A Summary of the Columnar Sections in Manchuria

Riuji Endo

More than twenty Japanese stratigraphers and paleontologists including Teiichi Kobayashi, Rinji Saito, Gijin Morita, Tokio Shikama, Mitsuo Noda, Shōichi Nishida, Shinya Minakawa, Rikizo Imaizumi, and the writer have been actively engaged in a geological survey of Manchuria for the past fifteen years. Some of the results of this work have already been published, principally in the Bulletin of the Geological Survey of Manchoukuo, the Memoirs of the Geological Survey of Manchoukuo, the Bulletin of the Central Museum of Manchoukuo, and the Bulletin of the Geological Society of Manchoukuo. However, a great deal of the most recent work has not yet been published. Moreover, almost all of the above bulletins have been burned or are so widely scattered that fairly complete runs are almost impossible to locate. Therefore, the writer desires to summarize the research of Japanese geologists on the columnar sections in Manchuria. It is believed that this may be of help to Japanese geologists and to others who may not be able to go to Manchuria for geological work.

A distinct stratigraphical boundary is located along the line which connects Cheng-te, Fu-hsin, Tieh-ling, Mo-chiang and An-tu in Manchuria and divides this vast area geologically into northern and southern districts.

The distribution of geological formations in the pre-Lower Jurassic Period is completely different on each side of the boundary line while those of the post-Lower Jurassic Period are quite similar to each other.

Granite, which was intruded in the form of batholiths in the Upper Palaeozoic, is the principal rock north of the boundary line. Therefore, as will be seen in the columnar section, none of the formations from Archaeozoic to Ordovician in age found in the northern area while those of the Devonian Period are not entirely developed in the southern district. Moreover, the depositional conditions under which the Upper Palaeozoic formations were laid down are entirely different in the northern and southern districts.

At the present time, it is not known whether the Triassic formation in the northern district is developed or not.

The terrestrial deposits of the Lower Jurassic to the Holocene are about the same in the northern and southern areas.
The summarized columnar sections based on the latest data for both northern and southern Manchuria are as follows:

A. Columnar Section of Southern Manchuria

Quaternary Period
  Alluvial Series
    Sand, gravel, and clay

Pleistocene Series
  Ku-hsiang-tun Stage
    Although the type locality of the present formation is the Wa-pen-yao-ho River, a tributary of the Wen-chuan River, near Harbin, North Manchuria, it occurs also in many valleys of the Jehol mountainland and Liao-ning Province.
    The formation consists of loess, yellow clays and red clays. *Rhinoceros-Elephas* fauna is found in the loess. Thickness about 30 m.

Tertiary Period
  Pliocene Series (Not developed)
  Miocene Series (Not developed)
  Oligocene Series
  Eocene Series
    Fu-shun Series (Eo-Oligocene?)
      The Fu-shun Series is found in the entire Fu-shun coal field in Liao-ning Province and extends 20 km eastward from the eastern border of the coal field. The series consists of green shale, oil shale, coal, tuffaceous sandstone; the following well preserved plant fossils are found in the lower part of the oil shale:
        *Sequoia chinensis* Endo
        *Glyptostrobus europaeus* (Br.) Heer
        *Fagus feroniae* Ung.
        *Alnus kefersteini* Goepp.
        *Quercus drymeja* Ung.
        *Carpinus grandis* Ung.
      The coal includes a great deal of amber containing excellently preserved insect remains such as *Cedidiomyia, Exetastes, Comptonotus, Cainoblatiopsis*. Sheets of basalt appear between the main and the lower coal-bearing series. The series is about 900 m thick.
Cretaceous Period
Upper Series
Cheng-te conglomerate
The present formation
crops out in the vicinities of
Jehol and Luang-ping District,
and consists of reddish-ochre
conglomerate and coarse-
grained sandstone. Thickness
probably exceeds 300 m.

Middle Series
Lower Series

Sun-chia-wan Series
This formation directly overlies the coal-bearing series
at the Fu-hsin coal fields,
140 km west of Hsinyang.
Characterized by Corbicula
anderssoni Gr labau and
Campeloma tani Gr labau in its
upper portion, by Estheria middendorfi
Muller in the mid-
dle portion, and tuffaceous
sandstone of variegated color in
the lower portion, usually
underlain by a thick heavy-
bedded conglomerate at the base.
Thickness 800–1,200 m.

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Jurassic Period
Upper Series
Fu-hsin Series
S. Oishi and G. Morita called the Upper Jurassic formation of the South
Manchurian type the Fu-hsin series. Typically developed in the Fu-hsin coal
field, it consists of cross-bedded coarse sandstone, pale grayish shale, white
tuffaceous fine-grained sandstone and conglomerate; its middle part contains
first and second groups of coal seams. Several horizons of shale yield very well
preserved fossils listed below. Thickness about 2,200 m.

Fossils:
Coniopteris hymenophylloides (Brogn.)
Ginkgoites cf. sibirica (Heer)

Miyano hara Series (Upper-Lower?)
The series is distributed extensively
along the south side of the Tai-tzu-ho
River, a tributary of the Liao-ho River
from Wu-lung on the east to Tuan-
shan-tzu on the west, with the Miyano-
hara station as its center. It consists
of green-grayish coarse-grained sand-
stone, variegated shale, and white
conglomerate with large pebbles.
Thickness about 2,800 m. ±

Flora: Salvinia sp.
Pinanxylon dakotense Knowlton
Protoedroxylon araucarioi dees
Gothan
Tsao-tzu-shan Stage

The present formation crops out on the northwestern slope of the 541-meter hill between Tsao-tzu-shan and Chiu-kang village in the eastern part of the Jehol mountainland. It consists of pale white limestone, pale gray to pale green shale, and thick conglomerates. Thickness about 250 m.

Fossils:

*Manchurochelys manchoukuoensis* **Endo & Shikama**

*Yabeinosaurus tenuis* **Endo & Shikama**

*Estheria sp.*, *Lycoptera sp.*

*Ephemeropsis trisetalis* **Eichwald**

Middle Series?

Lower Series?

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Triassic Period

Chiu-fo-tang Series (Rhaeto-Lias?)

The Chiu-fo-tang Series is distributed rather extensively in the following areas: Chien-chan, Ling-nan, Ning-cheng, Feng-ning, Yi-hsien, Hei-cheng-tze and Chao-yang in the Jehol mountainland. Alternation of thin-bedded, pale gray to pale green shale and grayish white sandstone, tuffaceous conglomerates containing thin seams of oil shales. Thickness 620 m.

Fossils:

*Monjurosuchus splendens* **Endo**

*Rynchosaurus orientalis* **Endo & Shikama**

*Lycoptera davidii* (**Sauvage**)

*Astacus licenti* v. **Sraeelen**

*Sinoblatta laiyangensis* **Ping**

*Czenkanowskia rigida* **Heer**

*Schizolepsis jeholensis* **Yabe & S. Endo**

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Upper Series

Pei-piao Series (Noric—Rhaetic)

The Pei-piao Series is typically found in the Pei-piao coal field, 180 km ssw of Hsin-yang. It occurs also in other coal fields in Jehol Province such as
Chiao-yang, Wei-chang, Ying-hua and Nan-piao. Gray to black shale, sandstone, conglomerate, and pyroclastic rocks which contain many coal seams. Gray shale of the upper part yields insect remains such as *Mesoblattina sinica Ping* and *Sinoperla abdominalis Ping*. The following, well preserved plant fossils are found in several horizons in this shale and the sandy shale complex. Thickness about 800–1,000 m.

Fossils:
- *Neocalamites hoerensis* (Schimper)
- *Cladophlebis haiburnensis* (L. et H.)
- *C. denticulata* (Br.)
- *Phoenicopsis* cf. *manchuriensis* Yabe & Oishi
- *Czekanowskia rigida* Heer
- *Podozamites lanceolatus* (L. et H.)
- *Ginkgoites sibirica* (Heer)

Middle Series?
Lower Series?

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Tai-tzu-ho System
Permian Period
Upper Series
Tsai-chia Series (Zechstein-Trias?)

Its type locality is Tsai-chia-tun along the Tai-tzu-ho River, about 4 km south of Pen-chi-hu. Its total thickness is estimated to be about 440 m. This series does not crop out in the southern part of the Liao-tung Peninsula but it is especially well developed in the vicinity of Pen-hsi-hu in the Tai-tzu-ho region. Variegated shale and thick complex of quartz sandstones. Thickness 480 m. The present series may correspond to the Gobangsan Series in Korea and the Shihhotze Series in North China.

Fossils:
- *Annularia crassiuscula* Halle
- *Cladophlebis Nystroemi* Halle
- *Gigantopteris nicotinaefolia* Schenk
- *Pecopteris samaropsis* Ogura

The last listed species is a very remarkable one in that a seed of *Samaropsis affinis* type distinctively adheres to a frond of *Pecopteris arborescens*. The present specimen was collected by the writer in 1945 and described by Y. Ogura in a paper entitled “A new example of seed-bearing Pteridosperms from Manchuria” in the Proceedings of the Japan Academy (XXIV: 10) in 1948.

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Lower Series
Liu-tang Series (Rotliegendes)
The type locality is the Liu-tang Mine, 2.7 km west of Pen-hsi-hu. This series does not crop out in the southern part of the Liao-tung Peninsula except at Fu-chou where its lower part alone is developed. However, its lithic character and fossils may be almost identical with those of the Tai-tzu-ho district. Alternation of gray to black sandstone and shales with many coal seams. Fire-clays and aluminous shales are contained in the upper part of this series. Many marine fossils, *Chonetes latesiniata Schellwien*, *Productus taiyuanfuensis Grabau*, *Aviculopecten manchuriensis Chao*, and *Lima striatiplicata Chao*, as well as many species of corals and sea-urchins are found in the dark-grayish shale from the lower part of the series at Niu-sin-tai coal field. This represents the last marine transgression in Manchuria. Moreover, many well preserved plant fossils are contained in several horizons throughout the series. Thickness about 55 m.

Fossils:

*Pecopteris hirta Halle*

*Cladophlebis Nystroemi Halle*

*Sphenophyllum oblongifolium (G. & K.)*

*Calamites Suckowi (Brongn.)*

*Annularia orientalis Kawasaki*

*Lepidodendron oculis-felis (Abb.)*

*Stigmalia ficoides (Germ.)*

*Taeniopteris multicornis Weiss.*

*T. Schencki Sterzel*

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Lowermost Series

Huangchi Series (Sakmarian)

The type locality of the Huang-chi Series is Huang-chi-kou, about 3 km west of Pen-hsi-hu; both lithic and faunal characteristics of the Tai-tzu-ho district and the southern part of the Liao-tung Peninsula are rather remarkably different in that no limestone strata are intercalated in the former while the latter contains many layers. There is alternation of pale black to gray sandstone and shale containing many coal seams. A good fire clay is found in the basal part. Several lenticular limestones containing *Pseudoschwagerina globosa (Schwager)*, *Schwagerina expansa (Lee)*, *Productus taiyuanfuensis Grabau* are intercalated in this series. About the same flora as that of the Liu-tang Series is found throughout this series. Thickness 90–100 m.

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Carboniferous Period

Upper Series?

Middle Series

Pen-hsi-hu Series (Moscovian)
In general, the Pen-hsi-hu Series rests unconformably parallel upon the Ssu-yen Series of the Middle Ordovician and belongs to the Middle Carboniferous Moscovian. It consists mainly of the alternation of shale and sandstone intercalated with several layers of limestone. The predominant color is a remarkable reddish ochre. The reddish-ochre shale is well developed in the basal part of this series. This series often contains aluminous shale, fire clay, and thin coal measures. Nodular limonite ores are often contained in the reddish-ochre aluminous shales in the basal part. In the Tai-tzu-ho district, black to grayish lenticular cherts are sometimes found in the upper part of the series. Its total thickness is estimated at 70–90 m in the southern part of the Liaotung Peninsula and about 120 m in the Tai-tzu-ho district.

Fossils:

_Fusulinella bocki_ MOLLER
_F. prae simplex_ (LEE)
_Fusulina cylindrica_ FISHER & DEWELPHEER
_Spirifer mosquensis_ FISHER
_S. jiguensis_ STUCK
_Squamularia asiatica_ CHAO
_Arachnastraea manchurica_ YABE & HAYASAKA
_Syringopora reticulata_ GOLDFUSS
_Chaetetes asiatica_ YABE & HAYASAKA

Lower Series?

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Devonian Period (Not developed)
Silurian Period (Not developed)
Ordovician Period
  Upper Series (Not developed)
Middle Series
  Ssu-yen Series
    Type locality is Ssu-yen-kou, just north of the Pen-hsi-hu Colliery, Liaoning Province. This series is relatively widely distributed in the Tai-tzu-ho, Pe-chi-li, Kuan-tung and Hun-chiang areas and also crops out sporadically in Jehol Province.
    Gray to light gray banded limestone, dolomitic limestone with intraformational conglomerates. A remarkable _Stromatocerium_ reef is found in the lower part. Several horizons of the banded limestone yield well preserved Actinocerroid fauna which are comparable to the Black River fauna in the United States. Thickness about 50–70 m.
    Fossils:
      _Armenoceras richthofeni_ (FRECH)
      _A. yabei_ ENDO
      _A. orientale_ ENDO
**A. elongatum** Endo  
**Polydesmia elegans** (Endo)  
**Nyhyoceras foerstei** Endo  
**Sactoceras kobayashii** Endo  
**Maclurites bigshyi** Hall  
**M. nitida** (Ulrich & Scofield)

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**Lower Series**  
**Kang-yao Series**

The Kang-yao series is found in association with the overlying Ssu-yen Series throughout South Manchuria. There are notable fossil localities of this series in the vicinity of Shang-kan-yao and the northern foot of San-ling hill near the Fu-chou Colliery.

Gray to dark gray banded limestones, occasionally intercalated with sandy limestone and intraformational conglomerates. Thickness about 140 m.

**Fossils:**  
*Armenoceras tani* (Grabau)  
*Lophospira aoji* Endo  
*L. producta pagodai* Endo  
*Eotomaria barbouri* Grabau  
*E. ulrichi* Endo  
*Ctenodonta takahashii* Endo  
*Anthaspidella? radiata* Endo

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**Lowermost Series**  
**Wu-ting Series**

The Wu-ting Series is widely distributed along the course of the Tai-tzu-ho River, on the coast of the Gulf of Pe-chi-li, and in the Kuan-tung district. It also crops out sporadically in Jehol Province. Gray to dark arenaceous limestone, with several intraformational conglomerate. Thickness about 90 m.

**Fossils:**  
*Orthis nipponica* Kobayashi  
*Raphistoma cf. aequilaterum* Koken  
*Wutingia rectangula* Endo  
*Hystriculus granosus* (Endo)  
*Asaphellus orientalis* Endo  
*Basiliella wusungensis* Endo  
*B. spiculum* (Endo)
San-tao Series
The San-tao Series is widely distributed along the course of the Tai-tzu-ho River, on the coast of the Gulf of Pe-chi-li, and in the Kuan-tung district. It also crops out sporadically in Jehol Province. Arenaceous limestone with intraformational conglomerate, and shaly limestone in the lower part. Thickness about 55 m.
Fossils:
Calathium frechi Endo
Anthaspidella? radiata Endo
Piloceras manchuriensis Endo
Penhsioceras fusiformae Endo
Cameroceras cf. styliforme Grabau

Wan-wan Series
The Wan-wan Series is widely distributed along the course of the Tai-tzu-ho River, on the coast of the Gulf of Pe-chi-li and in the Kuan-tung district. Gray massive limestone, calcareous shale with intraformational conglomerate and a thick complex of Collenia limestone in the lower part. Calcareous shale complex yields rather good trilobites and primitive cephalopods as well as well preserved Riberidae.
Fossils:
Tellerina orientalis Resser & Endo
Saukia ulrichi Resser & Endo
Calvinella striata Resser & Endo
Wanwanoceras peculiare Kobayashi
Ectenoceras ruedemanni Kobayashi
Eremoceras arcuata Resser & Endo
Wanwania cambrica Kobayashi
Wanwanaella striata Kobayashi
Wanwanoides trigonalis Kobayashi
Ribeiria manchurica Kobayashi
Eopteris asiatica Kobayashi
Other primitive cephalopod specimens Ellesmeroceras elongatum Kobayashi, Ectenoceras curvatum Kobayashi, and Multicameroceras multicameratum Kobayashi are also found in the Collenia limestone of the basal part.

Cambrian Period
Upper Series (Chau-mi-tian Series)
Yen-chou Stage
In Kuan-tung district the Yen-chou stage crops out in a small area near the middle of Kan-tao-tzu Island.
On the coast of the Gulf of Pe-chi-li, it crops out on the summits of Tai-shan and Pai-shan mountains.

In the Liao-yang—Yen-tai area, it occurs on the cliffs near Yen-chou-cheng, where it extends both southwest and northeast.

In the neighborhood of Pen-hsi-hu it occurs in the valley of Huo-lien-chai. It is distributed also near Niu-hsin-tai and Hsiao-shih Collieries.

The Yen-chou stage occurs sporadically in several areas of eastern Jehol. Gray limestone with intraformational conglomerate and thin beds of yellowish shale. The following three fossil zones are found in this stage. Thickness about 100 m.

Fossils:

**Dictyella zone**

*Prosaukia? orientalis* Kobayashi

*Pagodia divergens* Endo

*Dictyella trigonalis* Kobayashi

*D. wuhuensis* Kobayashi

*Eoorthis pagodiformis* Kobayashi

*Acrotreta kaoliensis* Endo

**Pagodia buda zone**

*Huenella sexplicata* Kobayashi

*Pagodia buda* Resser & Endo

*P. trigonalis* Endo

*Quadraticephalus calcchas* (Walcott)

*Saukia? orientalis* Resser & Endo

*Ptychaspis sphaerica* Resser & Endo

*Koldinioidia aspinosa* Kobayashi

*Parakoldinioidia typicalis* Endo

**Tsinania zone**

*Tsinania canens* Walcott

*T. longicephala* Resser & Endo

*Pagodia buda* Resser & Endo

*Tellerina sulcatifera* Endo

*Saukia? orientalis* Resser & Endo

*Kaolishania pustulosa* Sun

*Ptychaspis sphaerica* Resser & Endo

*Parakoldinioidia typicalis* Endo

*Asiptychaspis ceto* (Walcott)

*Agnostus hoiformis* Kobayashi

*Pseudagnostus solus* Endo

*Paramansuyia planilimbata* Endo

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Daizan Stage
The type of this stage is found on the northern slope of Dai-tzu hill, 1.6 km southeast of Chin-chia-cheng-tzu near the coast of the Gulf of Pe-chi-li. In addition to the type locality, the Daitzu Series has been recognized at Tan-shih-ling, 3.2 km southeast of the Yen-tai Colliery, and San-fan-la-tzu-shan on the eastern rim of Niu-hsin-tai Basin.

Black to gray limestone with intraformational conglomerate. Thickness about 25 m. *Paramansuyella granulosa* zone and *Paramansuyella puteata* zone are contained in this stage.

Fossils:

*Paramansuyella granulosa* zone
  *Paramansuyella granulosa* EnDO
  *P. planilimbata* EnDO
  *Mansuyella tokunagai* (KOBAYASHI)
  *Agnostus hoiformis* KOBAYASHI
  *Pseudagnostus cyclopygeformis* SUN
  *Crepicephalus chinchiaensis* EnDO
  *Hyolithes paishanensis* EnDO
  *Palaeostrophia orthia* (WALCOTT)
  *Acrotreta kaoliensis* EnDO

*Paramansuyella puteata* zone
  *Paramansuyella glabra* EnDO
  *P. puteata* EnDO
  *Maladioidella splendens* EnDO
  *M. convexolimbata* EnDO
  *Eymekops rectangularis* EnDO
  *Obolus sankiensis* KOBAYASHI

Pai-shan Stage

The type locality of the Pai-shan stage is found on the northern slope of Pai-shan and Dai-shan near Chin-chia-cheng-tzu on the coast of the Gulf of Pe-chi-li. It occurs also in several comparatively small areas in Kuan-tung district. In the Liao-yang—Yen-tai area this formation crops out on the northern lower slope of Tang-shih-ling-shan.

Alternation of black, compact limestone and grayish, sandy limestone with quite a few intraformational conglomerates and pale yellowish shale. Thickness about 40 m. *Chuanga transversalis* and *Chuanga batia* as well as *Prochuania* zones are found in this stage.

*Chuanga transversalis* zone

Fossils:

*Billingsella simplex* Resser & EnDO
  *Acrotreta paiensis* EnDO
  *Chuanga batia* (WALCOTT)
C. tolli **Resser & Endo**
*Agnostus hoiformis* **Kobayashi**
*Pseudagnostus cyclypeiformis* **(Sun)**
*Crepecephalus orientalis* **Endo**
*Maladioides asiaticus* **Kobayashi**
*Kingstonia paichiaensis* **Kobayashi**
*Pagodia trisulcata* **Endo**

**Prochuangia zone**
Fossils:

*Prochuangia imamurai* **Endo**
*Manchurocephalus deprati* **(Mansuy)**

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**Middle Series (Chang-hia Series)**

**Ku-shan Stage**

The type locality of the Ku-shan stage is found in Chang-hia district, Shantung. In Manchuria, it is developed most typically in the area adjacent to the Gulf of Pe-chi-li. It is also found in both Kuan-tung and Tai-tzu-ho districts but becomes very thin there and in several places cannot be identified without careful examination.

Compact, dove-colored limestone with cherty matter, and dark-greenish, sandy shale as well as yellowish shale. The latter predominates in the lower part. Five fossil zones are contained in this stage. Thickness 20–60 m.

**Blackwelderia longispina zone**
Fossils:

*Blackwelderia longispina* **Resser & Endo**
*Lorenzella ogurai* **Resser & Endo**

**Blackwelderia cornuta zone**
Fossils:

*Blackwelderia? cornuta* **Endo**
*B. granosa* **Endo**
*Teiniston alcus* **(Walcott)**

**Drepanura premesnili zone**
Fossils:

*Drepanura premesnili* **Bergeron**
*D. pusilla* **Resser & Endo**
*D. ketteleri* **Monke**
*Agnostus douvillei* **Bergeron**
*Liostracina krausei* **Monke**
*Shantungia spinifera* **Walcott**
*Damesella manchuriensis* **Resser & Endo**
*Stephanocare richthofeni* **Monke**
*Teiniston truncatus* **Endo**
Damesella paronai (AIRAGHI)
Blackwelderia longispina RESSER & ENDO
Lorenzella rotundata RESSER & ENDO

Lorenzella-Lingulella zone
Fossils:
Lingulella hsiensis RESSER & ENDO
Oboleta tschanghsingensis ENDO
Lorenzella ogurai RESSER & ENDO
Damesella damesi RESSER & ENDO
Blackwelderia spectabilis RESSER & ENDO

Koptura lisani zone
Fossils:
Lingulella tsuchidai ENDO
Koptura lisani (WALCOTT)
Damesella damesi RESSER & ENDO
D. latelimbata ENDO
Blackwelderia spectabilis RESSER & ENDO
Damesella paronai (AIRAGHI)
Fengtienia peculiaris ENDO

Taitzu Stage
The type locality of this stage is loacted on the Pao-ching Ridge along the Tai-tzu-ho River. The Tai-tzu stage forms comparatively high hills and ridges throughout South Manchuria.

Ping-shan Ridge, La-chu-shan, Hsi-tai-shan and Chi-ting-shan in the Kuantung district; Dai-shan and Pai-shan on the coast of the Gulf of Pe-chi-li; Pao-chin Ridge, Iwayama and Wo-lung Ridge in the Tai-tzu-ho area are representative ridges consisted of this stage.

Alternation of gray to black oolitic limestone and compact limestone. The stage contains four fossil zones. Dorypyge richthofeni is the most characteristic species. Thickness 80–120 m.

Damesella-Teiniston zone
Fossils:
Agnostus damesi RESSER & ENDO
Solenoparia tersa ENDO
Damesella conica RESSER & ENDO
Teiniston lanciforme ENDO
Aojia reflexa ENDO
Paishania parallela ENDO

Amphoton zone
Fossils:
Manchuriella convexa (ENDO)
Amphoton deois (Walcott)
Elrathia conoidea (Walcott)
Aoqia spinosa Resser & Endo
Solenoparia luna Endo
S. hemicyla Resser & Endo
S. liaoyangensis Endo
Anomocarella deflecta Endo
A. orientalis Endo
Dorpyge richthofeni Dames
Proasaphiscus ephori (Walcott)

Crepicephalina zone

Fossils:
Helcinella rugosa orientalis (Walcott)
Crepicephalina mukdensis Resser & Endo
C. quadrata Resser & Endo
C. pergranosa Resser & Endo
Anomocarella tumida Endo
Aoqia spinosa Resser & Endo
A. divergens Endo
Elrathia taitzuensis Endo
Dorpyge richthofeni Dames
Eymekops quadrilateralis Endo
Solenoparia planifrons Resser & Endo
S. sobyosiensis Endo
S. triangulata Resser & Endo

Anomocarella-Manchuriella-Ptychoparia zone

Fossils:
Taitzuia liaotungensis Endo
T. granulosa Endo
Proasaphiscus quadraticaudatus Endo
Dorpyge richthofeni Dames
Manchuriella granulosa Endo
Nisusia concentrica Resser & Endo

Tang-shih Stage
The type locality occurs on the northeastern slope of Tang-shih-ling, 3.2 km southeast of Yen-tai Colliery, north of the Tai-tzu-ho River. This stage crops out extensively throughout the Kuan-tung, Pe-chi-li, and Tai-tzu-ho areas. It is thickest in the Kuan-tung district and gradually thins toward the north; the Tang-shih is distributed also in the eastern part of Jehol Province. Alternation of pale yellowish-brown shale and brownish, sandy shale with
some reddish shale and lenticular oolitic limestone intercalated. Thickness
about 25 m.

The state of preservation of the fossils in this stage is probably better than
that of any of the other older formation in Manchuria. Baiiella ulrichi and
Proasaphiscus yabei zones are included in this stage.

Baiiella ulrichi zone
Fossils:
  Acrothele eryx (WALCOTT)
  Baiiella ulrichi RESSER & ENDO

Proasaphiscus yabei zone
Fossils:
  Acrothele eryx (WALCOTT)
  Hyolithes cariniferus RESSER & ENDO
  Proasaphiscus yabei RESSER & ENDO
  Asaphiscus walcotti RESSER & ENDO

Lower Series (Man-tou Series)
Shih-chiao Stage
  The type locality is on the low hill directly east of Shih-chiao-tzu Station on
the An-tung—Hsin-yang Railroad Line. The present stage has, as far as
is known, the same distribution as the underlying Misaki stage, with
which it is closely associated in all sections of the Kuan-tung, Liao-yang—
Yen-tai, and Pen-hsi-hu areas. It occurs on the coast of the Gulf of Pe-chi-li,
namely, on Chang-ling-shan, 3.2 km east of Chin-chia-cheng-tzu, and on the
southern slope of Chu-tzu-shan directly east of the same village. This stage
is distributed rather extensively in the eastern part of Jehol Province.
  Reddish-purple, micaceous shale and pale greenish shale with pale reddish
lenticular limestone. Thickness 50–110 m.
  Fossils:
    Wimanella taei RESSER & ENDO
    Hyolithes kuantungensis RESSER & ENDO
    Ptychoparia orientalis RESSER & ENDO

Misaki Stage
  The type locality of the Misaki stage is located on the southwestern slope
of the 74 m hill, 1.6 km southwest of San-shih-li-pu, and on the northern slope
of nearby Misaki-yama, slightly north of Chin-chou, Kuan-tung district.
  The upper limit of the stage is not well defined in any area because there
is transition into similar shales of the Shih-chiao stage. The Misaki stage crops
out throughout South Manchuria wherever the Cambrian system occurs.
  Reddish purple micaceous shale with lenticular pale reddish compact and
oolitic limestone. Pale reddish compact banded limestone is found in the basal part.

The lenticular limestones are often composed of *Girvanella* remains. Several horizons of reddish shale and banded limestone yield rather well preserved specimens of *Redlichia chinensis* Walcott, *Cheiruroides orientalis* Resser & Endo, and *Lingulella yabei* Resser & Endo. Thickness about 90–200 m.

Proterozoic (Sinian)

Neo-Proterozoic

S. P’yongan-Liaotung (Heinan-Ryoto) type of the Sinian (type I)\(^1\)

This consists of the following (in descending order):

### Nan-shan series

- Nan-shan stage: almost entirely slate, interbedded with quartzite and limestone: thickness 400–800 m

- Ma-chia-tung stage: siliceous limestone: thickness 50–200 m

- Shih-san-li-t’ai stage: *Collenia* limestone: thickness 50–150 m

---

Unconformity

### Kuan-tung series

- Ying-cheng-tan stage; black limestone: thickness 370–400 m

- Onoda stage: platy limestone containing *Collenia*: thickness 270–400 m

- Kan-ching-tzu stage: dolomite and limestone containing *Collenia*: thickness 450–700 m

- Nan-kuan-ling stage: limestone, lower part contains impure limestone: thickness 800–1,000 m

- Chang-ling-tzu stage: phyllitic slate, upper part contains limestone: thickness ?–700 m

---

Conformable

### Ta-ho-shang-shan series

- Lung-tou stage: white quartzite: thickness 150 m

- Ying-ke-shih stage: phyllitic limestone and calcareous phyllite: thickness 30–200 m

- Cha-kou stage: quartzite: thickness 1,000 m

- Lung-wan-tang stage: platy quartzite: thickness 800 m

- Wai-tou-shan stage: quartzite: thickness 500 m

- Huang-ni-choan stage: calcareous and phyllitic slate

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\(^1\) Matsushita, Susumu (1935); Mem. Ryojun Coll. Eng., Vol. VIII, No. 2.
The type locality is the southwestern part of the Liao-tung Peninsula covering Lu-shun, Ta-lien, and Chin-chou. The age is Neo-Proterozoic. It is unconformably overlain by the Lower Cambrian. Intruded by the granite of, or separated by mylonite from, the Liaotung system.

N. P'youngan-Taitzuho (Heihoku-Taisika) type of the Sinian (type II)

This type consists of the following (in descending order):

<table>
<thead>
<tr>
<th>Wu-hsing-shan series</th>
<th>Hsi-ho series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chin-chia black limestone:</td>
<td>Chiao-yu-tai quartzite: quartzite:</td>
</tr>
<tr>
<td>limestone: thickness</td>
<td>thickness</td>
</tr>
<tr>
<td></td>
<td>200–400 m</td>
</tr>
<tr>
<td>Kao-cha-tun shale and sandstone:</td>
<td>Chiao-yu-tai quartzite: quartzite:</td>
</tr>
<tr>
<td>calcareous shale and siliceous</td>
<td>thickness</td>
</tr>
<tr>
<td>sandstone: thickness</td>
<td>800–1,000 m</td>
</tr>
<tr>
<td></td>
<td>Conformable</td>
</tr>
<tr>
<td></td>
<td>220–750 m</td>
</tr>
<tr>
<td></td>
<td>380–1,200 m</td>
</tr>
<tr>
<td></td>
<td>80–200 m</td>
</tr>
</tbody>
</table>

“Pe-chi-li series” is an alternate name for Chin-chia black limestone. The Yung-ning sandstone in the vicinity of Fu-chou is partly contemporaneous to the Kao-chia-tun shale and sandstone, although the greater part of the Yung-ning sandstone belongs to the Lower Cambrian. The type locality is the Fu-chou area, and along the course of the Tai-tzu-ho. The age is Neo-Proterozoic. It underlies unconformably the Lower Cambrian and overlies unconformably the Kung-chiang-ling granite and older complex formations. The Wu-hsing-shan series is correlated with a part of the Kuan-tung series. The Hsi-ho series containing wind-faceted pebbles may be partly contemporaneous with the Torridonian sandstone of England.

Kung-chang-ling (Kyuchorei) granite

Cataclastic rock containing quartz, plagioclase (albite-oligoclase), microcline (20–25%), and a small amount of mica.

Hsiang-lu-shan granite and Hsiao-li-kuo granite are included in this granite. The type locality is near the An-shan Iron Mine. The age is Proterozoic. It is intruded into the Liaotung and the Huchen systems. It is unconformably overlain by the Sinian system. There are two ages of intrusion of the granite, corresponding to the Hsiang-lu-shan and the Hsiao-li-kuo granites.

An-shan (Anzan) series

This series consists of the following (in descending order):

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2) Aoji, Otoji (1928); Proc. Imp. Acad., Vol. IV, No. 10.
Shu-shan beds
Tuffaceous sandstone and shale interbedded with quartz porphyry: thickness unknown

An-shan series
An-shan series (Restricted)
Phyllites, schistose grits, quartzites, actinolite schists, and banded iron ore: thickness 350–500 m

The type locality is near the An-shan Mine. The age is Proterozoic. This series corresponds to a part of the Nu-chen system. It unconformably underlies the Hsi-ho series (Sinian) and overlies unconformably Tui-mien-shan granite. It is intruded by Kung-chang-ling granite, and may be contemporaneous to the Chi-tung group in North China. The present series is also distributed at Kung-chang-ling Iron Mine, near Chiao-tou (along the Mukden—Antung Railway Line).

Eo-Proterozoic
Tui-mien-shen (Taimonzan) granite

The rock is of leucocratic and cataclastic structure, composed almost wholly of feldspar and quartz, but containing 4–5% microcline. Accessory minerals are apatite and sphene.

The type locality is near the An-shan Iron Mine. The age is probably Eo-Proterozoic. This granite is probably intruded into the Liao-tung system and is also overlain unconformably by the Nu-chen system and the An-shan series. The Tui-mien-shen granite occurs also near Tich-ling.

Liao-ho (Ryoga) system

This system represents the oldest metamorphosed rocks undoubtedly of sedimentary origin. Order of succession (descending):

a. Upper (Kai-ping Series): Consists chiefly of greenish mica phyllite and mica schist commonly containing sillimanite and staurolite: thickness 10,000–15,000 m.

b. Middle (Ta-shih-chiao Series): Consists chiefly of crystalline dolomite and limestone, in places containing Collemia-like fossils: thickness 4,000 m.

c. Lower: Biotite schist, two-mica schist, staurolite-biotite schist, quartz schist, and limestone. Probably 1,000 m thick.

The type locality is the northern part of Liao-tung Peninsula including Hai-cheng and Kai-ping districts. The age is probably Archaeozoic or Eo-Proterozoic. It is unconformably overlain by the Hsi-ho series (Sinian), and intruded by the Kung-chang-ling granite (Proterozoic). There is no place of direct contact in the field, and it is not known whether the Nu-chen and the Liao-tung systems are younger or older than the Liao-ho system. The lowest part is indistinct because of

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a) Sarro, Rinji (1936); Bull. Geol. Inst. Manchukuo, No. 93.
the injection of granite. It may be correlated with the Wu-tai system of Shan-hsi, North China.

The Liaoho system is extensively distributed in a wide area along the course of the Yalu River in An-tung and Tung-pien-tao, especially near Lin-chiang-hsien.

Archaeozoic Era
Liaotung (Ryoto) system

This system consists of epidote-mica schist, epidote-mica granite gneiss, and a small amount of amphibolite. The Influence of an intrusion of aplitic is great. All of the rocks are of igneous origin. The process of metamorphism is inferred as follows:

a. Basic igneous rocks (plutonic or volcanic).
b. Intrusion of intermediate igneous rock.
c. Intrusion of basalt dikes.
d. Metamorphism to epidote-mica gneiss, epidote-mica schist.
e. Intrusion of granitic magma (muscovitization, potash feldspar metasomatism) to form epidote-mica granite-gneiss (injection gneiss, permeation gneiss).
f. Intrusion of "Halleflinta".

The type locality is Ta-ho-shang-shan, 5 km east of Chin-chou, Kuan-tung-chou. Age is probably Archaeozoic. It is separated from the overlying Liao-ho system by mylonite and was thought by Sawatari to be older than that system. The lower limit is indistinct owing to migmatization. It is distributed in the southern part of Liao-tung Peninsula covering Kuan-tung-chou, Ta-ku-shan, An-tung, etc.

B. Columnar section of Northern Manchuria

Quaternary Period
Alluvial Series
  Sand, gravel and clay
Pleistocene Series
  Ku-hsiang-tun Stage

Ku-hsiang-tun, a treasury of Diluvium fossils, is a village located along the Wen-chuan-ho, a tributary of Sung-hua-chiang, 5 km sw of the center of Harbin. The Diluvium series crops out along the Wen-chuan-ho River and its tributary the Wa-pen-yao-ho River. The Diluvium series, which forms the terrace group in the vicinity of Harbin, is estimated to be about 25 km. In the vicinity of Ku-hsiang-tun, its average thickness is about 10 m. It consists of a succession of clay, mud, sand, sandy clay, and other sediments, and it is one kind of flood-plain lacustrine deposit. It is different from the Ma-lan loess in that remarkable gravel beds are not found in it. The succession of the Ku-hsiang-tun stage is as follows:
Ku-hsiang-tun formation
Lower part: Bluish-gray to dark gray clay bed and sandy clay bed 2.8 m
Upper part: Yellowish-gray argillaceous sand to sandy clay bed 10 m

Forming of terrace: Dissection of the Wa-pen-yao-ho (Wa-pen-yao stage)

Wen-chuan ho bed: Black mud bed (1 m ± average thickness)
Forming of terrace: Dissection of the Wen-chuan ho (Sung-hua-chiang stage)

Fossils:
\textit{Rhinoceros antiquitatis} Blum.
\textit{Canis lupus} L.
\textit{Hyaena ultima} Matsumoto
\textit{Equus przewalskii} Polli.
\textit{Capreolus manchuricus} Lyd.
\textit{Bos primigenius} Boj.
\textit{Elephas primigenius} Blum.
\textit{Bison occidentalis} Lucas.
\textit{Djalainor} man.

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Tertiary Period
Pliocene Series
Wu-yun Stage

Wu-yun is located along the Hei-lung-chiang, 90 km se of Hei-ho, Hei-lung-chiang Province and is opposite Innokenchefskaya, USSR. Wu-yun village, Wu-yun hsien is one of the river ports between Hei-ho and Chia-mu-mu-ssu. The vicinity of Wu-yun is about 100 m above sea level. Hills of low relief, 280–290 m above sea level, are distributed in the southern part.

The distribution area of the Tertiary system near Wu-yun is divided into two localities, namely, the coastal district of the Hei-lung-chiang, and a distant area, 20 km south of the bank of the river.

The succession, in descending order, is as follows:
1. White arkose sandstone. Thickness about 30 m.
   It sometimes grades into conglomerate. The diameter of the pebbles is less than one cm. The present bed intercalates lenticular clay. Cross-bedding is developed. Carbonaceous and siliceous wood is contained along the bedding planes.
2. Coal measure 0.3–0.8 m
3. Coaly shale 0.2–0.3 m
4. Grayish-white arenaceous shale 20 m

Coal measures intercalate coarse sandstone(2), 0.1 m thick. Fragments of plant fossils are found in the coaly shale (3) and grayish-white arenaceous shale (4).
Miocene Series
Tomonsi (Tu-men-tzu) stage
- Grayish-white tuff: thickness 10± m
- Coarse sandy shale: thickness 100± m
- Diatomaceous sandy clay: thickness 1.5–4 m
- Conglomeratic sandstone: thickness 10± m
- Basal conglomerate: thickness 2 m

This formation rests upon Paleozoic hornfels and schists, granites, and the Hun-chun group: it is covered by Diluvium. The type locality is Tu-men-tzu, Chien-tao Province, Manchuria. Fossils of *Pinus, (Abies), Quercus, Tilia, Carpinus* and *Juglans*, are found in several horizons.

Oligocene Series
Hun-chun Stage

The Hun-chun stage is an extension of the Kainei Series in northeastern Korea and was deposited in the concave depressions on the bedrock of several localities on the west coast of the Tou-men River in eastern Manchuria.

Arkose sandstone and red to green tuffaceous shale, containing coal seams, are present. Thickness 600 m. The following listed plant fossils are found in several horizons.

- *Acer arcticum* Heer
- *Betula Brogniartii* Ett.
- *B. prisca* Ett.
- *Fagus Antipof* Heer
- *Populus arctica* Heer
- *Sequoia Langsdorfii* Brongn.

Pliocene?

Cretaceous Period
Upper Series?
Middle Series
Hua-shan Stage

The Hua-shan stage crops out along both sides of the Mu-ling River, showinganticrinium in e-w extension and conglomerate containing many fossils of conifers. Coals and bethnite are found in the lower part. Thickness 1,500–2,400 m.

Fossils:
- *Equisetites* sp.
- *Cladophlebas denticulata* Brongn.
- *Sphenopteris Goepperti* Dunber
Onychiopsis elongata BRONGN.

Baiera manchurica YABE & OISHI

Nilssonia sp.

?

Lower Series

Ta-la-tzu Stage

The Ta-la-tzu stage is distributed in an area situated approximately midway between the Ho-lung graben near San-tao-kou and the Tu-shan-tzu graben NW of the former, in eastern Manchuria.

Alternations of yellowish-brown sandstone and shale with oil shale are present. Pale yellowish-gray conglomerate is developed at the base. Thickness 1,000 m. The interesting fauna of Sphaerium chientaoense SUZUKI, Viviparus (Tulotomoides) talatzuensis SUZUKI, Bulimus cf. chobnokyi (SCHLOSSER) and a fish fossil, Manchurichthys uwatokoi SAITO, are found in some horizons of shales.

?

Chuan-tou Stage (Jura-Cretaceous Period)

The Chuan-tou stage is typically found near Kao-tai-tzu, east of Chuan-tou station on the main railroad between Ta-lien and Chang-chun. It is found northeastward along the railroad from Chuan-tou via Kai-ping, Chang-tu, Ssu-ping-kai, to Chang-chun and from the latter place to east of Harbin. Reddish-purple loose sandstone, sandy tuff, conglomeratic shale with the basal conglomerate are present. Thickness 500 m.

Fossils:

Onychiopsis elongata (GEYL.)

Sphenopteris Goeperti DUNKER

Baiera manchurica YABE & OISHI

Phoenicospis speciosa HEER

Podozamites lanceolatus (L. & H.)

Chelonia sp.

jurassic period

Lung-ching Stage

The Lung-ching is always developed in association with the Ta-la-tzu stage; therefore, some geologists insist that the present formation may be included in the latter stage. Reddish-brown sandy shale, pyroclastic rocks and a basal conglomerate are present. Coal and oil shale are contained in some horizons, and Onychiopsis elongata (GEYLER), Taeniopsis Uwatokoi OISHI, Pityophyllum Nordenskijoldi (HEER) are found in this stage.

Upper Series
Mi-shan Stage (Toyama Stage)

The present stage occurs typically in the Mi-shan coal field in northeastern Manchuria and it is distributed also in such coal fields as Hu-li-kang, Hu-lung, and Chao-ho.

The present stage may be equivalent to the Toyama stage in the Hulunbuir district.

There is alternation of black to gray shale and sandstone as well as conglomerates in the basal part, usually containing quite a few coal seams. Thickness 100–250 m. Several horizons of shale yield the following fine plant fossils:

- *Todites Williamoni* (BRONGN.)
- *Cladophlebis denticulata* (BRONGN.)
- *C. lobifolia* (PHILLIPS)
- *C. browniana* (DUNKER)
- *Coniopteris hymenophylloides* (BRONGN.)
- *Sphenopteris goepperi* (DUNKER)
- *Elatocladus manchurica* (YOKOYAMA)
- *Podozamites lanceolatus* (L. & H.)
- *Ginkgoites cf. sibirica* (HEER)
- *Pityophyllum Nordenskijoldi* (HEER)

Middle Series?
Lower Series?
Triassic Period?

The Mammo Group was named by T. Kobayashi in 1942. The term was applied to a series of Paleozoic formations extending from central and north Manchuria eastward to the maritime provinces of USSR. and westward at least as far as Mongolia. Other outcrops are known in northeastern Korea.

Upper group
Permian
Pyoksong formation

The present formation is distributed in the south of the Tou-man River, in the most northeastern part of Korea.

It consists of sandstone, shale, hornfels, conglomerate, clay slate, limestone, chlorite schist, mica schist, and hornblendite.

Fossils:

- *Productus* sp.
- *Spirifer* sp.
- *Pseudodoliolina* sp.
- *Parafusulina* sp.
Permo-Carboniferous

Tou-man stage

The present stage crops out in the Chien-tao district in the southeastern part of Manchuria. Gray clayslate, black shale, black phyllitic clayslate, grayish-green conglomerate, mica schists, and arenaceous hornfels are present. Thickness about 1,000 m.

Fossils:

Chonetoides chonetoides (Chao)
Spirifer cf. mooskhailensis Davidson
Polyptora manchoukuoensis Minato
Waagenophyllum indicum (Waagen & Wentzel)
Linopoductus lineatus (Waagen)
Spiriferina cristata Schlotheim
Neoschwagerina cf. margaritae Deprat
Yabeina hayasakai Ozawa

Middle group.
Carboniferous Period

Kirin Stage

The Kirin stage occurs typically in the Kirin sheet area and it is sporadically distributed in several areas of North Manchuria.

Brecciated conglomerate, limestone, hornfels, agglomerates, black shale and pale greenish tuff are present. Thickness more than 2,500 m.

Fossils:

Lonsdaleia floriformis Lonsd.
Aulloclista sp., Siphonodendron sp.
Gigantella cf. latissimus (Sowerby)
Dibunophyllum sp.

These fossils are found in the lower part of the stage and indicate Dinantian and Visean ages.

Devonian Period.

Upper Series

Hei-tai Stage (Frasnian)

The present stage occurs at Hei-tai in Shinano village (former name), Mi-shan-hsien.

Calcareous sandstone, conglomeratic arkose sandstone, coarse-grained sandstones as well as alternation of black shale and fine-grained sandstone are present. Thickness is uncertain.

Fossils:

Plectospirifer grabaui Yabe & Sugiyama
Atrypa aspera (Schlotheim)
Favosites multispinulosus YABE & SUGIYAMA

Middle Series

Ho-ling-men Stage (Eifelian)

The present stage is found at a place 41 km NE of Hou-ling-men on the North Manchurian plateau. Conglomerate, green limestone, black limestone, purple shale and ochered phyllytic marls are present. Thickness is uncertain.

Fossils:

Gypidula cf. mansuyi GRABAU
Atrypa desquamata SOWERBY
Spirifer tokinesis MANSUY

Lower series

Ni-chiu-ho Stage (Coblenzian)

A black shale found beneath the gold placer deposit at Ni-chiu-ho in the northern part of the North Manchurian plateau is considered to be Coblenzian by YABE and SUGIYAMA. It contains Pleurodictyum nodai YABE and SUGIYAMA, Syringoxon (?) sp., Stropheodonta cf. sedgwicki d'ARCHIAC & VERNEULI and an undetermined number of brachiopods.

Lowest group.

Silurian Period

The oldest fossils found are middle Silurian in age. They were collected from a limestone deposit at Erh-tao-kou west of Kirin and include Pseudoniphyma infundibula YABE & EGUCHI, Spongophyllum sugiyamae YABE & EGUCHI, Favosites sp. nov., cf. Striatopora cristata (BLUMENBACH), Cladopora (?) sp., Aulopora (?) sp., Pachyopora (?) sp.

Dark-gray shale

Fossils:

Pleurodictyum nodai YABE & SUGIYAMA
Stropheodonta cf. sedgwicki d'ARCHIAC & VERNEULI

Pre-Silurian Period

A complex of crystalline schists, gneiss and granite is characteristic of this period. Additional important data has been found since 1945 concerning the items which were marked with in the foregoing sections.

The geological age of the Chiu-fo-tung stage had been considered Cretaceous by many geologists in the Orient, because of the presence of Lycoptera davidi (SAUVAGE). However, the writer and Tokio SHIKAMA in studies of the Lycoptera bed found two distinct faunal groups—Tanankou and Tsao-tzu-shan fauna—in the

Chiu-fo-tang stage. In the former fauna *Monjurosuchus splendens*, *Rhynchosaurus orientalis*, and *Astacus licenti* together with *Licyoptera daviidi* were found, while in the latter fauna *Manchurochelys manchoukuoensis* and *Yabeiosaurus tenuis* together with *Licyoptera* species were identified.

Unfortunately, these two faunal localities are about two hundred kilometers apart, so we can not correlate them directly. Therefore, the writer and SHIKAMA concluded that the Tsao-tzu-shan fauna and Ta-nan-kou fauna (the latter belongs to the Chiu-fo-tang stage in a strict sense) are Upper Jurassic and Rhaeto-lia in age.

The writer formerly reported the Ordovician stratigraphy as follows:

- Middle Ordovician
  - Ssu-yen formation
- Lower Ordovician
  - Wu-ting formation
  - Kang-yao formation
- Lowest Ordovician
  - San-tao formation
  - Wan-wan formation

Since the exact contact between the Wu-ting and Kang-yao stages had not been seen in one continuous section, the writer had determined the stratigraphic order by palaeontological data alone. However, in the spring of 1947 the writer restudied the Ordovician sections in Tai-tzu-ho district. It was definitely observed that the Kang-yao always rests conformably on the Wu-ting stage, contrary to the former report. Moreover, it was found that the trilobite species contained in the Wu-ting stage could be referred to the Canadian Period in North America as already pointed out by Teiichi KOBAYASHI in the Bull. of Geological Soc. of Japan (42: 498), 1935.

The Kang-yao includes many well preserved specimens of *Lophospira*, *Eotomaria*, *Helicotoma*, and *Solenospira* and it is reasonable that the present stage is referable to the lower portion of the Stones River of N. America. Therefore, the writer wants to change the Ordovician sequences in Manchuria to the order listed in the above columnar section.

The formal report of the Djalainor skulls has not yet been published, but the writer has been studying the skulls during the past several years. The materials of Djalainor man are composed of a skull of a female and a skull of a male, left half of a mandible, a right ulna, a left ulna and a rib fragment. These skulls show characteristic features of the Mesolithic man in having a lower degree of the orbital and foraminal indices, relatively large value for the internal-bi-orbital breadth, very shallow fossa canina, downward-tapering maxilla and three foramina mentalia. Moreover it is very remarkable that these skulls are found together with many vertebrate skeletons and many chipped microlithic implements which indicate the late Pleistocene age. Many other skeletons of Djalainor man will probably be found in the future in Djalainor coal field.
Until a few years ago, the geological age of the Chuan-tou stage was disputed among the Manchurian stratigraphers, until Shigeo Sakaguchi, former member of the Coal Mining Co. of Manchuria, collected the fossils listed above in this formation at Hsi-ying-pan, Tieh-ling Prefecture, Liao-ning Province in 1943. He concluded that the present stage belongs to the lowest part of the Cretaceous Period or even to the boundary between the Cretaceous and Jurassic Periods.