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CAMBRIAN GEOLOGY AND PALEONTOLOGY

III

No. 1.— THE CAMBRIAN FAUNAS OF EASTERN ASIA

(With Plates 1 to 3)

BY
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INTRODUCTION

A memoir on "The Cambrian Faunas of China" was published by the Carnegie Institution of Washington in 1913 as a quarto volume illustrated by 9 text figures and 24 plates containing 946 figures of fossils. The volume was issued in an edition of 750 copies, of which 308 were sent to libraries, 29 to individuals, and the remainder held for sale at $5.00 per volume.

I find there is a desire on the part of teachers and students of geology and Cambrian paleontology that the general results of the study of the Cambrian faunas of eastern Asia be put in such form as to make them readily accessible for consultation without recourse to the memoir. With this in view, and in order to place the data contained in the introduction in the hands of many of the younger geologists and students who do not have access to the memoir, permission was obtained from the Carnegie Institution to republish the Introduction. Slight additions have been made to it with reference to the work on Cambrian geology and paleontology by M. J. Deprat and M. H. Mansuy[1] in Indo-China, and on the boundary line between the Cambrian and post-Cambrian formations.

[1] Mém. du Service géol. de l'Indo-Chine, Vol. I, 1912, Étude géologique du Yun-Nan oriental, Pt. 1, Géologie géneral; Pt. 2, Paléontologie.

In a preliminary paper, published in 1911, illustrations were given of a number of new genera and species of the Cambrian fauna of China.[1] All of the types of the genera and species described in the memoir have been recorded in the Catalogue of the United States National Museum and are deposited in the collections of the Museum.[2]

PREFATORY OBSERVATIONS

When looking over the descriptions of the stratigraphic sections of the Paleozoic formations of China by Baron Ferdinand von Richthofen,[3] and their contained Cambrian fossils described by Dr. W. Dames,[4] from Liau-tung, and Dr. Emanuel Kayser,[5] I was impressed with the necessity of having the stratigraphic sections studied in detail, and extensive collections of fossils made, in order that comparisons of value might be instituted between the Cambrian sections and faunas of the western portion of North America and the Paleozoic sections and their contained faunas in eastern Asia. This project was held in abeyance for eighteen years, and had it not been for the support of the Carnegie Institution of Washington it might not have been consummated.

Dr. Bailey Willis has given, in the preface of volume I, part I, of "Research in China," 1907, a brief statement of the events that led to the sending of an expedition in his charge and the securing of data and collections by him and his associate geologist, Mr. Eliot Blackwelder.

On the return of Messrs. Willis and Blackwelder, I made a preliminary study of the Cambrian fossils and submitted to them the results of the study bearing on the interpretation of the various

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[1] Cambrian Faunas of China, Smithsonian Misc. Coll., Cambrian Geology and Paleontology, Vol. 57, 1911, No. 4.

[2] Other papers that I have published on the Cambrian faunas of eastern Asia are as follows:

The Cambrian fauna of India, Proc. Washington Acad. Sci., Vol. 7, 1905, pp. 251-256.

Cambrian faunas of China, Proc. U. S. National Museum, Vol. 29, 1905, pp. 1-106.

Idem, Vol. 30, 1906, pp. 563-595.

[3] China, by Baron von Richthofen, 1882, Vol. 2, Das Nordliche China.

[4] China, by Baron von Richthofen, 1883, Vol. 4, Palæontologischer Theil, Cambrische Trilobiten, pp. 1-33.

[5] Idem, pp. 34-36.

geological sections in which the fossils occurred. These were included in their description and discussion of the stratigraphy of Shan-tung, Shan-si, and Shen-si. Mr. Blackwelder also made a rapid reconnaissance of the southwestern portion of the province of Liau-tung, Manchuria, and identified certain Cambrian formations, but did not find any fossils.

From the collections made by Baron von Richthofen, it was evident that a considerable Cambrian fauna existed in the western part of Liau-tung, so I delayed final publication of the description and discussion of the Cambrian collections made by Messrs. Willis and Blackwelder, in the hope that material could be secured from that region. Learning in the spring of 1909 that Prof. Joseph P. Iddings, of the University of Chicago, was about to visit Japan and China in connection with his study of eruptive rocks, I induced him to visit Manchuria and make a collection of Cambrian fossils for the Smithsonian Institution from the Island of Tschang-hsing-tau, east of Niang-niang-kung, in the province of Liau-tung. He was so fortunate as to secure the services of Li San, Dr. Bailey Willis's interpreter, who was also a good collector, and they obtained a large number of specimens, representing over fifty species of invertebrate fossils.

Wishing to have better illustrations of the species described by Messrs. Dames and Kayser for Baron von Richthofen, I wrote to Prof. W. Branco, Director of the Royal Geological and Paleontological Institute and Museum at Berlin, who very kindly had photographs made for me of all the specimens illustrated by Doctor Dames that could be identified in the collections.

Through the courtesy of Dr. Wilhelm Deecke, of the Geological Institute of the University of Freiburg, I have had the opportunity of studying most of the specimens from China used for illustration by Dr. Th. Lorenz.[1] This enabled me to make identifications that otherwise would have been very difficult, owing to the fragmentary character of the specimens illustrating the trilobites.

The chief results obtained from the study of the Chinese collections are the discovery of portions of the upper part of the Lower Cambrian fauna and a great development of a Middle Cambrian fauna of the same general character as that of the Cordilleran Prov-

[1] Zeitschr. deutsch. geol. Gesellsch., Vol. 58, 1906, pp. 53-108, pls. 4-6, and 55 text figs.: Beiträge zur Geologie und Palæontologie von Ostasien unter besonderer Berücksichtigung der Provinz Schantung in China; II: Palæontologischer Teil.

ince of western North America; also an Upper Cambrian fauna comparable with that of the Cordilleran Province and the Upper Mississippi Province of the United States. The fauna of the upper zone of the Lower Cambrian was found to be of the same general type as that of the Cambrian fauna of the Salt Range of India, and we were thus enabled definitely to locate the faunal horizons in India which have heretofore been referred to Upper Cambrian and post-Cambrian formations.

Another important discovery was that of the occurrence in the Middle Cambrian of China of a fauna comparable with that of the Middle Cambrian of Mount Stephen, British Columbia, and the southern extension of the same fauna in the Middle Cambrian of Idaho, Utah, and Nevada in the United States.

The determination of the age of the Man-t'o shales affords the data by which to fix the period of Cambrian time in which the Cambrian sea transgressed over eastern and southeastern Asia, and shows that it was somewhat later than the transgression in the Siberian area now occupied by the basins of the Lena and Yenesei rivers.

A noteworthy addition to the knowledge of the Cambrian faunas was the discovery for the first time of a true cephalopod in a fauna referred to the Upper Cambrian. This is illustrated by a species of *Cyrtoceras,* which occurs in the lower part of the Ch'au-mi-tién limestone. Other details will be found in the discussion of the subfaunas and their stratigraphic and geographic distribution.

From the study of the collections described in this memoir I anticipate that a large and varied fauna will soon be found in the Cambrian formations of China. What we now have is the result of hurried and superficial collecting. Persistent search by trained collectors will undoubtedly give material comparable in extent and beauty with that of America and Europe, and add many unique genera and species to the great Cambrian fauna.

THE CAMBRIAN FAUNAS OF CHINA

HISTORICAL REVIEW

The presence of Cambrian fossils in China was first announced by Baron von Richthofen in 1883.[1] The material gathered by him was studied by Dr. E. Kayser, to whom the brachiopods were intrusted, and by Dr. W. Dames, who described the trilobites.

[1] China, Vol. 4, Palæontologischer Theil, I. Abhand., pp. 31-33, pls. 1, 2: Cambrische Trilobiten von Liau-tung.

Doctor Kayser described and named the following brachiopods:[1]

Orthis linnarssoni=Eoorthis linnarssoni; Lingulella sp.; *L.* sp.

Of these, we have identified *Eoorthis linnarssoni* from the collections of the Carnegie Institution of Washington Expedition to China.

Doctor Dames described and named the following trilobites:[2]

Agnostus chinensis
Dorypyge richthofeni
Conocephalites frequens
Conocephalites quadriceps
Conocephalites subquadratus
Conocephalites typus
Anomocare latelimbatum
Anomocare majus
Anomocare minus
Anomocare nanum
Anomocare planum
Anomocare subcostatum
Liostracus megalurus
Liostracus talingensis
? Liostracus
? Liostracus
Two pygidia, gen. and sp. undt.

The material described by Doctor Dames came from three localities in Liau-tung, as follows:

Sai-ma-ki (in situ):
Lingulella
Agnostus chinensis
Conocephalites frequens
Conocephalites quadriceps
Anomocare latelimbatum
Anomocare majus
Anomocare nanum
Anomocare subcostatum

Ta-ling (loose rock in wall):
Dorypyge richthofeni
Conocephalites frequens
Conocephalites subquadratus
Conocephalites typus
Anomocare minus
Anomocare nanum
Liostracus talingensis
Liostracus sp. ?

Wu-lo-pu (débris slope):
Dorypyge richthofeni
Anomocare planum
Liostracus megalurus

Of the above we have identified in our collections:

Agnostus chinensis
Dorypyge richthofeni
Conocephalites subquadratus = Anomocare
Conocephalites typus = Ptychoparia
Anomocare latelimbatum
Anomocare minus
Liostracus megalurus = Anomocare

Doctor Dames compared the Cambrian trilobites with those of Europe, America, and India, and concluded that the trilobitic fauna of Sai-ma-ki and Ta-ling was about the age of the Scandinavian Andrarum limestone and the Potsdam group of North America. He did not find any Chinese species that could be identified with

[1] China, Vol. 4, Palæontologischer Theil, pp. 34-35; Cambrische Brachiopoden von Liau-tung.

[2] Idem, pp. 7-29; Cambrische Trilobiten von Liau-tung.

those of Scandinavia and America, but the general appearance of the fauna as a whole was so similar that he considered their equal age proven. He further states that the age of the rocks containing *Dorypyge richthofeni,* from Wu-lo-pu, is probably the same as that of the Quebec group, basing this upon comparisons with species from Utah, which he referred to the genus *Dorypyge.*[1]

The collections made by the Carnegie Institution of Washington Expedition prove that *Dorypyge richthofeni* occurs in the central and upper portion of the Ch'ang-hia formation and is of Middle Cambrian age. Baron von Richthofen's means of comparison were with the fauna referred to the Quebec group which was at that time supposed to be of Lower Silurian (Ordovician) age.

Dr. C. Gottsche, in 1886, called attention to the presence of Cambrian rocks and fossils in northwestern Korea, south of Wi-wön. He published a geological section and identified *Anomocare planum* Dames, *Anomocare majus* Dames, *Dorypyge richthofeni* Dames, and *Lingulella* cf. *nathorsti* Linnarsson. He also mentions the genera *Theca, Orthis, Lingulella* (two species), *Agnostus, Conocephalites, Crepicephalus,* and *? Remopleurides,* and correlates the formation with that of the "Andrarum limestone" of Scandinavia.[2]

In 1899 M. Bergeron[3] described the following Cambrian fossils from shaly limestones collected in the province of Shan-tung, China:

Agnostus douvilléi
Olenoides leblanci
Drepanura premesnili
Arthricocephalus chauveaui
Dicellocephalus ? sinensis
Calymmene ? sinensis

Of the above we have identified the following from the Ku-shan shale of the section made by Mr. Blackwelder:

Agnostus douvilléi
Olenoides leblanci
Drepanura premesnili
Dicellocephalus ? sinensis = *Stephanocare*
Calymmene ? sinensis = *Blackwelderia*

From the Cambrian formations of Siberia, Dr. Fr. Schmidt[4] described the following fossils:

[1] China, von Richthofen, 1883, Vol. 4, Palæontologischer Theil, 1. Abhand., pp. 31-33, pls. 1, 2: Cambrische Trilobiten von Liau-tung.

[2] Gottsche, C. Sitzungsberichte der königlich preussischen Akademie der Wissenschaften zu Berlin, 1886, zw. halb-bd. (June-Dec.), pp. 865, 867: Geologische Skizze von Korea.

[3] Bull. Soc. géol. France, 3d ser., Vol. 17, 1889, Paris, Notes paléontologiques, pp. 499-516.

[4] Mélanges physiques et chimiques tirés du Bulletin de l'Académie imperiale des Sciences de St. Pétersbourg, Vol. 12, 1886, pp. 407-424: Ueber einige neue ostsibirischen Trilobiten und verwandte Thierformen.

Agnostus czekanowskii
Proetus (Phaeton) slatkowskii = *Dorypyge*
Cyphaspis sibirica = *Solenopleura*
Liostracus ? maydeli = *Anomocarella*
Anomocare pawlowskii = *Anomocarella*

This fauna was subsequently reviewed by Eduard von Toll,[1] who added the following:

Confervites primordialis Bornemann
Archæocyathus acutus Bornemann
Archæocyathus aduncus Bornemann
Archæocyathus ijizkii von Toll
Archæocyathus patulus Bornemann
Archæocyathus proskurjakowi von Toll
Archæocyathus sibiricus von Toll
Coscinocyathus calathus Bornemann
Coscinocyathus campanula Bornemann
Coscinocyathus corbicula Bornemann
Coscinocyathus dianthus Bornemann
Coscinocyathus elongatus Bornemann
Coscinocyathus irregularis von Toll
Coscinocyathus vesica Bornemann
Coscinocyathus cf. *cancellatus* Bornemann
Spirocyathus sp. undt.
Rhabdocyathus sibiricus von Toll
Protopharetra sp. undt.
Helminthoidichnites sp.
Kutorgina cingulata Billings
? Obolella chromatica Billings
Hyolithes ? sp. undt.
Microdiscus kochi von Toll
Microdiscus lenaicus von Toll
Microdiscus sp. undt.
Agnostus schmidti von Toll
? Olenellus sp. undt.
Dorypyge slatkowskii Schmidt
Ptychoparia czekanowskii von Toll = *Inouyia*
Ptychoparia meglitzkii von Toll = *Inouyia*
? Solenopleura sibirica Schmidt
Bathyuriscus howelli Walcott

In 1903 Dr. H. Monke published a paper on the Geology of Shantung and described certain "Upper Cambrian" trilobites,[2] as follows:

Agnostus koerferi
Liostracina krausei
Teinistion lansi
Teinistion sodeni
Drepanura premesnili
Drepanura ketteleri
Stephanocare richthofeni
Stephanocare sp.

Of the above, three genera and species described by me in 1905 are synonyms:

Ptychoparia ceus Walcott..... = *Liostracina krausei* Monke
Dorypygella typicalis Walcott..... = *Teiniston lansi* Monke
Damesella chione Walcott..... = *Stephanocare richthofeni* Monke

The following have not been identified in the material collected by Willis and Blackwelder:

Drepanura ketteleri Monke
Teinistion sodeni Monke

[1] Mém. l'Acad. imp. Sci. St. Pétersbourg, 8th ser., Vol. 8, No. 10, 1899, pp. 21-57: Beiträge zur Kenntniss des sibirischen Cambrium.

[2] Beiträge zur Geologie von Schantung: I. Obercambrische Trilobiten von Yen-tsy-yai. Jahrb. königl. preuss. geol. Landesanstalt und Bergakademie zu Berlin, Vol. 23, Pt. I, 1903, pp. 103-151.

I do not find that *Agnostus koerferi* Monke differs materially from *Agnostus chinensis* Dames, except in the unattached pygidium.

Teinistion lansi Monke is similar in many respects to *Shantungia spinifera* Walcott, but differs in the presence of an incurved frontal margin, and the absence of the long frontal spine.

The detailed sections and the succession of the contained faunas prove that the horizon of the fauna is in the upper part of the Middle Cambrian, and not Upper Cambrian, as determined by Monke.

In 1904 Dr. Th. Lorenz[1] described some problematical fossils? as Algæ under the new family Ascosomaceæ of the Siphoneæ. The genus *Ascosoma* was proposed to include one species, *Ascosoma phaneroporata,* and a second species was placed under a new genus as *Mitscherlichia chinensis.* Doctor Lorenz stated that he would soon publish a full description, with illustrations, of the new family, genera, and species, but on further study he decided that the fauna was neither algæ nor sponges.[2]

In 1905 some of the results of the Carnegie Institution of Washington Expedition to China were published by the writer, and a second paper appeared in 1906.[3] These two papers included descriptions and certain introductory notes on the Cambrian fossils collected by Messrs. Bailey Willis and Eliot Blackwelder that are included in this memoir. Subsequently lists of the species appeared in the report on the stratigraphic geology by Messrs. Willis and Blackwelder.[4]

Dr. Henry Woodward reviewed, in 1905, the work of Dr. H. Monke[5] and discussed some of the species occurring in a collection of fossils obtained from "West Shan-tung, and south of Tsing-tshou-fu, 36° 40′ N. lat., 118° 40′ E. long." A slab of the fossils from near Yen-tsy-yai is illustrated.

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[1] Centralblatt für Min., Geol. und Pal., 1904, No. 7, pp. 193-194: Ascosomaceæ, eine neue Familie der Siphoneen aus dem Cambrium von Schantung.

[2] Zeitschr. deutsch. geol. Gesellsch., Vol. 58, 1905: Beiträge zur Geologie und Palæontologie von Ostasien unter besonderer Berücksichtigung der Provinz Schantung in China, I. Teil. pp. 12-13.

[3] Proc. U. S. National Museum, Vol. 29, 1905, pp. 1-106; Idem, Vol. 30, 1906, pp. 563-595.

[4] Research in China, Pt. I, pp. 19-43, 136-147, 272.

[5] On a collection of trilobites from the Upper Cambrian of Shantung, North China. Geological Magazine, London, new ser., Dec. V, Vol. 2, 1905, pp 211-215, 251-255, plate 13.

Late in 1906 a short memoir by Dr. Th. Lorenz appeared[1] in which he described a number of new genera and species of Cambrian fossils collected by him in the province of Shan-tung, and assigned stratigraphic horizons to them.

The fauna from Lai-wu was worked out of a single block found loose in the bed of a brook about 9 km. west of Lai-wu. Lorenz concludes that the fauna represents the time of the base of the Swedish Andrarum limestone, within the limits of the zone with *Paradoxides davidis* and *P. forchhammeri*.[2] The list of species given by him is as follows:

Olenoides (*Dorypyge*) *richthofeni* (Dames)
Agnostus fallax laiwuensis n. var.
Agnostus parvifrons Linnarsson
Anomocare commune n. sp.
Anomocare ovatum n. sp.
Alokistocare sp.
Amphoton steinmanni n. g. and sp.
Ptychoparia (*Solenopleura*) sp.
Hyolithes sp.
Raphistoma bröggeri Grönwall
Acrothele bohemica (Barrande)

From the descriptions and illustrations I have identified the above as follows:

Olenoides (*Dorypyge*) *richthofeni* (Dames) ..... = *Dorypyge richthofeni* Dames
Agnostus fallax laiwuensis Lorenz..... = *Agnostus chinensis* Dames
Agnostus parvifrons Linnarsson..... = *Agnostus* cf. *parvifrons* Linnarsson
Anomocare commune Lorenz..... = *Anomocarella chinensis* Walcott
Anomocare ovatum Lorenz..... = *Anomocare temenus* Walcott
Alokistocare sp. (not illustrated or described)
Amphoton steinmanni Lorenz..... = *Dolichometopus deois* Walcott
Raphistoma bröggeri Lorenz..... = *Platyceras willisi* Walcott
Acrothele bohemica Barrande..... = *Acrothele matthewi eryx* Walcott

The horizon of the *Dorypyge richthofeni* fauna in Shan-tung was definitely established by Messrs. Willis and Blackwelder as in the Middle Cambrian below the central part of the Kiu-lung group.[3] In Shan-si the fauna occurs in an oolitic limestone that, by its fauna, is related to the Ch'ang-hia oolite.[4]

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[1] Beiträge zur Geologie und Palæontologie von Ostasien unter besonderer Berücksichtigung der Provinz Schantung in China, Vol. 58, 1906, II, Palæontologischer Teil. Von Herrn Th. Lorenz in Marburg a. d. Lahn. Hierzu Taf. 4-6 u. 55 text fig.

[2] Idem, p. 91.

[3] Blackwelder, Eliot. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, Part 1, 1907, Chap. 2, p. 40: Stratigraphy of Shantung.

[4] Idem, p. 145.

The fauna from Wang-tschuang occurs at three horizons. It is listed by Doctor Lorenz as follows:[1]

A lower layer with (*a*):
Anomocare speciosum Lorenz
Bathyuriscus asiaticus Lorenz
Agnostus fallax Linnarsson
Agnostus parvifrons latelimbatus Lorenz
Acrothele granulata Linnarsson

Eighty meters higher up, a layer with (*b*):
Teiristion (?) sp.
Drepanura (?) sp.

At 80 meters above, an upper layer has (*c*):
Shantungia buchruckeri Lorenz
Liostracus latus Lorenz

I have identified the above-listed fossils as follows:

(*a*) *Anomocare speciosum* Lorenz.....=*Anomocarella speciosa* (Lorenz)
Bathyuriscus asiaticus Lorenz.....=*Dolichometopus deois* Walcott
Agnostus fallax Linnarsson.....=*A. chinensis* Dames
Agnostus parvifrons latelimbatus Lorenz .....=*A. latelimbatus* (Lorenz)
Acrothele granulata Linnarsson.....=*Acrothele matthewi eryx* Walcott
(*b*) *Teiristion* (?) sp.....=*Damesella* cf. *blackwelderi* Walcott
Drepanura (?) sp.....=*Damesella* cf. *blackwelderi* Walcott
(*c*) *Shantungia buchruckeri* Lorenz....=*Chuangia nitida* Walcott
Liostracus latus Lorenz.....=*L. latus* Lorenz

By comparison with the sections of Messrs. Willis and Blackwelder fauna (*a*) is located in the lower portion of the Kiu-lung group at about the same horizon as the fauna from Lai-wu; fauna (*b*) represents the zone of *Damesella blackwelderi* Walcott, which occurs in the central part of the Kiu-lung group; and fauna (*c*), or the upper fauna, may be assigned to the upper limestone of the Kiu-lung group, where the Upper Cambrian fauna is well developed.[2]

At the locality of Tai-shan south of Tsi-nan Doctor Lorenz found fragments of a trilobite that he named *Lioparia blautoeides,* which I have identified as *Anomocarella baucis* Walcott, which occurs near the summit of the Upper Cambrian Ch'au-mi-tién limestone.

At the locality of Tsing-tshou-fu he reports the following:[3]

Lioparia latelimbata (Dames)
Shantungia crassa n. g. and sp.
A not closely definable brachiopod
Obolella nitida n. sp.[4]
Orthis sp.
Acrothele sp.

[1] Zeitschr. der deutsch. geol. Gesellsch., Vol. 58, 1906, Beiträge zur Geologie und Palæontologie von Ostasien unter besonderer Berücksichtigung der provinz Schantung in China; II: Palæontologischer Teil, p. 93.

[2] Willis and Blackwelder, Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, 1907 (Apr.), Pt. 1, Descriptive topography and geology, pp. 23, 41.

[3] Lorenz, idem, p. 95.

[4] This is described as *Obolella gracilis* n. sp., on p. 88 of Lorenz, 1906.

My identification of the fauna is as follows:

Lioparia latelimbata (Dames) Lorenz..... = *Anomocare latelimbatum* Dames
Shantungia monkei Lorenz..... = *Pagodia monkei* (Lorenz)
Obolella gracilis Lorenz..... = cf. *Obolus obscurus* Walcott
Orthis sp. and *Acrothele* sp.

I do not find any statement of Doctor Lorenz that the species enumerated by him were found in association. They do not appear to have come from the same stratigraphic horizon. *Pagodia monkei* (Lorenz) is essentially an Upper Cambrian type, while *Anomocare latelimbatum* Dames is from the Middle Cambrian.

I have not attempted to follow the classification of the trilobites given by Doctor Lorenz which is largely based on the division of the shell structure into non-porous (dense) and porous. The mineralization of most of the specimens is such that it is often impracticable to determine with any degree of satisfaction whether the shell is non-porous (dense) or porous.

By the courtesy of Dr. W. Deecke, of the Geological Institute of the University of Freiburg, I received eight pieces of the rock containing original specimens studied by Lorenz. These did not include the types of *Liostracus latus, Shantungia buchruckeri, Obolella gracilis,* or the specimens referred to *Drepanura* and *Teinistion.* I have had three of the specimens photographed (plate 7, fig. 1*a*; plate 20, fig. 8; plate 22, figs. 2, 2*a*, 2*b*)[1] so that more direct comparison may be made. The original of *Shantungia monkei* Lorenz is too unsatisfactory to photograph.

The student of the Cambrian formations and faunas of China should consult the fine memoir of Dr. Eduard von Toll, 1899, on the Siberian Cambrian.[2] It has many suggestions that the future student of the Cambrian system in Asia should carefully consider. One of them is that a great and important work awaits the investigator of the Cambrian formations of Siberia. The field is a large one and what we now know of it indicates a rich reward to the individual who takes the time to thoroughly work out the formations and their contained faunas.

Mr. F. R. Cowper Reed, in discussing the pre-Carboniferous life provinces of Asia, points out that the Cambrian fauna of Spiti in

[1] The plate references in this paper are to be found in "The Cambrian Faunas of China," C. D. Walcott, 1913. Pub. No. 54, Carnegie Institution of Washington, Vol. 3.

[2] Mém. l'Acad. imp. Sci. St. Pétersbourg, 8th ser., Vol. 8, No. 10, 1899, pp. 1-57, pls. 1-8, and 9 text figs.: Beiträge zur Kenntniss des sibirischen Cambrium.

northern India has a stronger affinity with that of western North America than with any other Cambrian fauna.[1] The bearings of this are not enlarged upon further than to indicate a connection between the Himalayan region and North America during Middle Cambrian time.

The superb memoir of MM. J. Deprat and H. Mansuy, published as Volume 1, parts 1 and 2, of the Memoirs of the "Service géologique de l'Indo-Chine," 1912,[2] contains a great addition to our knowledge of the Cambrian rocks and faunas of Indo-China. Dr. Deprat[3] gives a very full description of the Cambrian formations as they occur at various localities with lists of the contained fossils. From this we learn that there is a series of coarse and fine sandstones at the base of the Cambrian some 500 meters (1,640 feet) thick that are overlain by shales, both calcareous and arenaceous, with interbedded quartzitic sandstones. Above the lower sandstones there are about 410 meters (1,345 feet) of beds containing remains of the trilobite genus *Redlichia,* that are referred to the Lower Cambrian, and from 200 to 300 meters (656 to 984 feet) of beds classed with the Middle Cambrian (Acadian). A great unconformity is indicated between these beds and the Ordovician strata by the absence of the Upper Cambrian and the lower Ordovician formations.

The faunas described by Dr. Mansuy from the Cambrian include:[4]

CAMBRIAN

ANNELIDS:

Planolites ?

BRACHIOPODS:

Obolus ? detritus Mansuy
Obolus damesi Walcott
Obolus cf. *chinensis* Walcott
Lingula yunnanensis Mansuy
Acrothele matthewi eryx Walcott
Acrothele orbicularis Mansuy

OSTRACODS:

Bradoria douvillei Mansuy
Aluta sp. ?
Nothozoe ?

TRILOBITES:

Redlichia chinensis Walcott
Redlichia nobilis Walcott
Redlichia walcotti Mansuy
Redlichia carinata Mansuy
Redlichia sp. ?
Palæolenus douvillei Mansuy
Palæolenus lantenoisi Mansuy
Palæolenus deprati Mansuy
Ptychoparia yunnanensis Mansuy

[1] Records Geol. Surv. India, Vol. 40, plate 1, 1910, p. 10.

[2] Mém. service géol. l'Indo-Chine, Vol. 1, 1912 (received May 8, 1913), fasc. 2, Étude géologique du Yun-Nan oriental, IIe partie, pp. 1-146, pls. 1-25: Paléontologie.

[3] Idem, Pt. 1, pp. 47-62.

[4] Idem, Pt. 2, pp. 1, 2.

SYNONYMIC REFERENCES

The following table mentions only those genera and species in which changes have been made since the publication of the original description and reference:

Former generic reference	*Present generic reference*
Agnostus koerferi Monke, 1903	*Agnostus douvillei* Bergeron
Agraulos abaris Walcott, 1905	*Inouyia abaris* (Walcott)
Agraulos acalle Walcott, 1905	*Inouyia ? acalle* (Walcott)
Agraulos agenor Walcott, 1905	*Levisia agenor* (Walcott)
Agraulos armatus Walcott, 1906	*Inouyia ? armata* (Walcott)
Agraulos (?) capax Walcott, 1906	*Inouyia capax* (Walcott)
Agraulos divi Walcott, 1905	*Inouyia divi* (Walcott)
Agraulos (?) melie Walcott, 1906	*Inouyia melie* (Walcott)
Agraulos regularis Walcott, 1906	*Inouyia ? regularis* (Walcott)
Amphoton Lorenz, 1906	*Dolichometopus* Angelin
Amphoton steinmanni Lorenz, 1906	*Dolichometopus deois* Walcott
Anomocare bergioni Walcott, 1905	*Anomocarella bergioni* (Walcott)
Anomocare bianos Walcott, 1905	*Coosia ? bianos* (Walcott)
Anomocare bigsbyi Walcott, 1906	*Anomocarella bigsbyi* (Walcott)
Anomocare biston Walcott, 1905	*Anomocarella biston* (Walcott)
Anomocare ? butes Walcott, 1905	*Anomocarella butes* (Walcott)
Anomocare commune Lorenz, 1906	*Anomocarella chinensis* (Walcott)
Anomocare daunus Walcott, 1905	*Coosia ? daunus* (Walcott)
Anomocare decelus Walcott, 1905	*Coosia decelus* (Walcott)
Anomocare eriopia Walcott, 1906	*Ptychoparia (Emmrichella) eriopia* (Walcott)
Anomocare limbatum Angelin, 1854	*Coosia ? limbata* (Angelin)
Anomocare speciosum Lorenz, 1906	*Anomocarella speciosa* (Lorenz)
Anomocare tatian Walcott, 1905	*Anomocarella tatian* (Walcott)
Anomocare temenus Lorenz, 1906	*Anomocarella temenus* (Walcott)
Anomocare temenus Walcott, 1905	*Anomocarella temenus* (Walcott)
Anomocarella ? bura Walcott, 1905	*Lisania bura* (Walcott)
Anomocarella carme Walcott, 1905	*Coosia carme* (Walcott)
Anomocarella continua Walcott, 1906	*Anomocarella albion* (Walcott)
Arionellus agonius Walcott, 1905	*Lisania agonius* (Walcott)
Arionellus ajax Walcott, 1905	*Lisania ajax* (Walcott)
Arionellus alala Walcott, 1905	*Lisania alala* (Walcott)
Bathyuriscus asiaticus Lorenz, 1906	*Dolichometopus deois* Walcott
Bradoria bergeroni Walcott, 1905	*Aluta bergeroni* (Walcott)
Bradoria enyo Walcott, 1905	*Aluta enyo* (Walcott)
Bradoria eris Walcott, 1905	*Aluta eris* (Walcott)
Bradoria fragilis Walcott, 1905	*Aluta fragilis* (Walcott)
Bradoria sterope Walcott, 1905	*Aluta sterope* (Walcott)
Bradoria woodi Walcott, 1905	*Aluta woodi* (Walcott)
Calymmene ? sinensis Bergeron, 1899	*Blackwelderia sinensis* (Bergeron)
Conocephalites subquadratus Dames, 1883	*Anomocare subquadratum* (Dames)
Conocephalites typus Dames, 1883	*Ptychoparia typus* (Dames)

Former generic reference	*Present generic reference*
Craniella ?? sp. Walcott, 1905	*Discinopsis sulcatus* (Walcott)
Damesella Walcott, 1905	*Stephanocare* Monke
Damesella chione Walcott, 1905	*Stephanocare richthofeni* Monke
Damesella sinensis Walcott, 1905	*Stephanocare ? sinensis* (Bergeron)
Dicellocephalus ? sinensis Bergeron, 1899	*Stephanocare ? sinensis* (Bergeron)
Dikelocephalus ? baubo Walcott, 1905	*Ptychaspis baubo* (Walcott)
Dikelocephalus ? brizo Walcott, 1905	*Ptychaspis brizo* (Walcott)
Dorypygella Walcott, 1905	*Teinistion* Monke
Dorypygella alastor Walcott, 1905	*Blackwelderia alastor* (Walcott)
Dorypygella alcon Walcott, 1905	*Teinistion alcon* (Walcott)
Dorypygella typicalis Walcott, 1905	*Teinistion typicalis* (Walcott)
Hoeferia Redlich, 1901	*Redlichia* Cossman, 1902
Illænurus canens Walcott, 1913	*Tsinania canens* (Walcott) [1]
Illænurus ceres Walcott, 1913	*Tsinania ceres* (Walcott)
Illænurus dictys Walcott, 1913	*Tsinania dictys* (Walcott)
Illænurus sp. Walcott, 1913	*Tsinania* sp. (Walcott)
Liostracus megalurus Dames, 1883	*Anomocare megalurus* (Dames)
Menocephalus adrastia Walcott, 1905	*Levisia adrastia* (Walcott)
Menocephalus belenus Walcott, 1905	*Lisania belenus* (Walcott)
Obolus (*Lingulepis*) *eros* Walcott, 1905	*Lingulella* (*Lingulepis*) *eros* (Walcott)
Obolus (*Lingulepis ?*) sp. undt. Walcott 1906	*Lingulella* (*Lingulepis ?*) sp. undt. (Walcott)
Olenoides ? cilix Walcott, 1905	*Blackwelderia cilix* (Walcott)
Olenoides leblanci Bergeron, 1899	*Blackwelderia sinensis* (Bergeron)
Orthis linnarssoni Kayser, 1883	*Eoorthis linnarssoni* (Kayser)
Orthis (*Plectorthis*) *agreste* Walcott, 1906	*Eoorthis agreste* (Walcott)
Orthis (*Plectorthis*) *doris* Walcott, 1905	*Eoorthis doris* (Walcott)
Orthis (*Plectorthis*) *kayseri* Walcott, 1905	*Eoorthis kayseri* (Walcott)
Orthis (*Plectorthis*) *kichouensis* Walcott, 1906	*Eoorthis kichouensis* (Walcott)
Orthis (*Plectorthis*) *linnarssoni* Walcott, 1905	*Eoorthis linnarssoni* (Kayser)
Orthis (*Plectorthis*) *pagoda* Walcott, 1905	*Eoorthis pagoda* (Walcott)
Orthis (*Plectorthis*) sp. undt. Walcott, 1906	*Eoorthis* sp. undt. (Walcott)
Platyceras chronus Walcott, 1905	*Pelagiella chronus* (Walcott)
Platyceras clytia Walcott, 1905	*Pelagiella clytia* (Walcott)
Platyceras pagoda Walcott, 1905	*Pegaliella pagoda* (Walcott)
Platyceras willisi Walcott, 1906	*Pelagiella willisi* (Walcott)
Ptychoparia ? batia Walcott, 1905	*Chuangia batia* (Walcott)
Ptychoparia ? bromus Walcott, 1905	*Ptychoparia* (*Emmrichella*) *bromus* (Walcott)
Ptychoparia ceus Walcott, 1905	*Liostracina krausei* Monke
Ptychoparia comus Walcott, 1906	*Anomocarella comus* (Walcott)

[1] For description of new genus *Tsinania*, see page 43, this paper.

Former generic reference	*Present generic reference*
Ptychoparia constricta Walcott, 1905	*Ptychoparia* (*Emmrichella*) *constricta* (Walcott)
Ptychoparia dryope Walcott, 1905	*Conokephalina ? dryope* (Walcott)
Ptychoparia granulosa Walcott, 1905	*Ptychoparia granosa* Walcott
Ptychoparia inflata Walcott, 1906	*Inouyia ? inflata* (Walcott)
Ptychoparia (*?*) *maia* Walcott, 1906	*Conokephalina maia* (Walcott)
Ptychoparia mantoensis Walcott, 1905	*Ptychoparia* (*Emmrichella*) *mantoensis* (Walcott)
Ptychoparia nereis Walcott, 1906	*Anomocare ? nereis* (Walcott)
Ptychoparia tellus Walcott, 1905	*Lonchocephalus tellus* (Walcott)
Ptychoparia tenes Walcott, 1905	*Anomocarella tenes* (Walcott)
Ptychoparia theano Walcott, 1905	*Ptychoparia* (*Emmrichella*) *theano* (Walcott)
Ptychoparia titiana Walcott, 1905	*Inouyia titiana* (Walcott)
Ptychoparia undata Walcott, 1906	*Anomocarella undata* (Walcott)
Ptychoparia vesta Walcott, 1906	*Conokephalina vesta* (Walcott)
Ptychoparia sp. undt. Walcott, 1906	*Conokephalina* sp. undt. (Walcott)
Ptychoparia (*Liostracus*) *intermedia* Walcott, 1906	*Solenopleura intermedia* (Walcott)
Ptychoparia (*Liostracus*) *megalurus* Walcott, 1905	*Anomocare megalurus* (Dames)
Ptychoparia (*Liostracus*) *subrugosa* Walcott, 1906	*Anomocarella subrugosa* (Walcott)
Ptychoparia (*Liostracus*) *thraso* Walcott, 1905	*Anomocarella thraso* (Walcott)
Ptychoparia (*Liostracus*) *toxeus* Walcott, 1905	*Anomocarella toxeus* (Walcott)
Ptychoparia (*Liostracus*) *trogus* Walcott, 1905	*Anomocarella trogus* (Walcott)
Ptychoparia (*Liostracus*) *tutia* Walcott, 1905	*Anomocarella tutia* (Walcott)
Ptychoparia (*Proampyx*) *burea* Walcott, 1905	*Proampyx burea* (Walcott)
Shantungia Lorenz, 1906	*Chuangia* Walcott
Shantungia Walcott, 1905	*Shangtungia* Walcott
Shantungia buchruckeri Lorenz 1906	*Chuangia nitidia* Walcott
Solenopleura abderus Walcott, 1905	*Menocephalus abderus* (Walcott)
Solenopleura acantha Walcott, 1905	*Menocephalus acanthus* (Walcott)
Solenopleura acidalia Walcott, 1905	*Menocephalus acidalia* (Walcott)
Solenopleura belus Walcott, 1905	*Conokephalina belus* (Walcott)
Stenotheca clurius Walcott, 1905	*Helcionella clurius* (Walcott)
Stenotheca rugosa chinensis Walcott, 1905	*Helcionella rugosa chinensis* (Walcott)
Stenotheca rugosa orientalis Walcott, 1905	*Helcionella rugosa orientalis* (Walcott)
Stenotheca simplex Walcott, 1906	*Helcionella ?? simplex* (Walcott)

Former generic reference	*Present generic reference*
Stephanocare sinensis Monke, 1903.....	*Blackwelderia sinensis* (Bergeron)
Straparollina circe Walcott, 1905.....	*Matherella circe* (Walcott)
Syntrophia orientalis Walcott, 1905.....	*Huenella orientalis* (Walcott)

LOCALITIES (WITH LISTS OF GENERA AND SPECIES AT EACH)

For convenience of reference and to avoid repetition, the following localities, with the genera and species found in each, are inserted. The lists published by Willis and Blackwelder[1] are composite lists made up by writing the lists of fossils from several localities in one list in order to give the fauna that in their judgment occurs at some one stratigraphic horizon of the Cambrian. For the purposes of the future student who may wish to study the geographic distribution of the various subfaunas and to work out the limits of the formations containing them, the local lists are essential and give all known data concerning localities from which fossils described in this paper have been obtained. When not otherwise stated, the collections were made by Dr. Eliot Blackwelder.

Chinese Localities

C 1. Just below C 2, same section; just above C 4, same section; about 75 feet below C 62, which occurs at a locality 3 miles east; about same horizon as C 10, different section; about 150 feet below C 12, same section.

Middle Cambrian: Lower shale member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 40 (part of the third list of fossils), and fig. 10 (bed 4), p. 38], 2 miles (3.2 km.) south of Yen-chuang, Sinta'i district, Shan-tung. (At the second "x" from left side of section given on page 38 of Blackwelder, 1907, Research in China.)

Protospongia chloris
Obolus minimus
Obolus (Westonia) blackwelderi
Acrotreta pacifica
Acrotreta shantungensis ?
Pelagiella chronus
Hyolithes cybele
Agnostus chinensis
Dorypyge richthofeni
Inouyia divi
Lisania agonius
Anomocarella albion
Anomocarella chinensis
Dolichometopus alceste
Dolichometopus deois
Dolichometopus derceto

[1] Willis and Blackwelder, Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, 1907, Pt. 1, pp. 1-353, figs. 1-65: Descriptive topography and geology.

C 2 Just above C 1, same section; above C 4, same section; about same horizon as C 10, different section.

Middle Cambrian: Lower shale member of the Kiu-lung [Blackwelder, 1907, pp. 37 and 40 (part of the third list of fossils), and fig. 10 (beds 4 and 5), p. 38], 2 miles (3.2 km.) south of Yen-chuang, Sin-t'ai district, Shan-tung. C 2 contains specimens from the central portion of the lower shale member—from the second "x" from the left side of the figure on page 38 to but not including the fourth "x" from the left.

Protospongia chloris
Obolus (Westonia) blackwelderi
Acrotreta pacifica
Hyolithes cybele
Orthotheca cyrene dryas
Agnostus chinensis
Dorypyge bispinosa
Lonchocephalus tellus
Lisania agonius
Anomocare latelimbatum
Anomocarella albion
Anomocarella biston
Anomocarella chinensis
Coosia ? daunus
Dolichometopus deois
Dolichometopus derceto

C 3. About 100 feet above the horizon of C 60, different section; about 175 feet below the horizon of C 8, different sections.

Lower Cambrian: Lower part of the Man-t'o shale formation [Blackwelder 1907, p. 28 (list of fossils at bottom of page), and fig. 8*a* (bed 20), p. 28], on the southeast slope of Hu-lu-shan, 2.5 miles (4 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung.

Billingsella richthofeni
Helcionella rugosa chinensis
Hyolithes delia
Redlichia nobilis
Ptychoparia (Emmrichella) constricta

C 4. Just below C 1, same section; same horizon as C 57, different section.

Middle Cambrian: In limestone nodules at the base of the lower shale member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 40 (second list of fossils), and fig. 10 (bed 4), p. 38], 3 miles (4.8 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung. In the section on page 38 of Blackwelder, 1907, this horizon is at the base of bed 4 about halfway between the first and second "x's" from the left side.

Protospongia chloris
Acrothele matthewi cryx
Acrotreta pacifica
Pelagiella chronus
Hyolithes cybele
Hyolithes ? (operculum)
Orthotheca delphus
Agnostus chinensis
Lisania alala
Anomocarella albion
Anomocarella chinensis
Dolichometopus alceste
Dolichometopus deois

C 5. About 25 feet above C 8, same section; about 40 feet below C 63, same section.

Middle Cambrian: Lower limestone member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 39 (first list of fossils), and fig. 8*a* (bed 30), p. 29], 3.2 miles (5.1 km.) southwest of Yen-chuang,

Sin-t'ai district, Shan-tung. In the section on page 29 of Blackwelder, 1907, this horizon is at the bed marked "30." On the figure this is placed as occurring below the line dividing the Man-t'o from the Kiu-lung, but on the basis of the fauna contained in it the limestone is referred to the base of the Kiu-lung. The text [p. 39] places the boundary between the Kiu-lung and the Man-t'o, 15 feet below C 5.

Globigerina ? mantoensis
Micromitra (Iphidella) pannula ophirensis
Acrotreta pacifica
Inouyia divi
Anomocare sp.
Anomocarella butes
Dolichometopus ? sp.

C 6. About 120 feet above C 12, same section; about 20 feet below C 61, same section.

Middle Cambrian: Thin platy limestone in the upper shale member of the Kiu-lung group just below the Ch'au-mi-tién limestone [Blackwelder, 1907, pp. 37 and 41 (second list of fossils), and fig. 10 (bed 12), p. 38], 2.5 miles (4 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung.

Obolus (Westonia) blackwelderi
Dicellomus parvus
Acrothele ? minuta
Agnostus douvilléi
Redlichia sp. undt.
Stephanocare ? monkei
Stephanocare richthofeni
Stephanocare ? sinensis
Stephanocare ? sp. undt.
Blackwelderia sinensis
Drepanura ketteleri
Drepanura premesnili
Ptychoparia (Emmrichella) bromus
Liostracina krausei
Shantungia spinifera

C 7. Just above C 9, same section; about same horizon as C 52, different section; about 200 feet below C 10, same section.

Middle Cambrian: Lower limestone member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 39 (last list of fossils), and fig. 8*a* *bed* 33), p. 29], 2.2 miles (3.5 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung. In the section on page 29 of Blackwelder, 1907, this horizon is not starred, but occurs at about the middle of the lower of the two bands of oolitic limestone numbered "33."

Obolus damesi
Lingulella (Lingulepis) eros
Inouyia abaris
Inouyia titiana
Agraulos dolon
Anomocare subquadratum
Anomocarella subrugosa
Anomocarella thraso

C 8. About 25 feet below C 5, same section; about 275 feet above C 60, same section; about 175 feet above the horizon of C 3, different section.

Middle Cambrian: Brown sandstone and limestone nodules in brown micaceous shales near the top of the Man-t'o formation [Blackwelder, 1907, fig. 8*a* (bed 27), p. 29], 3.4 miles (5.4 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung. This horizon is starred opposite bed "27" on the section on page 29 of Blackwelder, 1907. This is below the line between the Kiu-lung and the Man-t'o,

both as represented on page 29 and as given in the text at the top of page 39.

Two species, *Ptychoparia impar.* var. and *Anomocare* sp. undt.

C 9. Just below C 7, same section; about 25 feet above C 63, same section; about same horizon as C 52, different section.

Middle Cambrian: Lower limestone member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 39 (third list of fossils), and fig. 8*a* (bed 33), p. 29], 3 miles (4.8 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung. In this section on page 29 of Blackwelder, 1907, this horizon is not starred, but occurs at the base of the lower of the two bands of oolitic limestone numbered "33."

Micromitra (Paterina) labradorica orientalis
Inouyia abaris
Anomocare minus
Coosia decclus

C 10. About 200 feet above C 7, same section; about same horizon as C 1, C 2, and C 4, different section.

Middle Cambrian: Lower shale member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 40 (part of the third list of fossils), and fig. 8*a* (bed 35), p. 29], about 3 miles (4.8 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung.

Obolus damesi
Menocephalus sp. undt.
Anomocarella temenus

C 11. About same horizon as C 61, different section; above C 57, same section; about same horizon as C 33*a*, different section.

Upper Cambrian: Crystalline limestone 60 feet (18 m.) above the base of the uppermost limestone member [Blackwelder, 1907, pp. 37 and 41 (last list of fossils)] 2.1 miles (3.4 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung.

Two species, *Chuangia batia* and *Chuangia nitida.*

C 12. About 120 feet below C 6, same section; about 75 feet above C 62, same section but at a locality 3 miles east; C 13 includes the horizon represented by C 12; about 150 feet above C 1, same section.

Middle Cambrian: Gray limestone near the top of the middle limestone member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 41 (part of the first list of fossils), and fig. 10 (bed 7), p. 38], 3.25 miles (5.2 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung. This horizon is starred at the top of bed "7" in the section on page 28.

Acrotreta pacifica
Teinistion alcon
Teinistion typicalis
Blackwelderia alastor
Damesella blackwelderi
Pterocephalus asiaticus
Inouyia acalle
Lisania ajax
Anomocarella tutia

C 13. The horizon of C 13 includes that of C 12; about 120 feet below C 6, same section; about 75 feet above C 62; which is in the same section but at a locality 3 miles east; about 150 feet above C 1, same section.

Middle Cambrian: Yellow slabby limestone in the middle limestone member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 41, part of the first list of fossils), on the west slope of hill in angle between two faults, just east of the granite mass of the Liénhua-shan, 6 miles (9.6 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung. Collected at some distance from C 12 and includes more. Its horizon is that of bed 7 of fig. 10, page 38.

Two species, *Damesella bella granulata* and *Damesella blackwelderi.*

C 14. From the horizons of C 12 and C 13.

Middle Cambrian: In talus from the middle limestone member of the Kiu-lung group [Blackwelder, 1907, p. 37], 2.8 miles (4.5 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung. Field label says section 6 K, stratum 11, which is about 200 feet above C 61. Note by C. D. Walcott says it is from stratum 4, the horizon of C 12 and C 13.

One species, *Damesella blackwelderi.*

C 15. About same horizon as C 16 and C 27.

Lower Cambrian: Slaty black limestone in the lower part of the Man-t'o shale [Blackwelder, 1907, p. 26, third paragraph; and fig. 6 (bed 7), p. 25], at Ch'ang-hia, Shan-tung.

One species, *Redlichia chinensis.*

C 16. About same horizon as C 15 and C 27.

Lower Cambrian: Slaty black limestone in the lower part of the Man-t'o shale [Blackwelder, 1907, p. 26, third paragraph; and fig. 6 (bed 7), p. 25], 2 miles (3.2 km.) south of Ch'ang-hia, Shan-tung.

Two species, *Redlichia chinensis* and *Redlichia* sp. undt.

C 17. About 180 feet below C 23, same section; about 35 feet above C 20, adjacent sections; about 160 feet below C.28, adjacent sections.

Lower Cambrian: Ferruginous limestone nodules in the brown sandy shales at the top of the Man-t'o shale [Blackwelder, 1907, p. 27 (list of fossils at top of page) and fig. 6 (bed 15), p. 25], at Ch'ang-hia, Shan-tung.

Obolella asiatica
Ptychoparia aclis
Ptychoparia granosa
Ptychoparia impar

C 18. Below horizon of C 19, C 22, C 24, and C 26, same section; above C 21, same section.

Middle Cambrian: Dark gray oolitic limestone about 400 feet (120 m.) above the base of the Ch'ang-hia limestone [Blackwelder, 1907, p. 33, third list of fossils], in cliffs 1 mile (1.6 km.) east of Ch'ang-hia, Shan-tung.

Scenella clotho
Pelagiella chronus
Helcionella rugosa orientalis
Crepicephalus damia
Crepicephalus magnus
Menocephalus acerius

C 19. About the same horizon as C 22, C 24, and C 26, same section; about same horizon as C 25, different section.

Middle Cambrian: Uppermost layers of the Ch'ang-hia limestone [Blackwelder, 1907, p. 33, part of the last list of fossils], at Ch'ang-hia, Shan-tung.

Dorypyge richthofeni
Damesella brevicaudata
Lisania belenus
Menocephalus abderus
Anomocare daulis
Anomocarella tutia
Dolichometopus deois

C 20. About 15 feet above C 31, same section; about 35 feet below C 17, different section.

Lower Cambrian: Central part of the Man-t'o shale formation [Blackwelder, 1907, p. 26 (last list of fossils) and fig. 6 (bed 14), p. 25], on the west side of an isolated butte 1 mile (1.6 km.) south of Ch'ang-hia, Shan-tung.

Billingsella richthofeni
Ptychoparia aclis
Ptychoparia (Emmrichella) mantoensis

C 21. About 100 feet above C 30, different sections; about 100 feet below C 18, same section.

Middle Cambrian: Ocher-mottled phase of purple-gray limestone in the middle of the oolitic Ch'ang-hia formation [Blackwelder, 1907, p. 33, second list of fossils], at Ch'ang-hia, Shan-tung.

Helcionella rugosa orientalis
Crepicephalus damia
Solenopleura sp. undt.

C 22. About same horizon as C 19, C 24, and C 26, same section; above C 18, same section.

Middle Cambrian: Ch'ang-hia limestone in upper oolitic portion [Blackwelder, 1907, pp. 22 and 33 (part of the last list of fossils)], at Ch'ang-hia, Shan-tung.

Acrotreta lisani
Hyolithes cybele
Lisania alala
Lisania bura
Menocephalus acantha
Menocephalus admeta
Anomocarella temenus

C 23. About 180 feet above C 17, same section; about 25 feet above C 28, different section.

Middle Cambrian: Upper part of thin-bedded gray oolitic limestone at the base of the Ch'ang-hia formation [Blackwelder, 1907, p. 32 (second list of fossils), and fig. 6 (bed 20), p. 25], 50 feet (15 m.) below the base of the cliffs 1 mile (1.6 km.) east-southeast of Ch'ang-hia, Shan-tung. This horizon is the fourth bed above the black line in the figure on page 25, the one opposite bed "20."

Acrothele rara
Orthotheca daulis
Ptychoparia (Emmrichella) eriopia
Ptychoparia (Emmrichella) theano
Agraulos abrota
Anomocarella tatian

C 24. About same horizon as C 19, C 22, and C 26, same section; above C 18, same section; about same horizon as C 25, different section.

Middle Cambrian: Near top of black oolite group in the uppermost layers of the Ch'ang-hia formation [Blackwelder, 1907, p. 33, part of the last list of fossils], 2 miles (3.2 km.) each of Ch'ang-hia, Shan-tung.

Acrotreta cf. *pacifica*
Dorypyge richthofeni
Agnostus sp. undt. (pygidium)
Inouyia divi
Dolichometopus dirce

C 25. About same horizon as C 19, C 22, C 24, and C 26, different section; above C 35, same section.

Middle Cambrian: Limestone about 50 feet (15 m.) below the Ku-shan shale in the uppermost beds of the Ch'ang-hia formation [Blackwelder, 1907, p. 33, part of the last list of fossils], at Ch'ang-hia, Shan-tung.

Crepicephalus cf. *magnus*
Solenoplcura agno
Levisia agenor
Anomocare sp.
Anomocarella trogus

C 26. About same horizon as C 19, C 22, and C 24, same section; about same horizon as C 25, different section; above C 18, same section.

Middle Cambrian: Near the top of the black oolite group in the uppermost layers of the Ch'ang-hia limestone [Blackwelder, 1907, p. 33, part of the last list of fossils], 2 miles (3.2 km.) north-northeast of Ch'ang-hia, Shan-tung.

Eoorthis sp. undt.
Crepicephalus damia
Anomocare ? daulis

C 27. About same horizon as C 15 and C 16.

Lower Cambrian: Buff and drab shales in the lower part of the Man-t'o shale [Blackwelder, 1907, p. 26, third paragraph; and fig. 6 (bed 7), p. 25], on crest of ridge at Ch'ang-hia, Shan-tung.

Two species: *Redlichia chinensis* and *Redlichia* sp.

C 28. About 200 feet above C 20, same section; about 160 feet above C 17, adjacent section; about 25 feet below C 23, different section.

Middle Cambrian: Thin-bedded oolitic limestone at the base of the Ch'ang-hia limestone [Blackwelder, 1907, p. 32 (first list of fossils), and fig. 6 (bed 20), p. 25], just above the shales in the face of the cliff 1 mile (1.6 km.) east-southeast of Ch'ang-hia, Shan-tung. This horizon is the first layer in bed "20" (see figure on p. 25) above the black line.

Eoorthis agreste
Inouyia thisbe
Anomocarella tenes
Anomocarella toxeus
Bathyuriscus ? sp.

C 29. Below C 30, same section; about same horizon as C 48, different section.

Middle Cambrian: Near the top of the cliffy limestone in the Ch'ang-hia limestone [Blackwelder, 1907, p. 32, part of the last list of fossils], 1 mile (1.6 km.) west of Ch'ang-hia, Shan-tung.

Two species: *Dorypyge richthofeni* and *Agraulos dryas*.

C 30. About 100 feet below C 21, different section; above C 29, same section; below C 35, same section; about same horizon as C 51, different section.

Middle Cambrian: Layer in black oolite of Ch'ang-hia limestone [Blackwelder, 1907, p. 33, part of the first list of fossils], 25 feet 7.5 m.) above the second cliff at an elevation of 1,700 feet (568.9 m.) on top of the long north and south ridge at Ch'ang-hia, Shan-tung.

Dorypyge richthofeni
Lisania alala
Lisania sp. undt.
Anomocare sp.
Menocephalus acidalia
Menocephalus agave
Levisia adrastia

C 31. About 15 feet below C 20, same section.

Lower Cambrian: Gray crystalline limestone in the central portion of the Man-t'o shale [Blackwelder, 1907, p. 26 (first list of fossils), and fig. 6 (bed 12), p. 25], at Ch'ang-hia, Shan-tung.

Ptychoparia aclis
Ptychoparia ligea
Ptychoparia (Emmrichella) mantoensis

C 32. See also C 32', other drift blocks at the same locality.

Middle Cambrian: A fine-grained bluish-black limestone bowlder believed to have come from the lower part of the Ki-sin-ling limestone [Blackwelder, 1907, p. 272], collected in river drift 1 mile (1.6 km.) south of Chön-p'ing-hién, on the Nan-kiang River, southern Shen-si.

Obolus shansiensis
Dicellomus parvus
Acrotreta shantungensis
Orthotheca doris
Microdiscus orientalis
Aluta bergeroni
Aluta enyo
Aluta eris
Aluta fragilis
Aluta sterope
Aluta woodi

C 32'. See C 32, another drift block at the same locality.

Lower Cambrian: A limestone bowlder collected in river drift 1 mile (1.6 km.) south of Chön-p'ing-hién, on the Nan-kiang River, southern Shen-si.

Two species: *Obolella asiatica* and *Hyolithes* sp. undt.

C 33. *Upper Cambrian*: About 100 feet (30 m.) above the base of the Ch'au-mi-tién limestone, 9 miles (14.4 km.) north of Sin-t'ai-hién, Shan-tung.

One species, *Ptychaspis* sp. (free cheeks and fragments).

C 33a. About same horizon as C 11, different section.

Upper Cambrian: Talus near the base of the cliff of Ch'au-mi-tién limestone [Blackwelder, 1907, p. 41, part of the last list of fossils], 9 miles (14.4 km.) north of Sin-t'ai-hién, Shan-tung.

Two species, *Chuangia batia* and *Anomocarella bergioni*.

C 34. About same horizon as C 38, C 41, and C 49, different sections.
Upper Cambrian: Purplish-gray limestone about 100 feet (30 m.) above the base of the Ch'au-mi-tién formation [Blackwelder, 1907, p. 36, part of the first list of fossils] in road at northeastern corner of small village near Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

Pagodia macedo — *Ptychaspis ceto*
Agnostus sp. undt. — *Tsinania canens*

C 35. Below C 25, same section.
Middle Cambrian: Upper part of the Ch'ang-hia limestone [Blackwelder, 1907, p. 33, fifth paragraph], at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.
One species, *Menocephalus acis.*

C 36. About same horizon as C 45, different section; about same horizon as C 50, same section; above C 68, same section; about same horizon as C 47, same section.
Upper Cambrian: Upper part of the Ch'au-mi-tién limestone [Blackwelder, 1907, p. 36 (part of the third list of fossils), and fig. 9 (bed 2), p. 35], at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.
Two species, *Billingsella pumpellyi* and *Anomocarella baucis.*

C 37. About same horizon as C 72, same section; about 50 feet above C 71, same section; about 200 feet below C 73, same section; about 225 feet below C 74, same section.
Middle Cambrian: Upper part of the Ki-chóu limestone,[1] in dense black limestone nodules in green-gray shales 10 feet (3 m.) below the base of the cliff limestone, 8 miles (12.8 km.) south of Ting-hiang-hién, Shan-si.

Obolus shansiensis — *Anomocare megalurus*
Acrotreta shantungensis

C 38. About same horizon as C 34, C 41, and C 49, different sections; below C 43, same section.
Upper Cambrian: Crystalline limestone near the base of the Ch-au-mi-tién limestone [Blackwelder, 1907, p. 36, part of the first list of fossils], at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

Coosia carme — *Hysterolenus* sp.
Ptychaspis brizo — *Tsinania canens*
Ptychaspis ceto — *Tsinania ceres*

C 39 = *Ordovician.*

C 40. About same horizon as C 12, C 13, and C 14, same section.
Middle Cambrian: Limestone nodules in green shales in the middle limestone member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 41 (part of the first list of fossils)], in a gully in bank of river 2 miles (3.2 km.) south of Yen-chuang, Sin-t'ai district, Shan-tung.
Two species: *Damesella blackwelderi* and *Lisania ajax.*

[1] The fossils from this locality are not listed, but the presence of Cambrian strata at the locality is mentioned by Willis and Blackwelder [1907, p. 146]).

C 41. Same horizon as C 49, C 54, and C 56, same section; about same horizon as C 34 and C 38, different section.

Upper Cambrian: Lower part of the Ch'au-mi-tién limestone [Blackwelder, 1907, p. 36, part of the first list of fossils], 2.7 miles (4.3 km.) southwest of Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

Lisania sp. undt.
Pagodia dolon
Ptychaspis cadmus
Ptychaspis calchas
Tsinania canens

C 42. *Upper Cambrian*: In the central part of the Ch'au-mi-tién limestone [Blackwelder, 1907, p. 36, second list of fossils], 1.8 miles (2.9 km.) west-southwest from the temple of Tsing-lung-shan, 7.5 miles (12 km.) east of Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

Ptychaspis calyce
Ptychaspis campe
Tsinania canens

C 43. Above C 38, same section.

Upper Cambrian: Near the top of crystalline, mostly purple-gray limestone in the Ch'au-mi-tién limestone, at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

No identifiable species.

C 44. *Upper Cambrian*: In talus 200 feet (60 m.) above the top of the section containing C 46, C 48, and C 51, at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

One species, *Chuangia batia*.

C 45. Same horizon as C 36 and C 68, different section; about 900 feet (270 m.) above C 25, same section; supposed to be from same horizon as C 50 and C 67.

Upper Cambrian: Limestone about 40 feet (12 m.) below the top of the Ch'au-mi-tién limestone [Blackwelder, 1907, p. 36 (part of third list of fossils)], at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

Ptychaspis acamus
Ptychaspis ceto
Tsinania sp. undt.

C 46. Above C 51, same section; about same horizon as C 75, different section.

Middle Cambrian: Light gray crystalline limestone in the Ch'ang-hai limestone [Blackwelder, 1907, p. 33, fourth list of fossils], at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

Helcionella ? clurius
Lisania alala
Anomocare sp. (free cheek and pygidium)
Damesella sp. (free cheek)
Damesella ? sp. (free cheek)

C 47. About same horizon as C 36, same section.

Upper Cambrian: Upper part of the Ch'au-mi-tién limestone [Blackwelder, 1907, fig. 9 (top of bed 1), p. 35], at the top of a high col at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

Pelagiella clytia
Orthotheca cyrene
Ptychaspis sp.

C 48. Below C 51, same section; about same horizon as C 29, different section.
Middle Cambrian: Near the top of the cliffy oolitic limestone in the Ch'ang-hia limestone [Blackwelder, 1907, p. 32, part of the last list of fossils], at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.
Two species, *Ptychoparia* sp. undt. and *Crepicephalus magnus*.

C 49. Same horizon as C 41, C 54, and C 56, same section; about same horizon as C 34 and C 38, different sections.
Upper Cambrian: Purplish-brown limestone in the lower part of the Ch'au-mi-tién limestone [Blackwelder, 1907, p. 36, part of the first list of fossils], in roadway 2.5 miles (4 km.) west-southwest of Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.
One species, *Menocephalus ? depressus*.

C 50. About same horizon as C 36, C 47, and C 68, same section; supposed to be from horizon of C 45 and C 67.
Upper Cambrian: Upper part of the Ch'au-mi-tién limestone [Blackwelder, 1907, p. 36 (part of the third list of fossils)], on a low spur at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.
One species, *Ptychaspis* sp.

C 51. Below C 46, same section; above C 48, same section; about same horizon as C 30, different section.
Middle Cambrian: Lower part of gray crystalline limestone in the upper portion of the oolitic part of the Ch'ang-hia limestone [Blackwelder, 1907, p. 33, part of the first list of fossils], at Ch'au-mi-tién, Ch'ang-hia district, Shan-tung.

Shumardia sp.
Lisania alala
Solenopleura agno
Solenopleura intermedia

C 52. *Middle Cambrian*: In the lower part of the lower limestone member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 39 (second list of fossils), and fig. 7 (bed 22), p. 27], near base of cliffs in mountain 1,000 feet (305 m.) high, 3 miles (4.8 km.) north-northeast of Sin-t'ai-hién, Shan-tung.

Ptychoparia tolus
Agraulos dirce
Anomocare latelimbatum
Anomocarella butes

C 53 = *Ordovician*.

C 54. Same horizon as C 41, C 49, and C 56; about same horizon as C 34 and C 38, different sections.
Upper Cambrian: Lower part of Ch'au-mi-tién limestone [Blackwelder, 1907, p. 42 (part of the last list of fossils)], near top of limestone knoll two-thirds of a mile (1.1 km.) west of Tsi-nan, Shan-tung.

Obolus matinalis ?
Eoorthis pagoda
Syntrophia orthia
Pterocephalus busiris
Ptychaspis ceto
Ptychaspis sp. undt. (free cheek)
Tsinania canens
Tsinania sp. undt. (pygidium)

C 55. (See C 6.)
Middle Cambrian: Thin platy limestone in the upper shale member of the Kiu-lung group just below the Ch'au-mi-tién limestone [Blackwelder, 1907, p. 43], in isolated hills at an elevation of 380 feet (114 m.) above the Wön-ho, 12 miles (19 km.) south, 80° east of Tsi-nan, Shan-tung.

Straparollina sp. undt.
Agnostus douvilléi
Stephanocare richthofeni
Blackwelderia cilix
Drepanura ketteleri
Drepanura premesnili

C 56. Same horizons as C 41, C 49, and C 54.
Upper Cambrian: Lower part of Ch'au-mi-tién limestone, 25 feet (7.5 m.) below the top of Pagoda Hill [Blackwelder, 1907, p. 42 (part of the last list of fossils)], 1 mile (1.6 km.) west of Tsi-nan, Shan-tung.

Obolus (*Westonia*) sp. undt.
Discinopsis sulcatus
Eoorthis pagoda
Syntrophia orthia
Scenella sp. undt.
Matherella circe
Pelagiella pagoda
Orthotheca sp. undt.
Cyrtoceras cambria
Conokephalina belus
Conokephalina dryope
Pagodia bia
Pagodia lotos
Menocephalus ? depressus
Ptychaspis ceto
Hysterolenus ? (pygidium)
Tsinania dictys

C 57. Same horizon as C 4, different section; below C 11, same section; above C 58, same section.
Middle Cambrian: In limestone nodules in the lower shale member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 40 (first list of fossils)], 3 miles (4.8 km.) south of Kao-kia-p'u, and 4 miles (6.4 km.) north of Sin-t'ai-hién, Sin-t'ai district, Shan-tung.

Acrothele rara
Orthotheca delphus
Agnostus chinensis
Agnostus kushanensis
Dorypyge richthofeni
Anomocare alcinoe
Anomocarella albion
Anomocarella chinensis
Dolichometopus deois

C 58. Below C 57, same section.
Middle Cambrian: Green shale near the middle of the Ch'ang-hia limestone, at top of hill 2 miles (3.2 km.) south-southeast of Kao-kia-p'u, Shan-tung.
Two species, *Redlichia finalis* and *Ptychoparia ?* sp. (pygidium).

C 59 = *Ordovician* and *Carboniferous*.

C 60. About 100 feet below the horizon of C 3, different section; about 250 feet below C 8, same section.
Lower Cambrian: Slaty black limestones in the lower part of the Man-t'o shales [Blackwelder, 1907, p. 28 (third paragraph), and fig. 8 (bed 11), p. 28], 3.5 miles (5.6 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung.
One species, *Redlichia* sp.

C 61. About 25 feet above C 6, same section; about 125 feet below C 64, same section; about same horizon as C 11, different section.

Upper Cambrian: A dense black limestone in the uppermost limestone member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 41 (third list of fossils), and fig. 10 (bed 13), p. 38], 3 miles (4.8 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung. This horizon is at the lower of the two stars opposite bed "13" on page 38.

Billingsella pumpellyi
Proampyx burea
Pterocephalus busiris
Chuangia batia
Chuangia fragmenta
Ptychaspis baubo

C 62. About 75 feet above C 1, which occurs at a locality 3 miles east; about 75 feet below C 12 and C 13, same section.

Middle Cambrian: Earthy layer in the middle limestone of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 40 (last list of fossils, and fig. 10 (base of bed 7), p. 38], 2.5 miles (4 km.) south of Yen-chuang, on the north-northeast spur of Hu-lu-shan, Sin-t'ai district, Shan-tung.

Obolus chinensis
Acrotreta shantungensis
Hyolithes cybele
Anomocarella chinensis

C 63. About 40 feet above C 5, same section; about 25 feet below C 9, same section.

Middle Cambrian: Sandy shale near the base of the Kiu-lung group [Blackwelder, 1907, p. 37 (third paragraph), and fig. 8*a* (bed 32), p. 29], 3.5 miles (5.6 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung.

One species, *Obolus obscurus*.

C 64. About 125 feet above C 61, same section.

Upper Cambrian: Upper limestone member of the Kiu-lung group [Blackwelder, 1907, pp. 37 and 42 (first list of fossils), and fig. 10 (bed 20), p. 38], 2.7 miles (4.3 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung.

Obolus damesi
Eoorthis doris
Eoorthis kayseri
Eoorthis linnarssoni
Huenella orientalis
Syntrophia orthia
Hyolithes daphnis
Orthotheca cyrene
Solenopleura beroe
Chuangia batia
Chuangia nais
Ptychaspis baubo
Ptychaspis cacus
Ptychaspis callisto
Ptychaspis calyce
Ptychaspis ceto
Ptychaspis sp. undt. (free cheek)
Anomocare sp.
Coosia ? bianos

C 65 = *Ordovician.*

C 66. "Material probably lost." [Bailey Willis.]

C 67. Supposed to be from horizon of C 36, C 45, C 47, C 50, and C 68.
Upper Cambrian: Stream gravels (from the wash from the mountains south of the city) used in making the railroad grade one-third mile (0.5 km.) west of the west city gate at Tsi-nan, Shan-tung.

Obolus cf. *matinalis*
Eoorthis cf. *linnarssoni*
Ptychaspis sp. undt.

C 68. Same horizon as C 47 and C 50, same section; about same horizon as C 45, different section; below C 36, same section.
Upper Cambrian: Upper part of the Ch'au-mi-tién limestone [Blackwelder, 1907, p. 36 (part of the third list of fossils)], on crest of ridge east of Ch'au-mi-tién, 200 yards (183 m.) north of the wayside shrine, Ch'ang-hia district, Shan-tung.
Two species, *Eoorthis kayseri* and *Anomocarella ?* sp. undt.

C 69. 35 feet above C 70, same section; below C 71, same section.
Middle Cambrian: Limestone in shales about 65 feet (19.5 m.) above the base of the Ki-chóu limestone [Willis and Blackwelder, 1907, p. 145, first list of fossils], 4 miles (6.4 km.) east of Fang-lan-chön, Shan-si.

Conokephalina vesta
Inouyia inflata
Agraulos obscura
Anomocare nereis
Dolichometopus hyrie

C 70. 35 feet below C 69, same section.
Middle Cambrian: Oolitic limestone about 30 feet (9 m.) above the base of the Ki-chóu limestone [Blackwelder, 1907, p. 144, last list of fossils], 4 miles (6.4 km.) south-southwest of Tung-yü, Shan-si.

Scenella ? dilatatus
Helcionella ?? simplex
Conokephalina maia
Conokephalina sp.
Inouyia capax
Inouyia melie
Agraulos vicina

C 71. About 50 feet below the horizon of C 37 and C 72, same section; about 125 feet above C 75, different section.
Middle Cambrian: Massive cliff-making limestone in the central portion of the Ki-chóu formation [Willis and Blackwelder, 1907, pp. 139 and 145 (second list of fossils)], 4 miles (6.4 km.) southwest of Tung-yü, Shan-si.

Obolus shansiensis ?
Yorkia ? orientalis
Acrotreta shantungensis
Eoorthis sp. undt.
Orthotheca glabra
Agnostus chinensis
Dorypyge richthofeni lævis
Crepicephalus damia
Solenopleura pauperata
Anomocarella bigsbyi
Anomocarella comus
Anomocarella undata

C 72. About same horizon as C 37, same section; about 50 feet above C 71, same section; about 200 feet below C 73, same section; about 225 feet below C 74, same section.

Middle Cambrian: Thin green-gray limestone interbedded with ocherous and green clay shales, overlying the massive oolite in the Ki-chóu formation [Willis and Blackwelder, 1907, pp. 139 and 145 (third list of fossils)], 4 miles (6.4 km.) east of Fang-lan-chön, Shan-si.

Lingulella (*Lingulepis ?*) sp. undt.
Pelagiella willisi
Orthotheca glabra
Dorypyge richthofeni lævis
Conokephalina sp. undt.
Anomocare flava
Anomocare ? nereis

C 73. About 200 feet above C 37 and C 72, same section; about 25 feet below C 74, same section.

Middle Cambrian: Conglomeritic limestones near the top of the Ki-chóu formation [Willis and Blackwelder, 1907, p. 145, fourth list of fossils], 4 miles (6.4 km.) east of Fang-lan-chön, Shan-si.

Two species, *Blackwelderia cilix* and *Inouyia ? regularis*.

C 74. About 225 feet above the horizon of C 37 and C 72, same section; about 25 feet above C 73, same section.

Upper Cambrian: A dense blue dolomite limestone at the top of the Ki-chóu limestone [Willis and Blackwelder, 1907, pp. 139 and 145 (fifth list of fossils)], 4 miles (6.4 km.) east of Fang-lan-chön, Shan-si.

Two species, *Eoorthis kayseri* and *Ptychaspis bella*.

C 75. About 125 feet below C 71, different section.

Middle Cambrian: Limestone near the base of the Ki-chóu formation [Willis and Blackwelder, 1907, p. 143], 4.5 miles (7.2 km.) south of Wu-t'ai-hién, Shan-si.

Coscinocyathus elvira
Obolus obscurus
Eoorthis kichouensis
Ptychoparia lilia
Inouyia armata
Inouyia melie
Agraulos nitida
Agraulos uta

C 76. (Indeterminate fragments only.)

C 77. *Middle Cambrian*: Limestone interbedded in green shales not more than 300 feet (90 m.) above the Man-t'o shales [Willis and Blackwelder, 1907, p. 144, first list of fossils], 4 miles (6.4 km.) southeast of Yau-t'o, near Wu-t'ai-hién, Shan-si.

Lisania cf. *bura*
Anomocare sp. undt.
Anomocarella irma

Manchurian Localities

All of the collections from Manchuria came from Tschang-hsing-tau Island, east of Niang-niang-kung, in the southwestern section of the Province of Liau-tung. The general stratigraphic relations of the section are given by Blackwelder [1907, p. 92] and the detailed section of Iddings on page 56 of this memoir.

The collections were made by Prof. Joseph P. Iddings and his Chinese interpreter Li San, in September, 1909.

35 n. *Middle Cambrian*: *Fu-chóu series.* Limestones near the base of the series just above the white quartzite [see Blackwelder, 1907, p. 92, for general section giving stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria. [Field locality No. 4; 1 = 36*c*, 2 = 35*r*, 4 = 35*n*, 5 = 36*d*, and 6 = 36*e*, are stated by Mr. Iddings to be very nearly the same horizon and at the same locality. They are the lowest fossils found.]

Protospongia chloris
Protospongia sp. undt.
Micromitra sculptilis
Micromitra (*Paterina*) *lucina*
Micromitra (*Iphidella*) *pannula maladensis*
Micromitra (*Iphidella*) *pannula ophirensis*
Obolus chinensis
Obulus damesi
Acrothele matthewi eryx
Acrotreta shantungensis
Hyolithes cybele
Orthotheca cyrene
Orthotheca delphus
Orthotheca glabra
Agnostus chinensis
Dorypyge richthofeni
Ptychoparia kochibei
Pterocephalus liches
Solenopleura beroe
Agraulos sorge
Solenopleura sp. undt.
Anomorcare ephori
Anomocare latelimbatum
Anomocare megalurus
Anomocare minus
Anomocare minus var.
Anomocare subquadratum
Anomocarella chinensis
Anomocarella hermias
Anomocarella macar
Anomocarella temenus
Anomocarella cf. *temenus*

35 o. About 50 feet higher than 35*p*; about the same horizon as 36*h*; see 36*g*. *Middle Cambrian*: *Fu-chóu series.* Shales about 130 feet (40 m.) above the white quartzite [see Blackwelder, 1907, p. 92, for general section giving stratigraphic relations]; collected in drainage cuts a short distance back from the bluff (see 35*n*) forming the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

Obolus damesi
Acrothele matthewi eryx
Acrotreta shantungensis
Agnostus chinensis
Damesella sp. undt.
Ptychoparia typus
Dolichemotopus deois
Bathyuriscus manchuriensis

35 p. About 80 feet above 35*n*; about 50 feet below 36*h*.
Middle Cambrian: *Fu-chóu series.* Shales about 80 feet (24 m.) above the white quartzite [see Blackwelder, 1907, p. 92, for general section giving stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

Linguella manchuriensis
Acrotreta pacifica
Agnostus chinensis
Dorypyge richthofeni
Dolichometopus deois

35 q. About 70 feet higher than 36*h*; about 800 feet below 36*f*.
Middle Cambrian: *Fu-chóu series.* About 200 feet (61 m.) above the white quartzite [see Blackwelder, 1907, p. 92, for general stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

Protospongia chloris
Lingulella marcia
Acrotreta venia
Damesella blackwelderi
Anomocare lisania

35 r. Very nearly same horizon as 35*n*.
Middle Cambrian: *Fu-chóu series.* Limestones near the base of the series just above the white quartzite [see Blackwelder, 1907, p. 92, for general section giving stratigraphic relations], collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Manchuria.

Micromitra sculptilis
Micromitra (Paterina) lucina
Micromitra (Iphidella) pannula maladensis
Obolus damesi
Obolus shansiensis
Acrothele matthewi cryx
Acrotreta shantungensis
Hyolithes cybele
Orthotheca delphus
Agnostus chinensis
Dorypyge richthofeni
Ptychoparia kochibei
Crepicephalus convexus
Solenopleura agno
Solenopleura chalcon
Anomocare ephori
Anomocarella chinensis
Anomocarella temenus
Dolichometopus deois
Asaphiscus iddingsi

36 c. Very nearly same horizon as 35*n*.
Middle Cambrian: *Fu-chóu series.* Limestones near the base of the series just above the white quartzite [see Blackwelder, 1907, p. 92, for general section giving stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

No identifiable species.

36 d. Very nearly same horizon as 35*n*.
Middle Cambrian: *Fu-chóu series.* Shales near the base of the series just above the white quartzite [see Blackwelder, 1907, p. 92, for general section giving stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

Micromitra (Paterina) lucina
Obolus damesi
Acrothele matthewi eryx

36 e. Very nearly same horizon as 35*n*.
Middle Cambrian: *Fu-chóu series.* Shales interbedded with limestones near the base of the series just above the white quartzite [see Blackwelder, 1907, p. 92, for general section showing stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

Obolus damesi
Acrothele matthewi eryx
Agnostus chinensis
Ptychoparia kochibei
Anomocare minus
Anomocare minus var.
Asaphiscus iddingsi

36 f. About 800 feet above 35*q*; the highest horizon.

Middle Cambrian: *Fu-chóu series.* About 1,000 feet (305 m.) above the white quartzite [see Blackwelder, 1907, p. 92, for general stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

Planolites (annelid trails)
Lingulella ? marcia
Agnostus douvilléi
Albertella pacifica
Teinistion typicalis
Stephanocare sinensis
Blackwelderia sinensis
Damesella blackwelderi
Drepanura premesnili
Liostracina krausei
Shantungia spinifera

36 g. About 50 feet higher than 35*p*; about same horizon as 36*h*; see 35*o*.

Middle Cambrian: *Fu-chóu series.* Shale about 130 feet (40 m.) above the white quartzite [see Blackwelder, 1907, p. 92, for general section showing stratigraphic relations]; collected in drainage cuts a short distance back from the bluff (see 35*n*) forming the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

Obolus damesi
Acrothele matthewi eryx
Acrotreta shantungensis
Orthotheca cf. *delphus*
Agnostus chinensis
Anomocarella chinensis
Bathyuriscus manchuriensis

36 h. About 70 feet below 35*q*; about 50 feet above 35*p*; 36*g* and 35*o* are from approximately the same section.

Middle Cambrian: *Fu-chóu series.* Shales about 130 feet (40 m.) above the white quartzite [see Blackwelder, 1907, p. 92, for general section showing stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

Obolus damesi
Lingulella marcia
Acrotreta shantungensis
Agnostus chinensis
Anomocare minus
Bathyuriscus manchuriensis

36 i. Below 35*q*; above 36*h*.

Middle Cambrian: *Fu-chóu series.* Approximately 175 feet (53 m.) above the white quartzite [see Blackwelder, 1907, p. 92, for general section showing stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

36 j. Above 35*q*; below 36*f*.

Middle Cambrian: *Fu-chóu series.* Approximately 175 feet (53 m.) above the white quartzite [see Blackwelder, 1907, p. 92, for general section showing stratigraphic relations]; collected in a low bluff on the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

LIST OF ALL SPECIES FROM LIAU-TUNG, MANCHURIA, WITH LOCALITY NUMBERS

Protospongia chloris Walcott (35*n* Limestone) (35*q*).
Protospongia sp. undt. (spicules) (35*n* Limestone).
Planolites (annelid trails) (36*f* Limestone and shale).
Micromitra sculptilis Meek (35*n*) (35*r* Limestone).
Micromitra (*Paterina*) *lucina* Walcott (35*n*) (35*r* Limestone) (36*d*).
Micromitra (*Iphidella*) *pannula maladensis* Walcott (35*n*) (35*r* Limestone).
Micromitra (*Iphidella*) *pannula ophirensis* Walcott (35*n* Limestone).
Obolus chinensis Walcott (35*n* Limestone).
Obolus damesi Walcott (35*n* Limestone) (35*o*) (35*r*) (36*d*) (36*e* Shale) (36*g*) (36*h* Shale).
Obolus shansiensis Walcott (35*r* Limestone).
Lingulella manchuriensis Walcott (35*p* Shale).
Lingulella marcia Walcott (35*q*) (? 36*f* Limestone and shale) (36*h* Shale).
Acrothele matthewi eryx Walcott (35*n* Limestone) (35*o*) (35*r*) (36*a*) (36*e* Shale) (36*g*).
Acrotreta pacifica Walcott (35*p* Shale)
Acrotreta shantungensis Walcott (35*n* Limestone) (35*o*) (35*r*) (36*g*) (36*h* Shale).
Acrotreta venia Walcott (35*q*).
Hyolithes cybele Walcott (35*n* Limestone) (35*r*).
Orthotheca cyrene Walcott (35*n* Limestone).
Orthotheca delphus Walcott (35*n* Limestone) (35*r*).
Orthotheca cf. *delphus* Walcott (36*g*).
Orthotheca glabra Walcott (35*n* Limestone).
Agnostus chinensis Dames (35*n* Limestone) (35*o*) (35*p*) (35*r*) (36*e* Shale) (36*g*) (36*h* Shale).
Agnostus douvillei Bergeron (36*f* Limestone and shale).
Albertella pacifica Walcott (36*f* Limestone and shale).
Dorypyge richthofeni Dames (35*n*) (35*p* Shale) (35*r* Limestone).
Teinistion typicalis Walcott (36*f* Limestone and shale).
Stephanocare sinensis Bergeron (36*f* Limestone and shale).
Blackwelderia sinensis Bergeron (36*f*).
Damesella blackwelderi Walcott (35*q*) (36*f* Limestone and shale).
Damesella sp. undt. (35*o*).
Drepanura premesnili Bergeron (36*f* Limestone and shale).
Ptychoparia kochibei Walcott (35*n*) (35*r* Limestone) (36*e* Shale).
Ptychoparia typus Dames (35*o*).
Crepicephalus convexus Walcott (35*r* Limestone).
Liostracina krausei Monke (36*f* Limestone and shale).
Pterocephalus liches Walcott (35*n* Limestone).
Shantungia spinifera Walcott (36*f* Limestone and shale).
Agraulos sorge Walcott (35*n* Limestone).
Solenopleura agno Walcott (35*r* Limestone).
Solenopleura beroe Walcott (35*n* Limestone).
Solenopleura chalcon Walcott (35*r* Limestone).
Solenopleura sp. undt. (35*n* Limestone).
Anomocare ephori Walcott (35*n*) (35*r* Limestone).

Anomocare latelimbatum Dames (35*n* Limestone).
Anomocare lisani Walcott (35*q*).
Anomocare megalurus Dames (35*n* Limestone).
Anomocare minus Dames (35*n* Limestone) (36*e* Shale) (36*h*).
Anomocare minus Dames var. undt. (35*n* Limestone) (36*e* Shale).
Anomocare subquadratum Dames (35*n* Limestone).
Anomocarella chinensis Walcott (35*n*) (35*r* Limestone) (36*g*).
Anomocarella hermias Walcott (35*n* Limestone).
Anomocarella macar Walcott (35*n* Limestone).
Anomocarella temenus Walcott (35*n* Limestone) (35*r*).
Dolichometopus deois Walcott (35*o*) (35*p* Shale) (35*r* Limestone).
Bathyuriscus manchuriensis Walcott (35*o*) (36*g*) (36*h* Shale).
Asaphiscus iddingsi Walcott (35*r* Limestone) (36*e*).

GEOLOGICAL CONDITIONS

PRE-CAMBRIAN CONTINENTAL CONDITIONS

The material composing the surface of the land that was awaiting the advance of the Cambrian sea must have been, as described by Willis, very largely made up of clays and sands resulting from the long disintegration of the continental surface at a relatively low relief. Applying this conclusion, we infer that the Asiatic continent at the beginning of Cambrian time was practically a featureless continent and that the transgressing Cambrian sea gradually rose, carrying with it the marine life that developed in the sea on the continental slopes during the long period in which the pre-Cambrian continental surface had been worn down nearly to base-level.

If we now turn to the life contained in the first series of deposits, the Man-t'o formation, we find that it represents the closing epoch of Lower Cambrian time that succeeded the faunas of the *Olenellus* epoch of the older western American formations, and the traces of the Lower Cambrian fauna that have been found in Siberia. The presence of a portion of the later Lower Cambrian fauna in Siberia indicates that this portion of the Asiatic continent was at a lower level and hence was traversed at an earlier epoch by the Cambrian sea than the portions of southeastern and southern Asia, which include Manchuria, eastern and southern China, and northern India.

The relations of the Cambrian strata to the subjacent rocks compel the conclusion that the Asiatic continent was a land surface during the earlier part of Cambrian time and during the long Lipalian interval,[1] represented by the deposition of the great series of pre-Cambrian sedimentary rocks on the North American conti-

[1] Walcott, C. D. Smithsonian Misc. Coll., Vol. 57, Cambrian Geology and Paleontology, No. 1, 1910, Abrupt appearance of the Cambrian fauna on the North American continent, p. 14.

VIEW IN LATERAL CANYON OF THE O-SHUI-HO,

Showing unconformity between the pre-Cambrian Si-t'ai schists (Ws) and Cambrian shale (€m), near Yen-t'óu in the Wu-t'ai-shan, Province of Shan-si. (After Willis, Research in China, Pub No. 54, Carnegie Institution of Washington, Vol. 1, Pt. 1, 1907, Pl. 19, p. 140.)

nent and the lesser series on the Asiatic continent, described by Willis[1] as the Wu-t'ai and the Hu-t'o systems.

In speaking of the rocks of the Hu-t'o system he says:

> All of the rocks of the Hu-t'o system are sedimentary strata; conglomerate; quartzite, shale, and limestone, which resemble the unmetamorphosed Paleozoic rocks more nearly than they do the Wu-t'ai schists. The physical events which intervened between the close of the Wu-t'ai period and the beginning of the Hu-t'o involved greater changes and probably longer time than those which occurred after the Hu-t'o and before the Sinian; but the presence of a rich fauna in the Sinian seas distinguishes that period from the preceding time, during which the life forms, though probably numerous, did not generally become fossil. The nearest relations of the Hu-t'o system are with the Belt terrane of Montana (in America), and it is probable that pre-Cambrian fossils[2] such as have been found in the Belt may eventually be discovered in the Hu-t'o.[3]

In the above-quoted paragraph Doctor Willis unconsciously gives a strong argument for the non-marine origin of the rocks of the Hu-t'o system when he says that the presence of a rich fauna in the Sinian seas distinguishes that period from the preceding (Hu-t'o) time. It was the absence of marine life and the character of the sediments that led me to conclude that there were no marine deposits on the North American continent (nor probably on any of the continents) representing the Lipalian interval or the interval between the fossiliferous Cambrian formations and the period of the development of the early pre-Cambrian marine life along the shores of the continents.[4]

I now anticipate that if the rocks of the Wu-t'ai and Hu-t'o systems are studied with the view that they may not be of marine origin, they will be found deposited as epicontinental sediment accumulated on flood plains or in bodies of fresh water. In part they are more altered and metamorphosed than the pre-Cambrian sedimentary rocks of North America, and hence it may be more difficult to determine their origin.

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[1] Willis, Bailey. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 2, 1907, Systematic geology, pp. 4-20.

[2] Pre-Cambrian fossiliferous formations, C. D. Walcott, Bull. G. S. A., Vol. 10, p. 199, 1899.

[3] Willis, Bailey. Research in China, Vol. 2, 1907, Systematic geology, p. 7.

[4] Walcott, C. D. Smithsonian Misc. Coll., Vol. 57, Cambrian Geology and Paleontology, No. 1, 1910, Abrupt appearance of the Cambrian fauna on the North American continent, pp. 14, 15.

UNCONFORMITY AT BASE OF CAMBRIAN

Dr. Bailey Willis has given a very clear and full description of the Sinian system, the lower portion of which is referred to the Cambrian.[1] He found the unconformity at the base of the Sinian that divided the Paleozoic from the pre-Cambrian to be a break of the first magnitude even where the underlying strata are the Ta-yang (Nan-k'óu) limestone of the late Proterozoic.[2]

> The mechanical sediment of the basal formation has the character of a fine alluvium and is of uniform moderate thickness, 350 to 500 feet, 105 to 150 meters. The material is red soil, particles of ferruginous clay being thoroughly oxidized and grains of sand coated with ferric oxide. The plane of contact at the base is sharply defined, usually very even, not broken by abrupt hollows or decided projections, but swelling gently over rounded bosses of the harder rocks. Pebbles of the subjacent rocks are wanting in the basal deposits, as a rule, and where they occur are limited to very local accumulations. Beds of arkose have not been seen, nor even beds of clean sand such as waves usually spread. Thus none of the effects of violent breakers are present; the evidence is that a gentler agent cleaned the surface of the ancient rocks. The facts support the view that the lowest strata of the Man-t'o formation were laid down in the shallows, lagoons, and flood-plains of a very low, flat coast, where weak waves, feeble shore currents, and rivers interacted.[3]

In discussing the unconformity at the base of the Sinian, Doctor Willis states that each unconformity is somewhere represented by continuous, conformable deposits, and the area of unconformity is bounded by the areas of conformity:

> When we pass from one to the other there is difficulty in dividing the continuous series of strata at a plane corresponding to that indicated by the discontinuity in the neighboring series. This condition exists at the base of the Cambrian in certain localities in the United States, where the lowest fossiliferous Cambrian strata are conformably underlain by great thicknesses of sediments, that accumulated in the depressions from which the Cambro-Ordovician epicontinental sea expanded. Such sediments are by some regarded as pre-Cambrian, by some as the downward extension of the Cambrian. There is no difference of opinion regarding the base in sections where the unconformity intervenes, as is commonly the case.[4]

Since Willis wrote the above in 1907, I have completed my study of the relations of the Cambrian and pre-Cambrian in North America and have concluded that the pre-Cambrian unconformity is universal in all known localities of Cambrian sedimentation and that the depressions in which the pre-Cambrian sediments were deposited

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[1] Willis, Bailey. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 2, 1907, Systematic geology, pp. 35, 49.

[2] Idem, p. 31.

[3] Idem, p. 32.

[4] Idem, p. 35.

were epicontinental, mainly non-marine, and in no way connected directly with the subsequent Cambrian sedimentation.[1]

THE GEOLOGIC FORMATIONS

Lower Sinian, Man-t'o Shale

The basal formation, the Man-t'o, is a red shale that passes often into red or chocolate-brown shaly sandstone, and this is interbedded with thin, sometimes persistent, layers of gray, cream-colored limestone. The thickness varies from 350 to 500 feet (105 to 150 meters). The basal layers occasionally show local conglomerates. The calcareous layers of the Man-t'o occur occasionally near the base, persistently at horizons 100 to 150 feet (30 to 45 meters) higher up, and again less commonly near the top, which is often sandy. The transition into the overlying limestone of the Kiu-lung group is formed of interbedded brown shales and gray limestones.

The interbedding of the shale and limestone is irregular. It is apparent that local conditions were unlike in adjacent waters at any one time and varied in unlike manner from time to time, but red sediment from the land or calcareous sediment from the sea was deposited at any time, as stated by Willis,[2] who also says:

> One may form a concept of the conditions somewhat as follows: Along the flat, red shore of the Man-t'o sea, bars and islands formed where streams emptied, and shut off the mud-carrying currents from intermediate stretches of coast. More or less extensive lagoons were thus produced and within these the waters were clear. Being partly closed and shallow, they were relatively warm and liable to maximum evaporation. Rippling of the surface favored precipitation of lime carbonate by agitation. Warmth and protection invited organic life, both plant and animal, which probably occupied the lagoons in low forms that did not become fossil before trilobites, the earliest that have been preserved, discovered the habitat.
>
> The description of the Man-t'o formation has thus far dealt with it as it is developed in northern China. The red mud does not occur in the south on the Yang-tzĭ-kiang, where we saw the base of the Sinian, but the strata which we suppose to be equivalent are thin-bedded gray limestones which rest on a well-defined glacial till.[3]

The geological conditions thus briefly outlined clearly indicate that the Man-t'o formation was the first deposit made over a wide

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[1] Walcott, C. D. Smithsonian Misc. Coll., Vol. 57, Cambrian Geology and Paleontology, No. 1, 1910, Abrupt appearance of the Cambrian fauna on the North American continent, pp. 2-3.

[2] Willis, Bailey. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 2, 1907, Systematic geology, p. 38.

[3] Idem, pp. 38-39.

area by the slowly transgressing Cambrian sea. This area is outlined by Willis on his map of "Southern Asia during the Sinian period."[1]

Middle Sinian, Kiu-Lung Group

Willis describes this group in the following words:

> The Kiu-lung group of Shan-tung is a succession of limestones and shales which immediately follows the Man-t'o formation. Transition beds connect the two. Shale is a common rock in both, but in the Man-t'o it is red, whereas in the Kiu-lung it is green. Limestone is thin-bedded and subordinate in the former; in the latter it is usually massive and predominant. The Man-t'o contains a sparse Middle or Lower Cambrian fauna in its upper portion; the Kiu-lung carries very abundant faunas, which range from Middle Cambrian at the base to Upper Cambrian and possibly to lowest Ordovician at the top.[2]

The Kiu-lung group is divided into the Ch'ang-hia limestone at the base, the Ku-shan shale, and the Ch'au-mi-tién limestone.

Ch'ang-hia limestone.—The lower portion of the Kiu-lung group is composed of green shale and limestone, alternating in character and forming a series 400 to 500 feet thick (120 to 150 meters).

Ku-shan shale.—The upper portion of the group is characterized by dominance of shale, and Doctor Willis gave it the name of the Ku-shan shale in the vicinity of Shan-si, where a single stratum occurs 150 feet (45 meters) thick.

Ch'au-mi-tién limestone.—The upper part of the Kiu-lung group, the Ch'au-mi-tién limestone, horizontally maintains a uniform character. It is given a thickness of from 400 to 600 feet (120 to 185 meters). It represents a widespread condition of deposition.

The Upper Sinian, the Tsi-nan limestone, differs in lithologic characters and also contains fossils of Lower Ordovician type.[3]

The lower portion of the Kiu-lung group is designated as the Ch'ang-hia limestone in the Ch-ang-hia district, and in the Sin-t'ai district as the lower limestone. Blackwelder gives the reason for this as follows:

> The classification of the Kiu-lung group into three separate divisions is not appropriate for this district, in spite of the fact that the general paleon-

[1] Willis, Bailey. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 2, 1907, Systematic geology, pl. 4.

[2] Idem, p. 40.

[3] The Cambrian portion of the Sinian is described in detail with sections and distributions of faunas by Dr. Eliot Blackwelder in his description of the stratigraphy of Shan-tung [Blackwelder, Stratigraphy of Shan-tung, 1907, Vol. 1, part 1, pp. 19-58], and in the description of the stratigraphy of Chī-li in Shan-si [Reconnaissance in southwest Liau-tung, 1907, pp. 136-147], so that it will not be necessary for me to go further into the details of sedimentation and stratigraphy.

VIEW OF CLIFFS AND SLOPE OF ALGONKIAN AND CAMBRO-ORDOVICIAN STRATA ON SOUTH BANK OF THE RIVER,

Showing the location of the glacial deposit with reference to the overlying strata. It is very probable that the glacial deposit is of Algonkian age. €nq = quartzite at the base of Nan-t'óu formation; €nt = layer of glacial till 120 feet (37 m.) thick; €Oks = Ki-sin-ling limestone. Nan-t'óu on the Yang-tzi, Province of Shen-si. (After Willis, Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, Pt. 1, 1907, Pl. 37, A, p. 268.)

tologic horizons of the Ch'ang-hia area are recognized here with ease. The black oolite is much reduced in thickness, and is largely replaced by shales. The Ku-shan shale is thicker and carries fossils which belong to the Ch'ang-hia and Ch'au-mi-tién formations, respectively, in its upper and lower portions. The Ch'au-mi-tién limestone alone retains the general character noted in the first area studied, but its base is somewhat shifted. Thus, the Kiu-lung, which in the Ch'ang-hia district is a group composed of three formations, is in the Sin-t'ai district a consistent formation, containing members of limestone and shale, which are of local occurrence only.[1]

RELATION OF THE CAMBRIAN TO THE ORDOVICIAN

The Ch'au-mi-tién limestone is described by Blackwelder as a very dark gray, finely crystalline rock that has a distinctly blue color where exposed to the weather. The summit of the formation is marked by a change in the character of the sediments, the lower member of the next younger series being yellowish in color and notably dolomitic.[2]

The Tsi-nan formation above the Cambrian is one of the most widely distributed formations in China and is readily recognized by the light-colored argillaceous limestones or dolomites and thin shales of its lower member and the brown dolomitic limestone of its upper member.[3]

The Tsi-nan formation is referred to the Ordovician on the evidence of fossils found in its upper member. No fossils were found in the lower portion.[4]

The transition from the Upper Cambrian to the Tsi-nan formation is not marked by an unconformity, but the introduction of argillaceous and dolomitic limestones indicates a change in sedimentation that was brought about by diastrophic action that revived erosion and ultimately led to the great epeirogenic changes that marked the close of the Sinian. The fauna of the Cambrian disappeared, so far as known, everywhere in the western Pacific Province and the faunas of Ozarkian[5] and Canadian time did not flourish in the Tsi-nan sea, and apparently entered it only at rare intervals. It may be that faunas corresponding to the Lake Champlain and Mississippi

[1] Blackwelder, Eliot. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, Pt. 1, 1907, Stratigraphy of Shan-tung, pp. 36-37.

[2] Idem, pp. 34, 35.

[3] Idem, p. 44.

[4] Idem, pp. 44-46.

[5] Ulrich, E. O. Bull. Geol. Soc. America, Vol. 22, 1911, Revision of the Paleozoic systems, p. 627.

Valley Canadian and Ozarkian will be found on the Asiatic continent, but at present we must be content to close the Cambrian with the upper horizon of the Kiu-lung group, and wait for further data on the faunas of the Tsi-nan formation and their relation to the Cambrian and Lower Ordovician faunas of North America and Europe.

The presence of the genera *Syntrophia, Huenella, Cyrtoceras,* and *Tsinania* in the Ch'au-mi-tién limestone proves that the Upper Cambrian fauna was beginning to assume a post-Cambrian aspect toward the close of the deposition of the Ch'au-mi-tién limestone. It is quite possible that the fauna of the lower portion of the Tsi-nan formation, when found, will have an Upper Cambrian aspect, but it is more probable that it will have the general facies of that of the lower Pogonip of the Nevada Cordilleran sections.[1]

At present the trilobite fauna of the Upper Cambrian in the Pacific and Cordilleran provinces is readily recognizable at nearly all localities by the presence of such genera of trilobites as *Ptychaspis, Tsinania* and various genera of the Ptychoparidæ. *Dikelocephalus* is restricted in geographic distribution to a few localities in North America. I would place the formations containing a typical Cambrian trilobitic fauna in the Cambrian, and where a formation has a fauna characterized by a new group of forms that evidently belong to a later fauna it should be assigned to a post-Cambrian system even though it may have a few Cambrian genera of trilobites included in it.

In North America we find that the fauna of the Upper Cambrian in the Cordilleran region is quite distinctly marked by the presence of typical Cambrian genera and the absence of typical post-Cambrian genera. In the central area between the Rocky Mountains and the Appalachians the Upper Cambrian fauna as characterized by the trilobitic genera *Agnostus, Ptychaspis, Dikelocephalus, Ptychoparia,* and *Tsinania* is singularly free from commingling of typical post-Cambrian genera except in the case of the Eminence[2] fauna, where a few trilobitic genera have persisted into Ozarkian time.[3]

[1] Walcott, C. D. Bull. U. S. Geol. Survey, No. 10, 1884, On the Cambrian faunas of North America; Preliminary studies, p. 3.

[2] By error the Gasconade fauna was inserted in this place. The Gasconade is a later fauna. Neither the Eminence nor the Gasconade fauna includes the genus *Dikelocephalus.*

[3] Ulrich, E. O. Bull. Geol. Soc. America, Vol. 22, 1911, Revision of the Paleozoic systems, p. 631.

TSINANIA, new genus

Cranidium subrhomboidal in outline; moderately convex; slight traces of an occipital ring at base of glabella. Palpebral lobes just back of the center of the cranidium, and of medium size. Postero-lateral limbs subtriangular, short. Facial sutures curving inward so as to give a rounded front to the cranidium.

Surface smooth or minutely punctate.

Associated pygidia of species referred to the genus a little broader than long and with a slightly defined, narrow, long median lobe marked by obscure transverse furrows that may be faintly outlined on the broad lateral lobes.

Genotype.—Illœnurus canens Walcott.[1]

Stratigraphic range.—Upper Cambrian of eastern China. Lower portion of Ch'au-mi-tién limestone. Also Notch Peak formation, western Utah.

Geographic distribution.—Provinces of Shantung, China. Western Utah in House Range of Cordilleran Province of western America.

Observations.—The genus *Tsinania* differs from *Illœnurus* Hall in having the cranidium rounded in front by the incurving of the facial sutures and short, postero-lateral limbs. The associated pygidia of the three species from China are nearly as long as wide and quite unlike the short, transverse pygidium of *Illœnurus*. From *Symphysurus* Goldfuss, it differs in its smaller palpebral lobes, rounded front of the cranidium and the central portion of the cranidium, which is well defined and expanded anteriorly in *Symphysurus* and obscure and rounded inward in *Tsinania*.

The species referred to the genus are: *Tsinania canens* (Walcott),[2] *Tsinania ceres* (Walcott),[2] *Tsinania cleora* (Walcott),[3] and *Tsinania dictys* (Walcott).[2]

PALEONTOLOGY

STRATIGRAPHIC AND GEOGRAPHIC DISTRIBUTION OF SPECIES

The table gives the general stratigraphic and geographic distribution of the Chinese species described in this memoir. The asterisk used opposite the species by authors to indicate the position of the

[1] Research in China, Carnegie Institution of Washington, Publication No. 54, Vol. III, 1913, p. 222, pl. 23, fig. 3.

[2] Idem, pp. 222-224.

[3] *Illœnurus* Walcott. Smithsonian Misc. Coll., Vol. 53, 1908, p. 175, 1*a* of Notch Peak formation of the Upper Cambrian, House Range, Utah.

species is replaced by the locality number or numbers to enable the student to refer to the exact locality, stratigraphic position, and lists of associated species. [See pp. 17-34 for list of localities and associated species.]

The following is a summary of the genera and species:

Classification.	Genera.	Subgenera.	Species.	Varieties.
Foraminifera	1	.....	1	.....
Porifera	2	.....	2	.....
Anthozoa	1	.....	1	.....
Annelida	1	.....	1	.....
Brachiopoda	13	4	36	4
Gastropoda	5	.....	11	2
Pteropoda	2	.....	11	1
Cephalopoda	1	.....	1	.....
Trilobita	36	1	175	4
Ostracoda	1	.....	6	.....
	63	5	245	11

General Stratigraphic and Geographic Position of the Cambrian Faunas of China

Name.	Stratigraphic position.			General geographic position.		
	Lower Cambrian.	Middle Cambrian.	Upper Cambrian.	Near Yen-chuang.	Near Wu-t'ai-hién.	Tschang-hsing-tau Island.
FORAMINIFERA.						
Globigerina ? mantoensis	.....	×	.....	C_5	.....	.....
PORIFERA.						
Protospongia chloris	.....	×	.....	C_1, C_2, C_4	.....	35*n*, 35*q*
Protospongia sp. undt.	.....	×	.....	.....	.....	35*n*
ANTHOZOA.						
Coscinocyathus elvira	.....	×	.....	.....	C_75	.....
ANNELIDA.						
Planolites sp. undt.	.....	×	.....	.....	.....	36*f*
BRACHIOPODA.						
Micromitra sculptilis	.....	×	.....	.....	.....	35*r*, 35*n*
Micromitra (Paterina) labradorica orientalis	.....	×	.....	C_9	.....	.....
Micromitra (Paterina) lucina	.....	×	.....	.....	.....	35*n*, 35*r*, 36*d*
Micromitra (Iphidella) pannula maladensis*	.....	×	.....	.....	.....	35*n*, 35*r*
Micromitra (Iphidella) pannula ophirensis†	.....	×	.....	C_5	.....	35*n*
Obolus chinensis	.....	×	.....	C_62	.....	35*n*

* Also occurs in Idaho and Newfoundland. † Also occurs in Utah.

NOTE.—The columns "Near Ch'ang-hia," "Near Ch'au-ni-tién," "Near Sin-t'ai-hién," "Near Tsi-nan," "Near Fang-lan-chén," "Near Tung-yü," "Near Chén-ping-hién," "Near Ting-hiang-hién," and "Near Kao-kia-p'u" are omitted in this page, as the species recorded in the first column were not collected in those localities.

General Stratigraphic and Geographic Position of the Cambrian Faunas of China—Continued

Name.	Stratigraphic position.			General geographic position.										
	Lower Cambrian.	Middle Cambrian.	Upper Cambrian.	Near Ch'ang-hia.	Near Yen-chuang.	Near Ch'au-mi-tién.	Near Wu-t'ai-hién.	Near Tsi-nan.	Near Fang-lan-chén.	Near Tung-yü.	Near Chén-p'ing-hién.	Near Ting-hiang-hién.	Near Kao-kia-p'u.	Tschang-hsing-tau Island.
BRACHIOPODA—Continued.														
Obolus damesi	....	×	....	.....	C 7, C 10, C 64	....	....	.....	....	.....	.....	.....	.....	35*n*, 35*o*, 35*r*, 36*d*, 36*e*, 36*g*, 36*h*
Obolus matinalis ?	....	.....	×	.....	.....	....	....	C 54, C 67?	....	.....	.....	.....	.....	.....
Obolus minimus	....	×	....	.....	C 1	....	....	.....	....	.....	.....	.....	.....	.....
Obolus obscurus	....	×	....	.....	C 63	....	C 75	.....	....	.....	.....	.....	.....	.....
Obolus shansiensis	....	×	....	.....	.....	....	....	.....	....	C 71?	C 32	C 37	....	35*r*
Obolus (Westonia) blackwelderi	....	×	....	.....	C 1, C 2, C 6	....	....	.....	....	.....	.....	.....	.....	.....
Obolus (Westonia) sp. undt.	....	.....	×	.....	.....	....	....	C 56	....	.....	.....	.....	.....	.....
Lingulella manchuriensis	....	×	....	.....	.....	....	....	.....	....	.....	.....	.....	.....	35*p*
Lingulella marcia	....	×	....	.....	.....	....	....	.....	....	.....	.....	.....	.....	35*q*, 36*f*?, 36*h*
Lingulella (Lingulepis) eros	....	×	....	.....	C 7	....	....	.....	....	.....	.....	.....	.....	.....
Lingulella (Lingulepis ?) sp. undt.	....	×	....	.....	.....	....	....	.....	C 72	.....	.....	.....	.....	.....
Dicellomus parvus	....	×	....	.....	C 6	....	....	.....	....	.....	C 32	.....	.....	.....
Obolella asiatica	×	.....	....	C 17	.....	....	....	.....	....	.....	C 32'	.....	.....	.....
Yorkia ? orientalis	....	×	....	.....	.....	....	....	.....	....	C 71	.....	.....	.....	.....
Acrothele matthewi eryx	....	×	....	.....	C 4	....	....	.....	....	.....	.....	.....	.....	35*n*, 35*o*, 35*r*, 36*e*, 36*g*
Acrothele ? minuta	....	×	....	.....	C 6	....	....	.....	....	.....	.....	.....	.....	.....
Acrothele rara	....	×	....	C 23	.....	....	....	.....	....	.....	.....	.....	C 57	.....
Acrotreta lisani	....	×	....	C 22	.....	....	....	.....	....	.....	.....	.....	.....	.....
Acrotreta pacifica	....	×	....	C 24?	C 1, C 2, C 4, C 5, C 12	....	....	.....	....	.....	.....	.....	.....	35*p*
Acrotreta shantungensis	....	×	....	.....	C 1?, C 62	....	....	.....	....	C 71	C 32	C 37	....	35*n*, 35*o*, 35*r*, 36*g*, 36*h*
Acrotreta venia	....	×	....	.....	.....	....	....	.....	....	.....	.....	.....	.....	35*q*
Discinopsis sulcatus	....	.....	×	.....	.....	....	....	C 56	....	.....	.....	.....	.....	.....
Billingsella pumpellyi	....	.....	×	.....	C 61	C 36	....	.....	....	.....	.....	.....	.....	.....
Billingsella richthofeni	×	.....	....	C 20	C 3	....	....	.....	....	.....	.....	.....	.....	.....
Eoorthis agreste	....	×	....	C 28	.....	....	....	.....	....	.....	.....	.....	.....	.....
Eoorthis doris	....	.....	×	.....	C 64	....	....	.....	....	.....	.....	.....	.....	.....
Eoorthis kayseri	....	.....	×	.....	C 64	C 68	....	.....	C 74	.....	.....	.....	.....	.....
Eoorthis kichouensis	....	×	....	.....	.....	....	C 75	.....	....	.....	.....	.....	.....	.....
Eoorthis linnarssoni	....	.....	×	.....	C 64	....	....	C 67?	....	.....	.....	.....	.....	.....
Eoorthis pagoda	....	.....	×	.....	.....	....	....	C 54, C 56	....	.....	.....	.....	.....	.....
Eoorthis sp. undt. (*a*)	....	×	....	C 26	.....	....	....	.....	....	.....	.....	.....	.....	.....
Eoorthis sp. undt. (*b*)	....	×	....	.....	.....	....	....	.....	....	C 71	.....	.....	.....	.....
Huenella orientalis	....	.....	×	.....	C 64	....	....	.....	....	.....	.....	.....	.....	.....
Syntrophia orthia	....	.....	×	.....	C 64	....	....	C 54, C 56	....	.....	.....	.....	.....	.....

NOTE.—The column "Near Sin-t'ai-hién" is omitted in this page, as the species recorded in the first column were not collected in that locality.

General Stratigraphic and Geographic Position of the Cambrian Faunas of China
—Continued

Name.	Stratigraphic position.			General geographic position.								
	Lower Cambrian.	Middle Cambrian.	Upper Cambrian.	Near Ch'ang-hia.	Near Yen-chuang.	Near Ch'au-mi-tién.	Near Tsi-nan.	Near Fang-lan-chön.	Near Tung-yü.	Near Chön-p'ing-hién.	Near Kao-kia-p'u.	Tschang-hsing-tau Island.
GASTROPODA.												
Scenella clotho	....	×	....	C 18	.....	....	....	....	....	.....	....	.....
Scenella ? dilatatus	....	×	....	.....	.....	....	....	....	C 70	.....	....	.....
Scenella sp. undt.	....	.....	×	.....	.....	....	C 56	....	....	.....	....	.....
Matherella circe	....	.....	×	.....	.....	....	C 56	....	....	.....	....	.....
Straparollina sp. undt.	....	×	....	.....	.....	....	C 55	....	....	.....	....	.....
Pelagiella chronus	....	×	....	C 18	{ C 1 { C 4	....	....	....	....	.....	....	.....
Pelagiella clytia	....	.....	×	.....	.....	C 47	....	....	....	.....	....	.....
Pelagiella pagoda	....	.....	×	.....	.....	....	C 56	....	....	.....	....	.....
Pelagiella willisi	....	×	....	.....	.....	....	....	C 72	....	.....	....	.....
Helcionella ? clurius	....	×	....	.....	.....	C 46	....	....	....	.....	....	.....
Helcionella rugosa chinensis	×	.....	....	.....	C 3	....	....	....	....	.....	....	.....
Helcionella rugosa orientalis	....	.....	....	{ C 18 { C 21	.....	....	....	....	....	.....	....	.....
Helcionella ?? simplex	....	×	....	.....	.....	....	....	....	C 70	.....	....	.....
PTEROPODA.												
Hyolithes cybele	....	×	....	C 22	{ C 1 { C 2 { C 4 { C 62	....	....	....	....	.....	....	{ 35n { 35r
Hyolithes daphnis	....	.....	×	.....	C 64	....	....	....	....	.....	....	.....
Hyolithes delia	×	.....	....	.....	C 3	....	....	....	....	.....	....	.....
Hyolithes sp. undt.	×	.....	....	.....	C 4?	....	....	....	....	C 32	....	.....
Orthotheca cyrene	....	×	....	.....	C 64	C 47	....	....	....	.....	....	35n
Orthotheca cyrene dryas	....	×	....	.....	C 2	....	....	....	....	.....	....	.....
Orthotheca daulis	....	×	....	C 23	.....	....	....	....	....	.....	....	.....
Orthotheca delphus	....	×	....	.....	C 4	....	....	....	....	.....	C 57	{ 35n { 35r
Orthotheca cf. delphus	....	×	....	.....	.....	....	....	....	....	.....	....	36g
Orthotheca doris	....	×	....	.....	.....	....	....	....	....	C 32	....	.....
Orthotheca glabra	....	×	....	.....	.....	....	C 72	C 71	....	.....	....	35n
Orthotheca sp. undt.	....	.....	×	.....	.....	....	C 56	....	....	.....	....	.....
CEPHALOPODA.												
Cyrtoceras cambria	....	.....	×	.....	.....	....	C 56	....	....	.....	....	.....
TRILOBITA.												
Agnostus chinensis	....	×	....	.....	{ C 1 { C 2 { C 4	....	....	....	C 71	.....	C 57	{ 35n { 35o { 35p { 35r { 36e { 36g { 36h
Agnostus douvilléi	....	×	....	.....	C 6	....	C 55	....	....	.....	....	36f
Agnostus kushanensis	....	×	....	.....	.....	....	....	....	....	.....	C 57	.....
Agnostus parvifrons latelimbatus*	....	×	....	.....	.....	....	....	....	....	.....	....	.....
Microdiscus orientalis	....	×	....	.....	.....	....	....	....	....	C 32	....	.....
Shumardia sp. undt.	....	×	....	.....	.....	C 51	....	....	....	.....	....	.....
Redlichia chinensis	×	.....	....	{ C 15 { C 16 { C 27	.....	....	....	....	....	.....	....	.....
Redlichia ? finalis	....	×	....	.....	.....	....	....	....	....	.....	C 58	.....
Redlichia nobilis	×	.....	....	.....	C 3	....	....	....	....	.....	....	.....
Redlichia sp. undt (*a*)	....	×	....	.....	C 6	....	....	....	....	.....	....	.....
Redlichia sp. undt (*b*)	×	.....	....	C 16	.....	....	....	....	....	.....	....	.....
Redlichia sp. undt (*c*)	×	.....	....	C 27	C 60	....	....	....	....	.....	....	.....
Albertella pacifica	....	×	....	.....	.....	....	....	....	....	.....	....	.....
Dorypyge bispinosa	....	×	....	.....	C 2	....	....	....	....	.....	....	.....

* Occurs at Wang-tschuang, Shan-tung, China.

NOTE.—The columns "Near Sin-t'ai-hién," "Near Wu-t'ai-hién," and "Near Ting-hiang-hién," are omitted in this page, as the species recorded in the first column were not collected in these localities.

General Stratigraphic and Geographic Position of the Cambrian Faunas of China —Continued

Name.	Stratigraphic position.			General geographic position.										
	Lower Cambrian.	Middle Cambrian.	Upper Cambrian.	Near Ch'ang-hia.	Near Yen-chuang.	Near Ch'au-mi-tién.	Near Sin-t'ai-hién.	Near Wu-t'ai-hién.	Near Tsi-nan.	Near Fang-lan-chén.	Near Tung-yü.	Near Kao-kia-p'u.	Tschang-hsing-tau Island.
TRILOBITA—Continued.													
Dorypyge richthofeni	....	×	....	C 19, C 24, C 29, C 30	C 1	....	....	....	....	....	....	C 57	35n, 35p, 35r
Dorypyge richthofeni lævis	....	×	....	.....	.....	....	....	....	....	C 72	C 71	....	.....
Teinistion alcon	....	×	....	.....	C 12	....	....	....	....	....	....	....	.....
Teinistion lansi *	....	×	....	.....	C 6, C 12	....	....	....	....	....	....	....	.....
Teinistion typicalis	....	×	....	.....	C 12	....	....	....	....	....	....	....	36f
Stephanocare ? monkei	....	×	....	.....	C 6	....	....	....	....	....	....	....	.....
Stephanocare richthofeni	....	×	....	.....	C 6	....	....	....	C 55	....	....	....	.....
Stephanocare ? sinensis	....	×	....	.....	C 6	....	....	....	....	....	....	....	36f
Stephanocare ? sp. undt	....	×	....	.....	C 6	....	....	....	....	....	....	....	.....
Blackwelderia alastor	....	×	....	.....	C 12	....	....	....	....	....	....	....	.....
Blackwelderia cilix	....	×	....	.....	.....	....	....	....	C 55	C 73	....	....	.....
Blackwelderia sinensis †	....	×	....	.....	C 6	....	....	....	....	....	....	....	36f
Damesella bellagranulata	....	×	....	.....	C 13	....	....	....	....	....	....	....	.....
Damesella blackwelderi	....	×	....	.....	C 12, C 13, C 14, C 40	....	....	....	....	....	....	....	35q, 36f
Damesella brevicaudata	....	×	....	C 19	.....	....	....	....	....	....	....	....	.....
Damesella sp. undt. (*c*)	....	×	....	.....	.....	C 46	....	....	....	....	....	....	35o
Drepanura ketteleri	....	×	....	.....	C 6	....	....	....	C 55	....	....	....	.....
Drepanura premesnili	....	×	....	.....	C 6	....	....	....	C 35	....	....	....	36f
Ptychoparia aclis	×	.....	....	C 17, C 20, C 31	.....	....	....	....	....	....	....	....	.....
Ptychoparia granosa	×	.....	....	C 17	.....	....	....	....	....	....	....	....	.....
Ptychoparia impar	×	.....	....	C 17	.....	....	....	....	....	....	....	....	.....
Ptychoparia impar var. ?	....	×	....	.....	C 8	....	....	....	....	....	....	....	.....
Ptychoparia kochibei	....	×	....	.....	.....	....	....	....	....	....	....	....	35n, 35r, 36e
Ptychoparia ligea	×	.....	....	.....	C 31	....	....	....	....	....	....	....	.....
Ptychoparia lilia	....	×	....	.....	.....	....	....	C 75	....	....	....	....	.....
Ptychoparia ? tolus	....	×	....	.....	.....	....	C 52	....	....	....	....	....	.....
Ptychoparia typus	....	×	....	.....	.....	....	....	....	....	....	....	....	35o
Ptychoparia sp. undt	....	×	....	.....	C 4, C 5	C 48	....	....	....	....	....	C 58	.....
Ptychoparia (Emmrichella) bromus	....	×	....	.....	C 6	....	....	....	....	....	....	....	.....
Ptychoparia (Emmrichella) constricta	×	.....	....	.....	C 3	....	....	....	....	....	....	....	.....
Ptychoparia (Emmrichella) eriopia	....	×	....	C 23	.....	....	....	....	....	....	....	....	.....
Ptychoparia (Emmrichella) mantoensis	×	.....	....	C 20, C 31	.....	....	....	....	....	....	....	....	.....
Ptychoparia (Emmrichella) theano	....	×	....	C 23	.....	....	....	....	....	....	....	....	.....
Conokephalina belus	....	.....	×	.....	.....	....	....	....	C 56	....	....	....	.....
Conokephalina dryope	....	.....	×	.....	.....	....	....	....	C 56	....	....	....	.....
Conokephalina maia	....	×	....	.....	.....	....	....	....	....	....	C 70	....	.....
Conokephalina vesta	....	×	....	.....	.....	....	....	....	....	C 69	....	....	.....
Conokephalina sp. undt	....	×	....	.....	.....	....	....	....	....	C 72	C 70	....	.....
Crepicephalus convexus	....	×	....	.....	.....	....	....	....	....	....	....	....	35r
Crepicephalus damia	....	×	....	C 18, C 21, C 26	.....	....	....	....	....	....	C 71	....	.....
Crepicephalus magnus	....	×	....	C 25?, C 18	.....	C 48	....	....	....	....	....	....	.....
Lonchocephalus tellus	....	×	....	.....	C 2	....	....	....	....	....	....	....	.....
Liostracina krausei	....	×	....	.....	C 6	....	....	....	....	....	....	....	36f
Proampyx burea	.....	.....	×	.....	C 61	....	....	....	....	....	....	....	.....

* Also from Yen-tsy-yai.

† *Calymmene ? sinensis* Bergeron.

NOTE.—The columns "Near Chön-ping-hién" and "Near Ting-hiang-hién" are omitted in this page, as the species recorded in the first column were not collected in those localities.

General Stratigraphic and Geographic Position of the Cambrian Faunas of China
—Continued

Name.	Stratigraphic position.			General geographic position.									
	Lower Cambrian.	Middle Cambrian.	Upper Cambrian.	Near Ch'ang-hia.	Near Yen-chuang.	Near Ch'au-mi-tién.	Near Sin-t'ai-hién.	Near Wu-t'ai-hién.	Near Tsi-nan.	Near Fang-lan-chôn.	Near Tung-yü.	Tschang-hsing-tau Island.
TRILOBITA—Continued.												
Pterocephalus asiaticus	....	×	....	.....	C 12	.....	.....	....	.....	.....	.....	.....
Pterocephalus busiris	....	.....	×	.....	C 61	.....	.....	....	C 54	.....	.....	.....
Pterocephalus ? liches	....	×	....	.....	.....	.....	.....	....	.....	.....	.....	35*n*
Shantungia spinifera	....	×	....	.....	C 6	.....	.....	....	.....	.....	.....	36*f*
Inouyia abaris	....	×	....	.....	C 7, C 9	.....	.....	....	.....	.....	.....	.....
Inouyia ? acalle	....	×	....	.....	C 12	.....	.....	....	.....	.....	.....	.....
Inouyia armata	....	×	....	.....	.....	.....	.....	C 75	.....	.....	.....	.....
Inouyia capax	....	×	....	.....	.....	.....	.....	....	.....	.....	C 70	.....
Inouyia divi	....	×	....	C 24	C 1, C 5	.....	.....	....	.....	.....	.....	.....
Inouyia ? inflata	....	×	....	.....	.....	.....	.....	....	.....	C 69	.....	.....
Inouyia melie	....	×	....	.....	.....	.....	.....	C 75	.....	.....	C 70	.....
Inouyia ? regularis	....	×	....	.....	.....	.....	.....	....	.....	C 73	.....	.....
Inouyia thisbe	....	×	....	C 28	.....	.....	.....	....	.....	.....	.....	.....
Inouyia titiana	....	×	....	.....	C 7	.....	.....	....	.....	.....	.....	.....
Agraulos abrota	....	×	....	C 23	.....	.....	.....	....	.....	.....	.....	.....
Agraulos dirce	....	×	....	.....	.....	.....	C 52	....	.....	.....	.....	.....
Agraulos dolon	....	×	....	.....	C 7	.....	.....	....	.....	.....	.....	.....
Agraulos dryas	....	×	....	C 29	.....	.....	.....	....	.....	.....	.....	.....
Agraulos nitida	....	×	....	.....	.....	.....	.....	C 75	.....	.....	.....	.....
Agraulos obscura	....	×	....	.....	.....	.....	.....	....	.....	C 69	.....	.....
Agraulos sorge	....	×	....	.....	.....	.....	.....	....	.....	.....	.....	35*n*
Agraulos uta	....	×	....	.....	.....	.....	.....	C 75	.....	.....	.....	.....
Agraulos vicina	....	×	....	.....	.....	.....	.....	....	.....	.....	C 70	.....
Pagodia bia	....	.....	×	.....	.....	.....	.....	....	C 56	.....	.....	.....
Pagodia dolon	....	.....	×	.....	.....	C 41	.....	....	.....	.....	.....	.....
Pagodia lotos	....	.....	×	.....	.....	.....	.....	....	C 56	.....	.....	.....
Pagodia macedo	....	.....	×	.....	.....	C 34	.....	....	.....	.....	.....	.....
Lisania agonius	....	×	....	.....	C 1, C 2	.....	.....	....	.....	.....	.....	.....
Lisania ajax	....	×	....	.....	C 12, C 40	.....	.....	....	.....	.....	.....	.....
Lisania alala	....	×	....	C 22, C 30	C 4	C 46, C 51	.....	....	.....	.....	.....	.....
Lisania ? belenus	....	×	....	C 19	.....	.....	.....	....	.....	.....	.....	.....
Lisania bura	....	×	....	C 22	.....	.....	.....	....	.....	.....	.....	.....
Lisania cf. bura	....	×	....	.....	.....	.....	.....	C 77	.....	.....	.....	.....
Lisania sp. undt.	....	×	×	C 30	.....	C 41	.....	....	.....	.....	.....	.....
Solenopleura agno	....	×	....	C 25	.....	C 51	.....	....	.....	.....	.....	35*r*
Solenopleura beroe	....	×	×	.....	C 64	.....	.....	....	.....	.....	.....	35*n*
Solenopleura chalcon	....	×	....	.....	.....	.....	.....	....	.....	.....	.....	35*r*
Solenopleura intermedia	....	×	....	.....	.....	C 51	.....	....	.....	.....	.....	.....
Solenopleura pauperata	....	×	....	.....	.....	.....	.....	....	.....	.....	C 71	.....
Solenopleura sp. undt.	....	×	....	C 21	.....	.....	.....	....	.....	.....	.....	35*n*
Chuangia batia	....	.....	×	.....	C 11, C 61, C 64	C 44	C 33*a*	....	.....	.....	.....	.....
Chuangia fragmenta	....	.....	×	.....	C 61	.....	.....	....	.....	.....	.....	.....
Chuangia nais	....	.....	×	.....	C 64	.....	.....	....	.....	.....	.....	.....
Chuangia nitida	....	.....	×	.....	C 11	.....	.....	....	.....	.....	.....	.....
Menocephalus abderus	....	×	....	C 19	.....	.....	.....	....	.....	.....	.....	.....
Menocephalus acanthus	....	×	....	C 22	.....	.....	.....	....	.....	.....	.....	.....
Menocephalus acerius	....	×	....	C 18	.....	.....	.....	....	.....	.....	.....	.....
Menocephalus acidalia	....	×	....	C 30	.....	.....	.....	....	.....	.....	.....	.....
Menocephalus acis	....	×	....	.....	.....	C 35	.....	....	.....	.....	.....	.....
Menocephalus admeta	....	×	....	C 22	.....	.....	.....	....	.....	.....	.....	.....
Menocephalus agave	....	×	....	C 30	.....	.....	.....	....	.....	.....	.....	.....
Menocephalus ? depressus	....	.....	×	.....	.....	C 49	.....	....	C 56	.....	.....	.....
Menocephalus ? sp. undt.	....	×	....	C 30	C 10	.....	.....	....	.....	.....	.....	.....
Levisia adrastia	....	×	....	C 30	.....	.....	.....	....	.....	.....	.....	.....
Levisia agenor	....	×	....	C 25	.....	.....	.....	....	.....	.....	.....	.....
Ptychaspis acamus	....	.....	×	.....	.....	C 45	.....	....	.....	.....	.....	.....

NOTE.—The columns "Near Chön-p'ing-hién," "Near Ting-hiang-hién," and "Near Kao-kia-p'u" are omitted in this page, as the species recorded in the first column were not collected in those localities.

General Stratigraphic and Geographic Position of the Cambrian Faunas of China —Continued

Name.	Stratigraphic position.			General geographic position.										
	Lower Cambrian.	Middle Cambrian.	Upper Cambrian.	Near Ch'ang-hia.	Near Yen-chuang.	Near Ch'au-mi-tien.	Near Sin-t'ai-hien.	Near Wu-t'ai-hien.	Near Tsi-nan.	Near Fang-lan-chŏn.	Near Tung-yü.	Near Ting-hiang-hien.	Near Kao-kia-p'u.	Tschang-hsing-tau Island.
TRILOBITA—Continued.														
Ptychaspis baubo	....	.....	×	.....	C 61 / C 64	.....	.....	....	.....	.....	....	....	.....	.....
Ptychaspis bella	....	.....	×	.....	.....	.....	.....	....	.....	C 74	....	....	.....	.....
Ptychaspis brizo	....	.....	×	.....	.....	C 38	.....	....	.....	.....	....	....	.....	.....
Ptychaspis vacus	....	.....	×	.....	C 64	.....	.....	....	.....	.....	....	....	.....	.....
Ptychaspis cadmus	....	.....	×	.....	.....	C 41	.....	....	.....	.....	....	....	.....	.....
Ptychaspis calchas	....	.....	×	.....	.....	C 41	.....	....	.....	.....	....	....	.....	.....
Ptychaspis callisto	....	.....	×	.....	C 64	.....	.....	....	.....	.....	....	....	.....	.....
Ptychaspis calyce	....	.....	×	.....	C 54	C 42	.....	....	.....	.....	....	....	.....	.....
Ptychaspis campe	....	.....	×	.....	.....	C 42	.....	....	.....	.....	....	....	.....	.....
Ptychaspis ceto	....	.....	×	.....	C 64	C 34 / C 38 / C 45	.....	....	.....	C 54 / C 56	....	....	.....	.....
Ptychaspis sp. undt.	....	.....	×	.....	C 64	C 47 / C 50	C 33	....	C 54 / C 67	.....	....	....	.....	.....
Anomocare alcinoe	....	×	....	.....	.....	.....	.....	....	.....	.....	....	....	C 57	.....
Anomocare convexa *	....	×	....	.....	.....	.....	.....	....	.....	.....	....	....	.....	.....
Anomocare daulis	....	×	C 19 / C 26?	.....	.....	.....	.....	....	.....	.....	....	....	.....	.....
Anomocare ephori	....	×	....	.....	.....	.....	.....	....	.....	.....	....	....	.....	35n / 35r
Anomocare flava	....	×	....	.....	.....	.....	.....	....	.....	C 72	....	....	.....	.....
Anomocare latelimbatum	....	×	....	.....	C 2	.....	C 52	....	.....	.....	....	....	.....	35n
Anomocare lisani	....	×	....	.....	.....	.....	.....	....	.....	.....	....	....	.....	35q
Anomocare megalurus	....	×	....	.....	.....	.....	.....	....	.....	.....	....	C 37	.....	35n
Anomocare minus	....	×	....	.....	C 9	.....	.....	....	.....	.....	....	....	.....	35n / 36e / 36h
Anomocare minus var.	....	×	....	.....	.....	.....	.....	....	.....	.....	....	....	.....	35n / 36e
Anomocare ? nereis	....	×	....	.....	.....	.....	.....	....	.....	C 69 / C 72	....	....	.....	.....
Anomocare subquadratum	....	×	....	.....	C 7	.....	.....	....	.....	.....	....	....	.....	35n
Anomocare sp. undt.	....	×	....	.....	.....	.....	.....	C 77	.....	.....	....	....	.....	.....
Anomocare various sp. undt.	....	×	×	C 30	C 5 / C 8 / C 64	C 46	.....	....	.....	.....	....	....	.....	.....
Anomocarella albion	....	×	....	.....	C 1 / C 2 / C 4	.....	.....	....	.....	.....	....	....	C 57	.....
Anomocarella baucis	....	.....	×	.....	.....	C 36	.....	....	.....	.....	....	....	.....	.....
Anomocarella bergioni	....	.....	×	.....	.....	.....	C 33a	....	.....	.....	....	....	.....	.....
Anomocarella bigsbyi	....	×	....	.....	.....	.....	.....	....	.....	.....	C 71	....	.....	.....
Anomocarella biston	....	×	....	.....	C 2	.....	.....	....	.....	.....	....	....	.....	.....
Anomocarella butes	....	×	....	.....	C 5	.....	C 52	....	.....	.....	....	....	.....	.....
Anomocarella chinensis	....	×	....	.....	C 1 / C 2 / C 4 / C 62	.....	.....	....	.....	.....	....	....	C 57	35n / 35r / 36g
Anomocarella comus	....	×	....	.....	.....	.....	.....	....	.....	.....	C 71	....	.....	.....
Anomocarella hermias	....	×	....	.....	.....	.....	.....	....	.....	.....	....	....	.....	35n
Anomocarella irma	....	×	....	.....	.....	.....	.....	C 77	.....	.....	....	....	.....	.....
Anomocarella macar	....	×	....	.....	.....	.....	.....	....	.....	.....	....	....	.....	35n
Anomocarella smithi *	....	×	....	.....	.....	.....	.....	....	.....	.....	....	....	.....	.....
Anomocarella speciosa †	....	×	....	.....	.....	.....	.....	....	.....	.....	....	....	.....	.....
Anomocarella subrugosa	....	×	....	.....	C 7	.....	.....	....	.....	.....	....	....	.....	.....
Anomocarella tatian	....	×	....	C 33	.....	.....	.....	....	.....	.....	....	....	.....	.....
Anomocarella temenus	....	×	....	C 22	C 10	.....	.....	....	.....	.....	....	....	.....	35n / 35r
Anomocarella tenes	....	×	...	C 28	.....	.....	.....	....	.....	.....	....	....	.....	.....
Anomocarella thraso ‡	....	×	....	.....	C 7	.....	.....	....	.....	.....	....	....	.....	.....
Anomocarella toxeus	....	×	....	C 28	.....	.....	.....	....	.....	.....	....	....	.....	.....
Anomocarella trogus	....	×	....	C 25	.....	.....	.....	....	.....	.....	....	....	.....	.....
Anomocarella tutia	....	×	....	C 19	C 12	.....	.....	....	.....	.....	....	....	.....	.....

* Occurs in 90 x, Middle Cambrian, Coosa Valley, Alabama, and is introduced for comparison.

† Occurs at Wang-tschuang, Shan-tung, China. ‡ On rock with *Inouyia titiana*..

NOTE.—The column " Near Chŏn-p'ing-hién " is omitted in this page, as the species recorded in the first column were not collected in that locality.

General Stratigraphic and Geographic Position of the Cambrian Faunas of China —Continued

Name.	Stratigraphic position.			General geographic position.									
	Lower Cambrian.	Middle Cambrian.	Upper Cambrian.	Near Ch'ang-hia.	Near Yen-chuang.	Near Ch'au-mi-tién.	Near Tsi-nan.	Near Fang-lan-chön.	Near Tung-yu.	Near Chön-o'ing-hién.	Near Kao-kia-p'u.	Tschang-hsing-tau Island.
TRILOBITA—Continued.												
Anomocarella undata	....	×	....	....	.....	.....	.....	....	C 71	.....	....	.....
Coosia ? bianos	....	.....	×	....	C 61	.....	.....	....	.....	.....	....	.....
Coosia carme	....	.....	×	....	.....	C 38	.....	....	.....	.....	....	.....
Coosia ? daunus	....	×	....	....	C 2	.....	.....	....	.....	.....	....	.....
Coosia decelus	....	×	....	....	C 9	.....	.....	....	.....	.....	....	.....
Coosia robusta *	....	×	....	....	.....	.....	.....	....	.....	.....	....	.....
Coosia superba †	....	×	....	....	.....	.....	.....	....	.....	.....	....	.....
Dolichometopus alceste	....	×	....	....	C 1, C 4	.....	.....	....	.....	.....	....	.....
Dolichometopus deois	....	×	....	C 19	C 1, C 2, C 4	.....	.....	....	.....	C 57	....	35o, 35p, 35r
Dolichometopus derceto	....	×	....	....	C 1, C 2	.....	.....	....	.....	.....	....	.....
Dolichometopus dirce	....	×	....	C 24	.....	.....	.....	....	.....	.....	....	.....
Dolichometopus hyrie	....	×	....	....	.....	.....	.....	C 69	.....	.....	....	.....
Dolichometopus ? sp.	....	×	....	....	C 5	.....	.....	....	.....	.....	....	.....
Hysterolenus ? sp. undt.	....	.....	×	....	.....	C 38	C 56	....	.....	.....	....	.....
Bathyuriscus manchuriensis	....	×	....	....	.....	.....	.....	....	.....	.....	....	35o, 36g, 36h
Asaphiscus iddingsi	....	×	....	....	.....	.....	.....	....	.....	.....	....	35r, 36e
Tsinania canens	....	.....	×	....	.....	C 34, C 38, C 41, C 42	C 54	....	.....	.....	....	.....
Tsinania ceres	....	.....	×	....	.....	C 38	.....	....	.....	.....	....	.....
Tsinania dictys	....	.....	×	....	.....	.....	C 56	....	.....	.....	....	.....
OSTRACODA.												
Aluta bergeroni	....	×	....	....	.....	.....	.....	....	....	C 32	....	.....
Aluta enyo	....	×	....	....	.....	.....	.....	....	....	C 32	....	.....
Aluta eris	....	×	....	....	.....	.....	.....	....	....	C 32	....	.....
Aluta fragilis	....	×	....	....	.....	.....	.....	....	....	C 32	....	.....
Aluta sterope	....	×	....	....	.....	.....	.....	....	....	C 32	....	.....
Aluta woodi	....	×	....	....	.....	.....	.....	....	....	C 32	....	.....

* Occurs in 107, Middle Cambrian, Alabama, and is introduced for comparison.
† Occurs in 91, Middle Cambrian, Alabama, and is introduced for comparison.

NOTE.—The columns "Near Sin-t'ai-hién," "Near Wu-t'ai-hién," and "Near Ting-hiang-hién" are omitted in this page, as the species recorded in the first column were not collected in those localities.

RELATIONS OF THE FAUNA TO TYPICAL STRATIGRAPHIC SECTION

In order to avoid the repetition of the lists of species from the various localities, a list of localities with the species occurring in each is given (pp. 17-34). In the following stratigraphic sections the numbers designating the localities will be inserted so that the student may, if he desires to learn just which species occur in a given locality and position in the section, refer to the list under the locality number. In some instances it is not practicable from the known stratigraphic and paleontologic data to assign the exact horizon. In such cases an interrogation mark is placed before the locality number.

Sections in Shan-tung

The following sections are copied from Vol. I, part I, Research in China,[1] and in addition the locality numbers of the fossils are inserted.

				Locality numbers.	Feet.	Meters.	Present land surface.
Sinian.	Ordovician.	Tsi-nan dolomite.	€Ot		1,800	550	Dolomitic limestone, dark gray and liver-brown colors.
					300	90	Shaly gray limestones and shales, buff crystalline dolomite, and thin white limestone.
	Cambrian.	Ch'au-mi-tién limestone.	€cm	36, 45, 47, 50, 67, 68.	600	180	Blue-gray limestone, conglomeritic at various horizons.
				34, 38, 41, 42, 49.			
		Ku-shan shale.	€k		50	15	Green shale and slabby limestone
		Ch'ang-hia limestone.	€ch	22, 24, 25, 26	500	150	Gray limestone mottled with ocher.
				19.			
				18, 21, 35, 46.			Dark gray oolitic limestone.
				30, 51.			
				29, 48.			Olive-gray oolitic limestone.
				23.			
				28.			
		Man-t'o shales.	€m	17.	500	150	Brown shale with thin gray limestones.
				20.			Buff and gray shales with gray and buff earthy limestone and black slabby limestone.
				31.			
				15, 16, 27.			
T'ai-shan.	Archean.	T'ai-shan complex.	Ar				Schists and gneisses with intruded granite, syenite, etc.
				Totals	3,750	1,135	

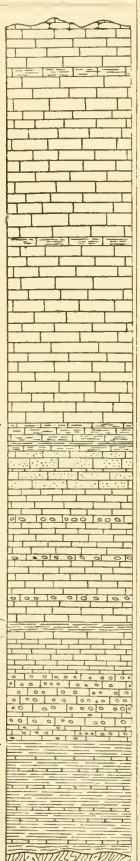


FIG. 1.—SECTION OF THE SINIAN SYSTEM IN THE CH'ANG-HIA DISTRICT, SHAN-TUNG

[1] Willis and Blackwelder, 1907. Pub. No. 54, Carnegie Institution of Washington, Vol. I.

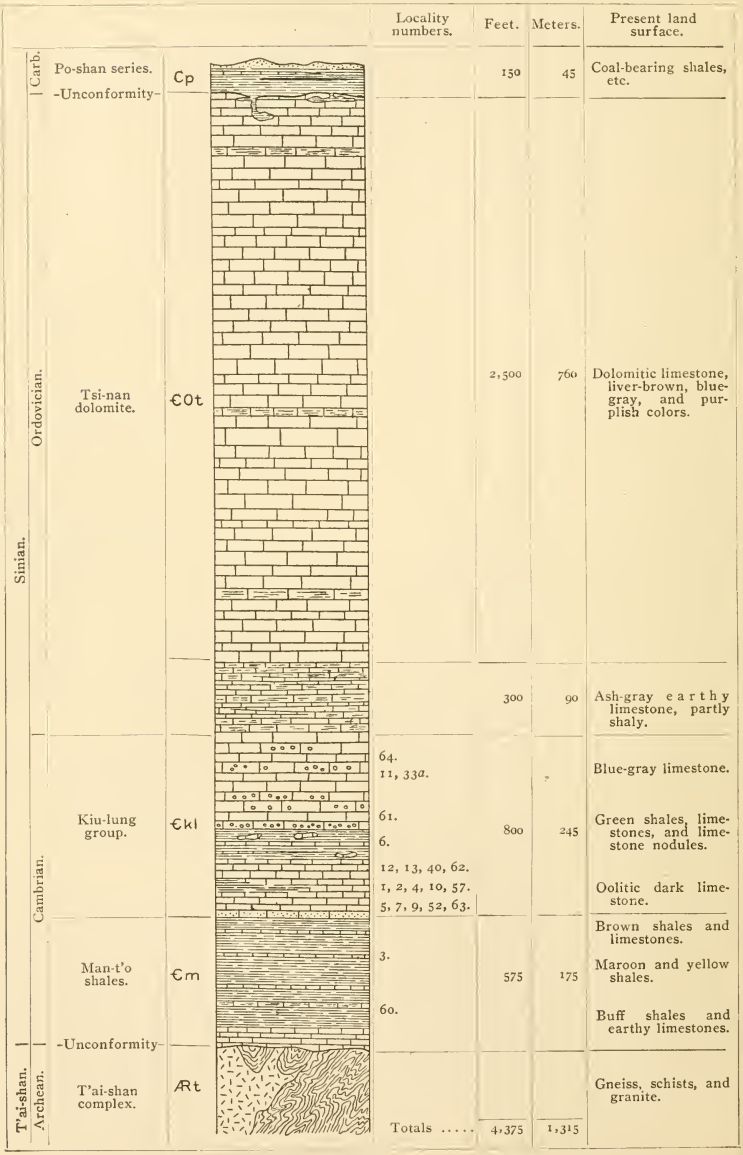
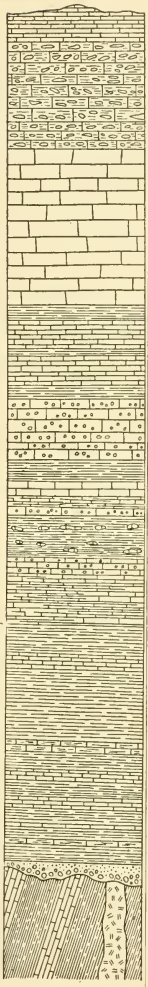


FIG. 2.—SECTION OF THE SINIAN SYSTEM IN THE SIN-T'AI DISTRICT, SHAN-TUNG



			Locality numbers.	Feet.	Meters.	Present land surface.
Cambro-Ordovician.	Ki-chóu limestones.	€Ok	74.	20+	6+	Dense blue limestone.
			73.	75	23	Ocherous, gray, dense, conglomeritic limestone.
			77.	110	33	Massive ocherous gray limestone.
			37, 72.	65	20	Brown and gray shales and thin-bedded limestone.
			71.	45	14	Massive gray oolitic limestone.
				15	4.5	Gray shales.
				9	3	Gray crystalline limestone.
				8	2.5	Gray calcareous shale.
				5	1.5	Oolitic limestone.
			69.	30	9	Gray and buff shales with limestone nodules.
			70.	12	3.5	Hard brown-gray oolitic limestone.
			75.	35	10.5	Slabby buff limestone, dense and hard.
	Man-t'o shales.	€m		80	25	Red shales with thin reddish limestones.
				40	12.5	Red shale and argillaceous limestone, with thin yellow limestones
				30	9	Red shale and thin limestone.
				4	1.3	Argillaceous yellow limestone.
				12	3.5	Red calcareous shale.
Algonkian.				3 to 15	1 to 5	Red sandstone and conglomerate.
	Hu-t'o system.	Ah		610+	180+	Purple argillites; siliceous limestones and dikes of greenstone.

FIG. 3.—PARTIAL SECTION OF THE SINIAN SYSTEM SOUTH OF TUNG-YÜ, SHAN-SI

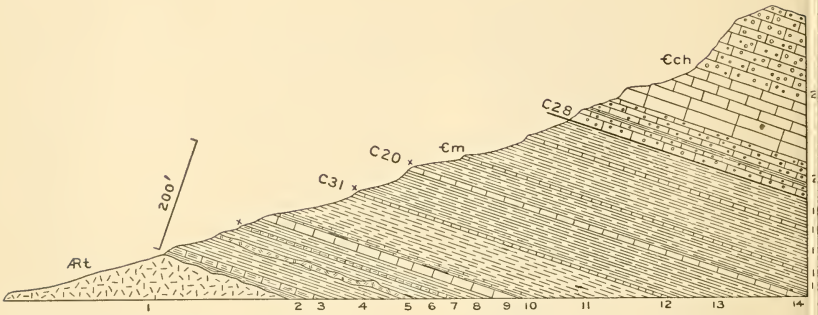


FIG. 4 (Blackwelder).—Ch'ang-hia, Shan-tung. Section of Cambrian strata in the north side of Man-t'o butte. 1 = red granite; 2 = soft yellow shales; 3 = buff earthy limestone; 4 = gray and buff calcareous shales; 5 = syenite-porphyry sheet; 6 = greenish shale; 7 = earthy limestone; 8 = maroon shale; 9 = buff earthy limestone; 10 = white calcareous shale; 11 = red shale; 12 = olive-gray limestone; 13 = dark shales; 14 = gray limestone; 15 = maroon shale; 16 = gray limestone; 17 = brown and gray shales; 18 = gray limestone; 19 = brown shale; 20 = thin-bedded, dark oolite and greenish shale; 21 = gray limestone with black oolitic bodies. This scale of thickness is indicated in feet.

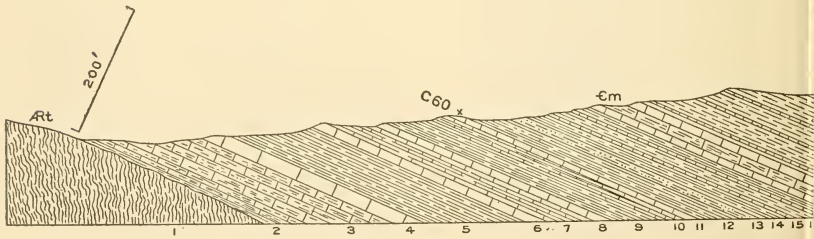


FIG. 5 (Blackwelder).—Yen-chuang, Shan-tung. Section of Cambrian strata in the western part of the Kiu-lung-shan. 1 = gray gneiss; 2 = bright green shale; 3 = gray earthy limestone; 4 = dense blue-black limestone; 5 = brown and yellow shale; 6 = blue-gray limestone; 7 = shaly gray limestone: 8 = dense blue-black limestone; 9 = yellow shale; 10 = gray limestone and shale; 11 = slaty black limestone; 12 = chocolate slate; 13 = brown shaly sandstone; 14 = yellow shale; 15 = buff earthy limestone; 16 = red shale. (Section continued in fig. 6.)

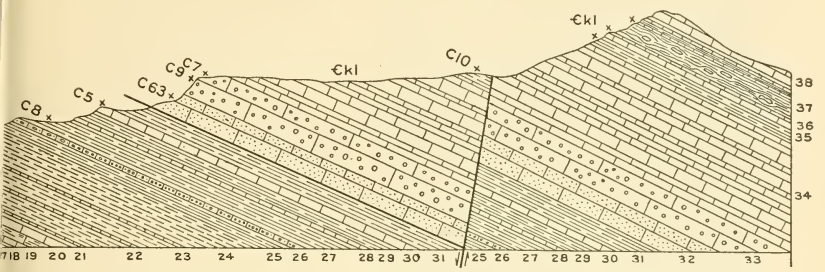


FIG. 6.—17 = black limestone; 18 = yellow shale; 19 = purple-gray limestone; 20 = gray limestone; 21 = yellow shale and thin limestone; 22 = red shale and thin limestone; 23 = green-gray limestone; 24 = red and yellow shale; 25 = maroon shale; 26 = greenish conglomeritic limestone; 27 = brown shale; 28 = buff earthy limestone; 29 = olive-green shale; 30 = cross-bedded green-gray limestone; 31 = olive shale; 32 = gray sandy limestone; 33 = hard dark oolite; 34 = light and dark gray limestone; 35 = green shale; 36 = dense gray limestone; 37 = green nodular shale and thin limestone; 38 = massive dark limestone. The scale of thickness of figures 5 and 6 is indicated in feet.

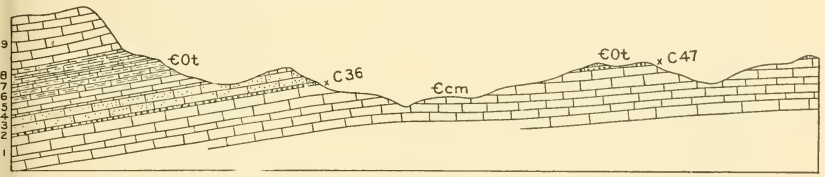


FIG. 7 (Blackwelder).—Ch'au-mi-tién, Shan-tung. Section of Upper Cambrian and Lower Ordovician strata in the ridge east of the village. 1 = dense blue-gray limestone; 2 = conglomeritic limestone; 3 = sandy yellow dolomite; 4 = white earthy limestone; 5 = buff crystalline dolomite; 6 = shaly gray limestone; 7 = blue-gray limestone; 8 = slabby yellow limestone; 9 = dense brown limestone.

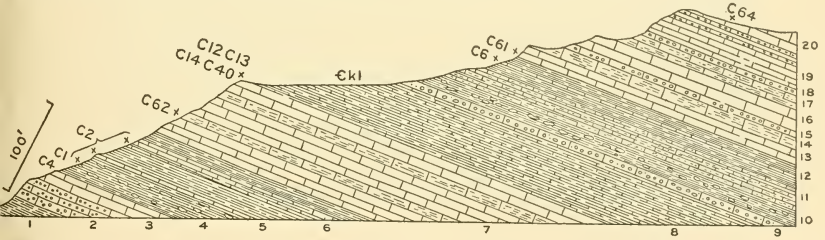


FIG. 8 (Blackwelder).—Yen-chuang, Shan-tung. Section of Kiu-lung formation in Kiu-lung-shan. 1 = Man-t'o shales; 2 = dark limestone, partly oolitic; 3 = dense gray limestone; 4 = nodular green shale; 5 = dense gray limestone; 6 = gray shale and slabby limestone; 7 = thin-bedded dense gray limestone; 8 = green calcareous shale; 9 = conglomeritic limestone; 10 = nodular green shale; 11 = slabby blue limestone; 12 = shaly limestone and gray shale; 13 = black limestone; 14 = slaty gray limestone; 15 = conglomeritic limestone; 16 = massive gray limestone; 17 = thin-bedded gray limestone; 18 = red conglomeritic limestone; 19 = dark gray limestone, locally conglomeritic; 20 = massive gray limestone.

The assembling of the various geologic sections for the purpose of correlating them and their contained faunas led to the construction of fig. 9, on page 57, in which each section is assigned its approximate position in relation to the other sections and to a theoretically entire section. The various finds of fossils are given the same locality number as in the sections already described and in the list of localities [pp. 17-34].

Section in Manchuria

The following section was measured by Prof. Joseph P. Iddings on the island of Tschang-hsing-tau, Province of Liau-tung, Manchuria. Read from the top downward:

	FEET
Massive dark gray limestone, in places mottled	200
About 500 feet of thinly bedded nodular limestone and shale. Hard and upturned, with occasional signs of trilobites. Locality 36*f* is in the upper portion of this belt	500
About 300 feet of massive limestone, in places oolitic. Locality 36*j*	300
20 feet of shale followed by thinly bedded limestone. Locality 35*q*	20
Huge concretions resembling corals—4 to 6 feet in diameter in thin buff shale. Locality 36*i*	4-5
More abundant shale, less limestone and green, dark gray, and brownish shales with thin layers of nodular limestone. Locality 35*p*	200
The exact connection is not shown of localities 35*n*, 35*r*, 36*c*, and 36*e*: green and purple shales	
White quartzitic sandstone in low cliffs, only narrow belt exposed	
Total	1,225

Notes on Horizon of Collections

Localities 35*n*, 35*r*, 36*c*, 36*d*, and 36*e* are very nearly the same horizon, being located above a low bluff, 10 feet high, with nearly horizontal strata in places slightly folded and faulted. These are the lowest beds and not far above the basal.

Locality 35*p* is about 80 feet higher up in the shales and limestone.

Locality 36*h* is about 50 feet higher than No. 35*p*.

Localities 36*g* and 35*o* are back from the bluff on drainage cuts in shale about the horizon of No. 36*h*, I judge.

Locality 35*q* is about 70 feet higher up than No. 36*h*.

Locality 36*f* is the highest from which fossils were collected and is possibly 800 feet higher up than No. 36*c*.

DISCUSSION OF THE CAMBRIAN FAUNA OF CHINA

The discussion of the fauna might be extended to include a detailed comparison of each species with forms resembling it from Cambrian formations in other parts of the world, but the illustra-

VIEW SHOWING MASSIVE CHARACTER OF CAMBRO-ORDOVICIAN LIMESTONE, IN BROAD SYNCLINE EAST OF YAU-T'ÓU COAL FIELD, PROVINCE OF SHAN-SI.

View also illustrates abrupt walls of recent canyons where they are cut in heavy limestone. On the T'ai shan-ho 4 miles (6.4 km.) southwest of Shi-pan-k'óu, in the district of Wu-t'ai-hién, Province of Shan-si. (After Willis, Research in China, Pub. No. 54, Carnegie Institution of Washington. Vol. 1, Pt. 1, 1907, Pl. 20, p. 148.)

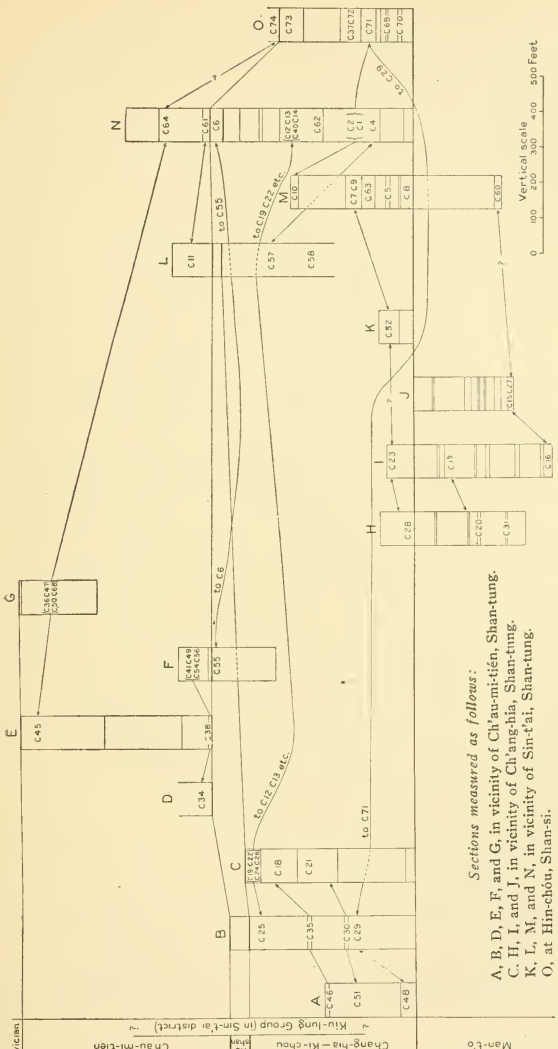


FIG. 9.—Correlation Table of the Fossiliferous Sections measured by Professors Willis and Blackwelder, showing Stratigraphic Positions of the Localities.

tions on the plates show the characters of the species so well that I will leave to each investigator the decision as to whether the species of the fauna he may be considering are similar to those of the Chinese Cambrian. In the following notes only general statements and conclusions are given.

Algæ.—So far as known no true Algæ have been found, but fillings of mud cracks and annelid trails occur resembling stems of Algæ; their true character may be determined by comparison with similar recent phenomena.

Foraminifera.—The almost total absence of Foraminifera is probably due to oversight connected with hurried collecting and to the absence of favorable conditions for the presence and preservation of specimens. The one species *Globigerina ? mantoensis* [plate 1,[1] fig. 1] is all that has been detected in the relatively large collections.

Porifera.—Only a few spicules of *Protospongia* are known. These indicate that when a favorable locality is discovered a fine representation of the sponges will be found.

Anthozoa.—One genus with one species of *Coscinocyathus* suggests the great development of the Archæocyathinæ in the Atlantic Basin fauna as found in the islands of Sardinia and Newfoundland, and the Pacific Basin fauna in the Cordilleran area of Nevada in western America. In Asia the type is known from Siberia as described by Eduard von Toll.[2]

Annelida.—A few trails are all the traces that have been found of the annelids. One of these is illustrated by plate 1, figure 5.

Brachiopoda.—Among the brachiopods none of the genera is peculiar to the Chinese Cambrian. All belong to genera found in the Middle Cambrian of western North America and northwestern Europe. The genus *Micromitra* is well developed and I have inserted on plate 1, figure 13, a photographic reproduction of a specimen from the Middle Cambrian of British Columbia, that has the pedicle and surface spines finely preserved.

Gastropoda.—The patelloid forms are represented by two genera, *Scenella* and *Matherella,* and three species, two from the Middle Cambrian (C 18, C 70) and one from the Upper Cambrian (C 56); the cone-shaped forms by three species of the genus *Helcionella,* one of which, *Helcionella rugosa chinensis* [plate 5, fig. 8], has a

[1] The plate numbers refer to plates accompanying the large memoir on "The Cambrian Faunas of China," Pub. No. 54, Vol. 3, Carnegie Institution of Washington, 1913.

[2] Mém. de l'Acad. imp. des sci. de St. Pétersbourg, 8th ser., Vol. 8, No. 10, 1899, Beiträge zur Kentniss des sibirischen Cambrium.

dissepiment toward the apex, a feature also shown by both *H. ? ? simplex* [plate 5, fig. 11] and *H. ? clurius* [plate 5, fig. 7]. The coiled gastropods are of unusual interest, as three forms, *Matherella ?* sp. undt. (C 55) [plate 5, fig. 6], *Pelagiella chronus* (C 1, C 4, C 18) [plate 5, figs. 9, 9*a-b*], and *P. willisi* (C 72) [plate 5, figs. 12, 13] are from the Middle Cambrian.

Pteropoda.—The species of the genera *Hyolithes* and *Orthotheca* are of the usual Cambrian type. I have introduced on plate 6, figure 8, a reproduction from a photograph of a *Hyolithes* (*H. carinatus* Matthew) that shows the operculum in position, also the support of the fin-like arms so characteristic of recent pteropods.

Cephalopoda.—One genus and one species from a horizon 480 feet (146 m.) below the summit assigned to the Upper Cambrian are all that are known of this class. The species *Cyrtoceras cambria* (C 56) [plate 6, figs. 4, 4*a-c*][1] is a typical example of the family Cyrtoceridæ and from its presence we are compelled to consider that there was a large and varied cephalopod fauna in the area, from which it migrated into the Sinian sea. It is a reminder of our want of data on the fauna of the Upper Cambrian and of the great harvest to be gathered by the future field-worker and student of the stratigraphic geology of Asia.

In the Ozark region of Missouri in North America Ulrich has found both the Cephalopoda and Gastropoda extensively developed at a horizon not much above that of *Cyrtoceras cambria,* if we base the correlation on the character of the trilobites in the two distant localities.

Trilobita.—The exceptional genera of the Trilobita found in China and not known to occur elsewhere are *Stephanocare* [plate 7], *Teinistion* [plate 9], *Blackwelderia* [plate 9], *Damesella* [plate 9], and *Drepanura* [plate 10]. All other genera are represented in western North America and western Europe, and there is a striking resemblance even to specific characters in many of the forms. The most noticeable omissions of American and European genera from the Chinese fauna are *Paradoxides* of the Atlantic Basin fauna and *Olenoides, Dikelocephalus,* and *Neolenus* of the North American fauna. The closely related genus *Dorypyge* (to *Olenoides*) is found abundantly in China, western United States, and on the island of Bornholm in northwestern Europe.

The genera *Ptychoparia, Conokephalina, Acrocephalites, Inouyia, Agraulos, Lisania, Solenopleura, Anomocare, Anomocarella* and

[1] The plate numbers refer to plates accompanying the large memoir on "The Cambrian Faunas of China."

Coosia are well represented in China, western North America, southwestern United States, and northwestern Europe. *Bathyuriscus* and *Asaphiscus* are essentially Pacific Basin types. They represent the most advanced forms of the Trilobita of Middle Cambrian time and may be compared with *Asaphus* and *Bathyurus* of the Ordovician fauna.

Redlichia is an intermediate form that serves in a limited degree to connect the Mesonacidæ[1] and the Paradoxidæ. Its tapering glabella and elongate eye-lobes recall those of *Nevadia,* and its small pygidium that of *Holmia* and *Callavia.*[2]

Many species of trilobites are represented only by fragments of the cephalon, scattered segments of the thorax, and pygidia that can only be tentatively designated as probably belonging to the same species as an associated cephalon. In some instances the cephala of otherwise distinct genera are so nearly similar that in the absence of the thorax and pygidium they would be referred to one genus. This is particularly the case among the genera of the Ptychoparidæ.

THE LARGER FAUNAL HORIZONS

The geographic distribution and characters of the Lower, Middle, and Upper Cambrian divisions of the eastern and southern Asiatic Cambrian faunas vary to such an extent as to make it desirable to consider them separately. It seems from our present information that the Cambrian sea first transgressed the southern and southeastern sections of the continent in late Lower Cambrian time and that certain changes occurred in its distribution at intervals during the remainder of Cambrian time. The data, however, are still too limited to give more than very approximate limits to the distribution of the faunas. Extended areal mapping of the distribution of the geologic formations and faunas will be necessary before paleogeographic maps of eastern Asia can be made that are more than broad outlines to be changed and filled in very much as the geographic map of Africa was modified from time to time during the last half of the nineteenth century.

Lower Cambrian fauna.—The Lower Cambrian (Man-t'o shale) *Redlichia* fauna of Shan-tung, Shan-si, Yun-nan, and northern India is, so far as known, very distinctive and confined to the Asiatic continent and Australia.

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[1] Walcott, C. D. Smithsonian Misc. Coll., Vol. 53, Cambrian Geology and Paleontology, No. 6, 1910, pp. 231-422, pls. 23-44: *Olenellus* and other genera of the Mesonacidæ.

[2] Idem, pl. 44.

The fauna is unknown in Manchuria, although Blackwelder considered that the Yung-ning sandstone of southern Liau-tung was probably of Lower Cambrian age.[1]

In this and the following lists I have combined the local lists, placing after each species the locality number, so that each species may be traced back to its local list and thus found with its immediate associates in the strata.

In Central Shan-tung the Man-t'o sandstones contain a small fauna, as follows:

Billingsella richthofeni (C 3, C 20)
Obolella asiatica (C 17, C 32')
Helcionella rugosa chinensis (C 3)
Hyolithes delia (C 3)
Hyolithes sp. undt. (C 32')
Redlichia chinensis (C 15, C 16, C 27)
Redlichia nobilis (C 3)
Redlichia sp. undt. (C 6)
Ptychoparia aclis (C 17, C 20, C 31)
Ptychoparia granosa (C 17)
Ptychoparia impar (C 17)
Ptychoparia ligea (C 31)
Ptychoparia (*Emmrichella*) *constricta* (C 3)
Ptychoparia (*Emmrichella*) *mantoensis* (C 20, C 31)

Of the above, *Obolella asiatica, Helcionella rugosa chinensis,* and *Redlichia chinensis* may be considered as characteristically Lower Cambrian. I do not know of the occurrence of the genus *Obolella* above the Lower Cambrian[2] and *Helcionella rugosa* belongs to the same fauna. *Redlichia chinensis* and *R. nobilis* have been referred to as descendent from *Olenellus,*[3] but I would now cite *Callavia* in place of *Olenellus,* as the latter genus appears to have left no descendants. It should also be noted that the very ancient form *Nevadia* has a tapering glabella and long eye-lobes,[4] which leads me to consider *Redlichia* as an example of reversion to a more primitive type in the form of the glabella. The thorax and pygidium of *Redlichia* are more like the same parts in *Wanneria,*[5] except for the median spines of the thoracic segments.

It is to be anticipated that the Man-t'o shale *Redlichia* fauna will be found at other localities in eastern China, but at the present writing the nearest locality is in southern China near Yun-nan, about 1,300 miles (2,100 km.) to the southwest. At this locality *Redlichia chinensis* occurs in a shale and associated with it a new genus of

[1] Blackwelder, Eliot. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, Pt. 1, 1907, Chap. 5, Reconnaissance in southwest Liau-tung, p. 87.

[2] Walcott, C. D. Monogr. U. S. Geol. Survey, Vol. 51, 1912, Cambrian Brachiopoda, p. 588.

[3] Idem, Smithsonian Misc. Coll., Vol. 53, Cambrian Geology and Paleontology, No. 6, 1910, *Olenellus* and other genera of the Mesonacidæ, p. 254.

[4] Idem, pl. 23.

[5] Idem, pl. 30.

trilobites allied to *Agraulos* named *Palæolenus* by Mansuy.[1] The fauna includes:

ANNELIDS:

Planolites ?

BRACHIOPODS:

Obolus ? detritus Mansuy
Obolus damesi Walcott
Obolus cf. *chinensis* Walcott
Lingula yunnanensis Mansuy
Acrothele matthewi eryx Walcott
Acrothele orbicularis Mansuy

OSTRACODS;

Bradoria douvillei Mansuy
Aluta sp. ?
Nothozoe ?

TRILOBITES:

Redlichia chinensis Walcott
Redlichia nobilis Walcott
Redlichia walcotti Mansuy
Redlichia carinata Mansuy
Redlichia sp.
Palæolenus douvillei Mansuy
Palæolenus lantenoisi Mansuy
Palæolenus deprati Mansuy
Ptychoparia yunnanensis Mansuy

An interval of about 1,700 miles (2,700 km.) occurs between the Yun-nan locality of *Redlichia* and its occurrence in northern India in Spiti as the closely allied species *R. noetlingi*.[2]

In western Australia *Redlichia* occurs in the Kimberley district. It was published as *Olenellus ? forresti* [Etheridge, Jr., MSS.] by Arthur H. Foord.[3]

In South Australia a very good specimen of the central portions of the cephalon is mentioned as *Olenellus* sp., by R. Etheridge, Jr.[4]

The distribution of *Redlichia,* of the *R. noetlingi* form, serves to demonstrate that the transgressing Lower Cambrian sea that contained the *Redlichia* fauna was confined to eastern and southeastern China and northern India. The presence of *Redlichia*-like trilobites in southern and western Australia indicates that there was direct connection between the Punjab Lower Cambrian sea of India and the shallow seas about the Australian area. There is no record pointing to a connection between the Punjab-Man-t'o sea and the Lower Cambrian seas of northern Siberia, or western North America.

Middle Cambrian fauna.—The lower portion of the Middle Cambrian section and its contained fauna show that a marked change

[1] Mém. service géol. l'Indo-Chine, Vol. 1, 1912 (received May 8, 1913), fasc. 2, Étude géologique Paléontologie, pp. 27-30.

[2] Mem. Geol. Surv. India, n. ser., Vol. 1, 1901, p. 2; also Idem, series 15, Vol. 7, No. 1, 1910, p. 7.

[3] Geol. Mag., London, Dec. III, Vol. 7, 1890, p. 199, plate 4, figs. 2, 2*a-b*.

[4] Trans. Roy. Soc. South Australia, Vol. 29, 1905, plate 25, fig. 1. (See Tate, idem, Vol. 15, 1892, Cambrian fossils of South Australia, pl. 2, p. 183.)

took place at the close of the Man-t'o shale epoch. Willis concludes that aridity and severe cold were conditions of the climate during Man-t'o shale time; that life was abundant elsewhere and with the changing climate it developed rapidly in the seas following the Man-t'o.[1] Of the rocks of the Kiu-lung group following the Man-t'o, he says:

Middle Sinian, Kiu-lung group.—The Kiu-lung group of Shan-tung is a succession of limestones and shales which immediately follows the Man-t'o formation. Transition beds connect the two. Shale is a common rock in both, but in the Man-t'o it is red, whereas in the Kiu-lung it is green. Limestone is thin-bedded and subordinate in the former, in the latter it is usually massive and predominant. The Man-t'o contains a sparse Middle or Lower Cambrian fauna in its upper portion; the Kiu-lung carries very abundant faunas, which range from Middle Cambrian at the base to Upper Cambrian and possibly to lowest Ordovician at the top.

The known distribution of the limestones and shales and their contained faunas of the Middle Cambrian is outlined by Willis, also the area in which they are supposed to occur.[2] The known distribution from Manchuria on the northeast to central China, and west into northern India,[3] taken with the occurrence of fragments of the fauna in Siberia in the valleys of the Lena, Yenisei, and Angara,[4] indicates something of the extent of the Middle Cambrian sea. The larger area outlined by Willis in which Cambrian rocks are supposed to occur is probably much too small, as later rocks undoubtedly conceal large areas of the Cambrian.

The prevalence of limestones with interbedded calcareous and argillaceous shales indicates relatively shallow seas and favorable environment for the life of the sea. This inference is supported by the number of genera and species already found in the hurried collecting necessitated by the conditions of exploration met with by the Willis and Iddings parties.

In the Ch'ang-hia District the Middle Cambrian is represented in the Ch'ang-hia limestone, in the Sin-t'ai district by the lower portion of the Kiu-lung limestone, and in Shan-si by the lower 400 feet (118 m.) of the Ki-chóu limestone.

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[1] Willis, Bailey. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 2, 1907, Systematic geology, p. 40.

[2] Idem, pl. 4.

[3] Reed, F. R. C. Mem. Geol. Survey India, Palæontologia Indica, ser. 15, Vol. 7, 1910, No. 1, The Cambrian fossils of Spiti, p. 66.

[4] Toll, E. von. Mém. l'Acad. imp. Sci. St. Pétersbourg, 8th ser., Vol. 8, No. 10, 1899, Beiträge zur Kentniss des sibirischen Cambrium, pp. 1-57, pls. 1-8, and 9 text figs.

The lower portion of the Kiu-lung group lower limestone contains the following fauna:

Globigerina ? mantoensis (C 5)
Coscinocyathus elvira (C 75)
Micromitra (Paterina) labradorica orientalis (C 9)
Micromitra (Iphidella) pannula ophirensis (C 5)
Obolus damesi (C 7)
Obolus obscurus (C 63, C 75)
Lingulella (Lingulepis) eros (C 7)
Eoorthis agreste (C 28)
Eoorthis kichouensis (C 75)
Acrotreta pacifica (C 5)
Acrothele rara (C 23)
Orthotheca daulis (C 23)
Scenella ? dilatatus (C 70)
Helcionella ? ? simplex (C 70)
Redlichia finalis (C 58)
Ptychoparia impar var. (C 8)
Ptychoparia lilia (C 75)
Ptychoparia tolus (C 52)
Ptychoparia sp. (C 58)
Ptychoparia (Emmrichella) eriopia (C 23)
Ptychoparia (Emmrichella) theano (C 23)
Conokephalina maia (C 70)
Conokephalina sp. (C 70)
Inouyia abaris (C 7, C 9)
Inouyia armata (C 75)
Inouyia capax (C 70)
Inouyia divi (C 5)
Inouyia melie (C 70, C 75)
Inouyia thisbe (C 28)
Inouyia titiana (C 7)
Agraulos abrota (C 23)
Agraulos dirce (C 52)
Agraulos dolon (C 7)
Agraulos nitida (C 75)
Agraulos uta (C 75)
Agraulos vicina (C 70)
Anomocare latelimbatum (C 52)
Anomocare minus (C 9)
Anomocare sp. (C 5)
Anomocare sp. undt. (C 8)
Anomocarella butes (C 5, C 52)
Anomocarella subrugosa (C 7)
Anomocarella tatian (C 23)
Anomocarella tenes (C 28)
Anomocarella thraso (C 7)
Anomocarella toxeus (C 28)
Coosia decelus (C 9)
Dolichometopus ? sp. (C 5)
Bathyuriscus ? sp. (C 28)

Of the above fauna only three species pass into the strata above. One is *Obolus damesi,* which occurs a little higher in the limestone beneath the horizon of the Ku-shan shale, and it has a possible representative in the upper part of the Upper Cambrian. *Inouyia melie* Walcott and *I. divi* Walcott are found in the strata a little higher in the section.

The next succeeding faunal zone contains:

Protospongia chloris (C 4)
Acrothele matthewi eryx (C 4)
Acrothele rara (C 57)
Acrocreta pacifica (C 4)
Pelagiella chronus (C 4)
Hyolithes cybele (C 4)
Hyolithes ? (operculum) (C 4)
Orthotheca delphus (C 4, C 57)
Agnostus chinensis (C 4, C 57)
Agnostus kushanensis (C 57)
Dorypyge richthofeni (C 57)
Conokephalina vesta (C 69)
Inouyia inflata (C 69)
Agraulos obscura (C 69)
Lisania alala (C 4)
Anomocare alcinoe (C 57)
Anomocare nereis (C 69)
Anomocarella albion (C 4, C 57)
Anomocarella chinensis (C 4, C 57)
Dolichometopus alceste (C 4)
Dolichometopus deois (C 4, C 57)
Dolichometopus hyrie (C 69)

This fauna is at the base of the rich *Dorypyge richthofeni* fauna and several of its species continue up into the next grouping of genera and species, which is one of the most important of the subfaunas of the Middle Cambrian of China. It includes, in the Sin-t'ai district of Shan-tung:

Protospongia chloris (C 1, C 2)
Obolus damesi (C 10)
Obolus minimus (C 1)
Obolus shansiensis ? (C 71)
Obolus (Westonia) blackwelderi (C 1, C 2)
Yorkia ? orientalis (C 71)
Acrotreta pacifica (C 1, C 2)
Acrotreta shantungensis (C 71) (? C 1)
Eoorthis sp. undt. (C 71)
Pelagiella chronus (C 1)
Hyolithes cybele (C 1, C 2)
Orthotheca cyrene dryas (C 2)
Orthotheca glabra (C 71)
Agnostus chinensis (C 1, C 2, C 71)
Dorypyge bispinosa (C 2)
Dorypyge richthofeni (C 1, C 29)
Dorypyge richthofeni lævis (C 71)
Agraulos dryas (C 29)
Inouyia divi (C 1)
Lisania agonius (C 1, C 2)
Solenopleura pauperata (C 71)
Menocephalus sp. undt. (C 10)
Anomocare latelimbatum (C 2)
Anomocarella albion (C 1, C 2)
Anomocarella bigsbyi (C 71)
Anomocarella biston (C 2)
Anomocarella chinensis (C1, C 2)
Anomocarella comus (C 71)
Anomocarella temenus (C 10)
Anomocarella undata (C 71)
Coosia ? daunas (C 2)
Ptychoparia sp. undt. (C 48)
Crepicephalus damia (C 71)
Crepicephalus magnus (C 48)
Lonchocephalus tellus (C 2)
Dolichometopus alceste (C 1)
Dolichometopus deois (C 1, C 2)
Dolichometopus dorceto (C 1, C 2)

In the Ch'ang-hia district, at a supposed slightly higher horizon, the following genera and species occur:

Obolus chinensis (C 62)
Obolus shansiensis (C 37)
Lingulella (Lingulepis ?) sp. undt. (C 72)
Acrotreta lisania (C 22)
Acrotreta cf. *pacifica* (C 24)
Acrotreta shantungensis (C 37, C 62)
Eoorthis sp. undt. (C 26)
Pelagiella willisi (C 72)
Hyolithes cybele (C 22, C 62)
Orthotheca glabra (C 72)
Agnostus sp. undt. (C 24)
Dorypyge richthofeni (C 19, C 24)
Dorypyge richthofeni lævis (C 72)
Damesella brevicaudata (C 19)
Conokephalina sp. undt. (C 72)
Crepicephalus damia (C 26)
Crepicephalus cf. *magnus* (C 25)
Inouyia divi (C 24)
Lisania alala (C 22)
Lisania belenus (C 19)
Lisania bura (C 22)
Solenopleura agno (C 25)
Menocephalus abderus (C 19)
Menocephalus acanthus (C 22)
Menocephalus admeta (C 22)
Levisia agenor (C 25)
Anomocare ? daulis (C 19, C 26)
Anomocare flava (C 72)
Anomocare megalurus (C 37)
Anomocare ? nereis (C 72)
Anomocare sp. (C 25)
Anomocarella chinensis (C 62)
Anomocarella temenus (C 22)
Anomocarella trogus (C 25)
Anomocarella tutia (C 19)
Dolichometopus deois (C 19)
Dolichometopus dirce (C 24)

Above this horizon the fauna again changes. The trilobitic genera *Dorypyge, Dolichometopus,* and *Solenopleura* drop out and the genera *Damesella, Blackwelderia,* and *Teinistion* foreshadow the rich and in many respects unique fauna of the Ku-shan shale.

This fauna in the upper horizon of the Ch'ang-hia limestone in Shan-tung contains the following:

Acrotreta pacifica (C 12)
Teinistion alcon (C 12)
Blackwelderia alastor (C 12)
Blackwelderia cilix (C 73)
Damesella bellagranulata (C 13)
Damesella blackwelderi (C 12, C 13, C 14, C 40)
Pterocephalus asiaticus (C 12)
Inouyia acalle (C 12)
Inouyia ? regularis (C 73)
Lisania ajax (C 12, C 40)
Anomocarella tutia (C 12)

In the Ku-shan shaly beds, just above the beds containing the preceding, the following occur:

Obolus (*Westonia*) *blackwelderi* (C 6)
Dicellomus parvus (C 6)
Acrothele ? minuta (C 6)
Straparollina sp. undt. (C 55)
Agnostus douvillei (C 6, C 55)
Redlichia sp. undt. (C 6)
Stephanocare ? monkei (C 6)
Stephanocare richthofeni (C 6, C 55)
Stephanocare sinensis (C 6)
Stephanocare ? sp. undt. (C 6)
Blackwelderia cilix (C 55)
Blackwelderia sinensis (C 6)
Drepanura ketteleri (C 6, C 55)
Drepanura ketteleri (C 6, C 55)
Ptychoparia (*Emmrichella*) *bromus* (C 6)
Liostracina krausei (C 6)
Shantungia spinifera (C 6)

This assemblage of genera and species forms a varied and unique fauna, which has little in common with the faunas above and below it in the strata. It is a local phase of the Cambrian fauna corresponding somewhat to one of the subdivisions of the Middle Cambrian fauna of western North America as represented by the fauna of the Stephen formation of British Columbia.[1] In each there are trilobites with large pygidia. *Damesella* and *Neolenus,* respectively, are typical examples, and there are several genera not found at other horizons or in other countries.

The Middle Cambrian fauna of China, like that of western North America, is marked by the absence of the genus *Paradoxides.* Fortunately there are other genera that serve to connect the *Paradoxides* fauna of the Atlantic Province with the *Dorypyge* fauna of the Pacific Province. *Dorypyge* is associated with *Paradoxides, Solenopleura, Anomocare,* etc., in northwestern Europe.[2] In China, *Dory-*

[1] Walcott, C. D. The Canadian Alpine Journal, Vol. 1, No. 2, 1908, Mount Stephen rocks and fossils, pp. 243-244, pls. 1-4.

[2] Grönwall, K. A. Danmarks geol. Unders., Række 2, No. 13, 1902, Bornholms Paradoxideslag og deres fauna, pls. 3, 4.

pyge [see Locality 35*r*, p. 33] is found with *Solenopleura, Anomocare, Dolichometopus,* and other genera associated with *Paradoxides* in the Atlantic Province. The order of stratigraphic succession of the *Dorypyge* fauna is essentially the same in the two provinces.

The Middle Cambrian fauna, like that of western North America, is much larger and more abundant than that of the Upper Cambrian. This was due in a considerable degree to the usually favorable conditions existing on account of the great variety of habitat afforded by the seas of the period. The advancing and deepening Middle Cambrian sea forced the local faunas to change their habitat from time to time and they had either to adjust themselves to the new conditions and habitat or to perish. Local isolation for long periods led to the development of new forms, and these, when the barriers were removed, contested and competed for their position and existence with other faunas until, by a process of elimination of those least fit to survive, the development was hastened of a large and varied fauna. By the close of the Middle Cambrian more stable conditions prevailed and the era of rapid evolution was checked until, under the impulse of new conditions of environment and accumulated tendency to change following the close of the Cambrian, a great evolution of new forms of life began.

Upper Cambrian fauna.—The geographic distribution of the formations containing this fauna is the same as for the Middle Cambrian, so far as now known. In the Sin-t'ai district the upper shale (Ku-shan?) and its fauna serve to form an upper horizon to the Middle Cambrian. The first fauna above the Ku-shan shale occurs in a limestone and, although only 10 feet (3 m.) higher in the section, is entirely distinct from that of the Ku-shan shale. It includes the following:

Billingsella pumpellyi (C 61)
Proampyx burea (C 61)
Pterocephalus busiris (C 61)
Chuangia batia (C 11, C 33*a*, C 61)
Chuangia fragmenta (C 61)
Chuangia nitida (C 11)
Ptychaspis baubo (C 61)
Anomocarella bergioni (C 33*a*)

Sixty feet (18 m.) above the Ku-shan shale the fauna includes:

Chuangia batia (C 11, C 33*a*)
Chuangia nitida (C 11)
Anomocarella bergioni (C 33*a*)

In the Ch'ang-hia district, at about 100 to 120 feet (30 to 36 m.) above the base of the formation, the fauna is relatively large and varied. It includes the following:

Obolus matinalis ? (C 54)
Obolus (*Westonia*) sp. undt. (C 56)
Discinopsis sulcatus (C 56)
Eoorthis pagoda (C 54, C 56)
Syntrophia orthia (C 54, C 56)
Scenella sp. undt. (C 56)
Matherella circe (C 56)
Pelagiella pagoda (C 56)
Orthotheca sp. undt. (C 56)
Cyrtoceras cambria (C 56)
Agnostus sp. undt. (C 34)
Conokephalina belus (C 56)
Conokephalina dryope (C 56)
Lisania sp. undt. (C 41)
Pterocephalus busiris (C 54)
Pagodia bia (C 56)
Pagodia dolon (C 41)
Pagodia lotos (C 56)
Pagodia macedo (C 34)
Menocephalus ? depressus (C 49, C 56)
Ptychaspis brizo (C 38)
Ptychaspis cadmus (C 41)
Ptychaspis calchas (C 41)
Ptychaspis calyce (C 42)
Ptychaspis campe (C 42)
Ptychaspis ceto (C 34, C 38, C 54, C 56)
Ptychaspis sp. undt. (C 54)
Coosia carme (C 38)
Hysterolenus sp. (C 38)
Hysterolenus ? (C 56)
Tsinania canens (C 34, C 38, C 54)
Tsinania ceres (C 38)
Tsinania dictys (C 56)
Tsinania sp. undt. (C 54)

The fauna of the upper portion of the Ch'au-mi-tién limestone is best represented from 50 to 75 feet (15 to 23 m.) below the summit of the limestone. It contains a characteristic grouping of genera and species, as follows:

Obolus damesi (C 64)
Eoorthis doris (C 64)
Eoorthis kayseri (C 64, C 68, C 74)
Eoorthis linnarssoni (C 64)
Huenella orientalis (C 64)
Syntrophia orthia (C 64)
Billingsella pumpellyi (C 36)
Pelagiella clytia (C 47)
Hyolithes daphnis (C 64)
Orthotheca cyrene (C 47, C 64)
Coosia ? bianos (C 64)
Anomocare sp. (C 64)
Anomocarella baucis (C 36)
Anomocarella ? sp. undt. (C 68)
Ptychaspis acamus (C 45)
Ptychaspis baubo (C 64)
Ptychaspis bella (C 74)
Ptychaspis cacus (C 64)
Ptychaspis callisto (C 64)
Ptychaspis calyce (C 64)
Ptychaspis ceto (C 45, C 64)
Ptychaspis sp. undt. (C 64)
Ptychaspis sp. (C 47, C 50)
Chuangia batia (C 64)
Chuangia nais (C 64)
Solenopleura beroe (C 64)
Tsinania sp. undt. (45)

The stratigraphic range of the genera of the Upper Cambrian in China is shown by the following table [p. 69]. Of the 27 genera in the table all occur in the Cambrian of North America, with the possible exception of *Chuangia*.

The Upper Cambrian fauna of China is characterized by genera that are well developed in the same fauna in North America. The genus *Ptychaspis* is particularly prominent in species and numbers in the Upper Cambrian both in China and America. *Tsinania* is represented by four species in the central portion of the Ch'au-mi-tién limestone and one at the upper horizon. In America it is found

in the limestones referred to the Upper Cambrian where it has a considerable vertical range[1] and wide geographic distribution.

The absence of a true *Dikelocephalus* is to be noted, as the genus is associated with *Ptychaspis* and *Tsinania* in the Upper Cambrian of the interior portions of the North American continent. It is not certainly known from the western or Cordilleran region.

Class and genus.	Lower Cambrian.	Middle Cambrian.	Upper Cambrian.		
			Base.	Central.	Near summit.
Brachiopoda:					
Obolus		×		×	×
Discinopsis				×	
Billingsella	×		×		×
Eoorthis		×		×	×
Huenella					×
Syntrophia				×	×
Gastropoda:					
Scenella		×		×	
Straparollina		×		×	
Pelagiella		×		×	×
Pteropoda:					
Hyolithes	×	×		×	×
Orthotheca		×		×	×
Cephalopoda:					
Cyrtoceras				×	

Class and genus.	Lower Cambrian.	Middle Cambrian.	Upper Cambrian.		
			Base.	Central.	Near summit.
Trilobita:					
Agnostus		×		×	
Conokephalina		×		×	
Proampyx			×		
Pterocephalus		×	×	×	
Pagodia		×			×
Lisania		×		×	
Solenopleura		×			×
Chuangia		×	×		×
Menocephalus		×		×	
Ptychaspis		×	×	×	×
Anomocare					×
Anomocarella		×	×		×
Coosia		×		×	
Hysterolenus				×	
Tsinania				×	×
Total number...	2	18	6	19	15

FAUNAL PROVINCES OF THE CAMBRIAN IN ASIA

Mr. F. R. Cowper Reed[2] has given a summary of the geographic distribution of the Cambrian formation in Asia, and called attention to the probability that Frech's "Pacific Zoögeographical province" would need to be subdivided.[3] I find that while the Cambrian fauna of the Pacific Province of eastern Asia has a strong generic relationship with that of the Rocky Mountain area of western North America, yet in each area there is a group of genera that are not found in the fauna of the other area. On this account it seems best to consider the Rocky Mountain Province[4] as a subprovince distinct from the Middle and Upper Cambrian of the eastern Asian subprovince of the same periods. The Lower Cambrian *Redlichia* fauna of Asia

[1] Walcott, C. D. Smithsonian Misc. Coll., Vol. 53, Cambrian Geology and Paleontology, No. 5, 1908, Cambrian sections of the Cordilleran area, pp. 175, 177, 192, 204, 205.

[2] Reed, F. R. C. Mem. Geol. Survey India, Palæontologia Indica, ser. 15, Vol. 7, 1910, No. 1, The Cambrian fossils of Spiti, pp. 62-70.

[3] Idem, p. 63.

[4] Walcott, C. D. Bull. U. S. Geol. Survey No. 81, 1891, Correlation papers, Cambrian, pp. 313-330, pl. 1.

is so distinct that there is no probability of its having lived in the same province with the Mesonacidæ fauna of North America. The North American Middle Cambrian fauna is distinctive in having the brachiopod genus *Nisusia* Walcott and the trilobitic genera *Karlia* Walcott, *Ogygopsis* Walcott, *Burlingia* Walcott, *Zacanthoides* Walcott, *Oryctocara* Walcott, and *Neolenus* Matthew.

The Chinese Middle Cambrian fauna has in its upper portion a few genera not known from the North American fauna. These include, as described in this memoir, *Damesella, Blackwelderia, Teinistion, Stephanocare, Drepanura, Shantungia,* and *Liostracina.* The fauna containing the genera mentioned, like that of the genera listed above from North America, belongs to a local fauna that did not obtain a distribution outside of the limited area in which it lived. It could not in either case have developed in the communicating seas in which the greater world-wide and typical fauna of the Middle Cambrian lived.

The Upper Cambrian fauna of China, as now known, is essentially the same in its generic aspect with that of western North America. This is discussed in the section on The Larger Faunal Horizons [pp. 60-69].

A comparison of the faunas in the four local areas of the Cambrian in Asia shows the presence of three provinces:

1. Shan-tung Province (including Manchuria and Shan-si subprovince).
2. Pun-jab Province (including Yun-nan area).
3. Siberian Province.

The largest fauna is that of the Shan-tung subprovince. This includes the Cambrian area in Shan-tung and its extension northward in Manchuria. The species common to the Shan-tung and Manchuria areas are:

Protospongia chloris
Micromitra (Iphidella) pannula ophirensis
Obolus chinensis
Obolus damesi
Obolus shansiensis
Acrothele matthewi cryx
Acrotreta pacifica
Acrotreta shantungensis
Hyolithes cybele
Orthotheca cyrene
Orthotheca delphus
Agnostus chinensis
Agnostus douvillei
Dorypyge richthofeni
Teinistion typicalis
Stephanocare sinensis
Blackwelderia sinensis
Damesella brevicaudata
Drepanura premesnili
Liostracina krausei
Shantungia spinifera
Solenopleura agno
Solenopleura beroe
Anomocare megalurus
Anomocare minus
Anomocare subquadratum
Anomocarella chinensis
Anomocarella temenus
Dolichometopus deois

The Shan-si subprovince[1] has five species of Middle Cambrian fossils and one Upper Cambrian species common to it and to the southern Shan-tung Province area in Shan-tung, as follows:

LOWER CH'ANG-HIA FAUNA.—*Obolus obscurus, Obolus shansiensis, Acrotreta shantungensis, Agnostus chinensis, Crepicephalus damia.*

CH'AU-MI-TIÉN FAUNA.—*Plectorthis kayseri.*

With the Manchurian extensions of the Shan-tung Province the Shan-si fauna has five species in common, as follows:

SHAN-SI AND MANCHURIA.—*Obolus shansiensis, Acrotreta shantungensis, Orthotheca glabra, Agnostus chinensis.*

In southern China, as previously stated [p. 62], there is no record pointing to a connection between the Punjab-Man-t'o sea and the Lower Cambrian seas of northern Siberia, or western North America. The fauna described by M. Mansuy [p. 62] is related to the Man-t'o shale *Redlichia* fauna of Shan-tung.

In Middle Cambrian time, as stated by Reed, the Spiti fauna is more strongly related to that of western North America than to any other Middle Cambrian fauna.[2] So far as China is concerned, the northern Indian fauna is that of another faunal province.

The Cambrian fauna of the Siberian Province includes species that are referred to the Middle Cambrian fauna, and a few that may be tentatively assigned to the Lower Cambrian. Doctor von Toll has identified a number of genera of the Archæocyathinæ[3] that may occur in the upper portion of the Lower Cambrian terrane. The one species of *Coscinocyathus* from China, *C. elvira* Walcott, occurs in the Middle Cambrian, but this is a very small form and may have been a survival in Middle Cambrian time of the large Archæocyathinæ fauna of late Lower Cambrian time. In North America the Archæocyathinæ flourished most abundantly in late Lower Cambrian time[4] on both the eastern and western sides of the continent. Von Toll lists from the *Archæocyathus* limestones of Torgoschino,[5] in

[1] The geographic distribution of the Shan-tung, Manchuria, and Shan-si Cambrian rocks is shown by Willis: Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 2, 1907, Systematic geology, plate 4.

[2] Reed, F. R. C. Mem. Geol. Survey India, Palæontologia Indica, ser. 15, Vol. 7, 1910, No. 1, The Cambrian fossils of Spiti, pp. 64, 65.

[3] Toll, E. von. Mém. l'Acad. imp. Sci. St. Pétersbourg, 8th ser., Vol. 8, No. 10, 1899, Beiträge zur Kentniss des sibirischen Cambrium, p. 53.

[4] Walcott, C. D. Tenth Ann. Rept. U. S. Geol. Survey, 1890, Pt. 1, The fauna of the Lower Cambrian or *Olenellus* zone, pp. 599-602, pls. 50-55.

[5] Toll, E. von. Mém. l'Acad. imp. Sci. St. Pétersbourg, 8th ser., Vol. 8, No. 10, 1899, Beiträge zur Kentniss des sibirischen Cambrium, p. 53.

addition to sixteen species of the Archæocyathinæ, two species of trilobites, *Dorypyge slatkowskii* Schmidt and *Solenopleura ? sibirica* Schmidt. The species of *Dorypyge* is quite unlike *Dorypyge richthofeni* Dames from the Middle Cambrian of Shan-tung, and the *Solenopleura ? sibirica* has no representative in the Chinese Cambrian fauna. He also places *Microdiscus lenaicus* von Toll in the Lower Cambrian along with the Torgoschino limestone fauna.[1] I see no objection to this arrangement, but I would place the fauna as of late Lower Cambrian age. This would bring it in point of time in correlation with the *Redlichia* fauna of the Shan-tung and Pun-jab provinces. The Siberian fauna, however, is that of the lower Cambrian of Australia, Sardinia, and North America. This leads to the conclusion that the Siberian province was quite distinct in Lower Cambrian time from the Shan-tung and Pun-jab provinces, and that, as von Toll so well states, "The Sinio-Siberian sea stood on the one hand in connection with the Pacific-Amercian and on the other with the Atlantic-European."[2]

In Middle Cambrian time a group of trilobites lived in the Shantung sea that I have illustrated on plate 15 under the genera *Inouyia* and *Levisia*. Among the species described by von Toll from the limestone on the Lena river is one that appears to come within the genus *Levisia*. *Ptychoparia czekanowskii* von Toll[3] is exceedingly close to *Levisia agenor* (Walcott) [plate 14, fig. 19]; and *Ptychoparia meglitzkii* von Toll[4] has the broad, swollen anterior limb, broad free cheeks, and conical glabella of some of the *Inouyia* [plate 14, figs. 9, 12, 13, 15]. Von Toll describes three species of *Microdiscus* and *Agnostus schmidti* from the Lena limestone; also a species of *Hyolithes*, fragments of a trilobite doubtfully referred to *Olenellus*, and two brachiopods, *Kutorgina cingulata* Billings and *? Obolella* cf. *chromatica* Billings.

The general facies of this Lena limestone fauna led von Toll to place it in the Lower Cambrian, but in the absence of forms that are distinctly of Lower Cambrian age there remains a doubt. In any event the fauna is, with the exception of the two trilobites referred to *Ptychoparia* by von Toll, distinct from the fauna of the Shantung Province.

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[1] Toll, E. von. Mém. l'Acad. imp. Sci. St. Pétersbourg, 8th ser., vol. 8, No. 10, 1899, Beiträge zur Kentniss des sibirischen Cambrium, p. 54.

[2] Idem, p. 56.

[3] Idem, pl. 1, fig. 1.

[4] Idem, pl. 1, fig. 2.

The two species of trilobites described by Schmidt from the banks of the Wilui[1] as *Anomocare pawlowskii* and *Liostracus ? maydeli,* are clearly Middle Cambrian forms and comparable with species that I have referred to the genus *Anomocarella* [plate 19] in respect to their large eyes and broad glabella, but not in their narrow frontal limb and rounded frontal rim. These trilobites indicate that in Middle Cambrian time there was no direct connection between the Shan-tung and Siberian provinces.

BIBLIOGRAPHY

The accompanying short Bibliography includes the titles of those publications to which reference is made in this paper.

BLACKWELDER, ELIOT. 1907a. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, pt. 1, 1907 (Apr.), chap. 2, pp. 19-58: Stratigraphy of Shan-tung.

——— 1907b. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, pt. 1, 1907 (Apr.), chap. 5, pp. 85-96: Reconnaissance in southwest Liau-tung.

——— 1907c. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, pt. 1, 1907 (Apr.), chap. 12, pp. 265-279: Stratigraphy of the Middle Yang-tzĭ Province.

——— 1907d. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, pt. 2, 1907 (June), pp. 357-507, pls. 52-63: Petrography and zoology.

BURRARD, S. G., and HAYDEN, H. H. 1908. A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet, pt. 4, 1908, pp. 207-308, pls. 39-50: The Geology of the Himalaya.

DAMES, WILHELM. 1883. China, by Baron von Richthofen, Vol. 4, 1883, pp. 1-33, pls. 1 and 2: Cambrische Trilobiten von Liau-tung.

DEPRAT, J. 1912. Mémoires du service géologique de l'Indo-Chine, Vol. 1, 1912 (received late in 1913), fasc. 2, Étude géologique du Yun-Nan oriental, Ie partie, pp. 1-370, pls. 1-20: Geologie générale. Accompanied by Atlas.

ETHERIDGE, R., JR. 1896. Proceedings of the Royal Society of Victoria for 1895, new (2d) ser., Vol. 8, 1896 (Apr.), pp. 52-64: The existence of a Cambrian fauna in Victoria.

——— 1905. Transactions and Proceedings and Report of the Royal Society of South Australia, Vol. 29, 1905 (Dec.), pp. 246-251, pl. 25: Additions to the Cambrian fauna of South Australia.

FOORD, A. H. 1890. Geological Magazine, London, Decade 3, Vol. 7, 1890 (March and Apr.), pp. 98-106, 145-155, pls. 4-7. Description of fossils from the Kimberley District, Western Australia.

[1] Toll, E. von. Mem. l'Acad. imp. Sci. St. Petersbourg, 8th ser., vol. 8, No. 10, 1899, Beiträge zur Kenntniss des sibirischen Cambrium, p. 3.

GOTTSCHE, C. 1886. Sitzungsberichte der königlich preussischen Akademie der Wissenschaften zu Berlin, 1886, zw. halb-bd. (June-Dec.), pp. 857-873, p. 8: Geologische Skizze von Korea.

GRÖNWALL, K. A. 1902. Danmarks Geologiska Undersögelse, Række 2, No. 13, 1902, pp. i-ix, 1-230, pls. 1-5: Bornholms Paradoxideslag og deres fauna.

KAYSER, F. H. E. 1883. China, by Baron von Richthofen, Vol. 4, Abth. 1, Abh. 2, 1883, pp. 34-36, pl. 3: Cambrische Brachiopoden von Liau-tung.

LORENZ, TH. 1904. Centralblatt für Mineralogie, Geologie und Palæontologie, 1904, No. 7, pp. 193-194: Ascosomaceae, eine neue Familie der Siphoneen aus dem Cambrium von Shan-tung.

——— 1905. Zeitschrift der deutschen geologischen Gesellschaft, Bd. 58, 1905: Beiträge zur Geologie und Palæontologie und Palæontologie von Ostasien unter besonderer Berücksichtigung der Provinz Shan-tung in China, pp. 5-64, 5 supplements, 2 text figs.: I Teil.

——— 1906. Zeitschrift der deutschen geologischen Gesellschaft, Bd. 58, 1906, pp. 53-108, pls. 4-6, and 55 text figures: Beiträge zur Geologie und Palæontologie von Ostasien unter besonderer Berücksichtigung der Provinz Schan-tung in China; II: Palæontogischer Teil.

MANSUY, H. 1913. Mémoires du service géologique de l'Indo-Chine, Vol. 1, 1912 (received May 8, 1913), fasc. 2, Étude géologique du Yun-nan oriental, 11e partie, pp. 1-146, pls. 1-25: Paléontologie.

MONKE, H. 1903. Jahrbuch der königlich Preussischen Geologischen Landesanstalt und Bergakademie zu Berlin, Bd. 23, Hft. 1, 1902, Beiträge zur Geologie von Schan-tung, pp. 103-151, pls. 3-9: 1. Obercambrische Trilobiten von Yen-tsy-yai.

REDLICH, K. A. 1901. Memoirs of the Geological Survey of India, Palæontologia Indica, new ser., Vol. 1, No. 1, 1901, pp. 1-13, pl. 1: The Cambrian fauna of the eastern Salt-Range.

REED, F. R. C. 1906. Memoirs of the Geological Survey of India, Palæontolgia Indica, new ser., Vol. 2, pp. 1-154, pls. 1-8: The Lower Palæozoic fossils of the Northern Shan States, Burma.

——— 1910. Memoirs of the Geological Survey of India, Palæontologia Indica, ser. 15, Vol. 7, 1910, No. 1, pp. 1-70, pls. 1-6: The Cambrian Fossils of Spiti.

RICHTHOFEN, F. VON. 1882. China, 1882, Bd. 2, Das Nördliche China, pp. 1-792, pls. 1-8.

——— 1883. China, 1883, Bd. 4, Palæontologischer Theil, 1. Abhand., pp. 31-33, pls. 1, 2: Cambrische Trilobiten von Liau-tung.

SCHMIDT, FR. 1886. Mélanges Physiques et Chimiques tirés du Bulletin de l'Académie impériale des sciences de St. Pétersbourg, Vol. 12, 1886, pp. 407-424, pl. 12, figs. 1-26: Ueber einige neue ostsibirische Trilobiten und verwandte Thierformen.

TATE, R. 1892. Transactions of the Royal Society of South Australia for 1892, Vol. 15, pt. 2, 1892 (Dec.), pp. 183-189, pl. 2: Cambrian fossils of South Australia.

TOLL, E. VON. 1899. Mémoires de l'Académie impériale des sciences de St. Pétersbourg, 8th ser., Vol. 10, 1899, pp. 1-57, pls. 1-8, and 9 text figs.: Beiträge zur Kenntniss des sibirischen Cambrium.

ULRICH, E. O. 1911. Bulletin of the Geological Society of America, Vol. 22, 1911, pp. 261-680, pls. 25-29: Revision of the Paleozoic Systems.

WALCOTT, C. D. 1884a. Bulletin United States Geological Survey No. 10, 1884, pp. 1-74, pls. 1-10: On the Cambrian faunas of North America: Preliminary studies.

——— 1891a. Tenth Annual Report United States Geological Survey, 1890, pt. 1, pp. 509-774, pls. 43-98: The fauna of the Lower Cambrian or Olenellus zone. (This report is dated 1890, but was not issued until well along in 1891.)

——— 1891b. Bulletin United States Geological Survey No. 81, 1891, pp. 1-447, pls. 1-3: Correlation papers, Cambrian.

——— 1899. Bulletin Geological Society of America, Vol. 10, 1899, p. 199: Pre-Cambrian fossiliferous formations.

——— 1905a. Proceedings Washington Academy of Sciences, Vol. 7, 1905 (July 24), pp. 251-256: The Cambrian fauna of India.

——— 1905b. Proceedings United States National Museum, Vol. 29, 1905 (Sept. 6), pp. 1-106: Cambrian faunas of China.

——— 1906. Proceedings United States National Museum, Vol. 30, 1906 (May), pp. 563-595: Cambrian faunas of China, paper No. 2.

——— 1908a. The Canadian Alpine Journal, Vol. 1, No. 2, 1908, pp. 232-248, 5 ills., 4 pls.: Mount Stephen rocks and fossils.

——— 1908b. Smithsonian Miscellaneous Collections, Vol. 53, Cambrian Geology and Paleontology, No. 5, 1908 (Dec.), pp. 167-230, pls. 13-22: Cambrian sections of the Cordilleran area.

——— 1910a. Smithsonian Miscellaneous Collections, Vol. 53, Cambrian Geology and Paleontology, No. 6, 1910 (Aug. 12), pp. 231-422, pls. 23-44: Olenellus and other genera of the Mesonacidæ.

——— 1910b. Smithsonian Miscellaneous Collections, Vol. 57, Cambrian Geology and Paleontology, No. 1, 1910 (Aug. 18), pp. 1-16: Abrupt appearance of the Cambrian fauna on the North American continent.

——— 1911. Smithsonian Miscellaneous Collections, Vol. 57, Cambrian Geology and Paleontology, No. 4, 1911 (June 17), pp. 69-108, pls. 13-17, text figs. 7 and 7*a*: Cambrian Faunas of China.

——— 1912. Monographs United States Geological Survey, Vol. 51, 1912, pp. 1-872, pls. 1-104, text figs. 1-76: Cambrian Brachiopoda.

——— 1913. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 3, 1913 (July), pp. 1-276, pls. 1-24, 9 text figs.: The Cambrian faunas of China.

WILLIS, BAILEY. 1907. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol 2, 1907 (July), pp. i-v, 1-133, pls. 1-8: Systematic geology.

——— BLACKWELDER, ELIOT and SARGENT, R. H. 1907. Research in China, Pub. No. 54, Carnegie Institution of Washington, Vol. 1, 1907 (Apr.), pt. 1, pp. 1-353, figs. 1-65: Descriptive topography and geology.

WOODWARD, HENRY. 1905. Geological Magazine of London, new ser., Dec. 5, Vol. 2, 1905, pp. 211-215, 251-255, pl. 13: On a collection of trilobites from the Upper Cambrian of Shan-tung, North China.