstanding a general similarity, there are fundamental differences. The median saddle of the siphonal lobe in *Hyattoceras* is much lower and much less scalloped than that of the Texan forms. The external saddle is a little narrower and not much higher than the rest of the saddles. The lobes of *Hyattoceras* are more or less digitate, while in the Texan species they end in a prominent point. In general the saddles of *Hyattoceras* are more narrowly and deeply cut than those of the Texan forms, and have a less triangular form, which is very characteristic for all the species from the Texan Permo-Carboniferous. This is because all the secondary lobes are cut deeply into the base of the saddles of the Sicilian genus, while they are always very shallow in the lower part of the saddles in the Texan species.

In the foregoing part we have only referred to *Waagenoceras Hilli* and *Waagenoceras Cummiusi,* but in the Glass Mountains occur two more species which belong to the same genus and which differ very little from *W. Hilli.* These permitted of a much better study of the suture than has been possible in the species described until now, and they show especially that the internal suture is generically different from that of *Waagenoceras.* The internal sutures of *Hyattoceras* are not known.

After having made clear the differences between the Texan species and those forms which belong to *Waagenoceras* and *Hyattoceras,* we are justified in uniting the American forms already described with those which were found in the Glass Mountains in a new genus, *Perrinites,* named after James Perrin Smith, to whom we owe the great progress made in the knowledge of Triassic and Anthracolitic cephalopods of America. This new genus has the following character:

Shell discoidal, compressed on the flanks, rounded on the venter, and involute. Cross-section generally parabolical and higher than broad, or only a little broader than high. Umbilicus deep and narrow with a steep wall and rounded shoulder. The smaller whorls always show on the mould rather deep constrictions, radial or slightly flexuous on the flanks and curved on the venter with the convexity toward the back. These show also on the shell, but there they are very narrow. The ornamentation consists of fine lines of growth, slightly flexuous

on the flanks and strongly curved on the venter, with the convexity toward the back, parallel to the constrictions.

The septa are very near, sometimes almost touching, each other.

The suture[1] (pl. VIII, fig. 4, 7; pl. IX, fig. 10) follows a straight line between the umbilicus and the sipho. The external suture consists of a siphonal lobe divided in two branches by a high median saddle, two lateral lobes and three auxiliary lobes, one external saddle, two lateral and three auxiliary saddles. The siphonal lobe is very broad, shows a number of adventive saddles which augment and become longer with age, and each branch ends in a long sharp point. The first lateral lobe is scarcely deeper than the branches of the siphonal lobe, its walls are deeply scalloped and it ends in a long, sharp point. All the other lobes are similar to this one, only shorter and narrow, decreasing gradually in depth and width toward the umbilicus. The median saddle of the siphonal lobe is high, slender, broader at the bottom than at the top and always shows several adventive lobes on both sides. At the top it is notched by a shallow indentation. All the lateral saddles are broad at the base and taper toward the top; they have a number of adventive lobes, which cut deep down near the upper end, but grow gradually shallower toward the base where they are very small. All the saddles end in one phylloid point and nearly all their branches end in a similar way. The external saddle is much higher and broader than any other one; the lateral and auxiliary saddles are very similar to the external one, but they decrease in height and width gradually toward the umbilicus while at the same time the number of secondary lobes and branches diminishes.

The internal suture (pl. X, fig. 21) is not entirely known, but the most important part could be uncovered. It consists of a very deep and very narrow antisiphonal lobe of lanceolate form and an undetermined number of lateral and auxiliary lobes, a very high internal saddle and an undetermined number of lateral and auxiliary saddles. The long and narrow antisiphonal lobe has several secondary saddles, the longest near the top, the smallest and last below the middle. The internal saddle is very high and very narrow, ending in a phylloid point and possessing several branches that end in a similar manner. It is broader at the base than at the upper end and the secondary

[1]Compare also the Appendix to this work, p. 187-190.

lobes cut into it deeply in the upper half while in the lower half they are extremely shallow. The first and second lobes are similar to the antisiphonal, but much shorter and comparatively broader; the only auxiliary lobe clearly visible is more irregular, and asymmetrical but ends likewise in a sharp point. The first and second lateral saddles are similar in shape to the internal, but less complicate and relatively stouter; the only auxiliary saddle visible is similar to them but much simpler. Saddles and lobes decrease rapidly in height and depth from the antisiphonal lobe and internal saddle toward the umbilicus.

The foregoing diagnose shows that our genus is not very nearly related to *Waagenoceras*. Especially characteristic are the internal lobes. While in *Waagenoceras*[1] the antisiphonal lobe is relatively short and broad, with two high adventive saddles inclined toward the center of the antisiphonal region (compare pl. X, fig. 28), that lobe is extremely long and narrow in *Perrinites* with two pairs of short adventive saddles inclined toward the center of the antisiphonal region. While in *Waagenoceras* the internal saddles are curved and bent over toward the center of the antisiphonal region, they are straight in *Perrinites*.

The differences between our new genus and *Hyattoceras* have been demonstrated already above. The two genera are to a certain degree related, but the differences in shape, especially with respect to the umbilicus, and the suture, are constant.

Diener[2] has described from the Productus shales of Byans, India, a *Hyattoceras* nov. sp. ex. aff. *H. Cumminsi* White. I doubt very much that this species belongs to *Hyattoceras* because it does not show the characteristic phylloid ends of the saddles and has only two lateral and two auxiliary lobes. It certainly is generically different from *Perrinites,* which in specimens of the same size shows already the typical suture with the high median saddle of the siphonal lobe and the saddles ending in phylloid points; although the number of saddles and lobes is not larger than in the Indian specimen.

The genus *Perrinites* is of great stratigraphical importance for Texas. It has been found, so far, in the Clear Fork and in the middle part of the Double Mountain formation of north Texas, and in the

[1]Gemmellaro, Calc. c. Fusulina, App., pl. A, fig. 3, 7.

[2]Diener, Perm. foss. of the Central Himalayas, p. 115, pl. 5, fig. 20.

Leonard formation of the Glass Mountains and the Mt. Ord range of Brewster County, West Texas. The genus seems to be represented by numerous specimens wherever it appears. White says that he found about forty specimens at the Military Crossing of the Big Wichita River, Baylor County. In the Glass Mountains we have collected in a short time about fifty specimens in one very limited locality, and we found them numerous wherever the genus was represented, with exception of only one place, where not more than two specimens could be found; although the locality was extremely rich in brachiopods. In west Texas, *Perrinites* so far seems to be limited to only one horizon, the Leonard formation,[1] while in the horizon above it, the Word formation, *Waagenoceras* appears. In north Texas it is probably also limited to a certain stratigraphical zone although appearing in two petrographical subdivisions; at least, J. P. Smith remarks that *P. Hilli* was found associated with *Popanoceras*, *Medlicottia* and other forms possibly identical with those described by Dr. Chas. A. White from the Clear Fork division. This would indicate that the faunas of the Clear Fork and the lower part of the Double Mountain formation are similar and belong to stratigraphical zones not very different in age.[2]

We may add that J. P. Smith presumed, when he established his genus *Shumardites,* that the Cyclolobinae were derived from this genus. As we shall show in the description of *P. vidriensis* n. sp, this species develops on very small whorls a suture (pl. X, fig. 20) which in general corresponds to that of *Shumardites* which proves that J. P. Smith was entirely right. *Perrinites* certainly is derived from *Shumardites.*

It may be remarked here that the *Waagenoceras Cummins*i var. *Guadalupensis* described by Girty[3] certainly does not belong to *Perrinites.* It may perhaps, represent several species of *Waagenoceras* or even of different genera. The very imperfect illustrations do not allow a full recognition of its shape and the form of the sutures. We shall discuss this species in our paragraph on *Waagenoceras.*

[1]I have lately seen some ammonoids from the Delaware beds which seem to belong to *Perrinites* with respect to their form, but the suture could not be made visible.

[2]Compare Appendix to this work.

[3]Girty, Guadalupian Fauna, p. 502, pl. 29, fig. 23-26.

Perrinites vidriensis nov. sp.

Pl. VIII, Fig. 1-10; Pl. IX, Fig. 1-10; Pl. X, Fig. 1-21

Shell discoidal, involute, with compressed flanks and rounded venter; greatest width at the umbilical shoulder in smaller specimens, and a little above in the larger individuals. Whorls not very deeply embracing, the involution being in the smaller whorls a little more than one-third of the height, and in the largest ones a little less than one-half of the height of a whorl. The cross-section is parabolical to elliptical, the height being greater than the width. There are four to six constrictions on the whorl, straight to slightly sinuous on the flank and strongly curving on the venter, with the convexity toward the back. The constrictions are deep on the cast, while on the shell they are noticeable by a thickening of the lines of growth on both sides of it; almost no depression is visible on the shell. The ornamentation consists of very fine lines of growth entirely parallel to the constrictions. The umbilicus is narrow, and the umbilical shoulder is comparatively sharp in the younger whorls, while in the older ones it becomes considerably rounded. The umbilical wall is steep and broad, although not perpendicular. The body chamber is unknown; even specimens with a diameter of 125 mm. do not show its beginning.

The septa are very near and often even almost touch each other in certain parts. The suture (pl. VIII, fig. 4, 7; pl. IX, fig. 10; pl. X, fig. 19) follows a straight line between the sipho and umbilicus. The siphonal lobe is divided in two branches by a high median saddle. Each of the branches ends in a long and sharp point. It tapers from the upper part toward the bottom. The first lateral lobe is scarcely deeper than the branches of the siphonal lobe; it is generally somewhat broader and more symmetrical and a little more scalloped. The second lateral lobe is similar to the first, but also deep and wide. The three auxiliary lobes are similar to the lateral ones, but decrease gradually in depth and width, as all the lobes do from the first lateral to the umbilicus. The third auxiliary lobe is on the umbilical shoulder.

The median saddle of the siphonal lobe is very high, broader at the base than at the top, where it is notched by an indentation. In a mature specimen (130 mm.) it has three secondary lobes on each side and several rudimentary ones; in those somewhat smaller (65 mm.) it shows only the three secondary lobes and in smaller whorls it loses

these also, gradually showing still one secondary lobe at each side on a whorl with 7 mm. diameter, while on one of 5.5 mm. diameter, the sides of the median saddle are almost entirely straight; the whole having a trapezoidal form with slightly concave sides. In the mature form the external saddle is very high, broad at the base and narrow above. Leaving out of consideration the secondary lobes, the whole saddle has a triangular form. It is scalloped on each side by about four secondary lobes, which cause the existence of slender secondary saddles; all those nearer the upper portion of the saddle end in phylloid points, one of them forming the highest part of the saddle; while two more branch off, not quite at the same height, somewhat below the upper end of the saddle. The secondary lobes become gradually shorter nearer to the base, where they constitute only small indentations. In the very largest specimens (110-130 mm.) there are a number of rudimentary lobes within those mentioned, which do not change the general character and only scallop farther the outside of the saddle. The first and second lateral saddles are practically built on the same plan as the external one; they also end in a phylloid point, but the next lower secondary saddles branch off at the same height. The same may be said of the first two auxiliary saddles, while the third seemingly is also similar to them, though its form could not quite be made out. It lies on the umbilical wall.

In smaller whorls the general outline of the saddles does not change, although the secondary lobes become simple and are not more subdivided by rudimentary saddles. In a specimen of about 10 mm. diameter we still see the same number of saddles, but the number of secondary lobes on the external saddle is now reduced to two on each; at a diameter of 7 mm. there are only four saddles visible—the external, two laterals and one auxiliary; but the general shape remains the same. One half whorl farther back, the external saddle shows only one slight adventive lobe on each side, while the other three are simple. On specimens with a diameter of 4 mm. the external saddle shows still a slight indentation on the side nearer to the umbilicus, but all the four saddles visible are of about the same height. One-half whorl farther back, the first auxiliary saddle splits up in three branches, the middle one of which is the highest. One half whorl farther back, the side branches, especially the one nearer towards the

sipho, diminish in height and the latter one even disappears, while the middle branch of the auxiliary saddle becomes now as high as the external saddle. The two lateral saddles are of equal but much lower height than the external and the first auxiliary. The suture line reaches here clearly the stage of *Shumardites* (pl. X, fig. 20). J. P. Smith already presumed, when he established the genus *Shumardites*, that this would prove to be the precursor of the Cyclolobinae, a hypothesis which is confirmed by our find.

The internal suture (pl. X, fig. 21) of the present species is not entirely known, but the most important part could be uncovered. The antisiphonal lobe is very long and extremely narrow. It is lanceolate in its general outline but has three pairs of secondary saddles of which the upper one is by far the largest, the middle one long and thin, while the lowermost in about one-third of the total depth is only a pair of sharp corners. All lean over toward the median line of the lobe. While the antisiphonal lobe is entirely symmetrical, the first lateral lobe is entirely asymmetrical. It ends in a long and sharp point and the shape and size of the secondary saddles which scallop its sides are entirely different. This lobe is shorter than the foregoing one. The second lateral lobe is also long and ends in a sharp point, but is shorter than the first. Its form is similar in general to that of the first lateral lobe, although the details are different. The first auxiliary lobe also ends in a long point, but is comparatively broader and more asymmetrical than the lateral ones. All the lobes decrease gradually but rapidly in depth from the antisiphonal to the first auxiliary lobe; the number of the auxiliary lobes is unknown.

The internal saddle is extremely long and slender, and tapers slightly from the base toward the upper end. It ends in a broad phylloid point and has several rounded branches farther down. The secondary lobes which scallop its sides are broad and deep near the upper portion and grow very shallow near the base. The first and second lateral saddles are built on exactly the same plan as the internal saddle, with the one exception that they do not show the same number of branches. Those near the base disappear. The first auxiliary saddle shows exactly the outline of the upper portion of the internal saddle, but all the secondary lobes and secondary saddles of the latter are missing on the auxiliary saddle. The exact number of auxiliary

saddles is unknown. This internal suture is taken from a fairly mature specimen.

Dimensions:[1]

	I		II		III	
Diameter	125.7 mm	(1)	102.6 mm	(1)	63.4 mm	(1)
Width	58.1 mm	0.46	49.5 mm	0.48	33.4 mm	0.53
Height of last whorl	67.5 mm	0.54	54.1 mm	0.53	33.5 mm	0.53
Diameter of umbilicus	15.0 mm	0.12	13.0 mm	0.13	6.7 mm	0.11

	IV		V		VI	
Diameter	56.6 mm	(1)	44.8 mm	(1)	43.1 mm	(1)
Width	30.7 mm	0.54	25.0 mm	0.55	24.1 mm	0.56
Height of last whorl	30.0 mm	0.53	23.6 mm	0.53	23.5 mm	0.54
Diameter of umbilicus	6.2 mm	0.11	5.0 mm	0.11	4.1 mm	0.10

	VII[2]		VIII		IX	
Diameter	36.1 mm	(1)	29.0 mm	(1)	16.5 mm	(1)
Width	20.7 mm	0.57	16.5 mm	0.57	10.2 mm	0.62
Height of last whorl	18.7 mm	0.52	15.0 mm	0.52	8.0 mm	0.48
Diameter of umbilicus	4.1 mm	0.11	?4.0 mm	0.14	?3.0 mm	0.18

	X		XI		XII	
Diameter	13.0 mm	(1)	7.6 mm	(1)	4.4 mm	(1)
Width	8.0 mm	0.62	5.7 mm	0.75	2.9 mm	0.66
Height of last whorl	5.3 mm	0.41	3.4 mm	0.45	1.8 mm	0.41
Diameter of umbilicus	1.1 mm	0.085	0.6 mm	0.08	0.4 mm	0.09

Relation to other species:

Very nearly related to our species is *P. Hilli* Smith.[3] It is a little more involute, its cross section is less elliptical than that of our specimens of the same size; the saddles of the suture are a little stouter, and the lobe narrower than in our species; the points in which the lobes end are somewhat shorter in *P. Hilli* than in *P. vidriensis.* These differences are relatively small, but one cannot expect great variety in such a simply built genus as the present one.

Less similar yet is *P. Cumminsi* White,[4] the whorls of which are less high, while the umbilicus is much larger than our species.

---

[1]In the very small specimens the measurements, especially those of the umbilicus, are not entirely exact, on account of the relative coarseness of my instrument.

[2]While all the rest of the measured specimens come from a point about two miles west-northwest of Iron Mountain, this one comes from a point three miles north of the old oil derrick on Wedin's Ranch on the north side of "Round Point ridge," Glass Mountains.

[3]J. P. Smith, Carb. Amm. of N. America, p. 140, pl. 27.

[4]Ch. A. White, The Texan Permian, p. 20, pl. 1, fig. 4-8.

The saddles of the suture are much shorter and stouter, although the general arrangement of the suture is the same. The small specimens of this species, like that figured by White in his pl. 1, fig. 4 and 5, are extremely similar to specimens of the same size of our species.

Perrinites compressus n. sp. is also a species which is very similar to *P. vidriensis* but its involution is more than one half of the height of a whorl and its umbilicus is wider than that of the latter species; the saddles of the suture are somewhat higher and less deeply scalloped.

There exists probably another species similar to *P. vidriensis*. Some specimens were collected by Udden[1] about 2½ miles N 20° E of the old oil derrick on Wedin's ranch on the top of the first ridge, and others were brought by Mr. Chas. L. Baker and myself from the first ridge northwest of Iron Mountain. Unfortunately, the specimens are too badly preserved and too small for a description. They seem to belong to a species the cross-section of which is similar to that of *P. Cumminsi,* while the umbilicus is extremely narrow. This species occurs in the lower part of the Leonard formation and may possibly allow a subdivision of that horizon.

Age:

Leonard formation, Permo-Carboniferous.

Number of specimens examined:

More than a hundred.

Locality:

Two miles west-northwest of Iron Mountain, at the base of a large clay slide (very frequent); 1½ miles west-northwest of Iron Mountain (frequent); 3 miles north of the old oil derrick on Wedin's ranch; valley north of Leonard Mountain (all these localities are in the Glass Mountains); three miles south of Bird's mine north of intrusive plug of Capt. James's ranch (very frequent); region of the Altuda Mountain in the Mt. Ord range.

[1]Through an error this was cited by Udden (Univ. Texas Bull. 1753, p. 13) under the name of *Waagenoceras.*

Perrinites compressus nov. sp.

Pl. X, Fig. *22-27*

Shell discoidal, involute, with compressed and flattened flanks, rounded venter, greatest width near the umbilical shoulder. Whorls deeply embracing, the involution being somewhat more than one-half of the height of the whorl; the cross-section is parabolical, as the height of the whorl is less than the width. No constrictions have been observed on the type specimens, but this may be due to the state of preservation. Both specimens are casts and no kind of ornamentation is visible on them. The umbilicus is narrow and deep, the umbilical shoulder is rounded, the umbilical wall is steep. The body chamber is unknown.

The septa are very near together and in places nearly touch each other. The suture (pl. X, fig. 25, 26) follows a straight line between the sipho and the umbilicus. The siphonal lobe is divided in two branches by a high median saddle; each of the branches ends in a long and sharp point. It tapers from the upper part toward the bottom. The first lateral lobe is very little deeper than the branches of the siphonal lobe, but broader, more symmetrical and more scalloped. The second lateral lobe is similar to the first one in every detail but less deep and wide. The same may be said of the first, second and third auxiliary lobes, although the last two are not very well preserved. All the lobes decrease gradually in depth and width from the first lateral to the umbilicus. The third auxiliary lobe lies on the umbilical wall.

The median saddle of the siphonal lobe is unusually high, broader at the base than at the top, where it is notched by an indentation. It has three secondary lobes on each side. The external saddle is very high, broad at the base and narrow above; leaving out of consideration the secondary lobes, the whole saddle has a triangular outline. It is scalloped on each side by about three to four secondary lobes which cause the existence of slender secondary saddles; all those on the upper portion of the saddle end in phylloid points, one of them forming the highest part of the saddle, while two more branch off, not quite at the same height, somewhat below the upper end of the saddle, giving it a tripartite aspect. The secondary lobes become shorter gradually nearer to the base of the saddle, where they form only small in-

dentations. The first and second lateral saddles are practically built on the same plan as the external one. They also end in a phylloid point but the next lower pair of secondary saddles branches off from the same place. The lateral saddles are lower than the external one. The three auxiliary saddles are more or less similar to the lateral one, but have a smaller number of branches. The third auxiliary saddle lies on the umbilical seam, the second one on the umbilical shoulder.

The internal suture is unknown in this species.

Dimensions:

Diameter	39.8 mm	(1)
Width	20.4	0.51
Height of last whorl	18.5	0.46
Diameter of umbilicus	7.0	0.18

Relation to other species:

At first glance, our species is very similar to *Perrinites vidriensis,* but it is easily distinguished by its different involution and the deeper embracing whorls. When we compare the ratio of dimensions of *P. compressus* with the nearest one in size (No. VII of the table of dimensions) of *P. vidriensis,* we find that they are very different, the ratio being in the present species 1:0.51:0.46:0.18, and in the other one 1:0.57:0.52:0.11. We may still add that the flanks of our species are more flattened and that the branches of the saddles in the suture are more delicate than in *P. vidriensis.* It should be noticed that the third auxiliary saddle in our species is on the umbilical seam, while in *P. vidriensis* it is on the umbilical wall.

P. Hilli is easily distinguished by its manner of involution, its generally greater width and its much smaller umbilicus; also the saddles on its suture are much stouter than in our species.

P. Cumminsi is entirely different with respect to the ratio of dimensions, and the umbilicus seems to be still wider than in our species; the suture is very different.

Age:

Lower part of Leonard formation, Permo-Carboniferous.[1]

[1]Through an error Udden (Univ. Texas Bull. 1753, p. 46) has cited the rest of the fauna occurring together with *P. compressus* as belonging to the Hess formation.

Number of specimens examined:
Two.

Locality:
Near the top of ridge about 2 miles N 65° W of Wolf Camp at head of valley leading down to tank one-half mile west of Wolf Camp, Glass Mountains.

Waagenoceras Gemm.

The genus *Waagenoceras* has been established by Gemmellaro[1] for ammonoids similar in form to the Triassic Arcestidae. Gemmellaro's original diagnosis says that the species belonging to this group are covered with fine transversal striae, are more or less globose, involute, and slow-growing, with convex ventral region, narrow and deep umbilicus; and that the form of the last whorl is different from that of the preceding ones. The internal whorls have two to three internal varices presented as straight and narrow constrictions on the cast, and extending from the umbilicus to the venter. The aperture is low, semilunar, and restricted by a strong and broad internal swelling on the margin; has no lateral ears and no ventral prolongation. Body chamber is one whorl and a half long; suture line curved; siphonal lobe strongly narrowed at the base and deeply divided in two curved branches by a high and broad median saddle. Six lobes exist between the siphonal one and the umbilicus. They are coarsely dentate; between them are seven deeply scalloped saddles which have phylloid ends.

Gemmellaro compares his genus with *Cyclolobus* and says that *Waagenoceras* differs from this genus because it has six lobes instead of fifteen; that it has no adventive lobes and that the siphonal lobe is narrowed at the base and has curved branches; and that the internal varices are straight instead of falciform.

Mojsisovics[2] tried to show that *Waagenoceras* cannot be separated from *Cyclolobus,* but Gemmellaro did not accept this view. He tried to show in an appendix to his works, that the two genera are very different from each other.

[1]Gemmellaro, Calc. c. Fusulina, p. 9, ibid., App., p. 5.
[2]Mojsisovics, Arkt. Trias-Amm., p. 18.

Gemmellaro does not make any remarks about the curious parabolical course of the suture of *Cyclolobus,* which alone probably would be sufficient to separate it generically from *Waagenoceras,* but his reasoning is entirely justified. The difference in the external form and the suture of the two genera are so great that one cannot even think of uniting them. *Waagenoceras* certainly belongs to the same subfamily as *Cyclolobus,* but the latter genus represents a much more highly developed form, and is at least as similar to *Joannites* as to *Waagenoceras.* It must be taken into account that the shape of the siphonal lobe of *Cyclolobus* is somewhat imperfectly known, as has been pointed out by Diener.[1] Waagen apparently has reconstructed the median saddle of the siphonal lobe in his figure of *Cyclolobus Oldhami*[2] and the suture of the very nearly related *Krafftoceras* Diener[3] shows that the median saddle of the siphonal lobe of *Cyclolobus* is possibly still much more different from that of *Waagenoceras* than we could suppose.

Whatever be the shape of the median saddle, there is no doubt that the branches of the siphonal lobe are much more subdivided than those of *Waagenoceras* and that their shape is entirely different, as Gemmellaro has shown. The external saddle in *Cyclolobus Oldhami* is curved with the convexity toward the siphonal region, while that of *Waagenoceras* has the convexity on the umbilical side. The most important feature is the parabolical curve followed by the suture between the sipho and the umbilicus, which is not only found in *C. Oldhami* but also in *C. Kraffti* Dien. and in *C. persulcatus* Rothpl. from the Permian of the Island of Timor, and which has the greatest similarity to the curvature of the suture in *Joannites. Waagenoceras,* on the contrary, always shows a suture the curvature of which is part of a circle, as has been pointed out by Mojsisovics. Diener[4] is certainly right, when he says that "*Cyclolobus* is linked as closely to *Joannites* Mojs. on the one hand as it is to *Waagenoceras* Gemm., on the other."

Most of the authors seem to have accepted the genus *Waagenoceras.* Haug[5] considers it as belonging to his Joannitidae together with *Cyclo-*

[1]Diener, Permian foss. Centr. Himalayas, p. 167.
[2]Waagen, Productus limestone fossils, I, p. 24, pl. 1, fig. 9.
[3]Diener, Permian foss. Centr. Himalayas, p. 162, pl. 6, fig.9.
[4]Diener, loc. cit., p. 14.
[5]E. Haug, Les Amm. du Permien et du Trias., p. 394.

lobus, Stacheoceras, and *Joannites,* while J. P. Smith[1] regards the genus as belonging to the family of the Arcestidae and unites it with *Shumardites* and *Cyclolobus* in the subfamily Cyclolobinae Zitt. J. P. Smith, however, does not figure a real *Cyclolobus,* but in its stead *Waagenoceras Stachei* Gemm., under the name of *Cyclolobus Stachei* Gemm.; while he figures on the same page, as a typical *Waagenoceras,* his *W. Hilli,* which we have discussed in our description of the new genus *Perrinites,* and shown to be generically different from *Waagenoceras.*

Waagenoceras has been cited from Texas Permian on several occasions but most of them belong to our genus *Perrinites,* as we have shown above. The only specimens which might really belong to *Waagenoceras* are some of those which have been described by Girty[2] as *W. Cumminsi* var. *Guadalupensis.* The shape of most of these specimens does not seem to be that of a real Waagenoceras. Girty says that they have a flattened subglobose shape, probably such as is shown in his fig. 24*a*. The suture taken from this specimen does not look much like that of *Waagenoceras,* showing hardly any curve at all. I doubt very much that fig. 25 belongs to the same species or perhaps even to the same genus, as the number of lobes is so different, and the suture follows entirely different lines. There must be some error in the explanation of this plate, as it is impossible that both sutures are enlarged twice or the suture fig. 24 could not belong to fig. 24*a*; nor that of 25*a* to fig. 25. The only specimen which may represent a real *Waagenoceras* is that shown in Fig. 26; at least the antisiphonal lobe and the internal saddles are very similar to those of the typical *Waagenoceras.* This latter specimen evidently belongs to a very globose shell which has certainly no sort of similarity to the rest of the specimens figured under the same name. Of course it is impossible to say if this specimen belongs to the new species of *Waagenoceras* which will be described below.

So far *Waagenoceras* has only been found in Sicily (if the above mentioned somewhat doubtful specimen figured by Girty in pl. 29, fig.

[1]J. P. Smith, in Eastman-Zittel, Textb. of Pal., 2nd ed., p. 642.
[2]Girty, Guadalupian Fauna, p. 502, pl. 29, fig. 23-26.

26 does not belong to that genus[1]). In the Glass Mountains the genus is represented by only one species, *W. Dieneri* n. sp., but this one is exceedingly common at most of the localities where the horizon occurs. It is found in the lower mass of limestone of the Word formation, where it occurs in greater numbers than most other species.

The nature of the rock does not allow of breaking the specimens up and studying the suture on the interior whorls. It has therefore not been possible to show if this genus has any ontogenetic relation to *Perrinites,* which always occurs in beds far below the *Waagenoceras* limestone.

Waagenoceras Dieneri nov. sp.

Pl. X, fig. 28-31; Pl. XI, fig. 1-27

Shell subglobose, involute, slightly flattened on the flanks, well rounded on the venter, whorls very deeply embracing and slowly growing. Cross-section semilunar, much broader than high. Umbilicus narrow and deep with a rather sharp umbilical shoulder; the umbilical wall is broad and nearly perpendicular. The involution is nearly four-fifths of the height of the whorl in the larger specimens, and about four-sevenths in the interior whorls. The casts of the inner whorls generally show about four deep constrictions which pass over the whole whorl in a practically straight line without having any inflection on the venter; these contrictions correspond to internal varices of the shell. On the larger whorls these constrictions grow more shallow and even seem to disappear entirely. The surface of the shell is not known but does not seem to have possessed any very strong ornamentation. The body chamber is unknown.

The septa are rather near together and in some places almost touch each other. The suture (pl. X, fig. 31; pl. XI, fig. 3, 5, 6, 10) follows a strongly curved line between the sipho and the umbilicus. The suture consists of the siphonal lobe, seven lateral and auxiliary lobes, and seven saddles between the sipho and the umbilical shoulder; there are one saddle and one lobe more on the umbilical wall.

[1]When the manuscript of this paper was already finished, I had the opportunity to look through a number of fossils collected by Mr. Ch. L. Baker in the west side of the Delaware Mountains at a point north of the Apache Mountains, West Texas. This collection contains not only several specimens of typical *Waagenoceras* but also generically different forms which seem to correspond to Girty's "*Waagenoceras*" *Cumminsi* var. *Guadalupensis.*

The siphonal lobe is divided into two branches by a moderately high and narrow median saddle. Each of the branches is strongly curved with the convexity toward the umbilical side; and they are bifid, the point on the siphonal side being a little longer than that on the umbilical side. There are two indentations on the umbilical side of the branch. The first lateral lobe is not as deep as the siphonal one. It is trifid and not quite symmetrical, and the middle point is longer than the lateral ones; the lobe has two more indentations on each side, and is narrower at the top than in the middle. The second lateral lobe is very similar to the first one, but less deep. The first and second auxiliary lobes are very similar to the lateral ones but less deep, but in the second auxiliary lobe the lateral point on the siphonal side becomes somewhat longer than that on the umbilical side. This character is still more pronounced in the third auxiliary lobe, which thus takes on the aspect of being bifid. The fourth auxiliary lobe is still more asymmetrical and ends in a long point, while a smaller point exists on each side of it, of which the one on the umbilical side is far longer than the other. A fifth and very small auxiliary lobe exists on the umbilical shoulder. The depth of the lobes begins to decrease from the first lateral, the second lateral being much less deep than the first one, while the first auxiliary is very little different from the second lateral. From the second auxiliary lobe to the umbilicus the lobes begin to decrease rapidly in depth. The lobe and saddle on the umbilical wall seem to be very simple and rounded, but they could be seen only on immature specimens.

The median saddle of the siphonal lobe (pl. X, fig. 31) is relatively low, narrower at the base than at the top, where it is notched by a slight indentation. It has also a slight indentation on each side above the base. The external saddle is about twice as high as the median saddle; it is distinctly curved with the convexity toward the umbilical side. It ends in a large phylloid point and has four short lateral branches. It is narrower at the base than at the top. The first lateral saddle is nearly as large as the external, but it is a little narrower and more delicate. On account of the curvature of the suture it looks as if it were higher than the external saddle. It ends in a large phylloidal point and has four lateral branches. The second lateral saddle is practically equal to the first one in size and shape, but perhaps a little

broader. The auxiliary saddles are built after the plan of the second lateral, but they lose first the lower pair of lateral branches and then the upper, while the phylloid end becomes longer. The fifth auxiliary saddle which lies on the umbilical wall is simple and entire.

The internal sutures are not completely known, but the most important part could be uncovered. The internal suture (pl. X, fig. 28) follows a slightly curved line. It is composed of the antisiphonal lobe, two lateral and probably five auxiliary lobes with one internal, two lateral and four auxiliary saddles between them.

The antisiphonal lobe is divided into three branches by two high and narrow secondary saddles, which lean considerably over toward the median line of the lobe. The two lateral branches are much less deep than the middle one, have two lateral indentations, and end in a long and sharp point. The middle branch has two short lateral points, and one long and sharp median point. The first lateral lobe is distinctly trifid, the median point being longer than the lateral ones. It has one secondary saddle on each side and is much narrower at the top than at the base. The details of the rest of the lobes could not be observed but they are probably similar to those of the first lateral lobe.

The internal saddle is very narrow at the base and in the middle, but ends in a very large phyllum which is a little higher than broad; it has one branch at each side, but these are of a different height; it is curved, bending over toward the antisiphonal lobe. The first lateral saddle is similar to the internal but not curved, the phyllum in which it ends being still a little longer with respect to the width than that of the preceding saddle. The following saddles are certainly built in a similar manner, but the details could not be made out.

Dimensions:[1]

	I		II		III	
Diameter	47.6 mm	(1)	25.5 mm	(1)	23.7 mm	(1)
Width	41.6 mm	0.87	?21.5 mm	0.84	20.3 mm	0.86
Height of last whorl	20.6 mm	0.43	11.5 mm	0.45	11.5 mm	0.49
Diameter of umbilicus (between the shoulders)	8.7 mm	0.18	4.7 mm	0.19	4.8 mm	0.20

	IV		V		VI	
Diameter	19.7 mm	(1)	17.4 mm	(1)	16.1 mm	(1)
Width	17.6 mm	0.89	16.3 mm	0.87	14.4 mm	0.89

[1]There are fragments of much larger specimens, one of which must have had a diameter of about 100 mm.

Height of last whorl.....	9.7 mm	0.49		8.7 mm	0.50		7.8 mm	0.48
Diameter of umbilicus.... (between the shoulders)	3.8 mm	0.19		3.3 mm	0.18		3.1 mm	0.19

	VII		VIII	
Diameter	14.5 mm	(1)	11.6 mm	(1)
Width.	12.5 mm	0.86	10.3 mm	0.89
Height of last whorl.....	7.0 mm	0.48	5.7 mm	0.49
Diameter of umbilicus.... (between the shoulders)	2.7 mm	0.19	2.2 mm	0.18

Relation to other species:

All the species of *Waagenoceras* described from Sicily are more or less similar to our species, there being no varying sculpture to distinguish them by, and all of them being very globose forms. When we compare the ratio of dimensions, *W. Nikitini* Gemm.[1] is certainly the species which most resembles our Texan form. Its ratio seems to be approximately 1 :0.82 :0.45 :0.17, against 1 :0.87 :0.43 :0.18 in a specimen of about the same size belonging to *W. Dieneri* n. sp. The principal differences between our species and *W. Nikitini* are to be found in the suture. Although the general character is very similar there are some distinctive features in the detail. The median saddle of the siphonal lobe is higher in the Sicilian species, the saddles in general are more slender and probably higher, the external saddle shows a much more triangular phyllum at its end, and in it as well as in all the rest of the saddles this terminal phyllum is larger and the connection between it and the lower part of the saddle is thinner. The siphonal lobe has in each branch one point much longer than the other, while in our species both points show very little difference in length. Similar differences exist with respect to the other lobes. The antisiphonal lobe also shows some differences; the secondary saddles in our species lean farther over toward the median line than in the Sicilian species, the median branch is broader, the lateral branches are not bifid as in the Sicilian form. The internal saddle leans more over toward the median line of the antisiphonal lobe in our species than in the Sicilian one; its highest branches begin at different heights while in *W. Nikitini* they branch off from the same point. Taking everything together, the internal suture of our species resembles more that of *W. Mojsisovicsi* Gemm.[2]

[1]Gemmellaro, Calc. c. Fusulina, App., p. 4, pl. A, fig. 1-4; pl. B., fig. 1.

[2]Gemmellaro, Calc. c. Fusulina, p. 10, pl. 1, fig. 1-3; pl. 2, fig. 1-2; pl. 7, fig. 35; app., pl. A, fig. 5, 7.

than that of any other species; the external suture resembles that of our species also, somewhat, although the saddles are more scalloped and more slender, but the external shape of the Sicilian species is entirely different from that of *W. Dieneri* n. sp.

W. Stachei Gemm.[1] is similar to our species in its external shape, although not quite identical with regard to the ratio of dimensions, and also the sutures are somewhat similar; but the saddles are more scalloped and their side branches are longer and the whole saddle straighter; the external saddles are much more curved than in our species.

A real *Waagenoceras* has probably been described from the Guadalupian of Texas. I refer to *W. Cummmsi* var. *Guadalupensis* Girty,[2] but of the different specimens figured, only one can be referred to *Waagenoceras* with any degree of certainty. This specimen shows part of the internal suture, especially the antisiphonal lobe and the internal saddle. The antisiphonal lobe differs from that of our species, because the lateral branches are nearly as long as the median branch, while in our species these are much shorter. The internal saddle seems to be much stouter than in our forms, while the first lateral saddle has apparently the same shape as that of *W. Dieneri.* The generic determination of the other specimens figured by Girty is uncertain. Figure 23 may represent a *Waagenoceras,* but the sutures, fig. 24 and 25*a*, are very different from each other. Figure 25*a* has a very uncommon siphonal lobe and apparently a very low median saddle, while Fig. 24 shows a very uncommon position of the suture, although the siphonal lobe seems to be similar to that of *Waagenoceras.* None of the specimens reproduced by Girty has anything to do with the so-called *Waagenoceras Cummmsi* White, which, as we have shown, belongs to our new genus *Perrinites. W. Dieneri* is a very common species in the higher part of our Permo-Carboniferous, the Word formation, but it is difficult to separate it from the rock.

Age:

Word formation, Permo-Carboniferous.

[1]Gemmellaro, Calc. c. Fusulina, pl. 1, fig. 4-6; pl. 2, fig. 3-4; pl. 4, fig. 1; App., pl. A, fig. 6.

[2]Girty, Guadalupian fauna, p. 502, pl. 29, fig. 26 (not fig. 23-25).

Number of specimens examined:

About fifty. The species is extremely common at the different localities.

Locality:

Surroundings of the junction of Road and Gilliam Canyons; mountains north of Leonard Mountain, Glass Mountains.

MEEKOCERATIDAE Waagen.

LECANITINAE Hyatt

Paralecanites Diener

The subgenus *Paralecanites* was established by Diener[1] for ammonites similar to *Lecanites* Mojs. but distinct from it by the absence of the second lateral lobe. To *Paralecanites* belong very evolute forms with low and little embracing whorls, wide umbilicus, practically no sculpture and simple septa consisting of a siphonal lobe, one external, one lateral and the beginning of an auxiliary saddle.

Frech[2] proposed to unite *Paralecanites* with *Paraceltites* Gemm. but Diener,[3] in a later article, showed that there was a fundamental difference between the two genera in so far as *Paraceltites* has an undivided siphonal lobe and always shows a rather strong sculpture.

Hyatt and J. P. Smith[4] accept *Paralecanites* as an independent genus and refer to it a form found in the *Meekoceras* beds of the Lower Triassic, *Paralecanites Arnoldi* Hyatt a. Smith.[5] This species is in so far interesting as it shows apparently one lobe more than the type species *Paralecanites sextensis* Dien. The authors explain that this lobe is not an auxiliary one, but an internal lobe which becomes visible outside of the umbilical seam on account of the evolution of the shell. It is to be supposed that the internal lobes of the genus "would consist of an antisiphonal lobe flanked by an internal lateral as this is the case with all primitive ammonites of this group." In the case of *P Arnoldi,* the authors actually observed that there exists a divided antisiphonal lobe and that the next lobe, the internal lateral, appears beyond the umbilical seam.

In the region of Altuda Mountains, Dr. J. A. Udden has found a very evolute cephalopod which shows a peculiar suture, very similar to that of *Paralecanites Arnoldi.* This cephalopod is so evolute that the dorsal portion touched and excavated by the next smaller whorl is

[1]Diener, Amm. u. Orthoc. d. Südtirol. Bellerophonkalk, p. 66.
[2]Frech, Lethaea Palaeozoica, 2 Bd, 3 Lief, p. 552.
[3]Diener, Ueb. d. syst. Stell. d. Amm. d. Südalp. Bellerophonkalkes, p. 426, et seq.
[4]Hyatt and Smith, Triass. ceph. genera of America, p. 136.
[5]Hyatt and Smith, loc. cit., p. 136, pl. 64, fig. 1-16; pl. 77, fig. 9-12.

so narrow that there is probably no more room than for an antisiphonal lobe, which makes it probable that we have a similar case as in *Paralecanites Arnoldi.* In our species the siphonal lobe is divided by a low saddle. There are the high external and first lateral saddles while the next one is extremely low and apparently has to be considered as an auxiliary saddle. The first lateral lobe is deep, while the next one is much smaller and may be considered as an auxiliary lobe; another lobe is visible in part near the umbilical seam. If our interpretation is right, we would have the same case as in *P. Arnoldi.* We would then regard the smaller lobe following the first lateral as the second lateral, and the lobe partly visible on the umbilical seam as an internal lobe. There would be no second lateral saddle but the small saddle following the first lateral would have to be regarded as the first lateral saddle of the internal suture. As long as the internal suture of this species is unknown, there is no possibility of proving our contention, but the case of *P. Arnoldi* makes it very possible that our species really belongs to *Paralecanites* and differs from the type by showing some of the internal elements beyond the umbilical seam.

Paralecanites has been first described from the Bellerophon limestone of the Alps, the highest member of the Alpine Permian, and certainly much younger than the beds in which our species has been found.

Paralecanites altudensis nov. sp.

Pl. XI, Fig. 28-45

Shell discoidal, evolute, strongly compressed on the flanks, rounded on the ventral part, whorls not deeply embracing; cross-section suboval, much higher than broad; greatest width about one-third above the umbilical seam. No umbilical shoulder is developed, the flank curving gradually down to the umbilical seam; the umbilical wall is little defined and has an inclination of not more than 30°. The umbilicus is very wide and shallow. No constrictions are visible on the whorls.

All the specimens are casts; no trace of ornamentation is visible. The body chamber seems to be more than one whorl long.

The septa are not very near together; the external suture (pl. XI, fig. 35) forms a straight line. The siphonal lobe is not very deep but broad and divided in two branches by a low median saddle. Each of

the branches ends in a point. The first lateral lobe is large, funnel-shaped, and apparently rounded; the second lateral lobe is similar to the first one, but at the outer side limited by a much lower saddle. A third and much more shallow lobe must exist right on the umbilical seam. The first two lateral lobes are much deeper than the siphonal one. The saddles are all entire and tongue-shaped. The median saddle of the siphonal lobe is less than half as high as the first lateral, is broad at the base, tapering toward the top, which is notched by an indentation. Unfortunately, this part of the suture is not very well preserved. The external and the first lateral saddle are high and nearly of the same size and shape. The third saddle is about half as high as the first two, but is not very well preserved.

Dimensions:

	I		II		III		IV	
Diameter ...	30.8 mm	(1)	19.8 mm	(1)	19.4 mm	(1)	11.5 mm	(1)
Width	?		3.3 mm	0.17	3.3 mm	0.17	1.8 mm	0.16
Height of last whorl	7.5 mm	0.24	6.1 mm	0.31	6.1 mm	0.31	3.5 mm	0.30
Diameter of umbilicus .	14.6 mm	0.47	9.3 mm	0.47	9.5 mm	0.49	6.0 mm	0.52

Relation to other species:

There is no species described which could be well compared with the present one. The form of this ammonoid is rather similar to that of *Paraceltites* but the characteristic ornamentation of the latter is lacking, and the suture seems to be entirely different, especially the siphonal lobe.

The generic determination remains somewhat doubtful, but better preserved specimens may be found later and allow a better drawing of the sutural line.

We have already indicated that our species has some similarity with *P. Arnoldi* Hyatt a. Smith, and that the lobe at the umbilical seam may in reality be the first lateral lobe of the internal suture, becoming visible beyond the seam on account of the narrowness of the dorsal portion. As long as we do not know the internal suture of our species, it is impossible to prove that our interpretation is right, but there exists certainly a great resemblance between the suture of our species and that of the form from the Lower Triassic of Idaho. Even the external shape is very similar, especially when we compare our specimens with the mature form illustrated by Hyatt and Smith on their pl. 77, fig.

9-12. The principal difference between our species and the Triassic species is that the latter shows a serrated first lateral lobe in a specimen of about 16 mm. diameter, while the lobes in ours are apparently all rounded.

The different species of *Paralecanites* described by Diener[1] are all less evolute and the dorsal portion is broader, which would account for the difference in the suture.

Age:

Leonard formation, Permo-Carboniferous.

Number of specimens examined:

Fourteen. The species appears to be very frequent at the locality but it is never very well preserved.

Locality:

South of the intrusive plug on Capt. James's ranch, Altuda Mountain, near Marathon.

[1]Diener, Amm. u. Orthoc. i. südtirol, Bellerophonkalk, p. 68-71, pl. 1, fig. 3-8.

APPENDIX

ON SOME NEW AMMONOIDS AND THE SUCCESSION OF THE AMMONOID-BEARING HORIZONS OF THE PERMO-CARBONIFEROUS IN CENTRAL TEXAS

APPENDIX

ON SOME NEW AMMONOIDS AND THE SUCCESSION OF THE AMMONOID-BEARING HORIZONS OF THE PERMO-CARBONIFEROUS IN CENTRAL TEXAS.

After the plates for the present work had been finished and the printing of the text begun, Dr. J. W. Beede, of Austin, sent me two small collections of Permo-Carboniferous ammonoids. One of these were collected by Mr. W. E. Wrather in 1914, in beds about 200 feet below the top of the Wichita formation, four miles south of Dundee, Baylor County, Texas. Mr. Wrather considers this horizon as being somewhat lower than the one of the old Military Crossing in the same county, where W. F. Cummins collected the material later on described by Dr. Charles A. White.

The other collection was made by Dr. Beede himself on the Colorado River, in western Runnels County, Texas, about four miles east of the western county line and 300 feet below the top of the Clear Fork beds. Dr. Beede considers this horizon as being approximately 675 feet higher than the one which contains the fossils described by Chas. A. White.

Unfortunately, the printing of the present paper is so far advanced that I cannot include here a description and illustrations of these fossils, but I have carefully studied them and drawn the sutures, and can at least add the main results I obtained, hoping that I may be able to publish later on a detailed description with the necessary illustrations of these new ammonoids and perhaps of some more material.

The stratigraphically older horizon found by Mr. Wrather four miles south of Dundee contains the following ammonoids:

Medlicottia n. sp. (aff. *M. artiensis* Gruenew.)
Perrinites n. sp. (aff. *P. Cumminsi* White)
Stacheoceras (*Marathonites?*) n. sp. (aff. *St. Romanowskyi* Karp.)
Agathiceras sp. ind. (aff. *A. uralicum* Karp.)

The fauna is entirely different from the one described by Chas. A. White and possibly slightly older. To show this we shall have to discuss every one of the species a little more in detail.

Medlicottia n. sp.

The shell is discoidal, very involute, flattened on the flanks and has a deep furrow on the venter. The cross-section of the whorl is sagittiform but truncated above and notched by the furrow, much higher than broad, the greatest width existing at about two-thirds of the height of the flank, counted from the umbilical border. On these lower two-thirds the flanks are nearly flat while in the upper third, the shell curves itself slightly toward the venter. On the venter are two lateral keels separated by a deep furrow; these keels are not sharp but rather strongly beaded; the nodules are rounded and separated from each other by narrow, nearly lineal, shallow depressions; the nodules are wider across the keel than in the direction of the spiral line. They occupy the same height on both keels and do not alternate as in certain stages of growth of *M. artiensis*. The umbilicus is very narrow, its border is rounded, the umbilical wall seems to be very steep. All the specimens are casts and no ornamentation could be observed on the flanks, only on the venter the shell is sometimes preserved and the nodules show in it as well as on the cast.

The suture is surprisingly simple, the septa stand very near each other, the points of the saddles touching the base of those of the next younger line.

The external lobe is apparently clearly bifid, narrow but not very deep, compared with other species of *Medlicottia*. The first lateral lobe is less deep than the second one and bifid, the branch nearer to the umbilicus being a little stouter than the one nearer to the venter. The second lateral lobe is similar to the first but much deeper. Neither is entirely symmetrical. The seven auxiliary lobes now following are much shallower than the lateral lobes and only the first three are still clearly bifid, while the rest are simply funnel-shaped.

The external saddle is divided in two very unequal branches by a bifid adventive lobe "A"; the branch on the venter and the contiguous part of the flank which, with *Noetling*, we shall call Es_1, is much higher and more complicate than the one nearer the umbilicus, Es_2. The former one is notched on its ventral flank by only one rudimentary lobe, and on the flank toward the umbilicus by two considerably deeper rudimentary lobes, which cause two rather long and not quite parallel rudimentary saddles. The adventive lobe "A' is bifid and symmetri-

cal, but not nearly as deep as the first lateral lobe and not half as wide. It is divided into two parts by a small saddle at its base. The branch nearer to the umbilicus Es_2 of the external saddle is simply tongue-shaped and in its form similar to the following lateral saddles but much smaller and rather resembling one of the rudimentary saddles of Es_1. The two lateral saddles are high, slender, narrow, tongue-shaped, and in the lower half slightly constricted. The auxiliary saddles, at least six in number, are much shorter than the lateral ones, and decrease slowly in height toward the umbilicus; the first two are still similar in form to the lateral saddles, while the next ones are triangular and rounded. A seventh and very low auxiliary saddle exists on the umbilical border; apparently there follows another one on the umbilical wall.

This species is represented by seven specimens.

The similarity between this species and *M. artiensis* Gruenew. is rather surprising. In both species we find the strongly beaded keels, although those of *M. artiensis* are much broader in adult individuals, while those of our species resemble more the keels of the younger specimens of *M. artiensis,* as figured by Karpinsky.[1] The ribs on the flanks observed by this author do not seem to exist in our species. The sutures are very similar, especially on account of the low and broad ventral branch Es_1 of the external saddle, with only two rudimentary lobes on the umbilical flank. *M. artiensis* has two rudimentary lobes on the ventral flank of Es_1, while our species has only one. The adventive lobe "A" is also very similar in both species,[2] as well as the form of the first two lateral saddles and lobes. In both species the difference in depth between the first and second auxiliary lobes is very great, and a quite characteristic feature. The form of the lateral and auxiliary saddles and lobes is in both species practically the same. The main difference between *M. artiensis* and our form may be found in the siphonal lobe and the external saddle, the former being much deeper in the Russian species and the latter somewhat broader, but these differences are only specific, while the general character of both forms shows that they belong to the same group.

[1]Karpinsky, Amm. d. Artinsk. Pl. I, fig. 1 *c*, 1 *d*.

[2]Especially fig. I-l, pl. I of Karpinsky, while later on A does not seem to be bifid.

Still much more similar to our species is the suture of the juvenile specimens of *M. Orbignyana* with a diameter of about 10 mm. For example, the suture reproduced by Karpinsky (loc. cit. pl. 2, fig. 1-j) can scarcely be distinguished from that of *Medlicottia* n. sp., the only real difference being that the Russian form has two auxiliary saddles less than ours. But the shape of Es_1 is practically the same, as well as the form of the lobes and saddles on the flank. We note that in the Russian juvenile form the branch Es_1 also shows only one rudimentary adventive lobe on the siphonal side and two on the umbilical side, the higher one being developed only as an insignificant notch, while in ours it is very little deeper. The adventive lobe A is not yet divided by a secondary saddle in the Russian form, which saddle develops in a later stage (pl. 2, fig. I-k), while in ours it is very distinct. Another difference is the greater depth of the siphonal sinus in the Russian form, but this character changes quickly and in pl. 2, fig. I-k we note a siphonal sinus similar to the one in our species.

Considering the similarity of this juvenile form of *M. Orbignyana* we are probably justified in concluding that our species represents a form somewhat older than the Russian species, because it evidently possesses a suture which in the latter one is only found in the internal whorls where these develop from the *Sicanites* stage.

Our new *Medlicottia* can be considered as the first American form found that is distinctly related to a species of the Russian Artinsk. This confirms our opinion expressed in the first part of this paper, that *at least a part of the cephalopod-bearing sandstone of the Artinsk is represented in America by part of the Wichita formation.* Another part may be represented by the Clear Fork formation, as we shall see farther on.

Our *Medlicottia* is entirely different from *M. Copei* White, which has been found in the same county and, according to Wrather, at a little younger horizon. The branch Es_1, of the external saddle, is much higher and more complicated in the species described by White, the number of the auxiliary lobes is greater, the keels are apparently less beaded,[1] and the cross-section is quite different. Still there are some features in both species which show that the younger one may have

[1]J. P. Smith, Carb. Amm., p. 48, says that the keels of *M. Copei* are slightly beaded while White does not mention this characteristic at all.

developed from our form, because in general form the lateral and auxiliary lobes and saddles are quite similar, and it may be easily thought that in the younger form the external saddle simply was a little more highly developed. Very characteristic in both species is the great difference in length between the first and second auxiliary lobes. We shall see later on that there exists a still younger form which may have developed from *M. Copei.* No other species in Texas or elsewhere shows any marked relationship with our species.

Perrinites n. sp.

Shell moderately involute, flattened on the flanks and strongly rounded on the venter. Cross-section of the whorl elliptical, much broader than high. The greatest width is a little above the umbilical border in medium-sized specimens, but in very young ones and in the completely mature forms the greatest width is at the umbilical border. Older specimens appear to have had a much higher whorl than very young ones. Flanks flattened on the third nearest the umbilical border, while in the upper two-thirds they are strongly convex and pass in a continuous curve into the rounded venter. Umbilicus moderately narrow and very deep, the umbilical border moderately sharp, slightly rounded; no real edge exists. Umbilical wall very steep and rather broad, nearly vertical.

The casts are smooth, the shell shows an ornamentation by extraordinarily numerous broad, flat, fine, transversal ribs, which on the flank are slightly curved backwards and which on the venter form a distinct curve backward, so that their fore side appears slightly concave. The transversal ribs or lines are separated from each other by very fine, deep, extremely narrow depressions. This ornamentation is apparently less delicate than the similar one seen in the other species so far described.

The septa stand very near each other, the saddles of the older suture touching the sides of the lobes of the next younger line. The suture is relatively quite complicate; between the sipho and the umbilical border it follows in general a straight line. The suture which shall be described here belongs to a mature specimen (height of the whorl about 25 mm.) and is the first complete one between the sipho and the umbilical seam that has been described so far. It is not essentially

different from the suture of the younger specimens down to a height of the whorl of 11 mm., while the suture of an individual of a height of the whorl of 4 mm. shows somewhat simpler elements, of the same general character.

The mature suture consists, between the sipho and the umbilical border, of six lobes and five saddles; on the umbilical border we find a sixth saddle, on the umbilical wall a lobe and a saddle as well as half of another lobe, the middle line of which coincides nearly with the umbilical seam.

The siphonal lobe is extraordinarily broad and is divided into two branches by a median saddle. This median saddle is very slender and high, its flanks are concave in the upper half and a deep rudimentary lobe causes the formation of a kind of shelf above a broad base, which toward both sides sends out a small but distinct rudimentary saddle. Each of the two branches of the siphonal lobe is nearly as wide as the first lateral lobe, but strongly asymmetrical, ending in a long point. The first lateral lobe is wide and deep, of a triangular form, if we do not consider the lateral ramifications; very wide at the mouth, terminating at the lower end in a long point, which reaches a little deeper than the branches of the siphonal lobe. The second lateral lobe is very similar in all its details to the first one, but shallower and narrower. The first auxiliary lobe has still a general similarity with the second lateral lobe but its ramifications are considerably simpler; this one also ends in a long point. Still more simple is the second auxiliary lobe, which shows nothing more than three in part rather shallow lateral incisions or notches; the point in which it ends is very short and not very sharp. The third auxiliary lobe near the umbilical border is still simpler and more irregular; it shows also three lateral notches and the terminal point is short and broad, but the lobe itself is uncommonly wide in relation to its height. Still wider is the fourth auxiliary lobe, which lies entirely on the umbilical wall; it is of an irregular form, shows on the flank nearer to the umbilical border a long point, and at the base two very short points of nearly equal length. Of a fifth auxiliary lobe only one half is visible; it seems to be of triangular form, and the umbilical seam appears to go through its median line.

In the description of the lobes we have not paid much attention to their ramifications, but in the discussion of the saddles, we shall indicate the form and number of the secondary saddles, and thus implicitly show the number and form of the secondary lobes not mentioned in the description given above.

The external saddle is very high, broad at the base and tapering toward the upper end. The rest of the saddles on the flank have the same form. The external saddle ends in a somewhat oblique phyllum, and it sends further out, at different heights and in alternating positions on both its flanks, three phylloidal branches or secondary saddles, which are separated by deep and asymmetrical secondary lobes ending in a rounded point; at the base of the saddle we see in different height at each side, a small, non-phylloidal branch. Of the phylloidal branches, one is directed toward the siphonal side, and two toward the umbilical side. The first lateral saddle is quite analogous in form to the external one and shows the same number of branches, but it is lower and narrower and the terminal phyllum is not quite so oblique. In general we must say that the height of the saddles decreases slowly from the external saddle to the last auxiliary saddle near the umbilical border. The second lateral saddle is also similar to the first one, but here one of the branches on the umbilical side is missing, and the terminal phyllum is still less oblique. Much more simple is the first auxiliary saddle; it also ends in a very little oblique phyllum, but on the ventral side, only one non-phylloid branch exists, while on the umbilical side no real branch develops, although a rounded secondary saddle is indicated between two rounded notches at the base. On the contrary, the following second auxiliary saddle shows a very broad terminal phyllum, a short branch on the ventral side and a longer one on the umbilical side. The third auxiliary saddle is quite analogous to the second one, only much lower and narrower; the phyllum is on the umbilical border, the ventral branch is on the flank and the umbilical one on the umbilical wall. The fourth auxiliary saddle is of a very simple form, asymmetrically triangular, terminating in a rounded point with the steeper flank toward the umbilical border and the less steep one toward the umbilical seam.

This *Perrinites* is similar to *P. Cumminsi* White, especially with respect to the general form and the number of the branches of the

saddles of the suture, but the saddles are much more slender in our species and the lobes are narrower. The number of the saddles and lobes is probably the same. In its external form our species distinguishes itself from *P. Cumminsi* by a still wider umbilicus, more flattened flanks and a much higher whorl. But both species are entirely distinct from the younger species of the genus. This refers especially to the form and number of branches on the siphonal saddle, which in the older forms is much simpler than in the younger ones, as we shall see even in the description of the new species found by Beede in the Clear Fork beds. Much more complicated are all those species described from the Double Mountain beds (*P. Hilli* Smith, *P.* n. sp. of Quanah) and of the Leonard formation (*P. compressus, P. vidriensis*). There does not seem to exist any doubt that our older forms, the one described here and *P. Cumminsi,* are the oldest antecessors known of the whole tribe of *Perrinites.* It should be mentioned also, that in the younger forms cited above, the branches of the siphonal lobe are much less asymmetrical and much deeper than in the older ones.

In general we can say that *Perrinites* is not a genus which may easily serve to distinguish horizons as all the species which belong to it are very similar to each other. The external form differs little, and the lobes have always the same general form. The genus lives through a relatively great number of quite different stratigraphical and paleontological horizons without changing much. Still, with care, it is possible to distinguish the different species quite clearly; but a determination of age should not be based entirely on a single specimen of *Perrinites,* although it might help in combination with other ammonoids.

At the locality four miles south of Dundee, our *Perrinites* is by far the most frequent form, being represented in our collection by twenty-one specimens. Nearly everywhere *Perrinites* has been found it is much more frequent than any other ammonoid genus.

Stacheoceras n. sp.

Shell very involute, slightly flattened on the flanks, well rounded on the venter. Cross-section of the whorl elliptical, nearly as wide as high, greatest width about one-third above the umbilical border.

Flanks flattened on the third nearest to the umbilical border, on the upper two-thirds the flanks pass into the venter in a continuous curve. Umbilicus very narrow and deep with a distinct though somewhat rounded border; umbilical wall very steep, nearly vertical.

Cast smooth, shell ornamented by extremely numerous and fine transversal lines, which on the flank in the region near the umbilical border are bent backward while on the upper part of the flank they are curved forward and on the venter slightly curved backward, the concavity being on the front side.

Septa rather well separated from each other, never touching each other. Suture very simple, following a slightly curved line between the sipho and the umbilical border, and consisting there of five lobes and four saddles, a fifth lying on the umbilical border.

The siphonal lobe is extraordinarily wide and is divided into two branches by a median saddle. The median saddle is high, slender, of the form of the upper part of a bottle, broader at the base than at the upper end, with slightly concave flanks. Each of the two branches of the siphonal lobe is much narrower than the first lateral lobe; each branch is asymmetrically bifid, the longer point lying nearer to the sipho; in its middle part the branch is wider than at the mouth. The first lateral lobe is much wider and a little shallower than the branches of the siphonal lobe; it is distinctly trifid, the central point being considerably longer than the lateral ones; in its lower half the lobe is a little wider than at the mouth. The second lateral lobe is extremely similar to the first in its form, equally symmetrically trifid, the middle point being much longer than the lateral ones; the lobe is a little shallower and narrower than the first and the flanks are only very slightly concave. The first auxiliary lobe is wide, triangular, funnel-shaped, ending in a sharp point; at the mouth it is as wide as the second lateral lobe. The second auxiliary lobe is similar to the first, but rounded at the base, with straight flanks, of triangular form, very wide at the mouth.

The external saddle is very high and broad, tongue-shaped rather than club-shaped, only very slightly constricted in the middle. The first lateral saddle is similar in form to the external one but much lower, narrower, and not constricted. The second lateral saddle is slightly asymmetrical, the flank nearer to the umbilicus being less

steep than the one nearer to the venter; its form, therefore, is rather obliquely tongue-shaped. The first auxiliary saddle is broad, triangular, rounded at the end, at the base as broad as the lateral saddles. The second auxiliary saddle is only visible in two-thirds of its form; it is similar to the first one but much lower and narrower.

We have described this form under the generic name of *Stacheoceras.* It certainly belongs to this genus, which probably should be considered a family, as it includes a great number of very different forms. It is very possible and even probable that this species belongs to *Marathonites,* but this question can only be decided when the internal suture will be known, or when the study of more material and of different species shows that all those *Stacheoceras* with very few lobes and saddles possess the characteristic internal suture of *Marathonites.*

The only species which can be compared to our form is *Stacheoceras Romanowskyi* Karp.[1] It has a very similar simple suture and shows also the bifid branches of the siphonal lobe and the trifid lateral lobes with a middle point much longer than the lateral ones. There are small differences in the suture, especially in the form and the number of the saddles, no second auxiliary saddle showing on the flank of the Asiatic species; this is enough to demonstrate that the two forms are specifically different, although they probably belong to the same group.

With *Stacheoceras Walcotti* White, our species has nothing in common. The species of White belongs to a much more highly developed section of the genus, and resembles rather those described by Gemmellaro from the Sicilian Sosio beds.

This species also indicates the relationship between our strata and the cephalopod-bearing sandstone of the Artinsk, or at least with the nearly synchronous strata of Darwas in Bokhara, Central Asia. No similar form has as yet been found in higher strata. Only *Stacheoceras pygmaeum* Gemm.[2] could possibly be compared with it, but the branches of the siphonal lobe are not bifid.

The species does not seem to be very rare at the locality four miles south of Dundee, our collection containing four specimens.

[1]Karpinsky, Amm. d. Artinsk, p. 77, pl. V, fig. 6.
[2]Gemmellaro, Calc. c. Fusulina, p. 39, pl. VIII, fig. 15-17.

Agathiceras sp. ind.

In our collection is a fragment belonging to *Agathiceras* which is sufficiently preserved for a description.

Shell very involute, slightly flattened on the flanks, especially toward the umbilicus, strongly rounded on the venter. Cross-section of the whorl elliptical, broader than high. Umbilicus very narrow, umbilical wall apparently rather deep, umbilical border rounded. Flanks flattened on the third nearest to the umbilicus, the rest being well rounded and curving continuously toward the venter. Greatest width near the umbilical border.

Ornamentation on the mold consists of fine and sharp spiral ribs, about 20 to 22 between the sipho and the umbilical border, separated from each other by shallow, wide furrows with rounded bottom, much wider than the ribs.

Septa rather well separated, never touching each other. Suture very simple, following a line slightly curved forward, and consisting between the sipho and the umbilical border of four lobes, with a fifth on the umbilical border, and four saddles.

The external lobe is very broad and divided into two branches by a high median saddle; each of these branches is wider than the first lateral lobe, slightly pointed at the base, below the middle a little wider than at the mouth. The median saddle is high, slender, and in the middle rather well constricted. The first lateral lobe is a little deeper than the branches of the siphonal lobe, it is symmetrical, slightly pointed at the bottom, wider in its lower third than at the mouth. The second lateral lobe is very similar in form to the first one, but a little shallower and perhaps also narrower. The first auxiliary lobe is asymmetrical, its flank nearest to the venter being convex while the flank toward the umbilicus is concave. The second auxiliary lobe on the umbilical border is apparently funnel-shaped, but not entirely visible.

The external saddle is very high and slender, higher than the median saddle and also a little higher than the first lateral saddle, strongly constricted at the base, club-shaped at the upper end. The first lateral saddle is very similar to the external one but lower and narrower. The second lateral saddle is asymmetrical, its flank nearest to the venter is concave, the flank nearer to the umbilicus is convex; the

upper end is club-shaped; this saddle is lower than the first lateral saddle. The first auxiliary saddle is very broad and asymmetrical, its flank nearest to the venter being concave, while the upper part and the flank nearer to the umbilicus form a wide, rather regular curve.

The fragmentary state of the only specimen found at four miles south of Dundee does not allow a comparison with other species, especially as most of the species belonging to *Agathiceras* are very similar even in their suture. Of course, in general this species is similar to *A. Suessi* and *A. uralicum,* but the state of preservation does not allow of drawing any conclusions. The species must be very rare at the locality.

The collection of ammonoids which was made by Dr. Beede in Runnels County comes from a hard dolomite; all the specimens are casts or molds, and it is often impossible to separate the fossils from the rock. The state of preservation is thus very bad, but in most cases we are able to get a good idea of the form and sutures of the ammonoids.

The little fauna consists of the following species:

Medlicottia n. sp. I.
Medlicottia n. sp. II.
Perrinites n. sp.
Gastrioceras n. sp.

This fauna is also entirely different from the one described by White as well as from the one collected by Wrather and discussed above. This does not surprise us, as it is considerably younger than these. To demonstrate this we shall discuss also these species somewhat in detail.

Medlicottia n. sp. I

Shell discoidal, very involute, flattened on the flanks, with a rather deep and moderately broad furrow on the venter, and two lateral keels. Cross-section of the whorl saggittiform, much higher than broad, greatest width at about three-fourths of the height of the flanks above the umbilical border, truncated on the venter and notched by the furrow. The flanks near the umbilicus, up to three-quarters of their height, are nearly flat, while the upper quarter is rather curved toward the venter. Both borders of the venter are formed by

sharp keels, which are not beaded at all, and are separated by a moderately wide and deep spiral furrow. The umbilicus is not preserved in any of our specimens. No ornamentation is visible on the casts.

The suture is in general very similar to that of Medlicottia n. sp. II, but shows also some very characteristic differences. The septa are very near each other, the ends of the saddles touching the base of those of the next younger line. The suture follows a slightly curved line, a very characteristic feature of it being that the lobes become very shallow from the second auxiliary lobe, although this feature is not quite so pronounced as in *Medlicottia* n. sp. II.

The siphonal lobe is long and narrow and clearly bifid, the small median saddle is relatively high, pointed, and narrow; the lobe reaches down to about the height of the small rudimentary saddle which divides the adventive lobe "A" on the umbilical flank of Es_1 into two parts. The first lateral lobe is less deep than the second lateral one. It has an extremely characteristic form. A club-shaped, high, narrow, secondary saddle, constricted near its base, divides it in two branches of which the one nearest to the venter is considerably longer and more strongly curved than the one nearer to the umbilicus; this latter one is again divided into two branches by a short, stout, triangular saddle, a complication which as yet never has been observed in another species of this genus. In both of our specimens, this bifid branch is clearly visible. The second lateral lobe is deeper than all the rest of the lobes; it is bifid, the branch nearer to the venter being a little broader than the one nearer to the umbilicus; in depth they are scarcely different. The first auxiliary lobe is very similar to the second lateral one, but the branch nearer to the umbilicus is a little longer than the one toward the venter. On the specimens we possess only five auxiliary lobes are preserved; all of them are bifid and the branch nearer the umbilicus is always longer than the one nearer the venter, but the difference is small. The auxiliary lobes are much shallower than the two lateral ones and toward the umbilicus decrease uniformly in depth. How large the number of auxiliary lobes really is in this species cannot be determined with our material, but the number must be rather large.

The external saddle is very high and relatively broad; a deep and bifid adventive lobe "A" divides it into two unequal parts. The

branch Es_1, lying on the venter, and the flank, is considerably higher and more complicate than the one nearer the umbilicus, Es_2. On its flank near the ventral furrow Es_1 is notched by five rudimentary lobes directed obliquely downward; on the flank nearer to the umbilicus it shows five rudimentary lobes which are much deeper and in a position nearly perpendicular to the spiral line. The lowest shows a slight swelling in the middle of its bottom; the bottom of the rest is rounded. At the end of Es_1 two lateral and very shallow notches produce a button-like point. We count, therefore, altogether, ten, or if we count the two notches, twelve rudimentary lobes on a specimen which has about the same size as the one of *Medlicottia* n. sp. II, the suture of which will be described later on. The rudimentary saddles lying between the rudimentary lobes on the flank near the ventral furrow are very short and rounded; those on the opposite flank are very long, the longest one being the lowest which forms the limit of the adventive lobe "A"; the next higher one is much shorter and the following decrease rapidly in length, this flank of Es_1 taking thus the form of one side of a pyramid tapering upward. The adventive lobe "A" is much larger than the rudimentary ones, it is divided by a slender and rather long secondary saddle in two parts, the lower one of which is deeper than the higher one; the lobe is much narrower at its mouth than at the bottom. The following branch, Es_2, of the external saddle is simply tongue-shaped, but a slight lateral swelling on each side indicates an inclination toward a trilobate form; this saddle is high, slender and slightly constricted near the base. It is much shorter and narrower than the first lateral saddle and leans strongly over toward the first lateral lobe. The first lateral saddle is much larger than Es_2, shows a slight lateral swelling on each side without becoming trilobate; it is rather tongue-shaped, high, slender and well constricted near its base. The second lateral saddle is very similar to the first one, but a little higher; in the same way, the first auxiliary saddle is only a little shorter than the second lateral one. These two also show the lateral swelling on both sides, but the constriction lies a little higher above the base than in the first lateral saddle. The next three auxiliary saddles which can be seen in one of our specimens are very similar to the lateral ones, only less high. Their height decreases slowly in the direction toward the

umbilicus. The exact number of auxiliary saddles cannot be observed but is certainly great.

Only two specimens of this form have been found at the locality. As the species is very similar to the next one, we shall defer a discussion of its relationships until we have described *Medlicottia* n. sp. II.

Medlicottia n. sp. II.

Shell discoidal, very involute, flanks very little curved, nearly flat in the portion near the umbilicus, venter truncated and provided with a deep and wide furrow, limited on both sides by a sharp keel. Cross-section of the whorl sagittiform, much higher than broad, greatest width in the middle, truncated at the ventral part and notched there by the furrow. The inner half of the flank near the umbilicus is almost flat, while the outer one is rather regularly curved toward the ventral keel. The borders of the venter are formed by sharp keels which do not show any tubercles or beads. The spiral furrow on the venter is wide and deep. The umbilicus is very narrow, the umbilical wall seems to be narrow and steep, the umbilical border is rounded. All the specimens are casts and do not show any ornamentation.

The suture is that of a typical *Medlicottia*. Between the sipho and the umbilicus it follows a curved line. A very characteristic feature of it is that the auxiliary lobes are considerably shallower than the two lateral ones and the first auxiliary. The septa stand very near together, the points of the saddles touching the base of those of the next younger line. The following description refers to a specimen with a whorl about 30 mm. high.

The external lobe is clearly bifid, but the form of the siphonal saddle could not be entirely recognized; the lobe is moderately deep, and reaches down to the base of the secondary saddle, which divides the adventive lobe "A" in two parts. The first lateral lobe is bifid and asymmetrically oblique, the branch nearest to the venter being considerably longer and stouter and much more curved than the one lying toward the umbilicus; it is shallower than the second lateral lobe. The second lateral lobe is deeper than all the rest of the lobes, bifid, the branch nearer to the venter being a little deeper than the one nearer to the umbilicus. The first auxiliary lobe is similar to the second lateral one although a little shallower but the branch nearer to the venter is

somewhat shorter than the one nearer to the umbilicus. The following ten auxiliary lobes are much shallower than the two lateral and first auxiliary ones. The first four are still bifid, while the last six seem to be rounded at the bottom or only slightly pointed. A twelfth auxiliary lobe lies apparently on the umbilical wall. The number of the auxiliary lobes and saddles varies with the age of the whorls; a specimen with a whorl 12 mm. high shows only six to seven auxiliary lobes and the corresponding saddles; but here also the first five are clearly bifid. In the first auxiliary lobe of this small individual the branch nearest to the umbilicus is clearly longer than the one nearer to the venter. In the bifid auxiliary lobes the branch nearer to the umbilicus is much longer than the other one, not only in the small but also in large whorls; the lobes are thus entirely asymmetrical.

The external saddle is very high and relatively broad, an adventive lobe "A" divides it in two unequal parts. The branch Es_1, lying on the venter and the contiguous portion of the flank is much higher and complicate than the one nearer to the umbilicus. The ventral flank of Es_1 is notched by four oblique rudimentary lobes, the opposite flank by four much deeper ones, the lowest of which shows a slight swelling in the middle of the bottom. At the end of Es_1 very shallow notches at both sides produce a button-like point. Therefore we count on Es_1, eight, or if we count the two notches, ten rudimentary lobes. The rudimentary saddles between these lobes are very short and rounded on the ventral flank but very long on the umbilical flank of the branch, the largest being the lowest, which forms the limit of the adventive lobe "A"; the next higher is shorter, and the following ones decrease rapidly in size, this side of Es_1 imitating a flank of a tapering pyramid. The adventive lobe "A" is quite conspicuous, oblique, strongly bifid, a relatively high and rather stout, somewhat triangular secondary saddle dividing it in two parts. The branch Es_2 of the external saddle is tongue-shaped with very slight lateral swellings, constricted at the base; it leans strongly over to the first lateral lobe and is much shorter and narrower than the first lateral saddle. The first lateral saddle is simply tongue-shaped, but shows in its outline an inclination to become trilobate; it is high, slender, narrow with slight lateral swellings near the middle, constricted at the base and in general quite similar

to the second lateral saddle, only a little lower. The second lateral saddle is high, slender, nearly symmetrical, with slight lateral swellings on both sides, but at different heights, which causes an indication of trilobate form. The first auxiliary saddle is very similar to the first one and nearly as high. The ten auxiliary saddles visible on the flank are much shorter than the two lateral ones and decrease in height toward the umbilicus. The first three are similar in form to the lateral saddles, while the rest have a tongue-shaped form.

This species is quite common at the locality; in our collection it is represented by more than a dozen specimens.

Both our *Medlicottia* belong to the same group, notwithstanding the exceptional form of the first lateral lobe in one of them. They have a certain relationship with *M. Copei* White, although they are specifically distinct. While our forms have sharp keels those of the older species are slightly beaded. The suture is also somewhat distinct although the ground plan is similar. The main differences are the greater number of rudimentary saddles and lobes, and of auxiliary saddles and lobes in the individuals from Runnels County, notwithstanding that the specimen figured by White is larger than most of those from Runnels County. There are still more differences in the details, as for example, the greater width of the first lateral saddle in the species from the old Military Crossing; the non-existence of a real secondary saddle in the adventive lobe "A" and the rounded bottom of the lowest rudimentary lobe on the umbilical flank of Es_1 in White's species. Nevertheless, both our species and *M. Copei* belong certainly to the same group of *Medlicottia* or at least to groups not very distinct. We must not forget that beaded keels are often found in the smaller whorls of species which have distinctly sharp keels in the larger ones (*M. Whitneyi* n. sp., *M. Orbignyana* Vern.). The nearest relative of our species, and belonging certainly to the same group, is *M. Orbignyana* Vern.[1] The similarity in the general form of the lobes is certainly surprising; we see the same general development of the external saddle and the lateral and auxiliary ones even down to details, as are the forms of the rudimentary lobes both on the umbilical and on the ventral flank of the branch Es_1, the form of the adventive lobe, the two laterals, etc. There is also the distinguishing feature of the sudden

[1]Karpinsky, Amm. d. Artinsk, p. 32, pl. 11, fig. 1.

shallowing of the lobes beginning with the second auxiliary lobe. The character of the saddle is also very similar, especially the tongue-like shape with the lateral swellings at different heights. We can distinguish our species from the Russian one only by minor details, as the greater width of Es_1 in *M. Orbignyana,* the somewhat narrower lateral and auxiliary saddles, the higher secondary saddles which divide the lobes, the narrower venter, etc., in our species; but the general form and the character of the suture are certainly surprisingly similar. Thus we find in the lower Permo-carboniferous of Central Texas another form which is intimately related to a species from the Artinsk, and we may say that this latter formation corresponds to at least two different formations or horizons of our region, (the Wichita at least in part) and the Clear Fork formations.

If we compare now the different forms of *Medlicottia* which have been found in Central Texas, we see that they probably constitute only different stages of development in a single tribe. The relationship between the *Medlicottia* from Runnels County and *M. Copei* is quite evident. There is scarcely a doubt that the one developed from the other, although this has to be proven later on when the development of the lobes in both species can be studied. But there is even a possibility that the older form of *Medlicottia* collected by Wrather at four miles south from Dundee in Baylor County, also may be antecessor of the later ones. If we compare the development of the suture in *M. Orbignyana* Vern., we see that at the stage where the *Medlicottia* suture develops from the *Sicanites* stage (compare fig. 1*e* and 1*j,* in Karpinsky's work), which corresponds to a height of the whorl of not quite seven millimeters, this suture is surprisingly similar to that of our *Medlicottia* from four miles south of Dundee. In this stage the keels are also strongly beaded, while later on they become sharp. This circumstance allows us to conclude that there may possibly be a similar development in our own species and that the three different forms of *Medlicottia* discussed here may belong to the same tribe and constitute simply different stages of development. We do not know yet in what relationship *M. artiensis* and *M. Orbignyana* stand, and if they are found always at the same horizon, but even if this were the case, we should not be surprised as it is very possible that only part of the tribe developed a more differentiated suture,

and that another part of it persisted in the more archaic form through several horizons.

We shall presently see that such development can also be shown to exist in the species of *Perrinites* in Central Texas.

Medlicottia Copei has been cited from higher horizons in Central Texas, but as long as the species is not described in detail nor figured, we cannot draw a conclusion, as these determinations may only be provisional and a close study of those forms may show that in reality they belong to different species.

The two new species from Trans-Pecos country, described in this paper (*M. Whitneyi* and *M. Burckhardti*) belong certainly to a different group. They are much more similar to some Sicilian species from the Sosio limestone and show an entirely different form of the saddles, which are distinctly trilobate.

We see that at least in Texas it seems to be possible to distinguish the different horizons in the Permo-carboniferous by the different form of development of *Medlicottia* and that possibly Haug and Noetling may not have been so far off of the truth, when they contended that such was the case generally; although this idea has been declared to be wrong by several distinguished authors. If we take into account the development of *Medlicottia* in higher stages of the Permian and the Triassic, including also *Episageceras,* with the extension of our knowledge of those forms, we may find that there is a very definite order of development in this tribe of the ammonoids. When Haug[1] first conceived the idea of subdividing the Permian into zones based on the different groups of *Medlicottia,* our knowledge of these forms was still very restricted and it therefore was too early to undertake this task; but at the end it may be shown that Haug's idea was entirely right, and that he only did not have sufficient material, at that time.

Perrinites n. sp.

Unfortunately, the numerous casts and molds collected by Beede are so fragmentary and badly preserved that a complete description of the species remains impossible, for the moment; even the suture can be observed only partly and on different specimens. But on the

[1]Haug, Et. s. l. Goniatites, p. 70.

other side this species is so characteristic that even an incomplete description is of a certain value, the more so as better preserved specimens may be found at other localities. The species is extremely common in Runnels County, more than twenty specimens existing in Dr. Beede's collection. Although our form is extremely similar externally to the one found by Wrather in a much deeper horizon, it can be easily distinguished from it by its more complicated suture. Our species shows the following features:

Shell semi-globular, rather involute, less curved on the flanks than on the venter. Cross-section of the whorl elliptical, a little broader than high, greatest width about one fourth above the umbilical border. The flanks are slightly flattened; or, better said, they are very slightly curved but pass higher on in an uninterrupted curve into the strongly rounded venter. The umbilicus is narrow and deep, the umbilical border is rounded, the umbilical wall steep and rather broad. No ornamentations could be observed on the casts or molds.

The septa stand very near together, but do not seem to touch each other. In none of the specimens could the whole suture between the sipho and the umbilical border be observed, only the elements from the siphonal lobe to the first lateral saddle being clearly visible.

The siphonal lobe is very wide, a median saddle dividing it into two branches. This median saddle is very high and slender, and shows two branches on each side, which are separated by deep secondary lobes and give the saddle the appearance of being extremely slender. Each of the branches of the siphonal lobe is rather narrow, a little wider at the mouth, its position is somewhat oblique with respect to the line of symmetry of the siphonal saddle, and rather ramified by the branches of the siphonal and the external saddle. The first lateral lobe is wider and a little deeper than each branch of the siphonal one; it ends in a long and sharp point and widens considerably toward the mouth. The branches of the external and first lateral saddles cause a number of ramifications of this lobe. The second lateral and the first auxiliary lobe seem to be entirely analogous to the first lateral in their form.

The external saddle is very high, broad at the base, and fairly regularly tapering toward the point. It ends in a somewhat oblique phyllum and at different heights sends out on both sides alternatingly

three branches to the ventral and three others to the umbilical side. In medium-sized specimens only the upper side branch is phylloid, but the two next ones show at least an inclination to a phylloid termination, while the lower ones rather seem to be somewhat pointed. The first lateral saddle is entirely analogous in its form to the external saddle, being only a little lower and narrower. Also the following saddles seem to have a similar form to the first ones.

In one specimen part of the internal suture could be observed. We see there the characteristic deep and slender anti-siphonal lobe and the extremely high and slender internal saddle which ends in an oblique phyllum, the first lateral lobe is similar to the anti-siphonal one but less deep and quite asymmetrical. These internal lobes and saddles correspond in their construction entirely to those of the type of the genus *Perrinites vidriensis,* described in another part of this paper.

Our species is similar to that occurring in the Wichita, found by Wrather and described above. It is perhaps a little stouter and more globular, certainly much more involute. The ventral part is flatter in our species. Much greater is the difference in the suture. In our species the siphonal saddle has two long branches on each side, while in the other species it has only a narrow shelf above the base. Similarly, the external and the first lateral saddle of our species show a greater number of side branches. Very different is the form of the siphonal lobe, each branch of which in the older form is much shorter and stouter, and also much more asymmetrical than in the species described here. The other saddles are similar to those of the older form but more ramified.

Similar differences we find between this species and *Perrinites Cumminsi* White, the lobes and saddles of our species being in general more ramified than those of the older form; another distinguishing feature is that the saddles of our species are much higher and the lobes much deeper and more slender than in *P. Cumminsi.*

On the other hand, if we compare our species with specimens of higher forms, as *P. Hilli* Smith, *P. compressus,* and *P. vidriensis,* we find that the suture of our species is very much simpler, the ramifications of the saddles and lobes in those younger forms being much more numerous and varied than in the specimens from Runnels County. Especially different is the form of the siphonal saddle and the first

lateral lobe, although the ground plan in all the species of the genus is evidently the same, and shows the near relationship between them.

Evidently we have here another example of development of one tribe in different horizons, the oldest form showing the simplest sutures, while the youngest have the most complicated. But the differences are much more difficult to describe, because the external form of the species varies very little, and the suture is more uniform, as for example in *Medlicottia*. The differences are mainly found in the secondary elements of the suture and only very close observations show that a real development exists. There may even be recurrences in higher horizons, as is shown by the relatively simple suture of the *Perrinites* found in the high horizon of Quanah.

No *Perrinites* has been found elsewhere than in Texas; this genus therefore cannot serve to correlate our horizons with those of other countries. We shall discuss this point later on, and refer also to what has been said in an earlier chapter.

Gastrioceras n. sp.

Shell discoidal, very evolute, whorls very little embracing, generally covering only the ventral part of the next older one, very slowly growing in height in the greater part of the inner whorls. Cross-section of the inner whorls much broader than high, nearly forming a rectangle or a trapeze with rounded edges; in the larger whorls broader than high, but nearly semi-circular, in the largest whorl apparently trapezoidal. On the inner whorls the flanks are only slightly convex and inclined toward the umbilicus while the venter is flattened, thus causing the cross-section to become somewhat angular. In whorls of medium size, flanks and venter are rather regularly rounded, no edge existing between the border and the flanks. In the largest whorl the flanks are nearly flat, strongly inclining toward the venter which is narrow and slightly rounded. The umbilicus is very wide and shallow, the umbilical border is strongly rounded and passes in a continuous curve into the narrow and not very steep umbilical wall; only in the largest whorls the umbilical border is more pronounced in consequence of the different relative position of the umbilical wall and the flank.

The specimen is preserved as a cast but shows a characteristic sculpture, which is different on the inner and the outer whorls. On the inner whorls we find on the flank numerous rather thick transversal ribs which commence at the umbilical seam, about forty to the whorl; these are thinner near the umbilical seam and thicken toward the rounded edge between the flank and the venter, where they disappear suddenly. They are slightly inclined forward. On the venter we find extremely fine transversal ribs or lines, nearly invisible to the naked eye, which are strongly curved forward and separated by very fine depressions; their number is at least twice or three times as high as the ribs on the flanks. On the whorls of medium size, the ribs on the flanks begin to disappear, becoming shorter as well as thinner. They bifurcate toward the venter, which thus shows a much greater number of fine rounded transversal ribs not curved forward, but straight and separated by shallow furrows with rounded bottom, almost as wide as the ribs. The ornamentation of the largest whorl could not be observed; it appears to be smooth, but that is frequently the case in casts of *Gastrioceras,* even where the shell shows strong spiral ornamentations. In our case no spiral sculpture could be observed on any of the whorls, although such are nearly always present on Permo-carboniferous *Gastrioceras;* but they may possibly have existed on the shell of our specimens.

The septa are rather distant from each other on medium-sized whorls, while on the smaller ones they are much nearer together, the flanks of the saddles touching the base of those of the next younger line. The mature suture is very simple. It consists between the sipho and the umbilical seam of three lobes and two saddles.

The siphonal lobe is very wide and is divided into two branches by a stout and not very high median saddle. This saddle is not more than half as high as the external saddle, broad at the base and slightly tapering toward the upper end. Each of the branches of the siphonal lobe is tongue-shaped, and ends in a sharp point. The first lateral lobe is a little less deep than the branches of the siphonal one and a little broader than either of them; it is tongue-shaped ending in a sharp point. The second lateral lobe is much shallower and a little narrower than the first one, but similar in form, terminating also in a sharp point.

The external saddle is twice as high as the median one, rather slender, and rounded at the end. The first lateral saddle is similar in form to the external one, but stouter and shorter. The second lateral saddle is only half visible, of more triangular form.

The internal lobes are very simple. They consist, between the anti-siphonal line of symmetry and the umbilical seam, of two lobes, one saddle and the larger half of the second lateral saddle of the external suture. The anti-siphonal lobe is lanceolate, very long and narrow, ending in a long and sharp point; the internal saddle is very high, slender and a little inclined toward the anti-siphonal lobe. The first lateral lobe is much shorter than the anti-siphonal, and slightly asymmetrical, the anti-siphonal flank being steeper than the umbilical one. The next saddle is considerably lower than the first one and much broader, the internal flank being much steeper than the one on the other side of the umbilical seam. Unfortunately, this part is not quite easy to recognize, but there does not seem to be room for doubt that there is only one very broad saddle between the internal saddle and the first lateral saddle on the external part of the suture.

This species represents a rather uncommon form of *Gastrioceras*. I do not refer to the sculpture or the involution, but to the suture. Generally, *Gastrioceras* shows between the sipho and the external border, only the siphonal and one lateral lobe, while in our species we observe two lateral lobes. The first lateral saddle is commonly very low and different in shape from the external one, while in our species it is nearly identical, in its form. The general outline of our external suture resembles more that of *Paralegoceras* than that of *Gastrioceras*. Evidently we have a similar case to that of *G. russiense* Zwetaev where the second lateral (or suspensive lobe) also lies on the flank. But the number of lobes and saddles as well as the sculpture shows that our species undoubtedly belong to *Gastrioceras*.

On account of the deficient preservation of the sculpture and the exceptional form of the suture, no comparison can be made with species from other localities.

Conclusions.

The new faunas discussed here allow us to draw some conclusions with respect to the different horizons of ammonoids in the Permo-

carboniferous of Central Texas and their relations to other strata of the earth.

In the Permo-carboniferous of Central Texas we know at the present time at least five different horizons characterized by ammonoids. All of these have in common the preponderance of *Perrinites* belonging to different species.

The succession of these horizons is as follows:

5. Horizon of Quanah with large *Perrinites* and large *Gastrioceras*.
4. Horizon of Salt Croton Creek with *Perrinites Hilli* and undescribed *Popanoceras, Medlicottia,* etc.
3. Horizon of Runnels County, with *Perrinites* n. sp., *Medlicottia* n. sp. I, *M.* n. sp. II, *Gastrioceras* n. sp.
2. Horizon of the old Military Crossing of the Wichita, with *Perrinites Cumminsi, Medlicottia Copei, Stacheoceras Walcotti, Paralegoceras Baylorense*
1. Horizon of Dundee with *Perrinites* n. sp., *Medlicottia* n. sp, *Agathiceras* sp. ind., *Stacheoceras* n. sp.

While the youngest horizon has been found rather high up in the Double Mountain formation, the lowest one seems to be still far above the limit between the Carboniferous and the Permo-carboniferous. Possibly there exists another horizon near San Angelo, Tom Green County, but only a *Medlicottia* has been cited from this locality, which is probably below the Runnels County locality.

We have seen that those genera which are found in several of these five horizons show a distinct development of species from simpler to higher stages of the suture; these genera are principally *Perrinites* and *Medlicottia* and in second line, *Stacheoceras*. If we now extend our comparisons to the Trans-Pecos region of West Texas, we find that our lowest horizons 1 and 2 have not yet been identified there, while on the other hand, the lowest horizon with *Uddenites* of the Glass Mountains has not yet been found in Central Texas. But our horizon 3 may possibly correspond with the lower part of the Leonard formation (horizon of *Perrinites*); at least the difference in age cannot be very great. Our upper horions 4 and 5 certainly correspond exactly to the horizon of *Perrinites vidriensis* or the upper Leonard formation. The Word formation is certainly younger than any of the ammonoid-bearing horizons so far found in Central Texas. The species of *Medlicottia* described from the Leonard and Word formations are clearly much younger and higher developed forms than those found in our horizons 1, 2, and 3. They are forms with distinctly trilo-

bate saddles as are most of the Sicilian species and *M. primas* Waag. of India.

Our two lowest horizons, 1 and 2, probably correspond to some part of the Hess limestone in which no larger fauna of ammonoids has yet been found.

If we now extend our comparisons to strata of the old world, we find for the first time distinct signs of relationship between a horizon of Texas and the cephalopod-bearing sandstone of the Artinsk. In our horizon 1 we found a *Medlicottia* which is nearly related to *M. artiensis;* in our horizons 2 and 3 we see a *Medlicottia* very similar to *Medlicottia Orbignyana.* In horizon 1 we also found a *Stacheoceras* nearly related to *St. Romanowskyi,* while horizon 2 contains a *Stacheoceras* with a much higher developed suture showing a great number of auxiliary lobes and saddles. These forms begin to develop in the cephalopod-bearing sandstone of the Artinsk, but are much more frequent in the younger Sosio limestone of Sicily, and in the corresponding Word formation of Trans-Pecos Texas.

The *Medlicottia* in horizon 3 is so similar to *M. Orbignyana* that one is nearly inclined to unite them in one species.

All this induces us to regard our horizons 1 to 3 as more or less corresponding in age to the cephalopod-bearing sandstone of the Artinsk. This is entirely in accordance with what we have found in the Trans-Pecos region. There we considered that the rocks containing *Prothalassoceras* are probably the equivalent of the Artinsk, while the underlying horizon with *Uddenites* is certainly older than the Artinsk, and may correspond to the period of erosion preceding it.

But we must not forget to mention that in the Artinsk one form is missing which in Texas is the most frequent one. I refer to *Perrinites.* No species belonging to the *Cyclolobinae* has been found in the Russian Artinsk; the first forms belonging to this group were discovered in the Sicilian Sosio limestone, certainly a little younger than the Russian strata. But it seems that as yet *Perrinites* has to be considered as a local Texan branch of the *Cyclolobinae,* and J. Perrin Smith has first advanced the theory that this branch developed from the American genus *Shumardites,* a theory which has been proven right in the present paper. It might thus be possible that the tribe of *Perrinites* developed in America and from there migrated to the oceans of the

old world. We find a very intimate relative of *Perrinites* in the Sicilian *Hyattoceras,* which may very well have been derived from the Texan form. Another genus which may have developed from *Perrinites* is *Waagenoceras,* which is found in Sicily, together with *Hyattoceras* and in Texas in a horizon overlying the zone of *Perrinites.* It cannot yet be decided if *Perrinites* persists still in the zone of *Waagenoceras,* although I have seen some ammonoids from the Delaware beds of the Guadalupe Mountains which look suspiciously like *Perrinites;* unfortunately I have not had an opportunity to study the suture.

In India we do not find either *Perrinites* nor *Waagenoceras,* but a much higher developed form of the *Cyclolobinae,* the type of the genus *Cyclolobus,* and quite a number of species nearly related to it.

Karpinsky was surprised by the non-existence of any *Cyclolobinae* in the cephalopod-bearing sandstone of the Artinsk of the Ural, as well as of Darwas in Bokhara, Central Asia. This led him to suppose that the Artinsk sandstone might be a little older than the Sosio limestone. But he justly remarks that those *Cyclolobinae* may simply not have developed in the Ural and may belong to a more southern province. Now we see that in the strata in Texas which most probably represent the cephalopod-bearing sandstone of the Artinsk, *Cyclolobinae* exist in great numbers; in fact, are the most frequent fossils. But these types are not known in other parts of the world.

I think it would be somewhat dangerous to suppose that the *Cyclolobinae* prove the existence of a southern province with a different fauna from that of the more northern regions. This might lead us to the supposition of climatic belts or provinces, for which I do not see sufficient reason at the present time, taking into account our limited knowledge of the marine fauna of the Permo-carboniferous and the Permian. We must always keep in mind that the faunas so rich in species and genera described from these formations occur in very few localities which are separated by extremely long distances. For the time being, I think it would be much more prudent to suppose that the *Cyclolobinae* originated in America, that they then migrated in part to southern Europe, and still later to the waters of the Australasian Ocean.

San Antonio, Texas,
August, 1918.

DR. EMIL BOSE.

TABLE SHOWING THE CORRELATION BETWEEN THE HORIZONS WITH AMMONOIDS OF CENTRAL TEXAS AND THOSE OF WEST TEXAS AND EUROPE.

Central Texas			Trans-Pecos Region		Sicily, Ural and Darwas
Formations	Horizons	Fossils	Formations	Horizons	Equivalents
			Word formation	Horizon of Waagenoceras	Sosio limestone of Palermo
Double Mountain formation	5. Quanah 4. Salt Croton cr.	Perrinites n. sp., Gastrioceras n. sp. Perrinites Hilli Smith, undescribed Popanoceras and Medlicottia.	Leonard formation	Horizon of Perrinites upper	Upper Dolomite of the Artinsk?
Clear Fork formation	3 Runnels County 2. Military Crossing of Wichita	Perrinites n. sp., Medlicottia n. sp., aff. M. Orbignyana Vern., Gastrioceras n. sp. Perrinites Cumminsi White, Medlicottia Copei White, Stacheoceras Walcotti White, Paralegoceras baylorense White.		lower	Cephalopod bearing strata of the Ural and Darwas, (Artinsk)
Wichita-Albany formation	1. Dundee	Perrinites n. sp. aff. P. Cumminsi, Medlicottia n. sp. aff. M. artiensis Gruen., Stacheoceras n. sp. aff., St. Romanowskyi Karp., Agathiceras sp. aff. A. uralicum Karp.	Hess formation	Horizon of Prothalassoceras	
				Unconformity	
			Wolffcamp formation	Horizon of Uddenites	Unconformity
Cisco formation				Schwagerina horizon of the Carboniferous	Schwagerina horizon of the Carboniferous

PLATES

Plate I

Fig. 1-8. . *Daraelites texanus* nov. sp.—Zone of *Uddenites* (Wolfcamp formation.)—Wolf Camp, Glass Mountains.

Fig. 1, side view; fig. 2, front; fig. 3, venter. Natural size.

Fig. 4, side view; fig. 5, front; fig. 6, venter, of the same specimen; twice natural size.

Fig. 7, external suture of the same specimen; twice natural size.

Fig. 8, internal suture of the inner whorl of the same specimen; four times natural size.

Fig. 9-23. . *Uddenites Schucherti* nov. gen. nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 9, side view; fig. 10, front; fig. 11, venter; natural size.

Fig. 15, side view; fig. 16, front; fig. 17, venter, of the same specimen; twice natural size.

Fig. 12, side view; fig. 13, front; fig. 14, venter; natural size.

Fig. 18, side view; fig. 19, front; fig. 20, venter, of the same specimen; twice natural size.

Fig. 21, external suture, not quite mature, taken from specimen illustrated in Fig. 9-11, 15-17; twice natural size.

Fig. 22, external suture, mature, taken from specimen illustrated in fig. 12-14, 18-20; twice natural size.

Fig. 23, internal suture of the next smaller whorl of specimen illustrated in fig. 9-11, 15-17, 21; four times natural size.

Fig. 24-40. . *Uddenites minor* nov. gen. nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 24, mature external suture of specimen illustrated in fig. 27-29 and fig. 38-40; twice natural size.

Fig. 25, mature suture of specimen illustrated in fig. 30-33, 35-37; twice natural size.

Fig. 26, immature external suture, *Pronorites* stage of inner whorl of specimen illustrated in fig. 32 and 34; four times natural size.

Fig. 27, front; fig. 28, venter; fig. 29, side view; natural size.

Fig. 38, venter; fig. 39, front; fig. 40, side view, of the same specimen; twice natural size.

Fig. 30, side view; fig. 31, venter; fig. 33, front; natural size.

Fig. 35, side view; fig. 36, front; fig. 37, venter, of the same specimen; twice natural size.

Fig. 32, side view, showing faint radial ribs on lower righthand side; natural size.

Fig. 34, side view of the same specimen; twice natural sixe.

Fig. 41-45a. *Medlicottia Whitneyi* nov. sp.—Zone of *Perrinites* (Leonard formation).—Two miles west-northwest from Iron Mountain, Glass Mountains.

Fig. 41, external suture of specimen illustrated in fig. 42-45, 45a; natural size.

Fig. 42, venter; fig. 43, front; fig. 44, side view; natural size.

Fig. 45, front of inner whorl of the same specimen, showing the two rows of tubercles replacing the sharp keels; natural size.

Fig. 45a, the same; twice natural size.

Fig. 46-52. *Medlicottia Burckhardti* nov. sp.—Zone of *Waagenoceras* (Word formation).—Junction of Gilliam and Road canyons, Glass Mountains.

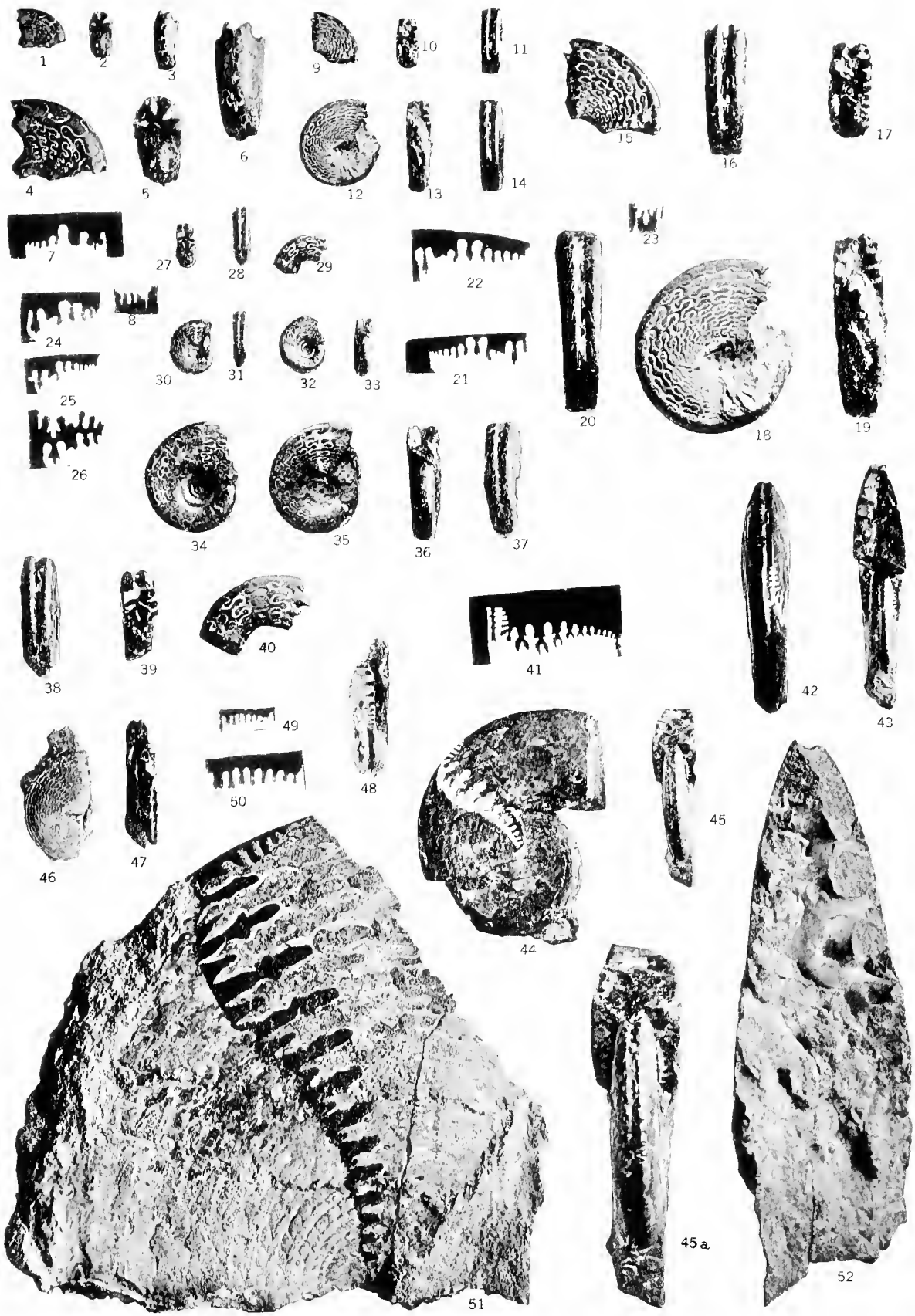
Fig. 46, side view; fig. 47, venter; fig. 48, cross-section of small specimen; natural size.

Fig. 49, internal suture of the preceding specimen, but belonging to the next larger whorl; natural size.

Fig. 50, the same; twice natural size.

Fig. 51, side view of mature specimen illustrated in Plate II, fig. 1-2; natural size.

Fig. 52, cross-section of the same specimen; natural size.



Carl Christianson, photo.

Plate II

Fig. 1-3. *Medlicottia Burckhardti* nov. sp.—Zone of *Waagenoceras* (Word formation).—Junction of Gilliam and Road canyons, Glass Mountains.

Fig. 1, venter, showing part of the furrow and keels. Specimen figured in Plate I, fig. 51, 52. Natural size.

Fig. 2, mature suture of the same specimen; natural size.

Fig. 3, part of nearly mature suture of a smaller specimen.

Fig. 4-27. *Gastrioceras modestum* nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 4, front; fig. 5, side view; fig. 6, venter; natural size.

Fig. 7, venter; fig. 8, side view; fig. 9, front, of the same specimen; twice natural size.

Fig. 10, front; fig. 11, side view; fig. 12, venter; natural size.

Fig. 13, venter; fig. 14, front, showing traces of ornamentation; natural size.

Fig. 15, side view, of the same specimen; twice natural size.

Fig. 16, side view; fig. 17, front; natural size.

Fig. 18, side view; fig. 19, front, showing traces of ornamentation, same specimen; twice natural size.

Fig. 20, venter; fig. 21, side view; natural size.

Fig. 23, venter; fig. 22, side view, of the same specimen; twice natural size.

Fig. 24, external suture of specimen shown in fig. 4-9; natural size.

Fig. 25, external suture; natural size.

Fig. 26, external suture of specimen shown in fig. 16-19; natural size.

Fig. 27, external suture of specimen shown in fig. 20-23.

Fig. 28-47. *Gastrioceras roadense* nov. sp.—Zone of *Waagenoceras* (Word formation).—Different localities, Glass Mountains.

Fig. 28, side view of young specimen; natural size. Junction of Gilliam and Road canyons.

Fig. 29, side view of the same specimen; twice natural size.

Fig. 31, side view of young specimen; natural size. Junction of Gilliam and Road canyons.

Fig. 30, side view of the same specimen; twice natural size.

Fig. 32, front; fig. 33, venter; fig. 34, side view of a young specimen; natural size. Mountain north of Leonard Mountain.

Fig. 35, side view; fig. 36, front; fig. 37, venter, of the same specimen; twice natural size.

Fig. 38, cross-section; fig. 39, side view; fig. 40, venter, of inner whorl of the specimen figured in fig. 41; natural size. Junction of Gilliam and Road canyons.

Fig. 41, side view. Plaster cast of outer whorl of the specimen illustrated in Fig. 38-40; natural size. Junction of Gilliam and Road canyons.

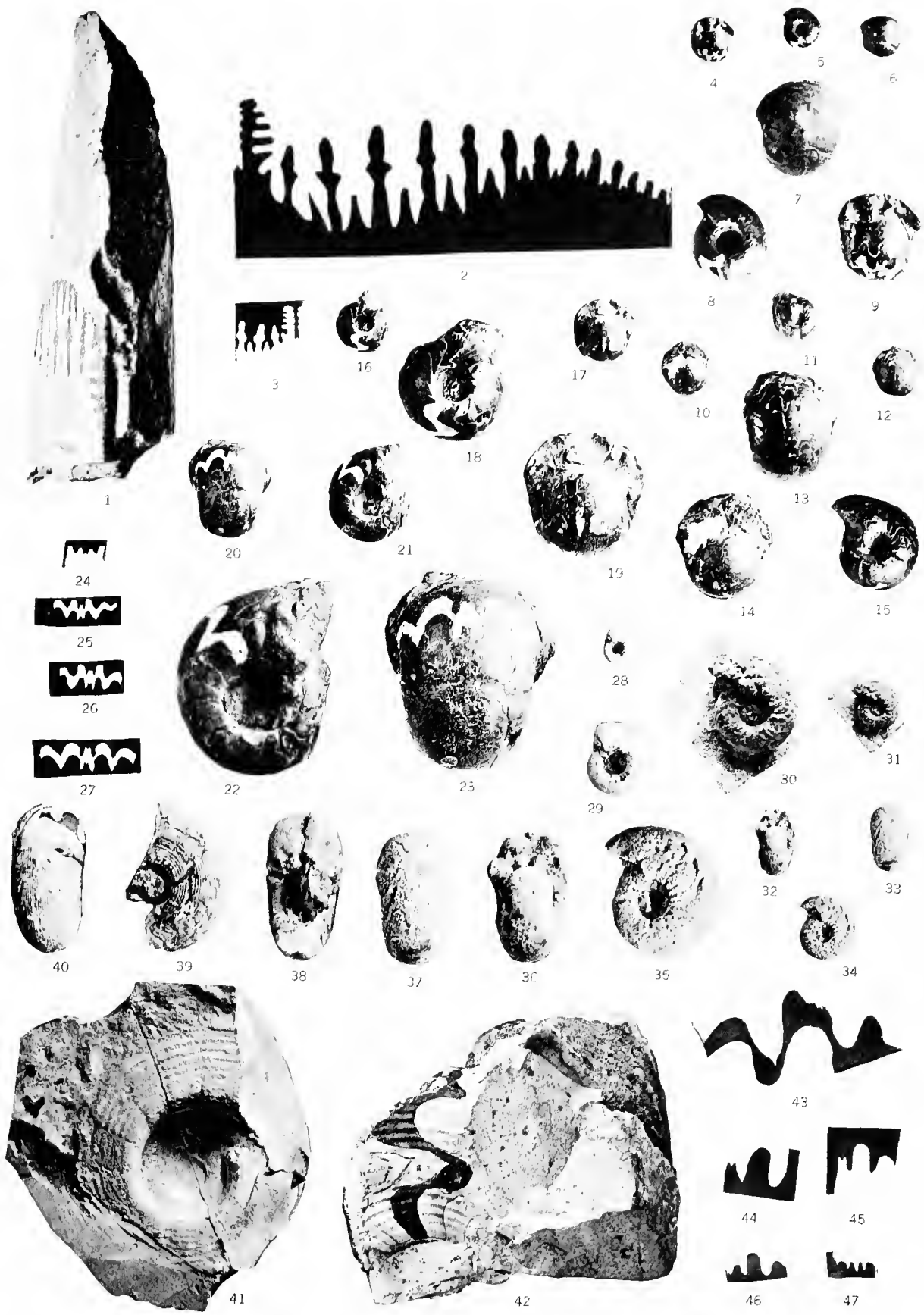
Fig. 42, ornamentation on a large specimen; natural size. Mountain north of Leonard Mountain.

Fig. 43, parts of two external sutures of specimen illustrated in fig. 42; natural size.

Fig. 44, external suture of the specimen illustrated in fig. 38-41; natural size.

Fig. 45 and 46, external sutures of smaller specimens; natural size. Junction of Gilliam and Road canyons.

Fig. 47, internal suture of small specimen; natural size. Mountain north of Leonard Mountain.



Carl Christianson, photo.

Plate III.

Fig. 1-6. . *Gastrioceras altudense* nov.sp.—Zone of *Perrinites* (Leonard formation).—South of Bird's mine near the intrusive plug on Capt. James's ranch, Altuda Mountain, near Marathon, Brewster County.

Fig. 1, side view; fig. 2, front; fig. 3, venter, of a medium-sized specimen; natural size.

Fig. 4, side view; fig. 5, front; fig. 6, venter, of a smaller specimen; natural size.

Fig. 7-8. . *Gastrioceras* sp. nov. indet.—Zone of *Waagenoceras* (Word formation).—Junction of Gilliam and Road canyons, Glass Mountains.

Fig. 7, side view; natural size

Fig. 8, ornamentation on venter of the same specimen; natural size.

Fig. 9-16. . *Schistoceras J. P. Smithi* nov. sp.—Gaptank formation, Pennsylvanian.—Two miles south of Gap Tank, Glass Mountains.

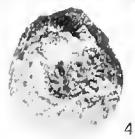
Fig. 9, front; fig. 10, side view; fig. 11, venter; fig. 12, external suture; natural size.

Fig. 13, front; fig. 14, side view; fig. 15, venter; fig. 16, external suture; natural size.

1

2

3


4

5

6

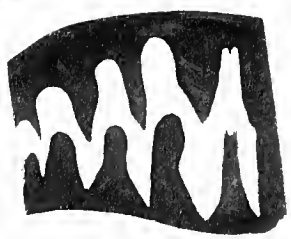
7

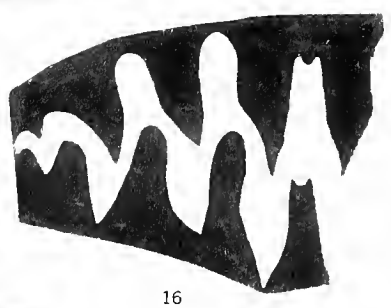
8

9

10

11


12


16

13

14

15

Carl Christianson, photo.

Plate IV.

Fig. 1-36. .*Schistoceras diversecostatum* nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 1, side view; fig. 2, front; fig. 3, venter; natural size.

Fig. 4, side view; fig. 5, venter; fig. 6, front; natural size.

Fig. 7, venter; fig. 8, side view; natural size.

Fig. 9, venter; fig. 10, front; fig. 11, side view; natural size.

Fig. 12, side view; fig. 13, front; fig. 14, venter, of the same specimen; twice natural size. Showing ornamentation.

Fig. 15, venter; fig. 16, front; fig. 17, side view; natural size.

Fig. 18, venter; fig. 19, front, of the same specimen; twice natural size .

Fig. 20, side view; fig. 21, front; fig. 22, venter; natural size.

Fig. 23, venter; fig. 24, front; fig. 25, side view, of the same specimen; twice natural size. Showing gastrioceran ornamentation.

Fig. 26, external suture of the specimen figured in fig. 7, 8; natural size.

Fig. 27, side view; fig. 28, front; fig. 29, venter; twice natural size of the specimen figured in fig. 30-32. Showing the ornamentation.

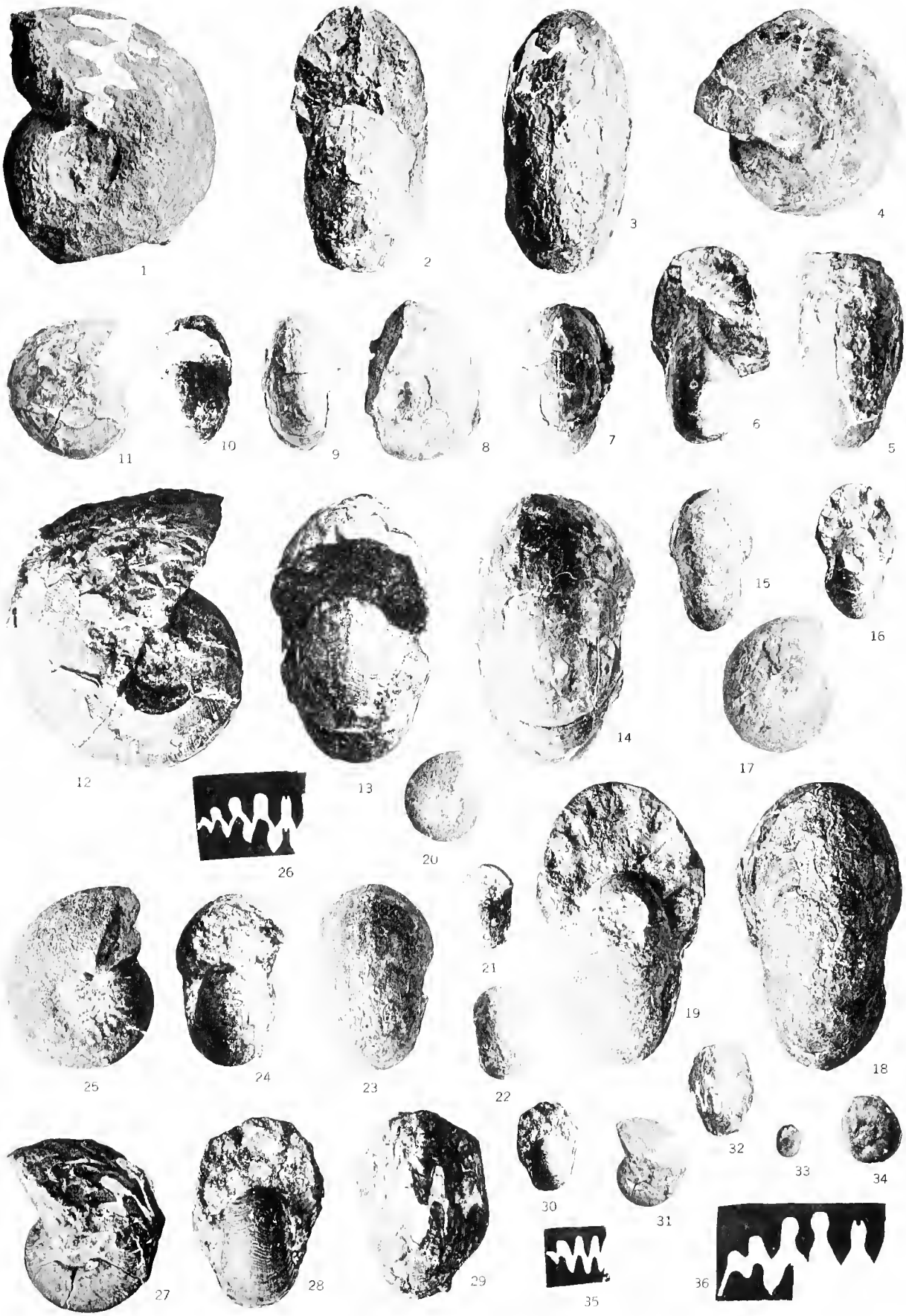
Fig. 30, front; fig. 31, side view; fig. 32, venter; natural size.

Fig. 33, side view; natural size.

Fig. 34, side view of the same specimen; twice natural size.

Fig. 35, internal suture of specimen illustrated in fig. 27-32. The suture belongs to the next larger whorl. Natural size.

Fig. 36, external suture of the specimen illustrated in fig. 1-3.



Carl Christianson, photo.

Plate V.

Fig. 1-13. .*Paralegoceras incertum* nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 1, side view; fig. 2, front; fig. 3, venter; natural size.

Fig. 4, front; fig. 5, venter, of the same specimen; twice natural size.

Fig. 6, external suture of the same specimen; natural size.

Fig. 7, front; fig. 8, venter; fig. 9, side view, of a small specimen; natural size.

Fig. 10, side view; fig. 11, front; fig. 12, venter, of the same specimen; twice natural size.

Fig. 13, external suture of the same specimen; natural size.

Fig. 14-18. .*Prothalassoceras Welleri* nov. gen. nov. sp.—Zone of *Prothalassoceras* (Hess formation).—Two and a half miles north 20 degrees east from the old oil derrick on Wedin's ranch at the foot of the first range of hills, Glass Mountains.

Fig. 14, venter; fig. 15, side view; fig. 16, front; natural size.

Fig. 17, external suture; fig. 18, last siphonal lobe, of the same specimen; natural size.

Fig. 19-32. .*Paraceltites multicostatus* nov. sp.—Zone of *Waagenoceras* (Word formation).—Two and a half miles north 70 degrees east from second tank above the headquarters ranch house of the Hess ranch, Glass Mountains.

Fig. 19, side view; fig. 20, cross-section; natural size.

Fig. 21, cross-section; fig. 22, side view, of the same specimen; twice natural size.

Fig. 23, side view; natural size.

Fig. 24, side view, of the same specimen; twice natural size.

Fig. 25, cross-section; fig. 26, side view; fig. 27, venter; natural size.

Fig. 28, venter; fig. 29, side view; fig. 30, cross-section, of the same specimen; twice natural size.

Fig. 32, side view; natural size.

Fig. 31, side view of the same specimen; twice natural size.

Fig. 33-38. .*Paraceltites* aff. *elegans* Girty.—Zone of *Waagenoceras* (Word formation).—Two and a half miles north 70 degrees east from second tank above the headquarters ranch house of the Hess ranch, Glass Mountains.

Fig. 33, venter; fig. 34, side view; fig. 35, cross-section; natural size.

Fig. 36, cross-section; fig. 37, side view; fig. 38, venter, of the same specimen; twice natural size.

Fig. 39-54. . *Agathiceras Frechi* nov. sp.—Zone of *Uddenites* (Wolfcamp formation)—Wolf Camp, Glass Mountains.

Fig. 39, venter; fig. 40, front; fig. 41, side view; fig. 42, external suture; natural size.

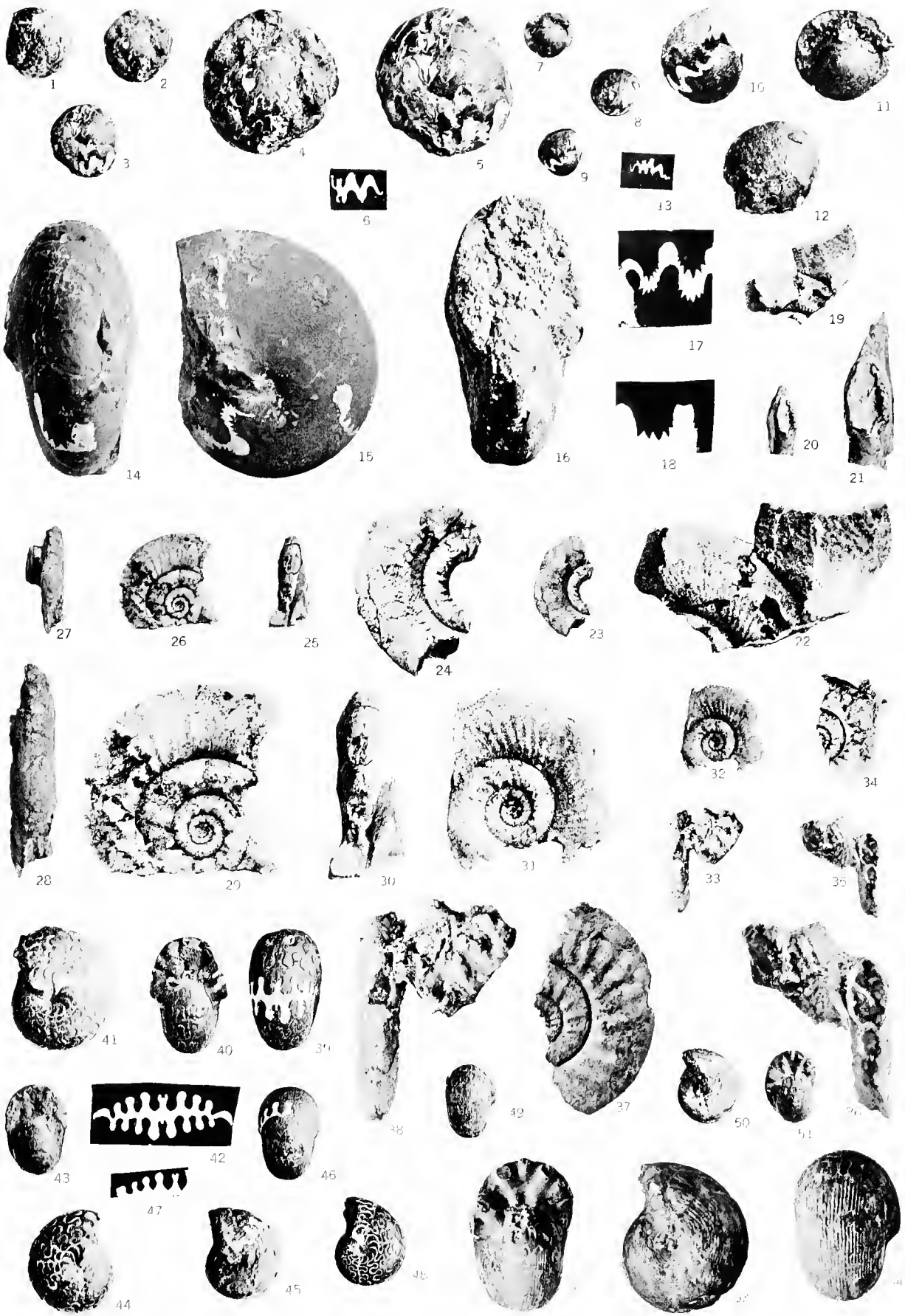
Fig. 43, front; fig. 45, side view; fig. 46, venter; fig. 47, external suture; natural size.

Fig. 44, side view; natural size.

Fig. 48, side view; natural size.

Fig. 49, venter; fig. 50, side view; fig. 51, front; natural size.

Fig. 52, front; fig. 53, side view; fig. 54, venter of the same specimen, showing the ornamentation; twice natural size.



Carl Christianson, photo.

Plate VI.

Fig. 1-26. . *Agathiceras Frechi* nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 1, side view; fig. 2, external suture taken from the same specimen; natural size.

Fig. 3, internal suture taken from a large specimen; natural size.

Fig. 4, side view; natural size.

Fig. 5, side view; natural size.

Fig. 6, side view; natural size.

Fig. 7, side view; natural size.

Fig. 8, side view; fig. 9, venter; fig. 10, front; natural size.

Fig. 11, side view; fig. 12, front; fig. 13, venter, of the same specimen; twice natural size. Showing the ornamentation.

Fig. 14, side view; natural size.

Fig. 15, venter; fig. 16, front; fig. 17, side view; natural size.

Fig. 18, side view; fig. 19, venter; fig. 20, front, of the same specimen; twice natural size.

Fig. 21, venter; fig. 22, front; fig. 23, side view, of very juvenile specimen; natural size.

Fig. 24, side view; fig. 25, front; fig. 26, venter, of the same specimen; twice natural size.

Fig. 27-46. . *Agathiceras Girtyi* nov. sp.—Zone of *Waagenoceras* (Word formation).—Junction of Gilliam and Road canyons, Glass Mountains.

Fig. 27, side view; fig. 28, front; natural size. All the septa which on the side view nearly resemble ribs, on this and the following specimens, are internal septa of the next larger whorl. The ornamentation seen in these with exception of figs. 39-42 is shown from the opposite side and belongs to the interior of the next larger whorl, the ribs showing as furrows and the furrows as ribs.

Fig. 29, front of the same specimen; twice natural size.

Fig. 30, side view; fig. 31, venter; natural size.

Fig. 32, venter of the same specimen; twice natural size.

Fig. 33, venter; fig. 34, front; fig. 38, side view; natural size.

Fig. 35, front; fig. 36, side view; fig. 37, venter, of the same specimen; twice natural size.

Fig. 39, venter; fig. 40, side view, of small specimen; natural size.

Fig. 41, side view; fig. 42, venter, of the same specimen, showing the real ornamentation of the species; twice natural size.

Fig. 43, 44, 45, external sutures of different specimens, fig. 45 belonging to one larger than any of those figured. Natural size.

Fig. 46, internal suture; natural size.

Fig. 47-56. . *Adrianites marathonensis* nov. sp.—Zone of *Waagenoceras* (Word formation).—Junction of Gilliam and Road canyons, Glass Mountains.

Fig. 47, venter; fig. 48, side view; fig. 49, front, of largest specimen found; natural size.

Fig. 50, side view; fig. 51, venter, of smaller specimen; natural size.

Fig. 52, external suture of specimen illustrated in figs. 47-49, 53-56. Twice natural size.

Fig. 53, the same in natural size.

Fig. 54, side view; fig. 55, front; fig. 56, venter, of specimen illustrated in Fig. 47-49, 52, 53. Twice natural size.

Fig. 57-69. . *Stacheoceras Bowmani* nov. sp.—Zone of *Waagenoceras* (Word formation).—Junction of Gilliam and Road canyons, Glass Mountains.

Fig. 57, side view; fig. 58, front; fig. 59, venter (upper part of fig. 57); natural size.

Fig. 60, part of external suture; the umbilicus on the right side indicates how many lobes are missing. Natural size.

Fig. 61, side view; fig. 62, cross-section; fig. 63, venter, showing the characteristic ornamentation; natural size.

Fig. 64, front; fig. 65, venter; fig. 66, side view, showing traces of the suture; natural size.

Fig. 67, venter; fig. 68, side view showing ornamentation; fig. 69, front; natural size.

Fig. 70-76. . *Stacheoceras gilliamense* nov. sp.—Zone of *Waagenoceras* (Word formation).—Junction of Gilliam and Road canyons, Glass Mountains.

Fig. 70, venter; fig. 71, side view; fig. 72, front; fig. 73, part of internal suture; natural size.

Fig. 74, front; fig. 75, venter, of the same specimen; twice natural size.

Fig. 76, side view of another specimen; natural size.

Fig. 77-89. . *Marathonites J. P. Smithi* nov. subgen. nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 79, internal and external suture taken from a fairly large specimen. The umbilical seam coincides with the straight limit between the black and white. Natural size.

Fig. 80, the same; twice natural size.

Fig. 81, side view; fig. 82, front; fig 83, venter; fig. 78, external suture of largest specimen found; natural size.

Fig. 84, side view; fig. 85, cross-section; fig. 86, venter; fig. 77, external suture; natural size.

Fig. 87, venter; fig. 88, front; fig. 89, side view; natural size.

Carl Christianson

Plate VII.

Fig. 1-4. . *Marathonites sulcatus* nov. subgen. nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 1, side view; fig. 2, venter; fig. 3, front; fig. 4, external suture; natural size.

Fig. 5-32. . *Marathonites vidriensis* nov. subgen. nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 5, side view; fig. 6, front; fig. 7, venter; fig. 8, external suture; natural size.

Fig. 9, front; fig. 10, venter; fig. 11, side view, of the same specimen; twice natural size.

Fig. 12, front; fig. 13, venter; fig. 14, side view; fig. 15, external suture; natural size.

Fig. 16, front; fig. 17, venter; fig. 18, side view; natural size.

Fig. 20, side view; fig. 21, venter; fig. 22, front, of the same specimen; twice natural size.

Fig. 23, venter; fig. 24, side view; fig. 25, front; fig. 26, external suture; natural size.

Fig. 27, side view; fig. 28, front; fig. 29, venter; natural size.

Fig. 19, external suture; fig. 30, the same; twice natural size of medium-sized specimen.

Fig. 31, internal suture, natural size; fig. 32, the same, twice natural size of large specimen.

Fig. 33-39. . *Marathonites Hargisi* nov. subgen. nov. sp.—Zone of *Prothalassoceras* (Hess formation).—Anticline on Hargis's ranch near Southern Pacific R. R. mile-post 580, near Marathon, Brewster County.

Fig. 33, side view; fig. 34, front; fig. 35, venter; fig. 36, external suture; natural size.

Fig. 37, front; fig. 38, venter; fig. 39, external suture of the same specimen; twice natural size.

Fig. 40-61. . *Vidrioceras Uddeni* nov. subgen. nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 40, front; fig. 41, venter; fig. 42, side view; fig. 43, external suture; natural size.

Fig. 44, front; fig. 45, side view; fig. 46, venter; fig. 47, external suture; natural size.

Fig. 48, side view; fig. 49, venter; fig. 50, front; natural size.

Fig. 51, venter; fig. 52, front; fig. 53, side view, of the same specimen; twice natural size.

Fig. 54, venter; fig. 55, front; fig. 56, side view; natural size.

Fig. 57, side view; fig. 58, front; fig. 59, venter, of the same specimen; twice natural size.

Fig. 60, external and internal suture of largest specimen; natural size. The umbilical seam coincides with the straight limit between black and white.

Fig. 61, external and internal suture of the same specimen; twice natural size.

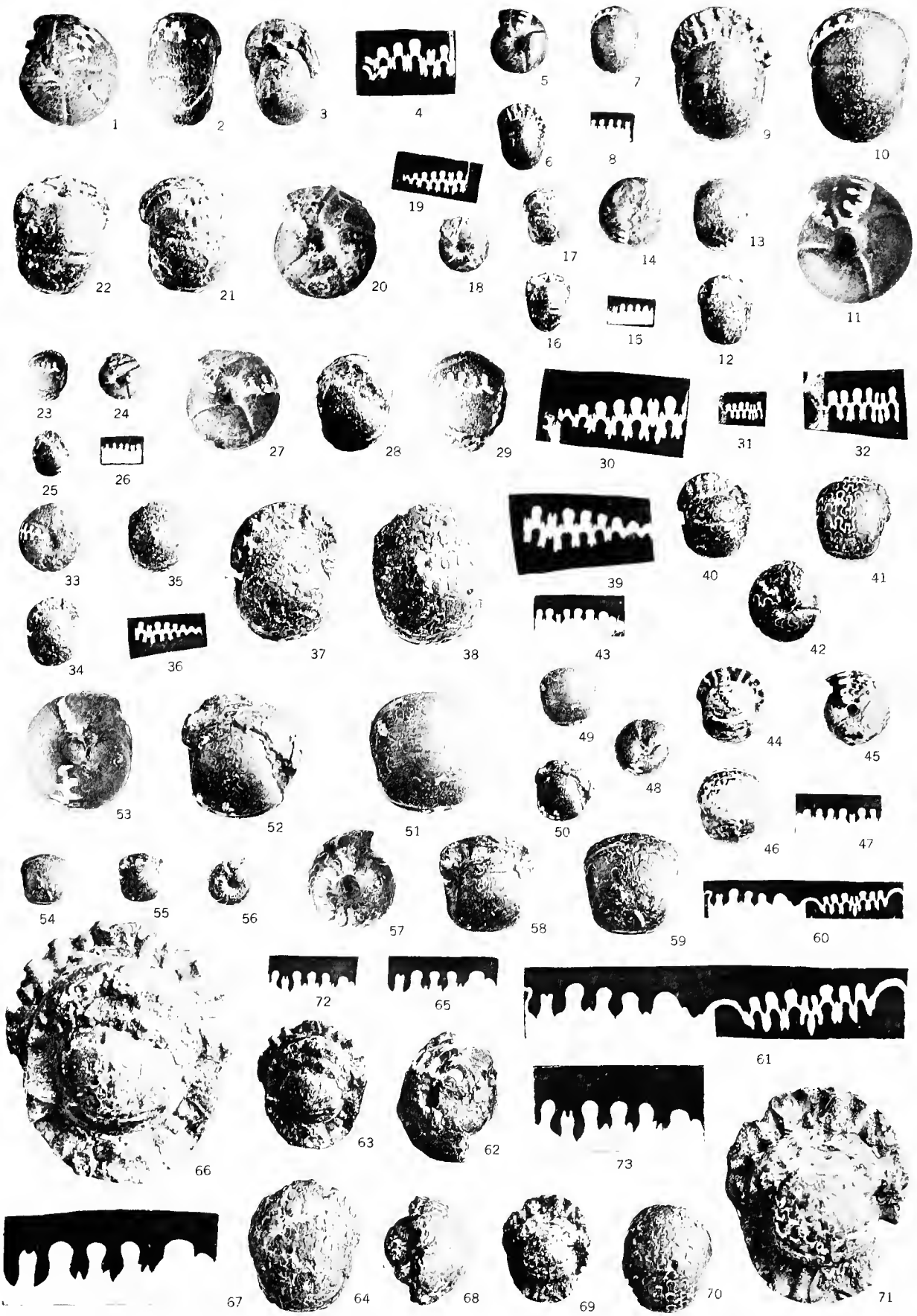
Fig. 62-73. *Vidrioceras irregulare* nov. subgen. nov. sp.—Zone of *Uddenites* (Wolfcamp formation).—Wolf Camp, Glass Mountains.

Fig. 62, side view; fig. 63, front; fig. 64, venter; fig. 65, external suture; natural size.

Fig. 66, front; fig. 67, external suture of the same specimen; twice natural size.

Fig. 68, side view; fig. 69, front; fig. 70, venter; fig. 72, external suture; natural size.

Fig. 71, front; fig. 73, external suture of the same specimen; twice natural size.



Carl Christianson, photo.

Plate VIII.

Fig. 1-10. . *Perrinites vidriensis* nov. gen. nov. sp.—Zone of *Perrinites* (Leonard formation).—Two miles northwest of Iron Mountain, Glass Mountains.

Fig. 1, front; fig. 2, side view; fig. 3, venter; fig. 4, external saddle of large specimen; natural size.

Fig. 5, side view; fig. 6, venter; fig. 7, external suture of medium-sized specimen; natural size.

Fig. 8, side view; fig. 9, venter; fig. 10, front, of a specimen found in lower part of zone of *Perrinites* at three miles north of the old oil derrick in Wedin's ranch, Glass Mountains.

1

2

3

4

5

6

7

8

9

10

Carl Christianson, photo.

Plate IX.

Fig. 1-10. .*Perrinites vidriensis* nov. gen. nov. sp.—Zone of *Perrinites* (Leonard formation).—Two miles northwest of Iron Mountain, Glass Mountains.

Fig. 1, venter; fig. 2, side view; fig. 3, cross-section of one of the largest specimens; natural size.

Fig. 4, front; fig. 5, venter; fig. 6, side view, of medium-sized specimen; natural size.

Fig. 7, front; fig. 8, venter; fig. 9, side view, of small specimen; natural size.

Fig. 10, siphonal lobe; external and first lateral saddle of medium-sized specimen; natural size.

1

4

10

2

9

3

8

7

5

6

Carl Christianson, photo.

Plate X.

Fig. 1-21. . *Perrinites vidriensis* nov. gen. nov. sp.—Zone of *Perrinites* (Leonard formation).—Two miles northwest of Iron Mountain, Glass Mountains.

Fig. 1, front; fig. 2, side view; fig. 3, venter; natural size.

Fig. 4, venter; fig. 5, side view; fig. 6, front; natural size.

Fig. 7, front; fig. 8, venter, of the same specimen; twice natural size.

Fig. 9, venter; fig. 10, front; fig. 11, side view; natural size.

Fig. 12, front; fig. 13, venter, of the same specimen; twice natural size.

Fig. 14, venter; fig. 15, side view; fig. 16, front; natural size.

Fig. 17, venter; fig. 18, front, of the same specimen; twice natural size.

Fig. 19, external suture of a small specimen; natural size.

Fig. 20, external suture of a specimen about 3 mm. in diameter, *Shumardites* stage; four times natural size.

Fig. 21, internal suture (partial) of medium-sized specimen, natural size, showing the antisiphonal, two lateral and one auxiliary lobe, the internal saddle, the two lateral and one auxiliary saddle.

Fig. 22-27. . *Perrinites compressus* nov. gen. nov. sp.—Zone of *Perrinites,* lower part (Leonard formation).—Near top ridge about two miles north 65 degrees west of Wolf Camp, at head of valley leading down to tank one half mile west of Wolf Camp, Glass Mountains.

Fig. 22, side view; fig. 23, venter; fig. 24, front; fig. 25, part of external suture; fig. 26, siphonal lobe and external saddle of another suture a little nearer to the living chamber of the same specimen; natural size.

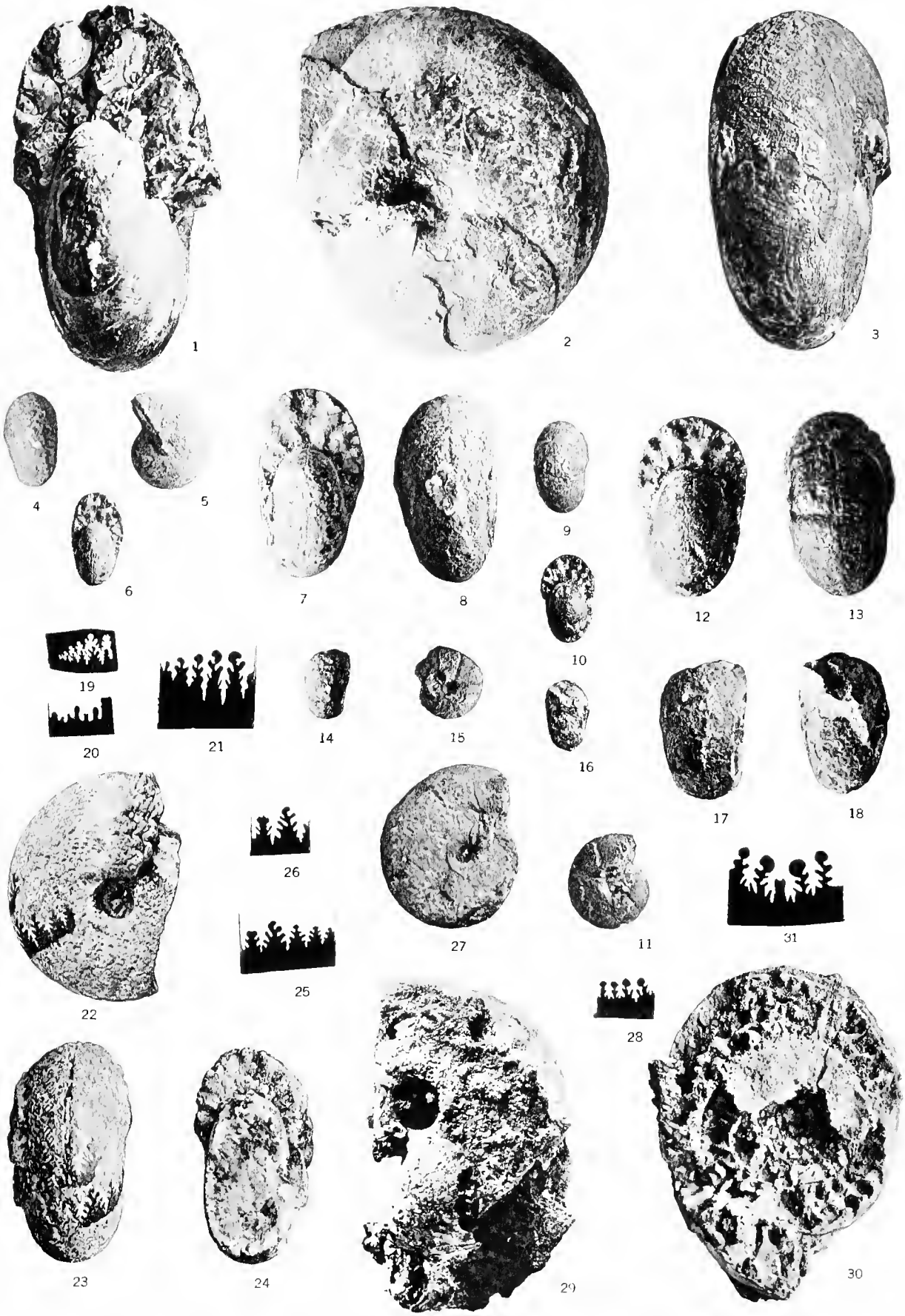
Fig. 27, side view of another specimen; natural size.

Fig. 28-31. . *Waagenoceras Dieneri* nov. sp.—Zone of *Waagenoceras* (Word formation).—Glass Mountains.

Fig. 28, internal suture (partial), natural size, showing the antisiphonal and the first and second lateral lobes, the internal and the two lateral saddles. From specimen illustrated in Plate XI, fig. 1-3. Junction of Gilliam and Road canyons.

Fig. 29, side view of largest specimen found; fig. 30, cross-section; fig. 31, siphonal and first lateral lobe, external and first lateral saddle, natural size. Mountain north of Leonard Mountain.

Plate X



Carl Christianson, photo.

Plate XI.

Fig. 1-27. . *Waagenoceras Dieneri* nov. sp.—Zone of *Waagenoceras* (Word formation).—Junction of Gilliam and Road canyons, Glass Mountains.

Fig. 1, side view; fig. 2, front; fig. 3, nearly complete external suture, natural size. The internal suture of this specimen, illustrated in Plate X, fig. 28, is taken from the whorl immediately following the one figured in fig. 2; part of the whorl where the internal suture was taken from, can still be seen on the lower righthand corner of fig. 2.

Fig. 4, front; fig. 5, external suture taken from the outermost whorl; fig. 6, external suture taken from the smaller whorl of the same specimen; natural size.

Fig. 7, venter; fig. 8, front; fig. 9, side view; fig. 10, external suture; natural size.

Fig. 11, front; fig. 12, venter, of the same specimen; twice natural size.

Fig. 13, venter; fig. 14, side view; fig. 15, front; natural size. From mountain north of Leonard Mountain, Glass Mountains.

Fig. 16, front; fig. 17, venter, of the same specimen; twice natural size.

Fig. 18, venter; fig. 19, side view; fig. 20, front; natural size.

Fig. 21, venter; fig. 22, front, of the same specimen; twice natural size.

Fig. 23, venter; fig. 24, side view; fig. 25, front; natural size.

Fig. 26, front; fig. 27, venter, of the same specimen; twice natural size.

Fig. 28-45. . *Paralecanites altudensis* nov. sp.—Zone of *Perrinites* (Leonard formation).—South of intrusive plug on Capt. James's ranch, Altuda Mountain, Brewster County.

Fig. 28, side view of one of the largest specimens; natural size.

Fig. 29, side view of a large fragment; fig. 30, venter; natural size.

Fig. 31, venter of the same specimen; twice natural size.

Fig. 32, side view; fig. 33, venter; fig. 34, cross-section; fig. 35, external suture; natural size.

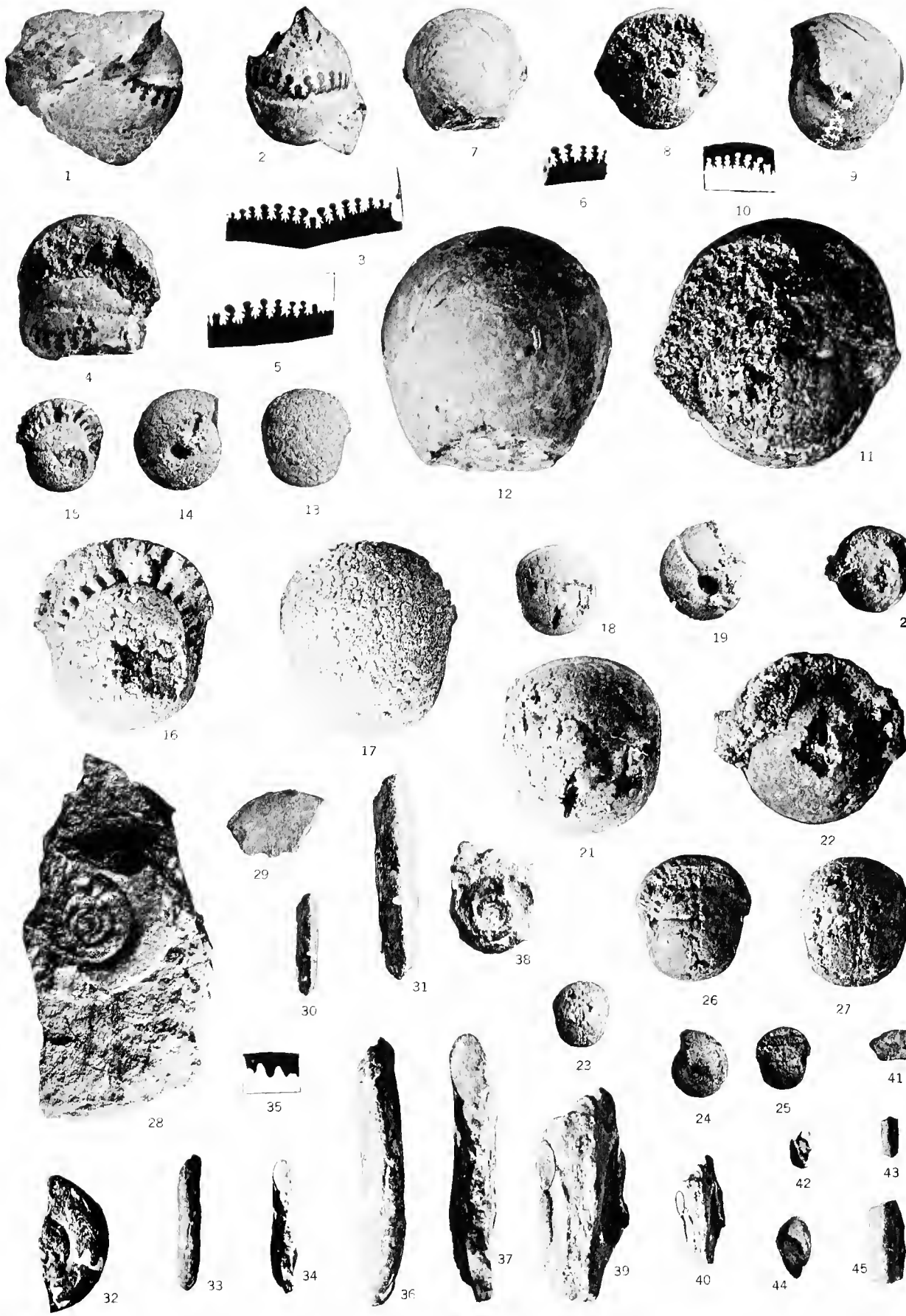
Fig. 36, venter; fig. 37, cross-section, of the same specimen; twice natural size.

Fig. 38, side view of small specimen; fig. 40, front; natural size.

Fig. 39, front of the same specimen; twice natural size.

Fig. 41, side view of small fragment; fig. 42, cross-section; fig. 43, venter; natural size.

Fig. 44, cross-section; fig. 45, venter, of the same specimen; twice natural size.



Carl Christianson, photo.

INDEX

[Figures in heavy-faced type indicate the page on which the description is given.]

Page

Abbreviations 9
Abich, H.....9, 45
Acme Cement Mills..... 26
Adrianites .....
....19, 29, 30, 38, 113, **121**, 124, 125
anceps 125
elegans 38, 126
Haueri 38
ensifer 125
(Hofmannia) sp. ind..... 40
insignis 33, 126
isomorphus 38, 125
marathonensis 18, 33, **123**, 224
Stuckenbergi 120, 123, 126
timorensis 126
Aganides, sp. ind..... 41
Agathiceras 29,
30, 39, 40, 92, 93, **113**, 114, 121, 124
anceps 117, 125
ciscoense 113, 117, 120
Frechi.....18, 36, 114, 119, 222, 223
Girtyi 18, 33, 117, 124, 223
Krotowi 120
sp. ind. 183, **193**, 207
Stuckenbergi 113
Suessi.....115, 117, 122, 125, 194
cfr. Suessi.....40, 113
texanum 117, 120
uralicum 36, 39, 194
cfr. uralicum.....113, 116
Aguilera, J. G..... 47
Ajer Mati..... 44
Albany formation, the.....26, 27, 47
Alps, the.....38, 39, 178
Altuda 90
Altuda Mountain.....90, 165, 177, 180
Amb group, the..... 42
America 208, 209
American fauna, Permian..... 39
Ammonoids, distribution of..... 17
Anthracolitic, the..... 157
Apache Mountains..... 171
Appalachian region, the..... 27

Page

Appendix 183
Arcestidae 28, 93, 113, 168
Arizona 48
Armenia 39, 45, 51
Arthaber, G. von.....45, 46
Artinsk, the.....
...28, 29, 36, 39, 40, 43, 70, 83, 88
108, 113, 116, 134, 186, 192, 200, 208
sandstone 40, 209
Artinskian in China, the.... 40
Asia 39, 45, 48
Asiatic beds..... 28
Auernigschichten 38
Austin 183
Australasian Ocean..... 209

Baker, Charles Laurence.....
...6, 8, 11, 12, 13, 93, 106, 165, 171
Barent Island.....28, 39
Basin Ranges..... 27
Baylor County.....27, 160, 183, 200
Beede, J. W.....
.....21, 23, 26, 183, 190, 194, 202
Bellerophon limestone.....39, 178
Big Wichita, the.....24, 25, 160
Bird, J. C., mine of.....90, 165
Bitaunu 40, 114
Boehm, G.....9, 126
Bokhara 192, 209
Böse, Emil... .....11, 16
Bowman, W. F.....5, 8, 108
Brewster County 160
British Honduras 27
Burckhardt, Carl..... 46
Burkart, Joseph..... 46
Byans, India..... 159

Calcare compatto..... 71
California 27, 39, 48
Camarophoria mutabilis..... 48
Caralp, J.....9, 52, 107
Carboniferous, the..... ..39, 43
Upper 37

	Page
Carnian Alps	28, 38
Celtites	107
Central Asia	39, 192, 209
Central Texas	47, 183, 200, 201
Central Texas series	27
Chaenomya leavenworthana	21
Chiapas, Mexico	27
Chideru group, the	42, 43, 44
Chihuahua	46
China	39, 103
Chinese localities	40
Chitichun I	44
limestone	45
Chonetes mesolobus	21
Christianson, Carl	8
Cisco formation, the	85, 93
Clear Fork beds, the	47, 183, 190
division	27, 160
formation	26, 159, 186, 200
Clinolobus	30
Clionites	42
Coahuila	46
Coal Measures	146
Coelocladia	21
Coleman County	47
Colorado River	183
Composita	21
Contents	3
Correlation of the Permo-Carboniferous	**23**
Correlation with European and Asiatic beds	**28**
Cretaceous, Upper	29
Croatia	28, 38, 107
Croton creek, Salt	24, 25
Cryptacanthia cf. compacta	21
Culberson County	23
Cummins, W. F	183
Cyclolobinae	19, 25, 30, 38, 41, 155, 170, 208, 209
Cyclolobus	30, 44, 168, 169, 170, 209
Kraffti	169
Oldhami	44
persulcatus	44, 169
Stachei	170
Dalmatites	45
Dandote group, the	42, 43
Daraelites	29, 31, 37, 39, **51**, 52, 59
elegans	36, 52, 54
Meeki	52, 54
texanus	17, 36, **52**, 213
Darwas	39, 192, 209
Delaware beds	33, 160, 209
Delaware formation	91
Delaware Mountains	171
Delaware Mountain beds	24
Diener, C	7, 9, 39, 40, 43, 44, 107, 121, 125, 155, 157, 159, 169, 177, 180
Dimple formation, the	17
Distribution of the ammonoids	17
Djulfa	39, 45, 46
Dogger	46
Doryceras	30
Double Mountain	159, 160, 207
beds	190
formation	25, 47
Dundee	183, 190, 194, 200, 207
Enteletes aff. waageni	22
hemiplicatus	22
Episageceras	68, 72, 201
latidorsatum	68
Wynnei, zone of	44
Euomphalus pernodosus	22
Euphemus carbonarius	22
nodocarinatus	22
Europe	47, 48, 209
European beds	28
fauna (Permian)	39
Mediterranean	47
Russia	28
Fort Douglas	27
Fort Scott limestone	21
Franconian, the	27
Frech, Fr	9, 27, 39, 40, 43, 46, 107, 108, 113, 146, 155, 157, 177
Fusulinae	21
Fusulina limestone	43
Fusulina longissimoidea	21
Gap Tank	15, 20, 23, 95
Gaptank formation, the	15, 16, 23, 95
Gastrioceras	19, 24, 26, 29, 30, 33, 38, 39, 40, 52, **82**, 84, 91, 93, 99, 101, 134, 194, 204, 205, 207
Abichi	45
altudense	18, 34, 35, **88**, 91, 217
calyx	82
Feodorowi	39

Page

globulosum 82
group of..... 83
Jossae 88, 90
modestum 17, 36, 37, **83**, 215
Nikitini 30
n. sp. **204**
nov. sp., indet 24, **90**
(?) Richthofeni 40
roadense 18, 33, **85**, 90, 215
Roemeri (?) 38
russiense 170, 206
serratum 24
sosiense 33, 88
sp. ind..... 45
aff. Marianum..... 40
sp. nov. indet..... ..18, 33, **90**, 217
subcavum 36, **85**
subglobulosum 85
Suessi 30, 88
Waageni 34
Zitteli ....
19, 30, 35, 38, 45, 83, 88, 89, 91
cfr. Zitteli 40
group of..... 85
Gemmellaro, G. G.....
.....9, 30, 34, 51, 67, 70, 88, 90, 91, 102, 103, 107, 108, 109, 111, 113, 115, 117, 121, 126, 127, 134, 138, 146, 159, 168, 169, 174, 175, 192
Geyerella 22
Gilliam Canyon (see Road and Gilliam Canyons)
Gilliam formation, the..... .....15, 17
Girty, G. H.....9, 8, 23, 24, 91, 108, 111, 117, 120, 160, 170, 175
Glass Mountains, the.....
..5, 14, 24, 31, 33, 34, 36, 38, 46, 48
Glyphioceras 30, 82, 84, 148
Glyphioceratidae 82, 93
Goniatites 122
primas 67
Gould, Chas. N..... 26
Great Salt Lake..... .. 27
Grube, Lieut. v..... 44
Guadalupe Mountains....23, 24, 46, 209
Guadalupian formation, the.....
.....108, 110, 175
Guatemala 27

Haack, W.....9, 27, 46
Haarman, Erich.....9, 27, 46

Page

Hardeman County.....24, 26
Hargis, ranch of..... 146
Haug, E..... .....
....10, 43, 82, 92, 113, 121, 169, 201
Haymond, formation, the.... 17
Heilprin, A.....140, 144, 145
Hess formation, the.....
. .....15, 18, 27, 104, 106, 146, 167
limestone 36, 38, 40, 208
Ranch 110, 112
Heterocoelia 21
Hill, R. T..... ... ... .5, 24
Himalayas 39, 40, 44
Hofmannia 30, 40, 41
Holzapfel 52
Hungarites 51
nov. form. sp. ind..... 45
pessoides 45
Raddei 45
Hyatt, A.....
.....10, 82, 92, 99, 107, 177, 179
Hyattoceras .....
28, 30, 32, 47, 155, 156, 157, 159, 209
Cumminsi 41
aff. Cumminsi..... 41
n. s. aff. Cumminsi..... 40
n. sp. ex. aff. H. Cumminsi..... 159
Hyattoceras (?) 34

Ibergiceras 51, 52, 68
Idaho 179
India .... .39, 70, 159, 208, 209
Indian Permo-Carboniferous. 47
Iron Mountain..... .. ..76, 164

James, Captain, ranch of....90, 165, 180
Joannites .... .169, 170
Julian alps..... 38
Junction of Road and Gilliam Canyons
...81, 88, 92, 121, 127, 131, 133, 176

Kalabagh beds.....42, 43
Kansas 24
Kansas section, the.. 21
Karakorum Pass..... 45
Karawanken 28
Karpinsky, A... ....
...10, 25, 28, 31, 32, 33, 39, 51, 55, 67, 74, 88, 100, 102, 103, 104, 105, 108, 113, 120, 121, 126, 127, 138, 145, 146, 185, 186, 192, 200, 209

Page

Katta beds 42
Kent County 24
Keyserling, A. de 11, 25
Kossmat, F 38, 39
Krafftoceras 44, 169
Krotow 25, 113
Kuling shales 44
Kungur dolomites 33
Kupang 44

Las Delicias, Mexico 27, 46
Lecanites 52, 177
Lecanitinae 52, 55
Leonard beds 48
formation 15, 18, 24, 25, 26, 27, 34, 39, 76, 90, 160, 165, 167, 180, 190, 207
Leonard Mountain .. 81, 88, 131, 146, 176
Liassic 46
Lilinthi 40, 41
Lilinthiceras 42
n. g. sp. ind 40
List of plates 216
Literature cited 9
Lo Ping 40
Lower Permian 22
Lower Triassic 177, 179
Lyttonia 16, 48

Marathon 5, 146, 180
Marathonites 19, 21, 30, 37, 132, 133, **135**, 146, 147, 148, 153, 193
Hargisi 18, 35, 140, 143, **144**, 138, 225
J. P. Smithi 18, 36, 134, **135**, 136, 140, 143, 224
sulcatus ... 18, 36, 138, **139**, 143, 225
vidriensis 36, 134, 138, 140, **141**, 143, 144, 148, 225
Maubesi 40
Mediterranean, European 47
Medlicottia 19, 25, 29, 37 55, **67**, 72, 183, 184, 199, 200, 204, 207
artiensis 67, 71, 184, 185, 200, 208
bifrons 34, 35, 67, 68, 71, 75
Burckhardti 18, 33, 34, 69, 75, **76**, 201, 214, 215
croatica 69
copei 25, 26, 69, 75, 186, 187, 199, 200, 201, 207

Page

Dalailamae 68
Karpinskyana 32, 67
magnotuberculata 44, 69
Marcoui 67, 71
n. sp. **184**
n. sp. I **194**, 207
n. sp. II 194, 195, 196, **197**, 207
Orbignyana 31, 67, 68, 71, 74, 186, 199, 200, 208
primas 44, 67, 68, 71, 75, 79, 208
sakmarae 67
Schopeni 67, 68
Trautscholdi 31, 67, 68, 71
Verneuili 33, 67, 71, 79
Whitneyi 18, 34, 35, 71, **72**, 74, 199, 201, 214
Wynnei 67, 68
Medlicottia (?) croatica 38
Meekoceras 51
beds 177
Meekoceratidae Waagen 177
Mesozoic, the 29
types 25
Mexico 27, 46, 47
Military Crossing 24, 25, 26, 100, 183, 199, 207
Mojsisovics, E. v 10, 113, 121, 127, 168, 169
Möller 45
Mount Ord 160
Mrzla-Vodica beds 28, 38, 39
Murchison, R. J 11, 25

New Mexico 48
Ning-Kwo-hsein 40
Noetling, Fr 10, 31, 42, 43, 68, 70, 71, 184, 201
Nomismoceras 39
Smithi 41
Noritinae 52, 55
North America 113
Nyan-hwei 40

Oklahoma 24
Oldhamina 48
Omphalotrochus (?) 22
Oppelia 122
Ord Mountain 165
Otoceras djoulfense 45
Fedoroffi 45
trochoides 45
tropitum 45

Page
Paleontological Part 51
Palermo 47
Paraceltites .....
.....29, 38, 39, 52, 92, **107**, 177, 179
elegans 108, 110, 111
aff. elegans.....18, 33, **110**, 221
Halli 11
Hoeferi 33, 38, 107, 109, 111
multicostatus ...18, 33, **108**, 109, 221
Münsteri 109
plicatus 33, 111
pseudo-opalinus 40, 108
Paragastrioceras 83
Paralecanites 39, 107, **177**
altudensis 18, 35, **178**, 233
Arnoldi 177, 178, 179
sextensis 177
Paralegoceras 93, **99**, 206
Baylorense 25, **207**
incertum 18, 36, **100**, 221
Parapopanoceras 128
Paraprolecanites 51, 52
Parapronorites 29, 51, 55, 59
aff. Koninckı..... 40
Penjabien, the..... 42
Pennsylvanian, the.....
.....20, 23, 95, 134, 140, 146, 147
fauna 21
Pericyclus 40
Perisphinctes 122
Permfauna aus Mexico..... 27
Permian, the.....16, 20,
39, 45, 55, 146, 169, 170, 178, 201, 209
of Europe..... 28
Russian 43
Permo-Carboniferous, the.....37,
38, 39, 47, 102, 110, 146, 147, 155, 209
correlation of..... 23
sediments 7, 12, 17
Perrinites 25, 26,
41, 44, 47, **155**, 159, 160, 170, 171,
175, 183, 190, 194, 204, 207, 208, 209
compressus .....
.....18, 34, 165, **166**, 190, 203
compressus nov. gen. n. sp..... 231
Cumminsi 24, 25, 26,
41, 164, 165, 167, 189, 190, 203, 207
Hilli .....
25, 26, 160, 164, 167, 190, 203, 207
n. sp.....**187**, **201**

Page
vidriensis .....
....18, 25, 26, 34, 41, 160, **161**,
164, 167, 190, 203, 207, 227, 229, 231
zone of.....
..18, 19, 20, 24, 26, 34, 38, 47, 48
Pleurotomaria altaica..... 22
Popanoceras .....
25, 29, 38, 40, 127, 134, 145, 146, 207
clausum 130
Ganti 127
Krasnopolskyi 128
Medlicottia 160
Moelleri 130
Parkeri 127
cf. Parkeri..... 35
priscum 45
Sobolevskyi 127
Walcotti 127
Porcellia 21
Presidio County..... 45
Prodaraelites 51
Productus giganteus..... 22
gratiosus 48
guadalupensis comancheanus 22
humboldti 22
limestone 25, 42, 43, 44, 45, 70
shales 40, 41, 42, 159
sino-indicus ..... .24, 48
Prolecanites 52, 92
Prolecanitidae 44, 51
Pronorites .....
...19, 29, 37, 55, 56, 59, 62, 63, 68
praepermicus 39
Propinacoceras 29, 40, 55, 59, 67
darwasi 39
Galilaei 38
sakmarae 67
Prothalassoceras .....
.....23, 31, 40, **102**, 104, 106, 208
Welleri 18, 35, **104**, 105, 221
zone of.....18, 19, 20, 35, 36
Pugnax rockymontana..... 21
Pyrenees 28, 31, 52, 107

Quanah 24, 26, 204, 207

Richthofenia 48
Rhipidomella corallina..... 48
Rio Grande River..... 46
Road and Gilliam canyons, junction of
...81, 88, 92, 121, 127, 131, 133, 176

Page

Roemer, F. 9
Rothliegendes, the. 42
Rothpletz, A. 10, 44, 45
Runnels County. 47, 183, 194, 199, 200, 202, 203, 207
Russia 28, 116

Sageceras primas. 67
St. Girons. 28, 31
Salt Croton Creek. 24, 25, 26, 207
Salt Range. 39, 42, 43, 46, 47, 51, 68, 70
San Angelo. 24, 207
San Luis Potosi. 46
Sapper, Carl. 27
Saxonian, the. 27, 43
Schistoceras 7, **92**
diversecostatum 17, 36, 37, 93, 95, **96**, 219
fultonense 93
Hildrethi 92, 93
Hyatti 21, 36, 92, 93, 95, 98, 99
missouriense 93
Smithi 21, **93**, 95, 98, 217
Schwagerina 21
limestone 48
Shafter 45
mine, the. 6
region, the. 46
Shumardites 160, 163, 170, 208
Sicanites 29, 32, 55, 68, 186, 200
Sicily 25, 28, 33, 47, 155, 170, 174, 208, 209
Sierra de Catorce. 46
Sierra del Vidrio. 5
Sierra Nevada. 27
Smith, F. H. 40
Smith, J. P. 10, 43, 52, 82, 92, 93, 95, 107, 117, 113, 121, 134, 140, 144, 146, 155, 156, 157, 160, 163, 164, 170, 177, 179, 185, 208
Sonora 46
Sosio beds the. 25, 28, 29, 31, 32, 36, 38, 39, 40, 41, 43, 45, 52, 55, 70, 104, 107, 108, 117, 192
limestone 208, 209
Speckled sandstone, the. 42
Spirifer aff. musakheylensis. 21, 22
Spiti (Himalaya) 44
Spitzbergen 28, 39

Page

Stacheoceras 19, 21, 25, 29, 38, **127**, 134, 146, 147, 170, 192, 207
antiquum 45
Benedictinum 134
Bowmani 18, 33, **128**, 131, 224
Ganti. . 36, 37, 133, 134, 138, 140, 144
Gaudryi 133
gilliamense. . . . 18, 33, 128, **131**, 224
globosum 33, 133
Karpinskyi 130
Kingianum 133
Krasnopolskyi 130, 133
Lahuseni 130, 133
mediterraneum 134
n. sp. **190**
Parkeri. . 133, 138, 140, 144, 145, 146
perspectivum 133
pygmaeum 133, 138, 144, 192
Romanowskyi 36, 37, 40, 133, 138, 144, 193, 208
subinterruptum 128
tridens 45, 131
Trimurti 45, 131
Walcotti 25, 131, 192, 207
Stacheoceras (Marathonites?). 183
Stoliczka 45
Stolley, E. 27
Stratigraphical Part. **15**
Strawn formation, the. 146
Sz-Tshwan 40

Ta-Pa-Shan 40
Talchir group, the. 42, 43
Tchernow, A. 10, 30, 52, 71, 74, 113, 121, 127
Tessey formation, the. 14, 15
Texas 24, 45, 47, 48, 52, 75, 93, 102, 155, 156, 159, 170, 171, 175, 183, 204, 208, 209
Thalassoceras 29, 38, 40, 103, 104
Gemmellaroi. . . . 35, 102, 103, 104, 105
Phillipsi 103
subreticulatum 103
varicosum 102
Thalassoceratidae. 19, 102
Thuringien, the. 42, 43
Timor, island of. . 39, 40, 44, 114, 169
Tom Green County. 24, 207
Torreon, Mexico. 27, 46, 47
Trans-Pecos, the. . . 46, 47, 201, 207, 208
sea 47, 48

Page

Triassic, the.....
....39, 43, 46, 68, 157, 168, 180, 201
Trogkofel limestone.....28, 38
Tropitidae 107
Tschernyschew, Th..... 43
Tsan-tien 114
Tshan-Tien 40
Tzwetaev, Marie.....11, 100

Udden, J. A.....5,
6, 8, 11, 23, 45, 90, 93, 165, 167, 177
Uddenites...19, 20, 23, 37, **55**, 207, 208
minor 17, 36, 62, **63**, 213
Schucherti 17, 36, **60**, 62, 65, 213
zone of..... .....18, 35, 36, 38
Uncinulus aff. wangenheimi.....21, 22
Upper Coal Measures.....25, 93
Upper Carboniferous..... 42
Upper Cretaceous. 29
Ural, the..... .33, 48
Uralian, the.....37, 43, 93, 95

Verneuil, E. de..11, 25, 42, 74, 88, 90
Vidrioceras 19, **146**, 147, 148
irregulare..18, 36, 151, **152**, 154, 226
Uddeni .....
18, 36, 146, **149**, 152, 153, 154, 225
Vidrio formation, the.....15, 17
Virgal beds..... 42
group, the..... 43
Vogl, D. V.....69, 107
Vogl, Victor..... 11

Waagen, W....11, 42, 67, 155, 157, 169
Waagenoceras .....
.....23, 24, 28, 30, 32, 44, 155,
156, 159, 160, 165, **168**, 170, 171, 209
Cumminsi .....
...155, 156, 157, 160, 170, 171, 175

Page

Dieneri .....
.....18, 33, 127, **171**, 231, 233
Hilli 155, 156, 157, 170
Mojsisovicsi 174
Nikitini 174
Stachei 170, 175
zone of....18, 19, 20, 24, 33, 38, 47
Wanner, J.....11, 40, 55, 114
Warcha group, the.....42, 43
Wedin's ranch.....106, 164, 165
Weissliegendes, the..... 42
Wewokella 21
White, Chas. A... .....11, 25,
131, 160, 164, 165, 183, 192, 194, 199
Wichita-Albany beds..... 47
Wichita formation, the.....
...24, 25, 27, 183, 186, 200, 203, 207
Upper, the..... 26
Woabjilga 39, 45
Wolf Camp...16, 20, 23, 54, 62, 66,
85, 101, 139, 141, 144, 152, 154, 168
Wolfcamp division..... 117
36, 54, 55, 60, 62, 66, 85, 93, 99,
101, 114, 117, 138, 141, 144, 146, 152
Word formation, the.....
.....5, 15, 16, 18, 20, 24, 26, 33,
45, 80, 88, 92, 110, 112, 114, 126,
131, 133, 134, 160, 171, 175, 207, 208
Wrather, W. E.....
.....183, 185, 194, 200, 202, 203

Xenaspis 43
carbonaria 44
Xenodiscus 43, 45, 51

Zacatecas 46
Zechstein, the..... 42

PUBLICATIONS OF THE BUREAU OF ECONOMIC GEOLOGY AND TECHNOLOGY.

One copy of each of the following will be furnished to an address in Texas, on request, without charge. For extra copies, or for copies sent outside the State, the prices shown apply. Stamps not accepted.

The Fuels Used in Texas. William B. Phillips and S. H. Worrell. University of Texas Bulletin No. 307, Dec. 22, 1913. Price, 40 cents.

The Mineral Resources of Texas. William B. Phillips. University of Texas Bulletin No. 365, Oct. 15, 1914. Price, 50 cents.

Road Materials of Texas. James P. Nash. University of Texas Bulletin No. 62, Nov. 5, 1915. Price, 20 cents.

Annual Report for the Year 1915, M. E. Stiles; Geological Maps in Texas, J. A. Udden. University of Texas Bulletin No. 35, June 20, 1916. (No price.)

Rustler Springs Sulphur Deposits. E. L. Porch, Jr. University of Texas Bulletin No. 1722, April 15, 1917. Price, 30 cents.

Texas Granites. James P. Nash. University of Texas Bulletin No. 1725, May 1, 1917. Price, 10 cents.

Geology of Camp Bowie and Vicinity. E. W. Shuler. University of Texas Bulletin No. 1750, Sept. 5, 1917. Price, 10 cents.

Notes on the Geology of the Glass Mountains, J. A. Udden; Geological Exploration of the Southeastern Front Range of Trans-Pecos, Texas, C. L. Baker, W. F. Bowman. (Bulletin includes geologic map in colors.) University of Texas Bulletin No. 1753, Sept. 20, 1917. Price, $1.00.

Geologic Conditions near Bridgeport and Chico, Wise County, Texas; with special reference to the occurrence of oil. Emil Bose. University of Texas Bulletin No. 1758, Oct. 15, 1917. Price, 50 cents.

The Geology of Val Verde County. (With special reference to manganese.) John R. Roberts and J. P. Nash. University of Texas Bulletin No. 1803, Jan. 10, 1918. Price, 40 cents.

Chemical Analyses of Texas Rocks and Minerals. Comprising all authentic analyses of Texas materials. E. P. Schoch. University of Texas Bulletin 1814, March 5, 1918. Price, —.

The Geology of Runnels County. (With geologic map.) J. W. Beede and V. V. Waite. University of Texas Bulletin No. 1816, March 15, 1918. Price, 40 cents.

The Geology of Dallas County. (With geologic map.) E. W. Shuler. University of Texas Bulletin No. 1818, March 25, 1918. Price, 50 cents.

The Geology of Terrell County. (With geologic map.) D. D. Christner and O. C. Wheeler. University of Texas Bulletin No. 1819, April 1, 1918. Price, 30 cents.

Fossil Ice Crystals: An instance of the practical value of "Pure Science." Fully illustrated. J. A. Udden. University of Texas Bulletin No. 1821, April 10, 1918. Price, 25 cents.

Aids to Identification of Geological Formations. J. A. Udden. Handbook Series No. 1 (especially designed for drillers). Pocket-size, bound. Price, $1.00.

SPECIAL LIST.

The following reports can be furnished only on receipt of price:

A Reconnaissance Report on the Geology of the Oil and Gas Fields of Wichita and Clay Counties. J. A. Udden, assisted by Drury McN. Phillips. University of Texas Bulletin No. 246, Sept., 1912. Price, $1.00.

Review of the Geology of Texas (with maps in colors). J. A. Udden, C. L. Baker, Emil Bose. University of Texas Bulletin No. 44, 1916. Price, $1.00.

Report on the Colorado Coal Fields of Texas. N. F. Drake. University of Texas Bulletin No. 1765 (reprinted from 4th Ann. Rep., Tex. Geol. Surv., 1892). Price, $1.00.

Geology and Underground Waters of the Northern Llano Estacado. Charles Laurence Baker. University of Texas Bulletin No 57, Oct. 10, 1916. Price, $2.00.

Contributions to the knowledge of Richthofenia from the Permian of West Texas. Emil Bose. University of Texas Bulletin No. 55, Oct. 1, 1916. Price, 50 cents.

The Thrall Oil Field. J. A. Udden, H. P. Bybee. University of Texas Bulletin No. 66, Nov. 25, 1916. Price, $2.00.

The Permo-carboniferous Ammonoids of the Glass Mountains, West Texas, and Their Stratigraphical Significance. Emil Bose. University of Texas Bulletin No. 1762, Nov. 5, 1917. Quarto edition, 11 plates. Price $2.50.

OUT OF PRINT.

The Composition of Texas Coals and Lignites and the Use of Producer Gas in Texas. William B. Phillips, S. H. Worrell, and Drury McN. Phillips. University of Texas Bulletin No. 189, July, 1911.

The Deep Boring at Spur. J. A. Udden. University of Texas Bulletin No. 363, Oct. 5, 1914.

Potash in the Texas Permian. J. A. Udden. University of Texas Bulletin No. 17, March 20, 1915.

Origin of Texas Red Beds. Charles Laurence Baker. University of Texas Bulletin No. 29, May 20, 1916.

NOTE.

We can also, as yet, furnish copies of the following:

The Geology of Western Texas, by George F. Shumard, Assistant State Geologist, 1886. Price, $1.00.

Third Annual Report of the Former Texas Geological Survey, 1891. Price, $2.50.

Soils and Waters of the Upper Rio Grande and Pecos Valleys in Texas, by H. H. Harrington. Bulletin No. 2, Geological Survey of Texas, 1890. Price, 50 cents.

A Sketch of the Geology of the Chisos Country, Brewster County, Texas. J. A. Udden. Bulletin, University of Texas, No. 93, 1907. Price, $2.00.

Address requests to

J. A. UDDEN, Director,
Bureau of Economic Geology and Technology,
Austin, Texas.

Jan., 1919. This supercedes all earlier lists.