

A Summary of the Columnar Sections in Manchuria

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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 *Cecidomiya*, *Exetastes*, *Componotus*, *Cainoblattiopsis*. 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* GRABAU and *Campeloma tani* GRABAU in its upper portion, by *Estheria middendorfi* MULLER in the middle 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.

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 sandstone, variegated shale, and white conglomerate with large pebbles. Thickness about 2,800 m. ±

Flora: *Salvinia* sp.

Pinoxylon dakotense KNOWLTON

Protocedroxylon araucarioides

GOTHAN

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)

Baiera cf. *gracilis* (BUNB.)
Elatocladus manchurica (YOK.)
Phoenicopsis speciosa HEER
P. angustifolia HEER
Pityophyllum cf. *lindstroemi* NATH.
Sphenopteris goepperti DUNKER, etc.

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?

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
Rhynchosaurus orientalis ENDO & SHIKAMA
Lycoptera davidi (SAUVAGE)
Astacus licenti v. STRAELEN
Sinoblatta laiyangensis PING
Czenkanowskia rigida HEER
Schizolepsis jeholensis YABE & S. ENDO

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 abdorminalis* 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?

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 distinctly 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.

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 latesinuata* 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 multinervis WELSS.
T. Schenkii STERZEL

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.

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. praesimplex (LEE)

Fusulina cylindrica FISHER & DEWELPHEER

Spirifer mosquensis FISHER

S. jigulensis STUCK

Squamularia asiatica CHAO

Arachnastraea manchurica YABE & HAYASAKA

Syringopora reticulata GOLDFUSS

Chaetetes asiatica YABE & HAYASAKA

Lower Series?

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 Actinoceroid 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)
Nybyoceras foerstei ENDO
Sactoceras kobayashii ENDO
Maclurites bigsbyi 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 aojii 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 rectangulosa ENDO
Hystriculus granosus (ENDO)
Asaphellus orientalis ENDO
Basiliella wusungensis ENDO
B. spiculum (ENDO)
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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
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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
Wanwanella striata KOBAYASHI
Wanwanoides trigonalis KOBAYASHI
Ribeiria manchurica KOBAYASHI
Eopteria 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 calchas (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

Asioptychaspis ceto (WALCOTT)

Aagnostus hoiformis KOBAYASHI

Pseudagnostus solus ENDO

Paramansuyia planilimbata ENDO

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

Hyalithes 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. *Chuangia transversalis* and *Chuangia batia* as well as *Prochuangia* zones are found in this stage.

Chuangia transversalis zone

Fossils:

Billingsella simplex RESSER & ENDO

Acrotreta paiensis ENDO

Chuangia batia (WALCOTT)

C. tolli RESSER & ENDO
Agnostus hoiformis KOBAYASHI
Pseudagnostus cyclopygeformis (SUN)
Crepicephalus orientalis ENDO
Maladioides asiaticus KOBAYASHI
Kingstonia paichiaensis KOBAYASHI
Pagodia trisulcata ENDO

Prochuangia zone

Fossils:

Prochuangia imamurai ENDO
Manchurocephalus deprati (MANSUY)

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
Teinistonalcon (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
Obolella 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 located 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 Kuan-tung 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)
Aojia spinosa RESSER & ENDO
Solenoparia luna ENDO
S. hemicycla RESSER & ENDO
S. liaoyangensis ENDO
Anomocarella deflecta ENDO
A. orientalis ENDO
Dorypyge 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
Aojia spinosa RESSER & ENDO
A. divergens ENDO
Elrathia taitzuensis ENDO
Drypyge 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
Dorypyge 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. *Bailiella ulrichi* and *Proasaphiscus yabei* zones are included in this stage.

Bailiella ulrichi zone

Fossils:

Acrothele eryx (WALCOTT)

Bailiella 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: <i>Collenia</i> limestone: thickness	50–150 m
-----Unconformity-----			
Kuan-tung series	{	Ying-cheng-tan stage; black limestone: thickness	370–400 m
		Onoda stage: platy limestone containing <i>Collenia</i> : thickness	270–400 m
		Kan-ching-tzu stage: dolomite and limestone containing <i>Collenia</i> : 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-chuan stage: calcareous and phyllitic slate	

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'yongan-Taitzuho (Heihoku-Taisika) type of the Sinian (type II)²⁾

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

Wu-hsing-shan series	{ { {	Chin-chia black limestone:	
		limestone: thickness	200-400 m
		Kao-cha-tun shale and sandstone:	
		calcareous shale and siliceous sandstone: thickness	800-1,000 m
----- Conformable -----			
Hsi-ho series	{ { {	Chiao-tou quartzite: quartaite, siliceous slate in alternation: thickness	220-750 m
		Nan-fen shale and marl: shale and marl: thickness	380-1,200 m
		Chiao-yu-tai quartzite: quartzite: thickness	80-200 m

“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-cha-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):

²⁾ Aoji, Otoji (1928); Proc. Imp. Acad., Vol. IV, No. 10.

An-shan series	}	Shu-shan beds	Tuffaceous sandstone and shale interbedded with quartz porphyry: thickness unknown
		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 Tieh-ling.

Liao-ho (Ryoga) system³⁾

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 *Collenia*-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

³⁾ SAITO, 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 aplite 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 Upper part: Yellowish-gray argillaceous sand to sandy clay bed	2.8 m
		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 \pm average thickness)	
Forming of terrace:	Dissection of the Wen-chuan ho (Sung-hua-chiang stage)	

Fossils:

Rhinoceros antiquitatis BLUM.*Canis lupus* L.*Hyaena ultima* MATSUMOTO*Equus przewalskii* POLLI.*Capreolus manchuricus* LYD.*Bos primigenius* BOJ.*Elephas primigenius* BLUM.*Bison occidentalis* LUCAS.*Djalainor* man.

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 Innokenchfskaya, USSR. Wu-yun village, Wu-yun hsien is one of the river ports between Hei-ho and Chia-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	1.5-4m
Conglomeratic sandstone: thickness	10±m
Basal conglomerate: thickness	2m

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 Brogniarti ETT.

B. prisca ETT.

Fagus Antipofi HEER

Platanus cf. *aceroides* GOEPP.

Populus arctica HEER

Sequoia Langsdorfi 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, showing anticlinorium in E-W extension and conglomerate containing many fossils of conifers. Coals and bethonite are found in the lower part. Thickness 1,500-2,400 m.

Fossils:

Equisetites sp.

Cladophlebis denticulata BRONGN.

Sphenopteris Goepperti DUNBER

Onychiopsis elongata BRONGN.
Baiera manchurica YABE & OISHI
Nilssonina 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 uwatokoii* 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 north-eastward 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 Goepfertii DUNKER
Baiera manchurica YABE & OISHI
Phoenicopsis 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 Uwatokoii* OISHI, *Pityophyllum Nordenskjoldi* (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 Williamsoni* (BRONGN.)
- Cladophlebis denticulata* (BRONGN.)
- C. lobifolia* (PHILLIPS)
- C. browniana* (DUNKER)
- Coniopteris hymenophylloides* (BRONGN.)
- Sphenopteris goepperti* (DUNKER)
- Elatocladus manchurica* (YOKOYAMA)
- Podozamites lanceolatus* (L. & H.)
- Ginkgoites* cf. *sibirica* (HEER)
- Pityophyllum Nordenskjoeldi* (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
Polypora manchoukuoensis MINATO
Waagenophyllum indicum (WAAGEN & WENTZEL)
Linoproductus 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.
Auloclesia 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 sandstone 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-lung-men Stage (Eifelian)

The present stage is found at a place 41 km NE of Hou-lung-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 tokinensis MANSUY

Lower series

Ni-chiu-ho Stage (Coblentzian)

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 Coblentzian by YABE and SUGIYAMA.⁴⁾ It contains *Pleurodictyum nodai* YABE and SUGIYAMA, *Syringoxon* (?) sp., *Stropheodonta* cf. *sedgwicki* d'ARCHIAC & VERNEULI and an undertermined 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 Kirin⁵⁾ and include *Pseudoniphyma infundibula* YABE & EGUCHI, *Spongophyllum sugiyamai* YABE & EGUCHI, *Favosites* sp. nov., cf. *Striatopora cristata* (BLUMENBACH), *Cladopora* (?) sp., *Aulopora* (?) sp., *Pachypora* (?) sp.

Dark-gray shale

Fossils:

Pleurodictyum nodai YABE & SUGIYAMA

Stropheodonta cf. *sedgwicki* d'ARCHIAC & VELNEULI

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 with⁵⁾ 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

⁴⁾ YABE, H. and T. SUGIYAMA (1942); A lower Devonian faunule from North Manchuria: Proc. Imp. Acad. Tokyo, Vol. 18, No. 8.

⁵⁾ YABE, H. and EGUCHI, M. (1943); On a limestone with favosites from Erh-tao-kou, west of Kirin, Manchuria: Proc. Imp. Acad. Tokyo, Vol. 19.

Chiu-fo-tang stage. In the former fauna *Monjurosuchus splendens*, *Rhynchosaurus orientalis*, and *Astacus licenti* together with *Lycoptera davidi* were found, while in the latter fauna *Manchurochelys manchoukuoensis* and *Yabeinosaurus tenuis* together with *Lycoptera* 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-lias 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.