CAMBRIAN GEOLOGY AND PALEONTOLOGY

III

No. 1.— THE CAMBRIAN FAUNAS OF EASTERN ASIA

(WITH PLATES 1 TO 3)

BY

CHARLES D. WALCOTT

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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 vol-
ume 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 remain-
der held for sale at $5.00 per volume.

I find there is a desire on the part of teachers and students of
gology 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
gologists and students who do not have access to the memoir, per-
mission 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. Mansuy¹ in Indo-China, and on the boundary line be-
tween the Cambrian and post-Cambrian formations.

Yun-Nan oriental, Pt. 1, Géologie général; 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. 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.

PREFATORY OBSERVATIONS

When looking over the descriptions of the stratigraphic sections of the Paleozoic formations of China by Baron Ferdinand von Richthofen, and their contained Cambrian fossils described by Dr. W. Dames, from Liau-tung, and Dr. Emanuel Kayser; 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 1, part 1, 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

---

2 Other papers that I have published on the Cambrian faunas of eastern Asia are as follows:
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. 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 Paläontologie von Ostasien unter besonderer Berücksichtigung der Provinz Schantung in China; II: Palæon- tologischer 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'ō 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, Paläontologischer Theil, I. Abhand., pp. 31-33, pls. 1, 2: Cambriische Trilobiten von Liau-tung.*
Doctor Kayser described and named the following brachiopods:¹

\[ \text{Orthis linnarssoni} = \text{Eoorthis linnarssoni; Lingulella sp.; L. sp.} \]

Of these, we have identified \text{Eoorthis linnarssoni} from the collections of the Carnegie Institution of Washington Expedition to China.

Doctor Dames described and named the following trilobites:²

\[
\begin{align*}
\text{Agnostus chinensis} & \quad \text{Anomocare nanum} \\
\text{Dorypyge richthofeni} & \quad \text{Anomocare planum} \\
\text{Conocephalites frequens} & \quad \text{Anomocare subcostatum} \\
\text{Conocephalites quadriceps} & \quad \text{Liostracus megalurus} \\
\text{Conocephalites subquadratus} & \quad \text{Liostracus talingensis} \\
\text{Conocephalites typus} & \quad ? \text{ Liostracus} \\
\text{Anomocare latelimbatum} & \quad ? \text{ Liostracus} \\
\text{Anomocare majus} & \quad \text{Two pygidia, gen. and sp. undt.} \\
\text{Anomocare minus} & \\
\end{align*}
\]

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

\[
\begin{align*}
\text{Sai-ma-ki (in situ):} & \quad \text{Anomocare latelimbatum} \\
\text{Lingulella} & \quad \text{Anomocare majus} \\
\text{Agnostus chinensis} & \quad \text{Anomocare nanum} \\
\text{Conocephalites frequens} & \quad \text{Anomocare subcostatum} \\
\text{Conocephalites quadriceps} & \\
\end{align*}
\]

\[
\begin{align*}
\text{Ta-ling (loose rock in wall):} & \quad \text{Anomocare minus} \\
\text{Dorypyge richthofeni} & \quad \text{Anomocare nanum} \\
\text{Conocephalites frequens} & \quad \text{Liostracus talingensis} \\
\text{Conocephalites subquadratus} & \quad \text{Liostracus sp. ?} \\
\text{Conocephalites typus} & \\
\end{align*}
\]

\[
\begin{align*}
\text{Wu-lo-pu (dèbris slope):} & \quad \text{Liostracus megalurus} \\
\text{Dorypyge richthofeni} & \quad \text{Anomocare planum} \\
\text{Anomocare majus} & \\
\end{align*}
\]

Of the above we have identified in our collections:

\[
\begin{align*}
\text{Agnostus chinensis} & \quad \text{Conocephalites typus} = \text{Ptychoparia} \\
\text{Dorypyge richthofeni} & \quad \text{Anomocare latelimbatum} \\
\text{Conocephalites subquadratus} & \quad \text{Anomocare minus} \\
= \text{Anomocare} & \quad \text{Liostracus megalurus} = \text{Anomocare} \\
\end{align*}
\]

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, Paläontologischer 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 Cam-
brian 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:

<table>
<thead>
<tr>
<th>Agnostus douvilléi</th>
<th>Arthricocephalus chauveaui</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olenoides leblanci</td>
<td>Dicellocephalus ? sinensis</td>
</tr>
<tr>
<td>Drepanura premesnili</td>
<td>Calymnene ? sinensis</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Agnostus douvilléi</th>
<th>Dicellocephalus ? sinensis = Stephanocare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olenoides leblanci</td>
<td>Calymnene ? sinensis = Blackwelderia</td>
</tr>
<tr>
<td>Drepanura premesnili</td>
<td></td>
</tr>
</tbody>
</table>

From the Cambrian formations of Siberia, Dr. Fr. Schmidt 4 de-
scribed the following fossils:

---

1 China, von Richthofen, 1883, Vol. 4, Palæontologischer Theil, 1. Abhand.,
pp. 31-33, pls. 1, 2: Cambrische Trilobiten von Liao-tung.
2 Gottsche, C. Sitzungsberichte der königlich preussischen Akademie der
Wissenschaften zu Berlin, 1886, zw. halb-bd. (June-Dec.), pp. 805, 807: Geo-
logische 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 impériale
ostsibirischen Trilobiten und verwandte Thierformen.
This fauna was subsequently reviewed by Eduard von Toll, who added the following:

- **Confervites primordialis** Bornemann
- **Archaeocyathus acutus** Bornemann
- **Archaeocyathus aduncus** Bornemann
- **Archaeocyathus iizkii** von Toll
- **Archaeocyathus patulus** Bornemann
- **Archaeocyathus proskurjakowi** von Toll
- **Archaeocyathus sibiricus** von Toll
- **Coscinocyathus calathus** Bornemann
- **Coscinocyathus campanula** Bornemann
- **Coscinocyathus corbica** Bornemann
- **Coscinocyathus dianthus** Bornemann
- **Coscinocyathus elongatus** Bornemann
- **Coscinocyathus irregularis** von Toll
- **Coscinocyathus vesica** Bornemann
- **Coscinocyathus cf. cancellatus** Bornemann

- **Ptychoparia czekanowskii** von Toll

**Inouyia sp. undt.**

**Microdiscus kochi** von Toll

**Microdiscus lenicus** von Toll

**Agnostus schmidti** von Toll

**Protaphoretra** sp. undt.

**Kutorgina cingulata** Billings

**? Obolella chromatica** Billings

**Hyolithes** sp. undt.

**Microdiscus slatkowskii** Schmidt

**Ptychoparia meglitzkii** von Toll

**Dorypygella typalis** Walcott

**=Inouyia**

**Dorypyge slatkowskii** Schmidt

**Ptychoparia meglitzkii** von Toll

**=Inouyia**

**? Solenopleura sibirica** Schmidt

**Bathyuriscus howelli** Walcott

**Coscinocyathus irregularis** von Toll

- **Coscinocyathus vesica** Bornemann

**Dorypyge slatkowskii** Schmidt

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

- **Agnostus koerferi**
- **Drepanura premesnili**
- **Drepanura ketteleri**
- **Drepanura ketteleri**
- **Stephanocare richthofeni**
- **Stephanocare sp.**

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

- **Ptychoparia eus** Walcott........ = **Liostracina krausei** Monke
- **Dorypygella typicalis** Walcott........ = **Teinistion 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

---


I do not find that *Agnostus koeferi* 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 Algae under the new family *Ascosomesae* 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 algae 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.

---

Late in 1906 a short memoir by Dr. Th. Lorenz appeared 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 davidi* and *P. forchhammeri*. The list of species given by him is as follows:

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

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

<table>
<thead>
<tr>
<th>Olenoides (Dorypyge) richthofeni</th>
<th>Dorypyge richthofeni Dames</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Dames)</td>
<td><em>Agnostus chinensis</em> Dames</td>
</tr>
<tr>
<td><em>Agnostus fallax laiwuensis</em> Lorenz</td>
<td></td>
</tr>
<tr>
<td><em>Agnostus parvifrons</em> Linnarsson.n.</td>
<td></td>
</tr>
<tr>
<td>Anomocare ovatum Lorenz.n.</td>
<td></td>
</tr>
<tr>
<td>Anomocare ovatum Lorenz.n.</td>
<td></td>
</tr>
<tr>
<td><em>Amphoton steinmanni</em> Lorenz.n.</td>
<td></td>
</tr>
<tr>
<td><em>Raphistoma bröggeri</em> Lorenz.n.</td>
<td></td>
</tr>
<tr>
<td><em>Acrothel bohemica</em> Barrande.n.</td>
<td></td>
</tr>
</tbody>
</table>

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. In Shan-si the fauna occurs in an oolitic limestone that, by its fauna, is related to the Ch’ang-hia oolite.

---


2 Idem, p. 91.


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

A lower layer with (a):
- Anomocare speciosum Lorenz
- Bathyriscus asiaticus Lorenz
- Agnostus fallax Linnarsson
- Agnostus parvifrons latelimbatus Lorenz
- Acronele granulata Linnarsson

Eighty meters higher up, a layer with (b):
- Teinistion (?) 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)
- Bathyriscus asiaticus Lorenz = Dolichometopus deois Walcott
- Agnostus fallax Linnarsson = A. chinensis Dames
- Agnostus parvifrons latelimbatus Lorenz = A. latelimbatus (Lorenz)
- Acronele granulata Linnarsson = Acronele matthezi eryx Walcott

(b) Teinistion (?) sp. = Damesella cf. blackwelderi Walcott
- Drepanura (?) sp. = Damesella cf. blackwelderi Walcott

(c) Shantungia buchruckeri Lorenz = Ch'angia 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.

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

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

- Lioparia latelimbata (Dames) = Obolella nitida n. sp.
- Shantungia crassa n. g. and sp. = Orthis n. sp.
- A not closely definable brachiopod = Acronele sp.


Lorenz, idem, p. 95.

This is described as Obolella gracilis n. sp., on p. 88 of Lorenz, 1906.
My identification of the fauna is as follows:

_Lioporia latelimbata_ (Dames) Lorenz...... _Anomocare latelimbatum_ Dames
_Shartungia monkei_ Lorenz............. _Pagodia monkei_ (Lorenz)
_Obolella gracilis_ Lorenz............... _Obolus obscurus_ Walcott

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, Shartungia buchruckeri, Obolella gracilis_, or the specimens referred to _Drepanura_ and _Teinistion_. I have had three of the specimens photographed (plate 7, fig. 1a; plate 20, fig. 8; plate 22, figs. 2, 2a, 2b)\(^1\) so that more direct comparison may be made. The original of _Shartungia 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

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\(^1\) 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.

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 inter-bedded 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:\(^4\)

**ANNEIDS:**

- *Planolites* ?

**BRACHIOPODS:**

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

**OSTRACODS:**

- *Bradoria douvillei* Mansuy
- *Aluta* sp. ?
- *Nothozoe* ?

**TRILOBITES:**

- *Redlichia chinensis* Walcott
- *Redlichia nobilis* Walcott
- *Redlichia walcotti* Mansuy
- *Redlichia carinata* Mansuy
- *Redlichia* sp. ?
- *Palaoleonus douvillei* Mansuy
- *Palaoleonus lantenoisi* Mansuy
- *Palaoleonus deprati* Mansuy
- *Ptychoparia yunnanensis* Mansuy

\(^1\) Records Geol. Surv. India, Vol. 40, plate 1, 1910, p. 10.


\(^3\) 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:

<table>
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1 For description of new genus Tsinania, see page 43, this paper.
Former generic reference

Ptychoparia constricta Walcott, 1905
Ptychoparia dryope Walcott, 1905
Ptychoparia granulosa Walcott, 1905
Ptychoparia inflata Walcott, 1906
Ptychoparia (?) maia Walcott, 1906
Ptychoparia mantoensis Walcott, 1905
Ptychoparia sp. undt. Walcott, 1906
Ptychoparia (Liostracus) intermedius Walcott, 1906
Ptychoparia (Liostracus) megalurus Walcott, 1905
Ptychoparia (Liostracus) subrugosa Walcott, 1906
Ptychoparia (Liostracus) thraso Walcott, 1905
Ptychoparia (Liostracus) toxeus Walcott, 1905
Ptychoparia (Liostracus) trogus Walcott, 1905
Ptychoparia (Liostracus) tutia Walcott, 1905
Ptychoparia (Proampyx) burea Walcott, 1905
Shantungia Lorenz, 1906
Shantungia Walcott, 1905
Solenopleura abdersus Walcott, 1905
Solenopleura acanthia Walcott, 1905
Solenopleura acanthia Walcott, 1905
Solenopleura belus Walcott, 1905
Solenopleura chunensis Walcott, 1905
Solenopleura orientalis Walcott, 1905
Solenopleura rugosa chinensis Walcott, 1905
Solenopleura rugosa orientalis Walcott, 1905
Solenopleura simplex Walcott, 1906

Present generic reference

Ptychoparia (Emmrichella) constricta (Walcott)
Ptychoparia (Emmrichella) dryope (Walcott)
Ptychoparia granos Walcott (Walcott)
Ptychoparia inflata (Walcott)
Ptychoparia maia (Walcott)
Ptychoparia mantoensis (Walcott)
Ptychoparia sp. undt. (Walcott)
Ptychoparia (Liostracus) intermedius (Walcott)
Ptychoparia (Liostracus) megalurus (Dames)
Ptychoparia (Liostracus) subrugosa (Walcott)
Ptychoparia (Liostracus) thraso (Walcott)
Ptychoparia (Liostracus) toxeus (Walcott)
Ptychoparia (Liostracus) trogus (Walcott)
Ptychoparia (Liostracus) tutia (Walcott)
Ptychoparia (Proampyx) burea (Walcott)
Shantungia (Chuangia) Walcott
Shantungia (Chuangia) ntidia Walcott
Solenopleura abdersus (Walcott)
Solenopleura acanthia (Walcott)
Solenopleura acanthia (Walcott)
Solenopleura belus (Walcott)
Solenopleura chunensis (Walcott)
Solenopleura orientalis (Walcott)
Solenopleura rugosa chinensis (Walcott)
Solenopleura rugosa orientalis (Walcott)
Solenopleura simplex (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 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 i. 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, Sin-ta'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
Acroreta pacifica
Acroreta shantungensis ?
Pelagiella chronus
Hyolithes cybele
Agnostus chinensis

Dorypyge richthofeni
Inouya divi
Lisania agonius
Anomocarella albion
Anomocarella chinensis
Dolichometopus alceste
Dolichometopus deois
Dolichometopus derceto

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
```

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. 8a (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
```

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
Acrofteta matthevi cryx
Acrotreta pacifica
Pelagiella chronus
Hyolithes cybele
Hyolithes ? (operculum)
Orthotheca delphus
```

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. 8a (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. 30] places the boundary between the Kiu-lung and the Man-t'o, 15 feet below C 5.

_Globigerina_ ? _mantoensis_  
_Inouyia divi_

_Micromitra (Iphidella) pan-
_nula ophirensis_  
_Anomocarella butes_

_Acrotrete pacifica_  
_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-tien 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) blackweld-
eri_  
_Stephanocare ? sp. undt._

_Dicellonus parvus_  
_Blackwelderia sinensis_

_Acrothela ? minuta_  
_Drepanura ketteleri_

_Agnostus douvilléï_  
_Drepanura premesnili_

_Redlichia sp. undt._  
_Ptychoparia (Emmrichella) bromus_

_Stephanocare ? monkei_  
_Liostracina krausei_

_Stephanocare richthofeni_  
_Shantungia spinifera_

_Stephanocare ? sinensis_

**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. 8a bed 33), p. 20], 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_  
_Agraulos dolon_

_Lingulella (Lingulepis) eros_  
_Anomocare subquadratum_

_Inouyia abaris_  
_Anomocarella subrugosa_

_Inouyia titiana_  
_Anomocarella thraos_

**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. 8a (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. 8a (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) labra-

*dorica orientalis*  Anomocare minus

*Coosia decclus*

Inouyia abaris

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. 8a (bed 35), p. 29], about 3 miles (4.8 km.) southwest of Yen-chuang, Sin-t’ai district, Shan-tung.

*Obolus damesi*  Anomocarella temenusa

*Menoccephalus* sp. undt.

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

*Teinistion alcon*  Inouyia acalle

*Teinistion typicalis*  Lisania ajax

*Blackwelderia alastor*  Anomocarella tutia

*Damesella blackwelderi*

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 Liènhua-shan, 6 miles (9.6 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung. Collected at some distance from C12 and includes more. Its horizon is that of bed 7 of fig. 10, page 38.

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


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 C61. Note by C. D. Walcott says it is from stratum 4, the horizon of C12 and C13.

One species, *Damesella blackwelder*.

C15. About same horizon as C16 and C27.

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*.

C16. About same horizon as C15 and C27.

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.

C17. About 180 feet below C23, same section; about 35 feet above C20, adjacent sections; about 160 feet below C28, 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 granosa*  *Ptychoparia aclis*  *Ptychoparia impar*

C18. Below horizon of C19, C22, C24, and C26, same section; above C21, 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*  *Crepicephalus damia*  *Pelagiella chronus*  *Crepicephalus magnus*  *Helcionella rugosa orientalis*  *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.

*Anomocarella daulis*  
*Dolichometopus deois*  
*Solenopleura sp. undt.*

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*  
*Solenopleura sp. undt.*

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.

*Acrothele rara*  
*Orthotheca daulis*  
*Ptychoparia (Emmrichella) theano*  
*Ptychoparia (Emmrichella) eriopia*  
*Menoccephalus acantha*  
*Menoccephalus admeta*  
*Anomocarella temenus*  
*Lisania bura*  
*Lisania alala*  
*Lisania buria*  
*Lisania belenus*  
*Anomocarella tutia*  
*Anomocarella abderus*  
*Damesella brevicaudata*  
*Dorypyge richthofeni*  
*Acrothele lisani*  
*Hyolithes cybele*  
*Menoccephalus abderus*  
*Menoccephalus acantha*  
*Menoccephalus admeta*  
*Anomocarella temenus*  
*Agraulos abrota*  
*Anomocarella tatian*
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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)

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
Solenopleura agno
Levisia agenor

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

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

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*  
*Menocephalus acidalia*  
*Lisania alala*  
*Lisania* sp. undt.  
*Anomocare* sp.

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* ligae

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*  
*Dicellonius parvus*  
*Acrotrcta shantungensis*  
*Orthotheca doris*  
*Microdiscus orientalis*  
*Aluta bergeroni*

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-tien 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-tien formation [Blackwelder, 1907, p. 36, part of the first list of fossils] in road at northeastern corner of small village near Ch'au-mi-tien, Ch'ang-hia district, Shan-tung.

*Pagodia macedo*  
*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-tien, 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-tien limestone [Blackwelder, 1907, p. 36 (part of the third list of fossils), and fig. 9 (bed 2), p. 35], at Ch'au-mi-tien, Ch'ang-hia district, Shan-tung.

Two species, *Billingsella pumellyi* 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-chou limestone, 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-hien, Shan-si.

*Obolus shansiensis*  
*Acrotreta shantungensis*  
*Anomocarella megalurus*

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-tien limestone [Blackwelder, 1907, p. 36, part of the first list of fossils], at Ch'au-mi-tien, Ch'ang-hia district, Shan-tung.

*Coosia carme*  
*Ptychaspis brizo*  
*Ptychaspis ceto*  
*Hysteroelenus* sp.  
*Tsinania canens*  
*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*.

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

*Lisania* sp. undt.  
*Ptychaspis calchas*

P. dolon  
*Tsinania Cancns*

P. cadium

C.42. *Upper Cambrian:* In the central part of the Ch'au-mi-tien 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-tien, Ch'ang-hia district, Shan-tung.

*Ptychaspis calyce*  
*Tsinania Cancns*

P. campbe

C.43. Above C.38, same section.

*Upper Cambrian:* Near the top of crystalline, mostly purple-gray limestone in the Ch'au-mi-tien limestone, at Ch'au-mi-tien, 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-tien, 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-tien limestone [Blackwelder, 1907, p. 36 (part of third list of fossils)], at Ch'au-mi-tien, Ch'ang-hia district, Shan-tung.

*Ptychaspis acamus*  
*Tsinania Cancns*

P. ceto

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-tien, Ch'ang-hia district, Shan-tung.

*Helcionella* ? chlorius  
*Damesella* sp. (free cheek)

*Lisania alala*  
*Damesella* ? sp. (free cheek)

*Anomocare* sp. (free cheek and pygidium)

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

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

*Pelagiella clitia*  
*Ptychaspis* sp.

*Orthotheca* cyrene
C 48. Below C 51, same section; about same horizon as C 29, different section. 
_Middle Cambrian_: Near the top of the clifty oolitic limestone in the Ch'ang-hia limestone [Blackwelder, 1907, p. 32, part of the last list of fossils], at Ch'au-mi-tien, 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-tien 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-tien, 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-tien limestone [Blackwelder, 1907, p. 36 (part of the third list of fossils)], on a low spur at Ch'au-mi-tien, 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-tien, 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-north-east of Sin-t'ai-hien, Shan-tung.

Ptychoparia tolus
Agraulos dirce
Anomocarella 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-tien 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
Tsinania cancns
Tsinania sp. undt. (pygidium)
C55. (See C6.)

Middle Cambrian: Thin platy limestone in the upper shale member of the Kiu-lung group just below the Ch‘au-mi-tien 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 douvillei
†Stephanocare richthofeni

C56. Same horizons as C41, C49, and C54.

Upper Cambrian: Lower part of Ch‘au-mi-tien 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
†Synthrophia orthia
†Scenella sp. undt.
†Matherella circe
†Pelegia pagoda
†Orthotheca sp. undt.
†Cyrtoceras cambria

C57. Same horizon as C4, different section; below C11, same section; above C58, 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

C58. Below C57, 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).

C59 = Ordovician and Carboniferous.

C60. About 100 feet below the horizon of C3, different section; about 250 feet below C8, 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 Chuangia batia
Proampyx burea Chuangia fragmenta
Pterocephalus busiris 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 Hyolithes cybele
Acrotreta shantungensis 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. 8a (bed 32), p. 29], 3.5 miles (5.6 km.) southwest of Yen-chuang, Sin-t'ai district, Shan-tung.

One species, Obolus obscurs.

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 Chuangia nais
Eoorthis doris Ptychaspis baubo
Eoorthis kaysleri Ptychaspis cacus
Eoorthis linnarsoni Ptychaspis callistio
Huenella orientalis Ptychaspis calyce
Syntrophia orthia Ptychaspis ceto
Hyolithes daphnis Ptychaspis sp. undt. (free cheek)
Orthotheca cyrene Anomocare sp.
Solenopleura beroe Coosia ? bianos
Chuangia batia

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-tien limestone [Blackwelder, 1907, p. 36 (part of the third list of fossils)], on crest of ridge east of Ch’au-mi-tien, 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-ch’ou limestone [Willis and Blackwelder, 1907, p. 145, first list of fossils], 4 miles (6.4 km.) east of Fang-lan-ch’ou, Shan-si.

*Conokephalina vesta*  
*Inouyia inflata*  
*Agraulos obscura*  

C 70. 35 feet below C 69, same section.

Middle Cambrian: Oolitic limestone about 30 feet (9 m.) above the base of the Ki-ch’ou 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.

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-ch’ou 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*  

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 ochreous and green clay shales, overlying the massive oolite in the Ki-chou 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. *Dorypyge richthofeni lavis*
*Pelagiella willisi* *Conokephalina* sp. undt.
*Orthotheca glabra* *Anomocare flavia*

**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-chou 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-chou 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 kayscri* and *Ptychaspis bella*.

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

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

*Coscinocyathus elvira* *Inouyia armata*
*Obolus obscurus* *Inouyia melie*
*Eoorthis kichouensis* *Agraulos nitida*
*Ptychoparia lilia* *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'ō shales [Willis and Blackwelder, 1907, p. 144, first list of fossils], 4 miles (6.4 km.) southeast of Yau-tō, near Wu-t'ai-hień, Shan-si.

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

**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-chou 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 = 36c, 2 = 35p, 4 = 35u, 5 = 36d, and 6 = 36e, are stated by Mr. Iddings to be very nearly the same horizon and at the same locality. They are the lowest fossils found.]

<table>
<thead>
<tr>
<th>Fossil Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protospongia chloris</td>
<td>Shales about 130 feet above the white quartzite</td>
</tr>
<tr>
<td>Protospongia sp. undt.</td>
<td></td>
</tr>
<tr>
<td>Micromitra sculptilis</td>
<td></td>
</tr>
<tr>
<td>Micromitra (Paterina) lucina</td>
<td></td>
</tr>
<tr>
<td>Micromitra (Iphidella) pannula maladensis</td>
<td></td>
</tr>
<tr>
<td>Micromitra (Iphidella) pannula aphyreensis</td>
<td></td>
</tr>
<tr>
<td>Obolus chinensis</td>
<td></td>
</tr>
<tr>
<td>Obulus damesi</td>
<td></td>
</tr>
<tr>
<td>Acrothela matthewi eryx</td>
<td></td>
</tr>
<tr>
<td>Acroreta shantungensis</td>
<td></td>
</tr>
<tr>
<td>Hyolithes cybele</td>
<td></td>
</tr>
<tr>
<td>Orthotheca cyrene</td>
<td></td>
</tr>
<tr>
<td>Orthotheca delphus</td>
<td></td>
</tr>
<tr>
<td>Orthotheca glabra</td>
<td></td>
</tr>
<tr>
<td>Agnostus chinensis</td>
<td></td>
</tr>
</tbody>
</table>

35 o. About 50 feet higher than 35p; about the same horizon as 36h; see 36g. *Middle Cambrian: Fu-chou 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 35n) forming the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

<table>
<thead>
<tr>
<th>Fossil Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obolus damesi</td>
<td></td>
</tr>
<tr>
<td>Acrothela matthewi eryx</td>
<td></td>
</tr>
<tr>
<td>Acroreta shantungensis</td>
<td></td>
</tr>
<tr>
<td>Agnostus chinensis</td>
<td></td>
</tr>
</tbody>
</table>

35 p. About 80 feet above 35n; about 50 feet below 36h. *Middle Cambrian: Fu-chou 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.

<table>
<thead>
<tr>
<th>Fossil Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linguella manchuriensis</td>
<td></td>
</tr>
<tr>
<td>Acroreta pacifica</td>
<td></td>
</tr>
<tr>
<td>Agnostus chinensis</td>
<td></td>
</tr>
</tbody>
</table>

Dorypyge richthofeni
Ptychoparia kochibei
Pterocephalus liches
Solenopleura boreae
Agraulos sorge
Solenopleura sp. undt.
Anomocare ephori
Anomocare latelimbatum
Anomocare megalurus
Anomocare minus
Anomocare minus var.
Anomocare subquadratum
Anomocarella chinensis
Anomocarella hermias
Anomocarella macar
Anomocarella temenus
Anomocarella cf. temenus

Damesella sp. undt.
Ptychoparia typus
Dolichometopus deois
Bathyuriscus manchuriensis

Dorypyge richthofeni
Dolichometopus deois
35 q. About 70 feet higher than 36h; about 800 feet below 36f.
Middle Cambrian: Fu-chou 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.

Protohypsaspis chloris  
Damesella blackwelderi
Lingulella marcia  
Anomocare lisania
Acrotreta venia

35 r. Very nearly same horizon as 35n.
Middle Cambrian: Fu-chou 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  
Dorypyge richthofeni
Micromitra (Paterina) lucina  
Ptychoparia kochibei
Micromitra (Iphidella) punnula maladensis  
Crepeicephalus convexus
Obulus danesi  
Solenopleura agno
Obulus shanensis  
Solenopleura chalcon
Acrothele matthewi eryx  
Anomocarella chinensis
Acrotreta shantungensis  
Anomocarella temenus
Hyolithes cybele  
Dolichometopus deios
Orthotheca delphus

36 c. Very nearly same horizon as 35n.
Middle Cambrian: Fu-chou 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 35n.
Middle Cambrian: Fu-chou 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  
Acrothele matthewi eryx
Obulus danesi

36 e. Very nearly same horizon as 35n.
Middle Cambrian: Fu-chou 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.

Obulus danesi  
Anomocare minus
Acrothele matthewi eryx  
Anomocare minus var.
Agnostus chinensis  
Asaphiscus iddingsi
Ptychoparia kochibei
36 f. About 800 feet above 35q; the highest horizon.

Middle Cambrian: Fu-chou 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)  Blackwelderia sinensis
Lingulella ? marcia    Damesella blackwelderi
Agnostus douvillei     Drepanura prosnesili
Albertella pacifica    Lingulella marcia
Teinistion typicalis   Damesella blackwelderi
Stephanocare sinensis

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

Middle Cambrian: Fu-chou 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 35i) forming the shore of Tschang-hsing-tau Island, east of Niang-niang-kung, Liau-tung, Manchuria.

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

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

Middle Cambrian: Fu-chou 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       Agnostus chinensis
Lingulella marcia       Anomocarella minus
Acrotreta shantungensis       Bathyriscus manchuriensis

36 i. Below 35q; above 36h.

Middle Cambrian: Fu-chou 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 35q; below 36f.

Middle Cambrian: Fu-chou 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 (35n Limestone) (35g).
Protospongia sp. undt. (spicules) (35n Limestone).
Planolites (annelid trails) (36f Limestone and shale).
Micromitra sculptulis Meek (35n) (35r Limestone).
Micromitra (Paterina) lucina Walcott (35n) (35r Limestone) (36d).
Micromitra (Iphidella) panulla maladensis Walcott (35n) (35r Limestone).
Micromitra (Iphidella) panulla ophirensis Walcott (35n Limestone).
Obolus chinensis Walcott (35n Limestone).
Obolus damesi Walcott (35n Limestone) (35o) (35r) (36d) (36e Shale) (36g) (36h Shale).
Obolus shansiensis Walcott (35r Limestone).
Lingulella manchuricnsis Walcott (35p Shale).
Lingulella marcia Walcott (35p) (? 36f Limestone and shale) (36h Shale).
Acrothele matthewsi cryr Walcott (35n Limestone) (35o) (35r) (36a) (36e Shale) (36g).
Acrotreta pacifica Walcott (35p Shale)
Acrotreta shantungensis Walcott (35n Limestone) (35o) (35r) (36g) (36h Shale).
Acrotreta venia Walcott (35q).
Hyolites cybele Walcott (35n Limestone) (35r).
Orthotheca cyrene Walcott (35n Limestone).
Orthotheca delphus Walcott (35n Limestone) (35r).
Orthotheca cf. delphus Walcott (36g).
Orthotheca glabra Walcott (35n Limestone).
Agnostus chinensis Dames (35n Limestone) (35o) (35p) (35r) (36e Shale) (36g) (36h Shale).
Agnostus dowilli Bereron (36f Limestone and shale).
Albertella pacifica Walcott (36f Limestone and shale).
Dorypyge richthofeni Dames (35n) (35p Shale) (35r Limestone).
Teinistia typocalis Walcott (36f Limestone and shale).
Stephanocarc sinensis Bereron (36f Limestone and shale).
Blackwelderia sinensis Bereron (36f).
Damesella blackwelderi Walcott (35q) (36f Limestone and shale).
Damesella sp. undt. (35o).
Drepanura tremesnili Bereron (36f Limestone and shale).
Ptychoparia kochiei Walcott (35n) (35r Limestone) (36e Shale).
Ptychoparia typus Dames (35o).
Crepecephalus convexus Walcott (35r Limestone).
Liostracina krausei Monke (36f Limestone and shale).
Pterocephalus liches Walcott (35n Limestone).
Shantungia spinifera Walcott (36f Limestone and shale).
Agraulos sorge Walcott (35n Limestone).
Solenopleura agno Walcott (35r Limestone).
Solenopleura beroe Walcott (35n Limestone).
Solenopleura chalcou Walcott (35r Limestone).
Solenopleura sp. undt. (35n Limestone).
Anomocare ephori Walcott (35n) (35r Limestone).
Lipalian pel indicates presence north of during in the continent at the Paleontology, sea epoch of the brian continental carrying the Bathyuriscus relief. By Dolichometopus Anomocarella Anomocarella Anomocarella Anomocarella Anomocare Anomocare Anomocare Bathyuriscus manchuriensis Walcott (35r) (35p Limestone) (36g). Bathyuriscus manchuriensis Walcott (350) (36g) (36h Shale). Asaphiscus iddingsi Walcott (35r Limestone) (36e).

**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-

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

Showing unconformity between the pre-Cambrian Si-t’ai schists (Ws) and Cambrian shale (Em), near Yen-t’ou 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 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, 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 such as have been found in the Belt may eventually be discovered in the Hu-t'o.

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.

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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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. 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’ou) limestone of the late Proterozoic.

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-planation of a very low, flat coast, where weak waves, feeble shore currents, and rivers interacted.

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 fissiliferous 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.

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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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'ö Shale**

The basal formation, the Man-t'ö, 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'ö 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'ö 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'ö formation has thus far dealt with it as it is developed in northern China.\(^3\) The red mud does not occur in the south on the Yang-tzi-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.\(^4\)

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

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

**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.

The Kiu-lung group is divided into the Ch'ang-hia limestone at the base, the Ku-shan shale, and the Ch'au-mi-tien 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-tien limestone.**—The upper part of the Kiu-lung group, the Ch'au-mi-tien 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.

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-

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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 Ch'i-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. \( Cnq \) = quartzite at the base of Nan-t’ou formation; \( Cnt \) = layer of glacial till 120 feet (37 m.) thick; \( Coks \) = Ki-sin-ling limestone. Nan-t’ou 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, Pt. 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-tien formations, respectively, in its upper and lower portions. The Ch'au-mi-tien 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-tien 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

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\(^2\) Idem, pp. 34, 35.

\(^3\) Idem, p. 44.

\(^4\) Idem, pp. 44-46.

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 Syntraphia, Huenella, Cyrtoceras, and Tsinania in the Ch'au-mi-tien 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-tien 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 Ptychoparidae. Dikeloecephalus 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, Dikeloecephalus, Ptychoparia, and Tsinania is singularly free from commingling of typical post-Cambrian genera except in the case of the Eminence formation, where a few trilobitic genera have persisted into Ozarkian time.²

²By 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 Dikeloecephalus.
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.—Illanurus canens Walcott.¹

Stratigraphic range.—Upper Cambrian of eastern China. Lower portion of Ch'au-mi-tien 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 Illanurus 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 Illanurus. 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.
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:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Genera</th>
<th>Subgenera</th>
<th>Species</th>
<th>Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foraminifera</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
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<tr>
<td>Porifera</td>
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<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Anthozoa</td>
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<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Annelida</td>
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<td></td>
</tr>
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<td>Brachiopoda</td>
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<td>4</td>
<td>36</td>
<td>4</td>
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<tr>
<td>Gastropoda</td>
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<td></td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Pteropoda</td>
<td>2</td>
<td></td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Cephalopoda</td>
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<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
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<td>175</td>
<td>4</td>
</tr>
<tr>
<td>Ostracoda</td>
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<td></td>
<td></td>
<td></td>
<td>63</td>
<td>5</td>
</tr>
</tbody>
</table>

General Stratigraphic and Geographic Position of the Cambrian Faunas of China

<table>
<thead>
<tr>
<th>Name</th>
<th>Stratigraphic position.</th>
<th>General geographic position.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Cambrian</td>
<td>Middle Cambrian</td>
</tr>
<tr>
<td>Foraminifera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Globigerina mantoensis</td>
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<td></td>
</tr>
<tr>
<td>Porifera</td>
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<td></td>
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<tr>
<td>Protopsponge chloris</td>
<td>X</td>
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<tr>
<td>Protopsponge sp. undt.</td>
<td>X</td>
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<tr>
<td>Anthozoa</td>
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<td></td>
</tr>
<tr>
<td>Csquerothys elvira</td>
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<tr>
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</tr>
<tr>
<td>Planolites sp. undt.</td>
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</tr>
<tr>
<td>Brachiopoda</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Micromitra sculptilis</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Micromitra (Paterina) labradorica orientalis</td>
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<td></td>
</tr>
<tr>
<td>Micromitra (Paterina) lucina</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Micromitra (Iphidella) pannonia maladensis*</td>
<td>X</td>
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</tr>
<tr>
<td>Micromitra (Iphidella) pannonia ophirensis</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Obolus chinensis</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

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

Note.—The columns "Near Ch'ang-h's," "Near Ch'au-mi-tien," "Near Sin-t'ai-hien," "Near Tai-nan," "Near Fang-lan-chien," "Near Yung-yü," "Near Ch'in-ping-hien," "Near Ting-hiang-hien," 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 | Lower Cambrian | Middle Cambrian | Upper Cambrian | Near Chang-hia | Near Yenchuang-chen | Near Chu-hai | Near Tian-chou | Near T'ai-hien | Near Tsian-yu | Near Tung-ching | Near Chou-ping-ki | Near Tung-chang-chen | Near Kaolien-pu | Tsinghwa-shan island |
|------|----------------|-----------------|----------------|----------------|---------------------|-------------|----------------|----------------|---------------|------------------|--------------------|----------------------|---------------------|
| **Brachiopoda**—Continued. | | | | | | | | | | | | | |
| Obolus damesi | X | | | C7 | C10 | C64 | | | | | | | 35h |
| Obolus matinalis | | | | | | | | | | | | | |
| Obolus minimus | X | | | C1 | | | | | | | | | 35f |
| Obolus obscurus | X | | X | C63 | | | | | | | | | |
| Obolus shansiensis | X | | | | | | | | | | | | 36d |
| Obolus (Westonia) blackwelderi | X | | | | | | | | | | | | |
| Obolus (Westonia) sp. undt. | X | X | | | | | | | | | | | |
| Lingulella manchuriensis | | | | | | | | | | | | | |
| Lingulella marcia | X | | | | | | | | | | | | |
| Lingulella (Lingulepis) eros. | X | | | C7 | | | | | | | | | 36f ? |
| Lingulella (Lingulepis) sp. undt. | X | | | | | | | | | | | | 36f ? |
| Diellomus parvus | X | | X | | | | | | | | | | 36f |
| Obolella atlntica | | | | | | | | | | | | | |
| Yorkia ? orientalis | X | | | | | | | | | | | | |
| Acrothele matthevi eryx | X | | | | | | | | | | | | |
| Acrothele ? minuta | X | | | | | | | | | | | | 35f |
| Acrothele rara | | | | | | | | | | | | | 36f 36f |
| Acroteretis lisani | X | | | | | | | | | | | | |
| **Acroteretis pacifica** | X | | | | | | | | | | | | C24 | 35b |
| | | | | | | | | | | | | C1 | C4 |
| | | | | | | | | | | | | C23 | C22 |
| | | | | | | | | | | | | C3 | C6 |
| | | | | | | | | | | | | C20 | C3 |
| | | | | | | | | | | | | C28 | C6 |
| | | | | | | | | | | | | C63 | C6 |
| | | | | | | | | | | | | C64 | C75 |
| | | | | | | | | | | | | C64 | C67 |
| | | | | | | | | | | | | C64 | C58 |
| | | | | | | | | | | | | C64 | C58 |
| | | | | | | | | | | | | 35b | 35f |
| | | | | | | | | | | | | 35f | 36b |
| | | | | | | | | | | | | 36b | 36b |
| | | | | | | | | | | | | 35f | 35f |
| | | | | | | | | | | | | 36b | 36b |
| **Acroteretis venia** | X | | | | | | | | | | | | |
| **Discinosia sulcatus** | X | | | | | | | | | | | | |
| **Billingsella pumpellyi** | X | | | | | | | | | | | | |
| **Billingsella richthofeni** | X | | | | | | | | | | | | |
| **Eotheis agrestis** | X | | | | | | | | | | | | |
| **Eotheis dominis** | X | | | | | | | | | | | | |
| **Eotheis kayseri** | X | | | | | | | | | | | | |
| **Eotheis kichtoensis** | X | | | | | | | | | | | | |
| **Eotheis linnessi** | X | | | | | | | | | | | | |
| **Eotheis pagoda** | X | | | | | | | | | | | | |
| **Eotheis sp. undt. (a)** | X | | | | | | | | | | | | |
| **Eotheis sp. undt. (b)** | X | | | | | | | | | | | | |
| **Huenella orientalis** | X | | | | | | | | | | | | |
| **Syntrophis orthia** | X | | | | | | | | | | | |}

**Note.**—The column "Near Sin-t'ai-hien" 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**

<table>
<thead>
<tr>
<th>Name</th>
<th>Stratigraphic position</th>
<th>General geographic position</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GASTROPODA.</strong></td>
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<tr>
<td>Scenella clotho</td>
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<tr>
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<tr>
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</tr>
<tr>
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<td>Pelagia willisi</td>
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<td>Helcionella rugosa orientalis</td>
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<td>Hyolithes daphnis</td>
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<td>Orthotheca cf. delphus</td>
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<td>Orthotheca doris</td>
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<tr>
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<td><strong>CEPHALOPODA.</strong></td>
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<tr>
<td>Cytoceras cambria</td>
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<tr>
<td><strong>TRILOBITA.</strong></td>
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<tr>
<td>Agnostus chinensis</td>
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<td>Agnostus donwelli</td>
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<td>Agnostus kushanensis</td>
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<td>Aognostus parviritrons latellimatus</td>
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</tr>
<tr>
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</tr>
</tbody>
</table>

* 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

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<td></td>
<td>C 19</td>
<td>C 24</td>
<td>C 29</td>
<td>C 30</td>
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<tr>
<td>Dorypyge richthofeni levis</td>
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* Also from Yen-tsy-yai.  
† Calymmene ? sinensis Bergeron.

Note.—The columns "Near Ch'ing-p'ing-hsien" and "Near Ting-hsiang-hsien" 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

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**Note.** — The columns “Near Ch'o-p'ing-hien,” “Near Ting-hiang-hien,” and “Near Kao-k'iao-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

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<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocare minus var.</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocare ? nereis</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocare subquadratum</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocare sp. undt.</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocare various sp. undt.</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella albion</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella baicus</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella bergioni</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella bigbyi</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella biston</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella butes</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella chinensis</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella comus</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella hermias</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella irma</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella macar</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella smithii *</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella speciosa †</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella subrugosa</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella tatian</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella temenus</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella tennes</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella thraso †</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella toxeus</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella trogus</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
<tr>
<td>Anomocarella tutia</td>
<td></td>
<td></td>
<td></td>
<td>C 71</td>
</tr>
</tbody>
</table>

* Occurs in go x, Middle Cambrian, Coosa Valley, Alabama, and is introduced for comparison.
† Occurs at Wang-tschuang, Shan-tung, China.
‡ On rock with *Inovia itiana*.

Note.—The column "Near Ch'eng-p'ing-hien" 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

<table>
<thead>
<tr>
<th>Name</th>
<th>Lower Cambrian</th>
<th>Middle Cambrian</th>
<th>Upper Cambrian</th>
<th>General geographic position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>TRILOBITA</strong> — Continued.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anomocarella undata</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>Near Chang-hia</td>
</tr>
<tr>
<td>Coosia ? blanci</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C61</td>
</tr>
<tr>
<td>Coosia carme</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C2</td>
</tr>
<tr>
<td>Coosia ? daunus</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C9</td>
</tr>
<tr>
<td>Coosia decelus</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C1</td>
</tr>
<tr>
<td>Coosia robusta</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C1</td>
</tr>
<tr>
<td>Coosia superba t</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C4</td>
</tr>
<tr>
<td>Dolichometopus alcesti</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C60</td>
</tr>
<tr>
<td>Dolichometopus deois</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C19</td>
</tr>
<tr>
<td>Dolichometopus derceo</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C1</td>
</tr>
<tr>
<td>Dolichometopus dirce</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C1</td>
</tr>
<tr>
<td>Dolichometopus hyrie</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C5</td>
</tr>
<tr>
<td>Dolichometopus ? sp.</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C38</td>
</tr>
<tr>
<td>Hysterocanus ? sp. und.</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C56</td>
</tr>
<tr>
<td>Bathyurusicus manchuriensis</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C34</td>
</tr>
<tr>
<td>Asaphiscus iddinsi</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C34</td>
</tr>
<tr>
<td>Tsinania canens</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C41</td>
</tr>
<tr>
<td>Tsinania ceras</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C42</td>
</tr>
<tr>
<td>Tsinania dictys</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C38</td>
</tr>
<tr>
<td><strong>OSTRACODA.</strong></td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C50</td>
</tr>
<tr>
<td>Aluta bergeronii</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C32</td>
</tr>
<tr>
<td>Aluta enyo</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C32</td>
</tr>
<tr>
<td>Aluta cris</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C32</td>
</tr>
<tr>
<td>Aluta fragilis</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C32</td>
</tr>
<tr>
<td>Aluta strophe</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C32</td>
</tr>
<tr>
<td>Aluta woodi</td>
<td></td>
<td><strong>x</strong></td>
<td><strong>x</strong></td>
<td>C32</td>
</tr>
</tbody>
</table>

* 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-hien," "Near Wu-t'ai-hien," and "Near Ting-liang-hien" 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.
The following sections are copied from Vol. 1, part 1, Research in China,¹ and in addition the locality numbers of the fossils are inserted.

<table>
<thead>
<tr>
<th>Section</th>
<th>Localities</th>
<th>Feet</th>
<th>Meters</th>
<th>Present land surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>T'ai-shan complex</td>
<td>17, 20, 31</td>
<td>500</td>
<td>150</td>
<td>Brown shale with thin gray limestones, buff and gray shales with gray and buff earthy limestone and black slabby limestone.</td>
</tr>
<tr>
<td>Man-t'o shales</td>
<td>15, 16, 27</td>
<td>500</td>
<td>150</td>
<td>Schists and gneisses with intruded granite, syenite, etc.</td>
</tr>
<tr>
<td>Ch'ang-hia limestone</td>
<td>22, 24, 25, 26, 19, 18, 21, 35, 46, 30, 51, 29, 48, 27, 28</td>
<td>500</td>
<td>150</td>
<td>Olive-gray oolitic limestone.</td>
</tr>
<tr>
<td>Ku-shan shale</td>
<td>134, 38, 41, 142, 49</td>
<td>300</td>
<td>90</td>
<td>Shaly gray limestones and shales, buff crystalline dolomite, and thin white limestone.</td>
</tr>
<tr>
<td>Ch'an-mi-tien limestone</td>
<td>136, 45, 47, 150, 67, 68</td>
<td>1,800</td>
<td>550</td>
<td>Dolomitic limestone, dark gray and liver-brown colors.</td>
</tr>
<tr>
<td>T'ai-nan dolomite</td>
<td>cot</td>
<td>1,800</td>
<td>550</td>
<td>Dolomitic limestone, dark gray and liver-brown colors.</td>
</tr>
<tr>
<td>Cambrian</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schists and gneisses with intruded granite, syenite, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1.—Section of the Sinian System in the Ch'ang-hia District, Shan-tung

**Fig. 2.—Section of the Sinian System in the Sin-t'ai District, Shan-tung**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cp</td>
<td>150</td>
<td>45</td>
<td>Coal-bearing shales, etc.</td>
</tr>
<tr>
<td>T'ai-nan dolomite.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C0t</td>
<td>2,500</td>
<td>760</td>
<td>Dolomitic limestone, liver-brown, blue-gray, and purplish colors.</td>
</tr>
<tr>
<td>Kiu-lung group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ckl</td>
<td>300</td>
<td>90</td>
<td>Ash-gray earthly limestone, partly shaly.</td>
</tr>
<tr>
<td>Cambrian.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Man-t'o shales.</td>
<td></td>
<td></td>
<td>Blue-gray limestone.</td>
</tr>
<tr>
<td>Cm</td>
<td>800</td>
<td>245</td>
<td>Green shales, limestones, and limestone nodules.</td>
</tr>
<tr>
<td>T'ai-shan complex.</td>
<td></td>
<td></td>
<td>Oolitic dark limestone.</td>
</tr>
<tr>
<td>Rt</td>
<td>575</td>
<td>175</td>
<td>Brown shales and limestones.</td>
</tr>
<tr>
<td></td>
<td>4,375</td>
<td>1,315</td>
<td>Maroon and yellow shales.</td>
</tr>
<tr>
<td></td>
<td>60.</td>
<td></td>
<td>Buff shales and earthy limestones.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gneiss, schists, and granite.</td>
</tr>
<tr>
<td>Locality numbers</td>
<td>Feet</td>
<td>Meters</td>
<td>Present land surface</td>
</tr>
<tr>
<td>------------------</td>
<td>------</td>
<td>--------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>74.</td>
<td>20+</td>
<td>6+</td>
<td>Dense blue limestone.</td>
</tr>
<tr>
<td>73.</td>
<td>75</td>
<td>23</td>
<td>Ocherous, gray, dense, conglomeritic limestone.</td>
</tr>
<tr>
<td>77.</td>
<td>110</td>
<td>33</td>
<td>Massive ocherous gray limestone.</td>
</tr>
<tr>
<td>37, 72.</td>
<td>65</td>
<td>20</td>
<td>Brown and gray shales and thin-beded limestone.</td>
</tr>
<tr>
<td>71.</td>
<td>45</td>
<td>14</td>
<td>Massive gray oolitic limestone.</td>
</tr>
<tr>
<td>15</td>
<td>4.5</td>
<td></td>
<td>Gray shales.</td>
</tr>
<tr>
<td>9</td>
<td>3</td>
<td></td>
<td>Gray crystalline limestone.</td>
</tr>
<tr>
<td>8</td>
<td>2.5</td>
<td></td>
<td>Gray calcareous shale.</td>
</tr>
<tr>
<td>5</td>
<td>1.5</td>
<td></td>
<td>Oolitic limestone.</td>
</tr>
<tr>
<td>30</td>
<td>9</td>
<td></td>
<td>Gray and buff shales with limestone nodules.</td>
</tr>
<tr>
<td>70.</td>
<td>12</td>
<td>3.5</td>
<td>Hard brown-gray oolitic limestone.</td>
</tr>
<tr>
<td>75.</td>
<td>35</td>
<td>10.5</td>
<td>Slabby buff limestone, dense and hard.</td>
</tr>
<tr>
<td>80</td>
<td>25</td>
<td></td>
<td>Red shales with thin reddish limestones.</td>
</tr>
<tr>
<td>40</td>
<td>12.5</td>
<td></td>
<td>Red shale and argillaceous limestone, with thin yellow limestones</td>
</tr>
<tr>
<td>30</td>
<td>9</td>
<td></td>
<td>Red shale and thin limestone.</td>
</tr>
<tr>
<td>4</td>
<td>1.3</td>
<td></td>
<td>Argillaceous yellow limestone.</td>
</tr>
<tr>
<td>12</td>
<td>3.5</td>
<td></td>
<td>Red calcareous shale.</td>
</tr>
<tr>
<td>3 to 15</td>
<td>1 to 5</td>
<td></td>
<td>Red sandstone and conglomerate.</td>
</tr>
<tr>
<td>610+</td>
<td>180+</td>
<td></td>
<td>Purple argillites; siliceous limestones and dikes of greenstone.</td>
</tr>
</tbody>
</table>

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:

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

Notes on Horizon of Collections

Localities 35n, 35r, 36c, 36d, and 36e 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 35p is about 80 feet higher up in the shales and limestone.

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

Localities 36g and 35o are back from the bluff on drainage cuts in shale about the horizon of No. 36h, 1 judge.

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

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

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'OU 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-p'an-k'ou, in the district of Wu-t'ai-hien, 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.)
Sections measured as follows:
A, B, D, E, F, and G, in vicinity of Ch'au-mi-tién, Shan-tung.
C, H, I, and J, in vicinity of Ch'ang-hia, Shan-tung.
K, L, M, and N, in vicinity of Sin-t'ai, Shan-tung.
O, at Hin-chou, Shan-si.

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.

Algae.—So far as known no true Algae have been found, but fillings of mud cracks and annelid trails occur resembling stems of Algae; 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, fig. 1] is all that has been detected in the relatively large collections.

Porifera.—Only a few spicules of Protospongium 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 Archaeocyathine 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


2 Mém. de l’Acad. imp. des sci. de St. Pétersbourg, 8th ser., Vol. 8, No. 10, 1899, Beiträge zur Kenntniss des sibirischen Cambrium.
dissepiment toward the apex, a feature also shown by both H. ? ? simplex [plate 5, fig. 11] and H. ? chirius [plate 5, fig. 7]. The coiled gastropods are of unusual interest, as three forms, Mattherella ? sp. undt. (C 55) [plate 5, fig. 6], Pelagiella chronus (C 1, C 4, C 18) [plate 5, figs. 9, 9a-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, 4a-c] is a typical example of the family Cyrtoceridae 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], Teinstion [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, Inouvia, 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, south-western 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 Mesonacidae and the Paradoxidae. Its tapering glabella and elongate eye-lobes recall those of Nevadia, and its small pygidium that of Holmia and Callavia.

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 cephalic 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 Ptychoparidae.

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.


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** (C3, C20)
- **Obolella asiatica** (C17, C32')
- **Helcionella rugosa chinensis** (C3)
- **Hyolithes delia** (C3)
- **Hyolithes sp. undt.** (C32')
- **Redlichia chinensis** (C15, C16, C27)
- **Redlichia nobilis** (C3)
- **Redlichia sp. undt.** (C6)

- **Ptychoparia aclis** (C17, C20, C31)
- **Ptychoparia granosa** (C17)
- **Ptychoparia impar** (C17)
- **Ptychoparia ligea** (C31)
- **Ptychoparia (Emmrichella) constricta** (C3)
- **Ptychoparia (Emmrichella) mantoensis** (C20, C31)

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 **Nevidia** 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

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4. Idem, pl. 23.
5. Idem, pl. 30.
trilobites allied to *Agraulos* named *Palcuolenus* 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 walcottii* Mansuy
- *Redlichia carinata* Mansuy
- *Redlichia* sp.
- *Palcuolenus douvillei* Mansuy
- *Palcuolenus lantenoisi* Mansuy
- *Palcuolenus 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

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


\(^4\) 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. 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. Lime-
stone 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. The known distribution
from Manchuria on the northeast to central China, and west
into northern India, taken with the occurrence of fragments of the
fauna in Siberia in the valleys of the Lena, Yenisei, and Angara, 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 con-
ceal 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-chou limestone.

*Willis, Bailey. Research in China, Pub. No. 54, Carnegie Institution of
Idem, pl. 4.
3 Reed, F. R. C. Mem. Geol. Survey India, Palaeontologia Indica, ser. 15,
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* (C5)
- *Coscinocyathus elvira* (C75)
- *Micromitra* (Paterina) *labradorica orientalis* (C9)
- *Micromitra* (Pithidella) *pannula ophi-rensis* (C5)
- *Obolus damesi* (C7)
- *Obolus obscurus* (C63, C75)
- *Lingulella* (Lingulepis) *eros* (C7)
- *Eoorthis agrestis* (C28)
- *Eoorthis kichouensis* (C75)
- *Acrotreta pacifica* (C5)
- *Acrothele rara* (C23)
- *Orthotheca daulis* (C23)
- *Scenella? dilatatus* (C70)
- *Helcionella? simplex* (C70)
- *Redlichia finalis* (C58)
- *Ptychoparia impar* var. (C8)
- *Ptychoparia lilia* (C75)
- *Ptychoparia tolus* (C52)
- *Ptychoparia sp.* (C58)
- *Ptychoparia* (Emmrichella) *eriopia* (C23)
- *Ptychoparia* (Emmrichella) *theano* (C23)
- *Conokephalina maia* (C70)
- *Conokephalina sp.* (C70)

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* (C4)
- *Acrothele matthewi eryx* (C4)
- *Acrothele rara* (C57)
- *Acrocreta pacifica* (C4)
- *Pelagiella chronus* (C4)
- *Hyolithes cybele* (C4)
- *Hyolithes? (operculum)* (C4)
- *Orthotheca delphus* (C4, C57)
- *Agnostus chinensis* (C4, C57)
- *Agnostus kushanensis* (C57)
- *Dorypyge richthofeni* (C57)
- *Inouyia abaris* (C7, C9)
- *Inouyia armata* (C75)
- *Inouyia capar* (C70)
- *Inouyia divi* (C5)
- *Inouyia melie* (C70, C75)
- *Inouyia thisbe* (C28)
- *Inouyia titiana* (C7)
- *Agraulos abrota* (C23)
- *Agraulos dirce* (C52)
- *Agraulos dolon* (C7)
- *Agraulos nitida* (C75)
- *Agraulos uta* (C75)
- *Agraulos vicina* (C70)
- *Anomocare latellimbatum* (C52)
- *Anomocare minus* (C9)
- *Anomocare sp.* (C5)
- *Anomocare sp.* undt. (C8)
- *Anomocarella butes* (C5, C52)
- *Anomocarella subrugosa* (C7)
- *Anomocarella tatan* (C23)
- *Anomocarella tenes* (C28)
- *Anomocarella thraso* (C7)
- *Anomocarella toxens* (C28)
- *Coosia decelus* (C9)
- *Dolichometopus? sp.* (C5)
- *Bathyuriscus? sp.* (C28)
- *Conokephalina vesta* (C69)
- *Inouyia inflata* (C69)
- *Agraulos obscura* (C69)
- *Lisania alala* (C4)
- *Anomocare alcinoe* (C57)
- *Anomocare nereis* (C69)
- *Anomocarella albion* (C4, C57)
- *Anomocarella chinensis* (C4, C57)
- *Dolichometopus alceste* (C4)
- *Dolichometopus deois* (C4, C57)
- *Dolichometopus hyric* (C69)
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 (C1, C2)  
Obolus damaes (C10)  
Obolus minimus (C1)  
Obolus shansiensis ? (C71)  
Obolus (Westonia) blackwelderi (C1, C2)  
Yorkia ? orientalis (C71)  
Acrotreta pacifica (C1, C2)  
Acrotreta shantungensis (C71)  
EEoorthis sp. undt. (C71)  
Pelagiella chronus (C1)  
Hyolithes cybele (C1, C2)  
Orthotheca cyrene dryas (C2)  
Orthotheca glabra (C71)  
Agnostus chinensis (C1, C2, C71)  
Dorypyge bispinosa (C2)  
Dorypyge richthofeni (C1, C29)  
Dorypyge richthofeni levis (C71)  
Agraulos dryas (C29)  
Inouya divi (C1)  
Lisania agonius (C1, C2)  
Solenopleura pauperata (C71)  
Menocephalus sp. undt. (C10)  
Anomocarella latelimbataum (C2)  
Anomocarella albion (C1, C2)  
Anomocarella bigsbyi (C71)  
Anomocarella chihom (C1, C2)  
Anomocarella chinensis (C71)  
Anomocarella conus (C71)  
Anomocarella temenuses (C10)  
Anomocarella undata (C71)  
Coasia ? daumas (C2)  
Ptychoparia sp. undt. (C48)  
Crepicephalus damia (C71)  
Crepicephalus magnus (C48)  
Lonchocephalus tellus (C2)  
Dolichometopus alcestes (C1)  
Dolichometopus deois (C1, C2)  
Dolichometopus derceto (C1, C2)  

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

Obolus chinensis (C62)  
Obolus shansiensis (C37)  
Lingulella (Lingulepis ?) sp. undt. (C72)  
Acrotreta xisania (C22)  
Acrotreta cf. pacifica (C24)  
Acrotreta shantungensis (C37, C62)  
EEoorthis sp. undt. (C26)  
Pelagiella willisi (C72)  
Hyolithes cybele (C22, C62)  
Orthotheca glabra (C72)  
Agnostus sp. undt. (C24)  
Dorypyge richthofeni (C19, C24)  
Dorypyge richthofeni levis (C72)  
Damesella breviculata (C19)  
Conokephalina sp. undt. (C72)  
Crepicephalus damia (C26)  
Crepicephalus cf. magnus (C25)  
Inouya divi (C24)  
Lisania alala (C22)  
Lisania belenus (C19)  
Lisania bura (C22)  
Solenopleura agno (C25)  
Menocephalus aderens (C19)  
Menocephalus acanthus (C22)  
Menocephalus admeta (C22)  
Levisia agenor (C25)  
Anomocare ? daulis (C19, C26)  
Anomocare flavus (C71)  
Anomocare megaturnus (C37)  
Anomocare ? nereis (C72)  
Anomocare sp. (C25)  
Anomocarella chihom (C62)  
Anomocarella temenuses (C22)  
Anomocarella trogus (C25)  
Anomocarella tutia (C19)  
Dolichometopus deois (C19)  
Dolichometopus derceto (C1, C2)
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* (C12)  
*Teinistion alcon* (C12)  
*Blackwelderia alastor* (C12)  
*Blackwelderia ciliix* (C73)  
*Damesella bellagranulata* (C13)  
*Damesella blackwelderi* (C12, C13, C14, C40)

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

*Obolus* (Westonia) *blackwelderi* (C6)  
*Dicellomus parvus* (C6)  
*Acrothele ? minuta* (C6)  
*Straparollina* sp. undt. (C55)  
*Agnostus douvilli* (C6, C55)  
*Redlichia* sp. undt. (C6)  
*Stephanocare ? monkei* (C6)  
*Stephanocare richthofeni* (C6, C55)  
*Stephanocare sinensis* (C6)

*Pterocephalus asiaticus* (C12)  
*Inouyia acalle* (C12)  
*Inouyia ? regularis* (C73)  
*Lisania ajax* (C12, C40)  
*Anomocarella tutia* (C12)

*Stephanocare ? sp. undt.* (C6)  
*Blackwelderia ciliix* (C55)  
*Blackwelderia sinensis* (C6)  
*Drepanura ketteleri* (C6, C55)  
*Ptychoparia (Emmrichella) bromus* (C6)  
*Liostracina krausci* (C6)  
*Shantungia spinifera* (C6)

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. 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. In China, *Dory-

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Dorypyge [see Locality 35r, 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'aii 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 pumellyi (C61) Chuangia fragmenta (C61)
Proampyx burea (C61) Chuangia nitida (C11)
Pterocephalus busiris (C61) Ptychaspis baubo (C61)
Chuangia batia (C11, C33a, C61) Anomocarella bergioni (C33a)

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

Chuangia batia (C11, C33a) Anomocarella bergioni (C33a)
Chuangia nitida (C11)

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? (C54)
Obolus (Westonia) sp. undt. (C56)
Discinopsis sulcatus (C56)
Eooorthis pagoda (C54, C56)
Synorthia orthia (C54, C56)
Scenella sp. undt. (C56)
Matharella circe (C56)
Pelagiella pagoda (C56)
Orthotheca sp. undt. (C56)
Cyrtoceras cambria (C56)
Agnostus sp. undt. (C34)
Conokephalina belus (C56)
Conokephalina dryope (C56)
Lisania sp. undt. (C41)
Pteroccephalus busiris (C54)
Pagodia bia (C56)
Pagodia dolon (C41)
Pagodia lotos (C56)

The fauna of the upper portion of the Ch'au-mi-tien 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 (C64)
Eooorthis doris (C64)
Eooorthis kayseri (C64, C68, C74)
Eooorthis linnarssoni (C64)
Huenella orientalis (C64)
Synorthia orthia (C64)
Billingsella pumpellyi (C36)
Pelagiella clytia (C47)
Hyolithes daphnis (C64)
Orthotheca cyrene (C47, C64)
Coosia ? bianos (C64)
Anomocare sp. (C64)
Anomocarella baucis (C36)
Anomocarella ? sp. undt. (C68)

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-tien limestone and one at the upper horizon. In America it is found

Ptychaspis acamus (C45)
Ptychaspis baubo (C64)
Ptychaspis bella (C74)
Ptychaspis cacus (C64)
Ptychaspis callisto (C64)
Ptychaspis calyce (C64)
Ptychaspis ceto (C45, C64)
Ptychaspis sp. undt. (C64)
Ptychaspis sp. (C47, C50)
Chuangia batia (C64)
Chuangia nais (C64)
Solenopleura beroe (C64)
Tsinania sp. undt. (45)
in the limestones referred to the Upper Cambrian where it has a considerable vertical range 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.

<table>
<thead>
<tr>
<th>Class and genus</th>
<th>Lower Cambrian</th>
<th>Middle Cambrian</th>
<th>Upper Cambrian</th>
<th>Class and genus</th>
<th>Lower Cambrian</th>
<th>Middle Cambrian</th>
<th>Upper Cambrian</th>
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**FAUNAL PROVINCES OF THE CAMBRIAN IN ASIA**

Mr. F. R. Cowper Reed 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. 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 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

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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.
3 Idem, p. 63.

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*, *Teiniestion*, *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)* *pan-nula* *ophirensis*
- *Obolus chinensis*
- *Obolus damesi*
- *Obolus shansiensis*
- *Acrothele matthewi cryx*
- *Acrotreta pacifica*
- *Acrotreta shantungensis*
- *Hyolithes cybele*
- *Orthotheca cyrene*
- *Orthotheca delphus*
- *Agnostus chinensis*
- *Agnostus douvilléi*
- *Dorypyge richthofeni*
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 domia.*

**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 Cambriani fauna, and a few that may be tentatively assigned to the Lower Cambrian. Doctor von Toll\(^3\) has identified a number of genera of the Archaeocyathinæ\(^4\) 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 Archaeocyathinæ fauna of late Lower Cambrian time. In North America the Archaeocyathinæ flourished most abundantly in late Lower Cambrian time\(^5\) on both the eastern and western sides of the continent. Von Toll lists from the *Archaeocyathus* limestones of Torgoschino,\(^6\) in

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addition to sixteen species of the Archæocystinæ, 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. 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."  

In Middle Cambrian time a group of trilobites lived in the Shan-tung 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 is exceedingly close to *Levisia agenor* (Walcott) [plate 14, fig. 19]; and *Ptychoparia meglitzkii* von Toll 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 schmidtii* 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 Shan-tung Province.

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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 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.


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


—— 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.)


—— 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 7a: Cambrian Faunas of China.


