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REPORT No. 198

GEOLOGICAL SURVEY OF JAPAN

ON THE BOUNDARY BETWEEN THE PERMIAN AND TRIASSIC SYSTEMS IN JAPAN

WITH THE DESCRIPTION OF THE PERMO-TRIASSIC FORMATIONS AT TAKACHIHO-CHO, MIYAZAKI PREFECTURE IN KYUSHU AND THE SKYTIC FOSSILS CONTAINED

By

Nobukazu KAMBE

GEOLOGICAL SURVEY OF JAPAN

Hisamoto-cho, Kawasaki-shi, Japan

1963

551.736+551.761 (522.7) (550.85/.86)

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Katsu KANEKO, Director

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Nobukazu KAMBE

Abstract

In 1952, the writer has discovered molluscan fossils in grayish white limestone i. e. the Kamura formation and fusulinids in dark grayish limestone i.e. the Iwato formation at Kamura in Takachiho-cho, Nishiusuki-gun, Miyazaki Prefecture. Subsequently, in 1957, Dr. SAITO recognized that the grayish white limestone is situated on the northern side and the dark grayish limestone on the southern side at Saraito, Takachiho-cho and that there is neither an unconformity nor a fault at the boundary between the two limestones. Still later, in 1959, the writer has confirmed the above boundary relation between the Permian Iwato formation and the Triassic Kamura formation.

The Kamura formation is composed of grayish white limestone, 35 m thick, clayslate and sandstone beds, several meters thick, and dark grayish chert, 3～5 m thick in the Kamura section and of grayish white limestone, 30 m thick, clayslate and sandstone beds, 20m thick, chert, 30m thick, sandstone, 20 m thick and alternation of siliceous clayslate, sandy clayslate and sandstone, 60 m thick in the Saraito section.

The limestone of the Kamura formation contains *Eumorphotis*, *Pteria*, *Gervillia*, *Entolium*, *Chlamys* (?), *Eopecten*, *Pecten*, *Anodontophora*, Gastropoda, *Pseudosageceras*, *Clypites*, *Parahedenstroemia* and *Aspenites*. Some of these fossils are known from the Kurotaki formation in Kochi Prefecture and the Shionosawa formation in Gumma Prefecture. Therefore the Kamura formation must be Skytic or Lower Triassic in age. The Skytic ammonites of the Kamura formation range as genera from Flemingitan to Owenitan. In view of the non-fossiliferous part subjacent to the fossiliferous zone, it may be concluded that the Kamura formation extends to the pre-Flemingitan of the Skytic stage.

The Kamura formation is in contact with the Middle Permian Toroku formation on the north side with a thrust fault in between. On the south side of the Kamura formation, there is the Iwato formation which is composed of dark grayish limestone, sandstone, clayslate and chert. The limestone, 60～100 m thick, contains *Yabeina* and *Neoschwagerina*. The age of the Iwato formation is Middle and Upper Permian. The Iwato formation and the Kamura formation are laterally traceable more than eight kilometers.

As the result of the stratigraphical and paleontological studies, it was ascertained that there is neither a structural difference, a fault nor an unconformity between the Iwato and Kamura formations.

Furthermore the writer examined the geological relations between the Permian Toyoma and Triassic Inai groups in the southern Kitakami mountains and between the Permian Maizuru and Triassic Yakuno groups in the Maizuru Zone. As the results it was ascertained that the boundary between the Permian and Triassic systems is indicated by parallel unconformity or disconformity in the Inner Zone of Southwest Japan and the southern Kitakami mountains. Therefore the movement at the transitional interval between the two periods must have been a broad gently undulatory upheaval and a gradual subsidence after a short erosion interval and by no means an orogenic movement.

The Permian and Triassic systems are conformable in the Outer Zone of Southwest Japan where neither upheaval nor erosion can be actually recognized.

On the basis of these facts, it can be deduced that the sedimentation was continued on the Pacific side of Japan without any cessation at the Permo-Triassic transition but on the continental side of Japan there is a stratigraphic break which indicates an epirogenic movement.

In spite of the weakness of crustal deformation at the boundary, the difference between the faunas of the two systems is conspicuous.

In this paper, the writer described the fossils of the Kamura formation. They are 7 genera 18 species of pelecypods, gastropod, gen. et sp. indet., and 4 genera 6 species of ammonites beside an indeterminable ammonite.

I. Introduction and acknowledgements

The Permian and Triassic systems in Japan have been studied by many geologists and palaeontologists, and the geological history of these periods is now fairly well clarified. Nevertheless many questions still remain as to the boundary between the two systems.

It was about 20 years ago that Prof. T. KOBAYASHI advocated the Tate epirogenesis between the Permian Toyoma and the Triassic Inai groups. He asserted in his studies that the Sambosan group in the outer side of Southwest Japan was accumulated without any conspicuous gap at the Permo-Triassic transition.

Fortunately the writer has been able to study the Triassic system in Japan for over fourteen years. In 1947, the writer commenced the stratigraphic and palaeontological studies of the Shidaka group in Kasa-gun, Kyoto Prefecture (KAMBE, 1948, 1950, 1951). It was separated from the underlying Palaeozoic formation by a conspicuous clino-unconformity. On this occasion marine fossils were discovered in the upper part of the group, namely in a horizon a little below the Shidaka plant bed. The writer described the Shidaka fauna in 1951. Its geological age must be either Upper Carnic or Noric.

In 1949 and 1950 when the writer carried out the geological survey of the Tajima-Takeda sheet-map area (scale 1:50,000) (HIROKAWA, TOGO and KAMBE, 1954), he investigated the mutual relations among the Palaeozoic formation (especially the Chihara and Nukada formations), the Lower and Middle Triassic Kawanishi and Yakuno groups, and the Upper Triassic Hegi and Hirotani formations. In the geological survey of the Oyaichiba sheet-map area (scale 1 : 50,000) in 1950 (HIROKAWA, TOGO and KAMBE, 1954) (HIROKAWA and KAMBE, 1951) (KAMBE, 1957), he was fortunate enough to discover Upper Triassic fossils in the Miharaiyama group which was composed of conglomerate, sandstone and clayslate. The Miharaiyama fauna which is a correlative to the Shidaka fauna is Upper Carnic or Noric in age. The stratigraphic relation between the Miharaiyama group and the underlying Palaeozoic Oya formation is indicated there by a conspicuous clino-unconformity.

Subsequently the writer carried out the geological surveys of the Mitai sheet-map area (scale 1:50,000) in 1952 (SAITO, KAMBE and KATADA, 1958), of the Yawatahama and the Iyotakayama sheet-map areas (the same scale) in 1954 (HIRAYAMA and KAMBE, 1956), of the Kuraoka sheet-map area (the same scale) from 1952 to 1955 (KAMBE, 1957), and of the Koyasan sheet-map area (the same scale) from 1956 to 1957 (HIRAYAMA and KAMBE, 1959). Through these surveys he has made extensive observations on the formation which is known by the name of the Sambosan group on the northern side of the Butsuzo Tectonic Line.

In the geological survey of the Mitai sheet-map area the writer could discover two kinds of fossiliferous limestones in the northwestern part of Kamura in Takachiho-cho, Nishiusuki-gun, Miyazaki Prefecture. One is a dark grayish muddy limestone which contains abundant fusulinids, while the other is a white grayish limestone rich in molluscan fossils. Later, Dr. M. SAITO, the leader of the survey in the Mitai sheet-map area, advised him to appraise the molluscan fossils.

It was done with the kind instruction of Prof. T. KOBAYASHI of the University of Tokyo and the assistance of Mr. Y. YABE of Japan Information Center of Science and Technology. As the result the close alliance of the Kamura fauna was found with the Kurotaki fauna in Kochi Prefecture, Shikoku, and the Shionosawa fauna, in Gumma Prefecture, Kwanto mountains, both Lower Triassic. In 1957, Dr. M. SAITO discovered the molluscan limestone and the fusulinid limestone along the Saraito forest-road in the eastern part of Saraito. There the molluscan limestone overlies the fusulinid limestone without either an unconformity or a fault between the two limestones. (KAMBE and SAITO, 1957)

Then the writer has surveyed the geology around Kamura in a great detail in 1959. As the result, the fusulinid limestone as well as the molluscan limestone was traced for more than ten kilometers. Palaeontology of their fossils has shown that the former limestone is Upper Permian in age and the latter, Lower Triassic. From the field observation, it has been warranted that they are continuous without unconformity. (KAMBE, 1960)

Further the writer surveyed the Kesennuma geological sheet-map area (scale 1:50,000) in 1957 and 1958 (KAMBE and SHIMAZU, 1961), and a part of the Ishinomaki compiled geological sheet-map area (scale 1:200,000) in 1958 (KAMBE, 1959). On these occasions, the writer could actually examine the relation between the Permian Toyoma and Triassic Inai groups. Moreover, in the survey of the Sayo geological sheet-map area (scale 1:50,000) in 1958 and 1959 (HIROKAWA and KAMBE), the writer could investigate the relation between the Permian formation and the unknown Mesozoic formation of which the rock-facies is akin to the Lower Triassic Yakuno group.

The Permo-Triassic boundary has already been discussed by Dr. T. KOBAYASHI (1941, 1948, 1951, 1952, 1956, 1959), Dr. S. HANZAWA (1954), Dr. Y. ONUKI (1956), Dr. K. NAKAZAWA (1958) and Mr. N. YAMASHITA (1957) from various standpoints and different opinions are expressed. Because the writer could examine most of the known contact points, if not all, and made a precise study of the Kamura area which is most important, the writer wishes to describe here all what is known of the boundary problem to elucidate it as much as possible.

Here, the writer wishes to acknowledge his indebtedness to Prof. T. KOBA-

YASHI of the University of Tokyo for his guidance and encouragement given to the writer through this investigation from the beginning, to Prof. F. TAKAI, Prof. T. KIMURA and Assist. Prof. T. HANAI of the University of Tokyo for their valuable suggestions and encouragements, to Dr. K. KANEKO, the Director of the Geological Survey of Japan for the support and facility of the study, to Dr. M. SAITO, the Chief of the Geology Department of the Survey for his guidance and cooperation, to Dr. K. HIRAYAMA and Mr. O. HIROKAWA of the Survey for the valuable suggestion and encouragement. Thanks are also due to Mr. M. KAWADA of the Survey, who kindly read and corrected the manuscript.

The writer is also much obliged to Dr. K. ICHIKAWA of the Osaka City University, Dr. K. NAKAZAWA of the Kyoto University, Dr. K. KANMERA of the Kyushu University, Dr. I. HAYAMI and Dr. A. TOKUYAMA of the University of Tokyo, Dr. K. OYAMA, Mr. H. ISOMI, Mr. T. YOSHIDA, Mr. K. KURODA and Dr. H. INOUE of the Geological Survey and Mr. Y. YABE of the Japan Information Center of Science and Technology for their valuable suggestions and to Mr. C. UEKI and Mr. T. ICHIKAWA of the University of Tokyo and Mr. Y. MASAI of the Geological Survey of Japan for their photographies of the fossils.

II. Geology and paleontology of the Permian and Triassic systems at Takachiho-cho, Miyazaki Prefecture

II. 1 Outline of geology

From the tectonic point of view T. KOBAYASHI (1941) divided the Outer Zone of Southwest Japan into the Nagatoro belt, the Chichibu belt and the Shimanto-Nakamura belt from north to south. The area under consideration belongs to the Chichibu belt.

The Median Tectonic Line reveals a remarkable topographic significance in the Kii peninsula and Shikoku island, while the Usuki-Yatsushiro Tectonic Line which belongs mostly to the Mikabu Line between the Nagatoro and Chichibu belts is prominent in Kyushu.

The Takachiho area lies at a distance of 2,500 m to the south of the Usuki-Yatsushiro Line which passes the southern part of the early Miocene Sobosan volcanic rocks. The volcanic rocks and the early Miocene Mitate formation are extensive in the northeastern part of the Mitai geological sheet-map area.

The Palaeozoic formations there are called Toroku formation in the north and Iwato formation in the south. They are distributed with steep dips and strike trending from the east-north-east to west-south-west direction, and anticlines and synclines are repeated as shown in the Mitai geological sheet-map.

As a result of the survey in last year, it was clarified that a Lower Triassic formation called the "Kamura" forms a narrow strip stretching for more than 8 km on the north side of the Iwato formation. A recent survey by H. INOUE has shown that the Kamura formation recurs in the western part of Tsukumi City in Oita Prefecture, 50 km or more apart from the preceding locality.

The Upper Mesozoic Tabaru formation and the Tsuchiiwa formation, probably Upper Cretaceous occur on the north side of the Toroku formation and the Silurian (i.e. Gotlandian) Gionyama formation (SAITO and KAMBE, 1954), the Upper Triassic Tonegoyama formation (TAMURA, 1960) and the Upper Mesozoic

Takayasan and the Oishi formations are present on the southwestern side of the Iwato formation, resulting in complicated geologic structure of the area. There is an extensive belt of remarkably thick limestone, chert, schalstein in the southern part of the Chichibu belt. The Shimanto group is distributed to the south of the Chichibu belt beyond the so-called Butsuzo Tectonic Line. Granite, diorite, peridotite, serpentine and other Mesozoic igneous rocks occur in the Chichibu belt. These intrusive bodies are usually elongated in parallel to the surrounding formations and the boundaries with the surrounding formations are sometimes fault contacts. Porphyritic granodiorite is found along the northern periphery of the Chichibu belt.

After the Mesozoic and Palaeozoic rocks had been strongly folded and arranged in zones, the area was subjected to conspicuous erosion. (SAITO, KAMBE, INOUE and KINO, 1955)

In the Tertiary period, probably early Miocene epoch the accumulation of the Mitate formation was followed by violent eruption of the Sobosan volcanic rocks and the intrusion of granite and granite porphyry, the latter of which gave extensive contact effects in the central to the northeastern part of the Mitai sheet-map area. (See Fig. 1)

II. 2 Permian Toroku formation

To the north beyond a conspicuous thrust fault on the north side of the Kamura formation, there is an extensive formation composed of schalstein, limestone, sandstone, clayslate, conglomerate, chert and phyllite. This is the Toroku formation. It strikes in ENE-WSW and dips 40~85° N or S, forming some anticlines and synclines. Several strike faults are observed in the field. (See Pl. IX, Fig. 2)

In the formation of the northern zone in the sheet-map area the predominant rock is clayslate which exceeds sandstone, schalstein and diabase, is intruded by peridotite and serpentine, and becomes phyllitic in the northeastern part of the Obira mine.

In the east, these rocks are mostly altered into hornfels by the intrusions of granite and granite porphyry. G. IISAKA (1933) reported fusulinids from a small lens of limestone near the Toroku mine. Later, K. KONISHI (1953) pointed out the presence of *Schwagerina* sp., *Neoschwagerina craticulifera* (SCHWAGER), *Verbeekina verbeeki* (GEINITZ) among them. Besides, S. MIYAZAWA (1940) reported that *Neoschwagerina* sp., *Schwagerina* cfr. *japonica* (GÜMBEL) and *Schwagerina* sp. which had been determined by H. MOTIZUKI, from the limestone of Toroku.

According to H. ISOMI *Neoschwagerina* sp. in the Toroku limestone belongs to a small primitive form, and a part of the Toroku formation belongs to the lower part of the *Neoschwagerina* zone.

II. 3 Permian Iwato formation

This formation in the center of the Mitai sheet-map area is composed of sandstone and clayslate with intercalation of thick chert and thin conglomerate and has the strike of ENE-WSW and the dip of 35~85° generally to north, but sometimes to south, probably being due to synclines, anticlines and strike faults.

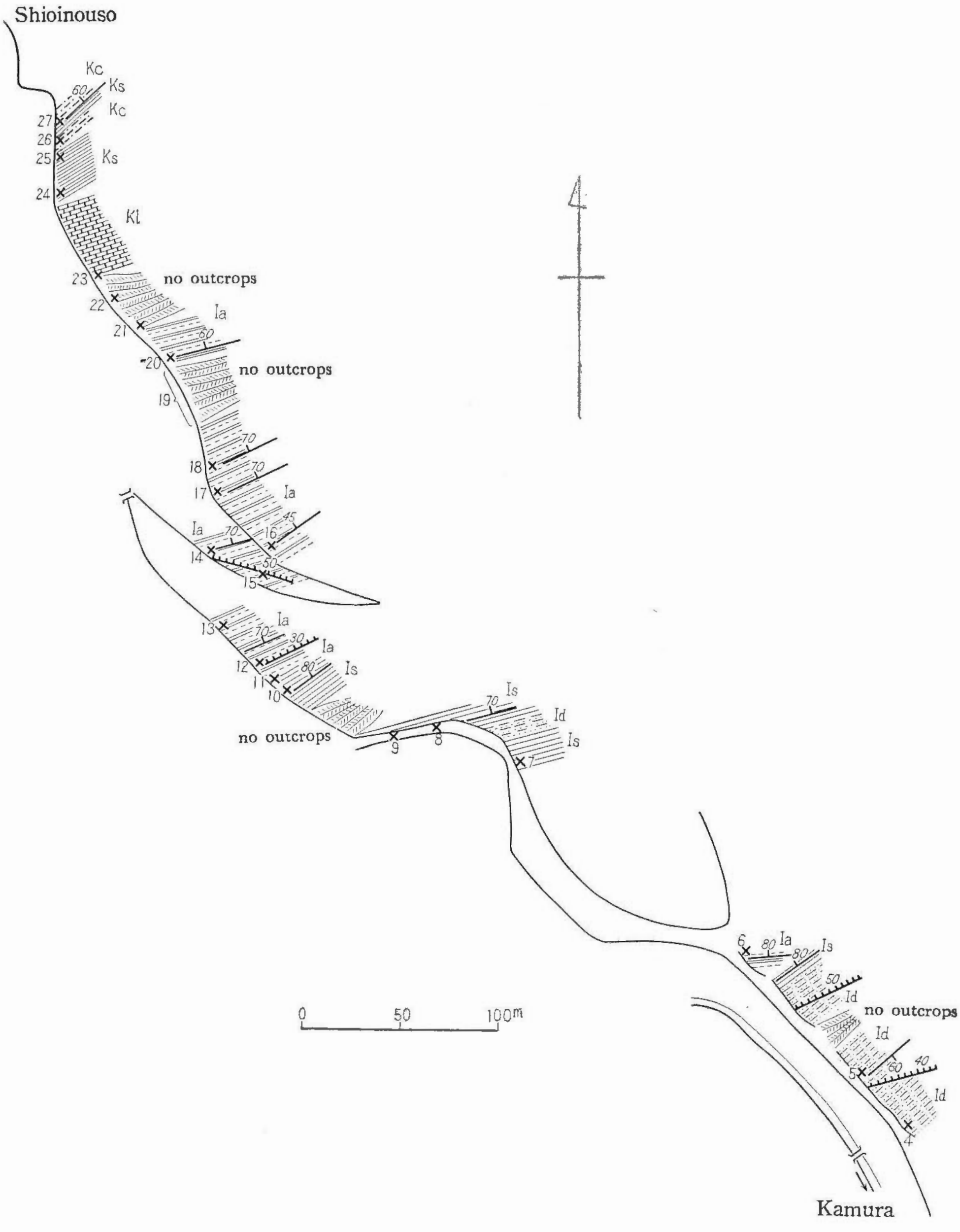

Figure 2 Route-map along the road through Kamura to Shioinouso

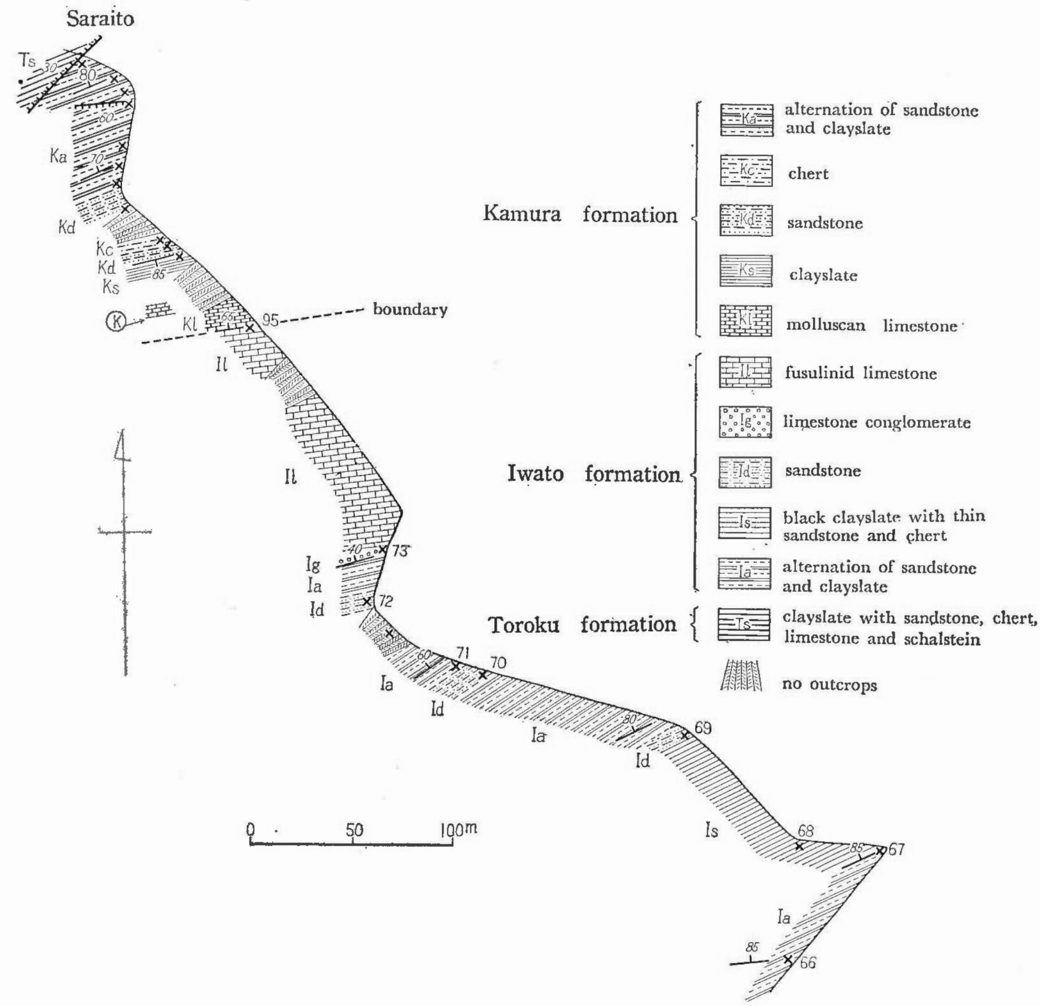

Figure 3 Route-map along the Saraito forest-road

(See Pl. XIV)

The formation is typically exposed around Hirokino of Kamino village, and Kamura, Tachiyadori, Saida, Hinata, Nishinouchi and Mitsuai of Takachiho-cho. The best outcrops are seen along the forest-road through Kamura to Saraito and along the road through Saida to Nakanouchi. There it is similarly composed of sandstone, clayslate, chert, limestone and limestone conglomerate as in the center of the sheet-map area, but ordinary conglomerate is absent.

The fusulinid-bearing dark grayish limestone, 60 to 100 m thick is well seen in the northern part. (See Pl. XIII)

Sandstone is generally medium- or coarse-grained, rarely fine-grained, and dark white or dark gray, but dark brown or brown in color, when decomposed. Sandstone is compact, massive and hard, but its strike and dip are measurable where it intercalates black sandy clayslate. Although sandstone often has the

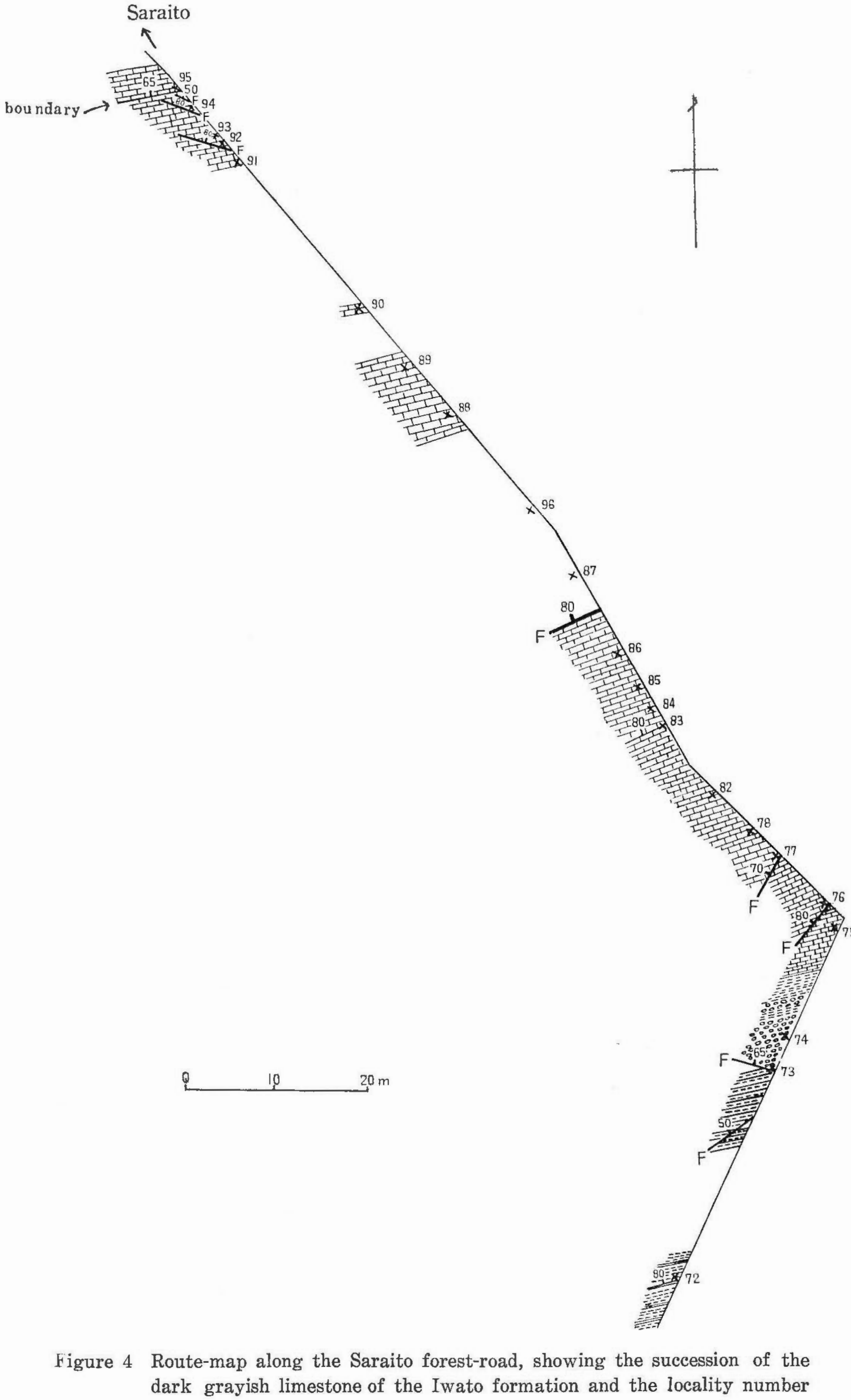

Figure 4 Route-map along the Saraito forest-road, showing the succession of the dark grayish limestone of the Iwato formation and the locality number

thickness attaining to thirty or sixty meters as a single bed, near Mitsuai, sandstone frequently repeats to alternate with black clayslate. Black sandstone is conspicuous near Mitsuai. Clayslate is generally black in color, and becomes phyllitic in the disturbed zone.

Clayslate is easily changeable into sandy clayslate, or alternates with sandstone. Near Mitsuai, black clayslate alternates with limestone. Along the Saraito forest-road calcareous clayslate, limestone, limestone conglomerate, calcareous clayslate and the main part of limestone are accumulated from the base upward.

Chert is generally dark gray in color and joints develop in it. Each layer of the chert is mostly about 5 centimeters thick and frequently alternates with clayslate about 1 centimeter thick. There, chert is comparatively rare and its thickness seldom reaches to 7 meters.

Large boulders of conglomerate with the pebbles of granitic rocks are found at the locality 9 of Kamura and its matrix is black clayslate. Their provenance is unknown.

Thick dark grayish limestone is accumulated above these rocks.

The limestone along the road from Kamura to Shioinouso contains *Neoschwagerina megasphaerica* DEPRAT, *Neoschwagerina margaritae* DEPRAT, *Yabeina* cf. *Katoi* (OZAWA) and *Neoschwagerina* sp. as determined by ISOMI.

Yabeina gubleri, which is reported from the Upper Permian Kuma formation at Middle Kyushu, is the most developed *Yabeina* and is identified with *Neoschwagerina megasphaerica* DEPRAT reported by J. GÜBLER (1935) from the Upper Permian system at Cambodge. From this fact, it is considered that the Iwato formation belongs to the top of the *Neoschwagerina* zone and the *Yabeina* zone. (See Figs. 2, 3, 4)

II. 4 Lower Triassic Kamura formation

This is distributed on the south side of the Toroku formation, with a conspicuous thrust fault between them, but it continues to the Iwato formation on its south side without break. (See Pl. VIII, Pl. IX, Fig. 1, Pl. XI, Fig. 2)

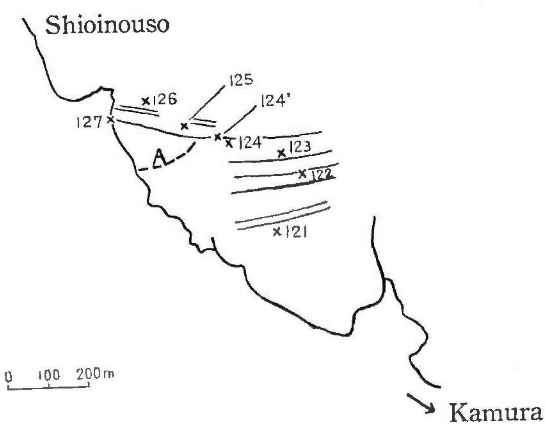

Figure 5 Route-map at the eastern part of the road through Kamura to Shioinouso, showing the locality number

It is composed of white grayish limestone (35 m), clayslate and sandstone (a few meters), and dark grayish chert (3 or 5 m) along the Kamura section, and composed of white grayish limestone (30 m), clayslate and sandstone (20 m), chert (30 m), sandstone (20 m) and alternation of siliceous clayslate, sandy clayslate and sandstone (about 60 m) along the Saraito section. The upper limit of the Kamura formation is obscure. The formation is distributed along the strike side for about 8 km from Hirokino to Mitsue through Kamura, Saraito, the southern part of Toroku and Tsuzura, though the thickness is more or less changeable.

According to H. INOUE the limestone of the Kamura formation is partly dolomitic. It is crystallized near Tsuzura and Mitsuai.

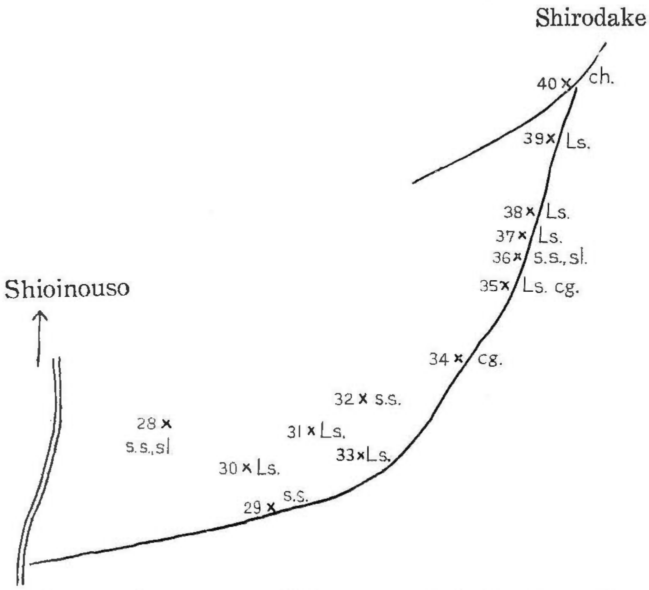

Figure 6 Route-map which corresponds to A in figure 5, showing the locality number

Pelecypods, cephalopods and gastropods are discovered at Kamura and Saraito. The Kamura fauna will be described in Chapter VII.

List of the Kamura Fauna

Pelecypoda

Eumorphotis multiformis (BITTNER)
Eumorphotis multiformis shionosawensis ICHIKAWA et YABE
Eumorphotis multiformis subspecies nov. indet.
Eumorphotis sp.
Pteria ussurica yabei NAKAZAWA
Gervillia cf. *exporrecta* (LEPSIUS)
Entolium discites (v. SCHLOTHEIM)
Entolium sp. indet.
Chlamys ? kryshtofowichi (KIPARISOVA)
Eopecten minimus (KIPARISOVA)

Eopecten cf. *minimus* var. *reticulatus* (KIPARISOVA)
Pecten (s.l.) sp. indet.
Anodontophora canalensis CATULLO
Anodontophora cf. *canalensis* CATULLO
Anodontophora canalensis var. *bittneri* ICHIKAWA and YABE
Anodontophora fassaensis (WISSMANN)
Anodontophora cf. *fassaensis* (WISSMANN)
Anodontophora sp.

Gastropoda
Gastropoda gen. et sp. indet.

Cephalopoda
Pseudosageceras sp.
Clypites japonicus KAMBE, new species
Parahedenstroemia α sp. nov. indet.
Parahedenstroemia β sp. nov. indet.
Aspenites kamurensis KAMBE, new species
Aspenites ? sp.
Ammonite, gen. et sp. indet.

These pelecypods were reported from the Kurotaki formation in Kochi Prefecture, Shikoku and from the Shionosawa formation in Gumma Prefecture, Kwanto mountains and indicate Skytic. The ammonites range from Flemingitan to Owenitan.

The fossils are collected from the part, 15 to 23 m above the base of the Kamura formation. Therefore the non-fossiliferous part above the base must be Otoceratan or Gyronitan. (See Pl. X, Figs. 1, 2)

II. 5 On the boundary between the Permian and Triassic systems

Here, the writer will try to describe the boundary between the Permian and Triassic systems on each route in the surveyed area in detail. (See Pl. XI, Fig. 1, Pl. XII)

Southern part of Hirokino: In the northern part of sandstone and clayslate alternation of the Iwato formation, there is dark grayish limestone with a few thin intercalations of schalstein.

The limestone of the formation is crystallized and unfossiliferous. On the north side of this limestone, there is white grayish limestone of the Kamura formation which contains the molluscan remains. No fault is found between these limestones and they appear continuously.

Northern part of Kamura: On the north side of sandstone and clayslate alternation of the Iwato formation, there is dark grayish limestone of the Iwato formation which is well exposed at Kurodake in the west and at Shirodake in the east. The dark grayish limestone boulders on the south slope of Kurodake bear abundant fusulinids.

The limestone of the Iwato formation along the road from Kamura to Shioinouso contains *Neoschwagerina megasphaerica* DEPRAT, *Neoschwagerina margaritae* DEPRAT, *Yabeina* cf. *Katoi* (OZAWA) and *Neoschwagerina* sp. The limestone of the Iwato formation on the south slope of Shirodake is divided into the lower and upper parts by the intervention of the alternation of sandstone, clayslate and conglomerate, as shown in figure 6.

The thickness of the lower limestone attains to 33 m, that of the middle alternation of sandstone, clayslate and conglomerate attains to 18 m and that of the upper limestone attains to 28 m.

Limestone conglomerate intercalation in the middle part shows the strike of N 75° E and the dip of 40° N. The lower and upper limestones yield fusulinids and corals abundantly. The upper one strikes in N 65~75° E and dips 50° to N. Fusulinids and corals are abundant especially at localities 124 and 124', and ten meters' limestone above the preceding lacks fusulinids.

The grayish white limestone of the Kamura formation continues to the above-mentioned limestone of ten meters thickness without break. At the locality 39 the same continuous relation is seen between the grayish white limestone and dark grayish one. (See Figs. 2, 5, 6)

Southern part of Saraito: In the Iwato formation to the north of the sandstone and clayslate alternation, there are limestone conglomerate, black clayslate and siliceous limestone, about 20 m in thickness and the transition from the above bed to the dark grayish limestone is observed. As shown in the route-map, the dark grayish limestone is generally muddy, but siliceous in parts. The dark grayish limestone, though the outcrop is not quite continuous, contains fusulinids in several horizons.

Fusulinids are found from the horizon of 6 m below the base of the Kamura formation. Neither sandstone nor clayslate is intercalated in the section of Saraito. The dark grayish limestone attains to about 100 m in thickness. The limestone in the Iwato formation shows the strike of N 65° E and the dip of 80° N.

Neither a fault plane nor an inconformity plane is recognized at the boundary between the dark grayish limestone of the Iwato formation and the white grayish limestone of the Kamura formation. The boundary plane strikes in N 79° E and dips 65° to N. In so far as the writer can see, they are continuous and there is no break. (See Figs. 3, 4)

Eastern part of Saraito: At the mountain between Saraito and Toroku dark grayish limestone of the Iwato formation occurs in the south, and white grayish limestone of the Kamura formation, in the north. Corals are contained in the dark grayish limestone. The thickness is indeterminable.

Eastern part of Toroku and neighbourhood of Tsuzura: The dark grayish limestone of the Iwato formation is in the south and the white grayish limestone of the Kamura formation, in the north, but no fossil is discovered owing to the recrystallization.

Neighbourhood of Hinata and Mitsuai: The same geological relation as seen at Saraito, Toroku and Tsuzura is recognized at this place, but the rocks are recrystallized and unfossiliferous. A thin black clayslate is intervened between the two kinds of limestones in the west of Mitsuai.

As described above, the Iwato formation represents the top of the *Neoschwagerina* zone and the *Yabeina* zone, and the Kamura ranges from Otoceratan to Owenitan in Eo-triassic. Now it is quite warranted that the Permian and Triassic systems are continuous in all route sections and not interrupted by either a fault or a discordance.

III. New observation in the western part of Tsukumi City, Oita Prefecture

Recently, H. INOUE discovered shelly dolomitic limestone at Gobangadake in the western part of Tsukumi City. Afterwards, in 1960 the writer could survey the Tsukumi district, and clarified that the shelly dolomitic limestone continued conformably to the Lower to Middle Permian Tsukumi limestone formation, containing the *Pseudofusulina* faunule, *Neoschwagerina iisakai* TORIYAMA or *Cancellina kobayashii* TORIYAMA faunule, *N. craticulifera* (SCHWAGER) faunule, *N. margaritae* DEPRAT faunule and *Yabeina globosa* (YABE) faunule in ascending order (FUJII, 1954). The clayslate of 2 meters thickness is intercalated between the shelly dolomitic limestone and the Tsukumi Limestone formation. The former limestone shows the strike of N 70° E and the dip of 70° N and the latter, the strike of N 60°E and the dip of 50°N. The difference of the dip may be due to a small fault or any disturbance. It is considered that neither a fault nor an unconformity is recognized along the boundary between the two formations. The shelly dolomitic limestone is distributed along the synclinal axis which trends to ENE through Gomagarayama and Gobangadake.

Fossils discovered from the dolomitic limestone are not well preserved, but some small pelecypods are recognizable. Although the fossils are not yet determined, the geology around the Tsukumi City shows that the dolomitic limestone belongs to the eastern extension of the Kamura formation.

IV. On the boundary between the Permian and Triassic systems in Japan

IV. 1 Kitakami mountains

The Permian and Triassic formations have long been known in the Kitakami mountains, where the former is quite extensive but the latter is limited to the southern Kitakami.

In the standard sequence of Kitakami the Permian system is divided into the Sakamotozawa, Kanokura and Toyoma groups in ascending order.

The Sakamotozawa group overlies the Carboniferous system with the discordance which denotes the Sakamoto phase of the crustal movement by T. KOBAYASHI. Its basal conglomerate is seen in the Hosoozawa near Kamiyatsuse, Kesennuma in the Kesennuma sheet-map area. The Sakamotozawa group is mainly composed of conglomerate, sandstone, clayslate, schalstein and limestone, and the Kanokura group, of clayslate, limestone and conglomerate. These groups contain abundant fossils of fusulinids, corals and brachiopods etc. The former group is Sakmarian-Artinskian (*Pseudoschwagerina-Parafusulina* zone) while the latter is Socian-Baslean (*Neoschwagerina-Yabeina* zone) in age. (ONUKI, 1956)

The Upper Permian Toyoma group is extensive, and consists of the Usuginu conglomerate and the Toyoma black clayslate facies.

The Usuginu conglomerate bed measures from 800 to 1000 m and the Toyoma clayslate, 1500 to 2000 m in thick parts. T. KOBAYASHI (1945, 1948) discovered the Lebenspuren called *Notaculites toyomensis* KOBAYASHI in the lower Toyoma black clayslate at the neck of Iwaizaki and concluded that the black clayslate was deposited on anaerobic sea-bottom. Subsequently M. MINATO (1944) noted that the Toyoma black clayslate was inland sea deposits. *Bellerophon,* *Protocycloceras* (*Cycloceras*), *Leptodus*, *Calamites* etc. are discovered from the Toyoma black clayslate. In the Kesennuma geological sheet-map area the Usuginu conglomerate beds are known to occur in several horizons of the Permian system the lowest of which suggests the *Parafusulina* zone, but most are developed above the *Yabeina* zone.

Inai, Onagawa and Ogatsu districts

In these districts the Permian system is distributed only around Ogatsu-machi, Monō-gun, Miyagi Prefecture, and the axis of its anticlinorium pitches southerly. Its stratigraphy was studied by Y. INAI and N. TAKAHASHI (1940) and its palaeontology, by K. ZIMBO, H. YABE and I. HAYASAKA.

The Permian system is divided there into the Maiya and the Toyoma series. The lower or Maiya series is subdivided into Oyakejima sandstone (more than 100 m thick), Koyakejima alternation of conglomerate and sandstone (30 m thick) and Kohama limestone (30 m thick) in ascending order. This series is correlated to the Sakamotozawa and Kanōkura series. The upper or Toyoma series is mainly composed of monotonous black clayslate rarely with sandstone of one meter thickness. The thickness of the series attains 350 m.

The Toyoma series contains *Calamites Takahashii* ENDO, *Pecopteris*? sp., *Leda* sp., *Protocycloceras* cf. *cyclophorum* WAAGEN, *Leptodus* sp., *Bellerophon* sp., *Pleurotomaria* sp., *Nuculites kimurai* HAYASAKA, *Nuculana* sp., *Palaeoneilo ogachiensis* HAYASAKA, *Coeloconus*? sp., *Omphalotrochus* sp., *Eoptychia* sp., "*Auriptygma*" sp., crinoid stems, etc., and the beds are correlated to the *Bellerophon* beds in the Toyoma district. The Toyoma series of this district is younger than the *Yabeina* limestone. (ONUKI, 1956)

The Triassic system in the districts occupies an area extending from the southern part of the Oppagawa fault to the neck of the Ojika peninsula. It was already studied by Y. INAI and N. TAKAHASHI (1940) and K. ICHIKAWA (1951). The Triassic system represents an anticlinorium and a synclinorium together with the underlying Permian system in the Ogatsu district. INAI and TAKAHASHI (1940) classified the Lower Triassic Inai formation into the Kojima conglomerate and sandstone, the Onagawa gray clayslate and the Inai sandy clayslate in ascending order, but Y. ONUKI and Y. BANDO (1959) divided the Triassic Inai group into the Hiraiso formation, the Osawa formation, the Fukkoshi formation and the Isatomae formation as follows:

Hiraiso formation: about 250 m thick in Ogatsu district; composed of basal conglomerate, alternation of conglomerate and sandstone, massive sandstone and alternation of sandstone and fine sandstone containing pelecypods and crinoids.

Osawa formation: about 350 m thick in Ogatsu district; composed of gray calcareous and fine banded clayslate; containing *Ophiceras*? sp. (*Xenodiscus* sp.), "*Pecten*" sp. and *Conulariopsis quadrata* SUGIYAMA.

Fukkoshi formation: 250 to 450 m or 10 to 150 m thick in the Ogatsu district.

Isatomae formation: 1300 to 1500 m thick.

The Isatomae formation yields the following fossils:

Japonites planiplicatus (MOJSISOVICS)
Monophyllites sp.
Ussurites yabei (DIENER)
Balatonites kitakamiensis (DIENER)
B. gottschei (MOJSISOVICS)
Cuccoceras aff. *submarinoii* SHIMIZU

Hollandites japonicus (MOJSISOVICS)	*Gymnites watanabei* MOJSISOVICS
H. j. crassicostatus (SHIMIZU)	*G.* sp. indet. aff. *kirata* DIENER
H. haradai (MOJSISOVICS)	*Ussurites yabei* (DIENER)
H. nodai (DIENER)	*Sturia japonica* DIENER
H. sp.	*Ptychites inaicus* DIENER
"Danubites" naumanni (MOJSISOVICS)	*P.* sp. indet.
"D." japonicus SHIMIZU	*Neocalamites* cf. *hoerensis* (SCHIMPER)
"D." cf. *kansa* (DIENER)	

The geological age of the Inai group ranges from Skytian to Anisian.

The latter two formations are used to be combined into the Inai sandy clayslate by INAI and TAKAHASHI and are composed of sandy clayslate with the intercalation of sandstone.

The contact between the Toyoma and Inai groups has been reported by INAI, TAKAHASHI, ONUKI and BANDO from several localities, namely along the road to the east of Karakuwa in Ogatsu-machi (A), along the road to the west of Karakuwa (B), along the seashore to the west of Karakuwa (C), along the road to the north of Kojima (D) and at an exposure to the south of Myojinyama (E).

(A) At an outcrop along the road, the clayslate of the Toyoma group is distributed in the western part with the strike of N 11~23° E and the dip of 38~50° E, and the basal conglomerate of the Inai group with a few intercalations of clayslate occurs in the east with the strike of N 27~35° E and the dip of 48~54° E. Slight erosion of clayslate is recognizable from the observation. (See Pl. XV, Fig. 1)

(B) At an outcrop along the road, the clayslate of the Toyoma group is found in the east with the strike of N 35° E and the dip of 48° W, and the basal conglomerate and sandstone of the Inai group are found in the west with the strike of N 19° E and the dip of 52° W. There slight erosion of the clayslate bed is recognizable. (See Pl. XV, Fig. 2)

(C) At an outcrop along the seashore, the clayslate of the Toyoma group is seen in the east with the strike of N 17~21° E and the dip of 58~74° W, and the basal conglomerate and sandstone of the Inai group, in the west with the strike of N 11~25° E and the dip of 66~68° W. Here again slight erosion of clayslate is recognizable. Joint is developed in clayslate. (See Pl. XVI, Fig. 1)

(D) At an outcrop along the road, the clayslate of the Toyoma group with the strike of N 15° E and the dip of 27° W occurs in the lower part, and the basal conglomerate and sandstone of the Inai group, in the upper part with the strike of N 5° E and the dip of 30° W. Therefore slight erosion of clayslate can be recognized also at this locality. (See Pl. XVII, Fig. 2)

(E) At a quarry of clayslate to the south of Myojinyama, black clayslate of the Toyoma group is distributed in the eastern part with the strike of N 75° W and the dip of 40° N and the basal conglomerate and sandstone of the Inai group are in the western part with the strike of N 40~75° E and the dip of 40~48° NW. Thus, slight erosion of clayslate is recognized. Joint is developed in clayslate. (See Pl. XVI, Fig. 2, Pl. XVII, Fig. 1)

At these five outcrops, the dips of the Toyoma and Inai groups differ 16°, 4°, 10°, 3° or 8° at the maximum at each locality. Judging from this fact and the distribution of these groups, the unconformity between the Toyoma and Inai groups does not mean any conspicuous crustal movement but only slight tilting or undulation of the basement. Of course, slight erosion of the basement is indisputable.

Toyama, Yanaizu and Tokura districts

The Permian system is mainly distributed in the districts around Toyoma and extends into the Usuginu district in Iwate Prefecture. The system has been studied by many students, and Y. ONUKI (1956) classified it into the following manner:

Toyoma formation

Usuginu conglomerate—Horizon of *Yabeina-Waagenophyllum limestone,* 800 m thick near Yamazaki.

Maiya group { Tenjinnoki formation—Kanōkura group
Rodai formation— } Sakamotozawa group
Nishikōri formation— }

Maiya group attains 700 m in thickness near Maiya.

The Toyoma group is mainly composed of black clayslate often phyllitic, and joint is prevalent. The group 1200 m thick near Toyoma yields *Bellerophon* sp., *Omphalotrochus* sp., *Capulus*? sp., *Architectonica*? sp., *Straparollus* sp., *Euomphalus* sp., *Allorisma regularis* KING., *Allorisma* sp., *Palaeopharus* sp., *Schizodus* sp., *Lima* sp., *Cardinia*? sp., *Myalina* sp., *Paleolucina* sp., *Edmondia myströmi* CHAO, *Linoproductus*? sp., *Spirifer*? sp., *Dentalium* sp., *Cypicardinia sinensis* CHAO, *Parallelodon* sp., *Pleurotomaria* sp., *Nuculites* sp., *Palaeoneilo* sp., Bryozoa and Crinoid stems.

The Triassic Inai group is surrounded by the Toyoma group extending from west to north near Toyoma, and forms anticlines and synclines. Y. ONUKI and Y. BANDO (1959) divided the group into 4 formations as follows:

Hiraiso formation: alternation of conglomerate and sandstone with an intercalation of reddish tuffaceous shale and sandstone in the lower part; 200~250 m thick; containing *Nuculopsis* sp., *Palaeophalus* sp. and *Myalina*? sp.

Osawa formation: 300 m thick; containing plant remains.

Fukkoshi formation: sandstone often with an intercalation of clayslate and conglomerate; 0~150 m thick; containing *Gymnites* cf. *watanabei* (MOJSISOVICS), *Hollandites* sp. and *Balatonites* cf. *kitakamicus* (DIENER).

Isadomae formation: banded clayslate; 1400~1600 m thick; containing *Hollandites haradai* (MOJSISOVICS).

The above succession applies to the Toyoma and Yanaizu districts, but for the Tokura district it may be modified by ONUKI and BANDO (1959) as below:

Hiraiso formation: about 150 m thick.

Osawa formation: 180~230 m thick; containing *Equisetites* sp.

Fukkoshi formation: 120~260 m or 0~600 m thick; containing *Spiriferina* spp., *Terebratula* sp., *"Pteria"* spp., *Palaeoneilo*? sp. and *Isocrinus* sp.

Isadomae formation: 1400~1600 m thick; containing *Hollandites japonicus* var. *tokuraensis* ONUKI and BANDO, *H.* sp., *Sturia* cf. *sansovinii* (MOJSISOVICS), *Beyrichites* sp., *Balatonites* cf. *kitakamicus* (DIENER), *Sturia* sp., *Monophyllites sphaerophyllus* (HAUER), *Rikuzenites nobilis* YABE and *Metanothosaurus nipponicus* YABE and SHIKAMA.

In this district, the upper part is unconformably overlain by the Jurassic system.

The relation between the Toyoma and Inai groups is observable at the eastern part of Kawabukuro, Toyoma-machi (A), at the eastern part of Hineushi (B), and at the southern valley of Asadanuki, Towa-cho (C), although the very contact is somewhat obscure.

(A) Kawabukuro is the typical locality of the Toyoma group, where its black clayslate represents the strike of N 55° E and the dip of 60° SE. The basal conglomerate and sandstone of the Inai group reveal the strike of N 55° E and the dip of 60° SE in the east of Kawabukuro. But their actual contact is unexposed.

(B) In the eastern valley of Hineushi, the black clayslate of the Toyoma group having the strike of N 15~35° E and the dip of 40~52° SE, occurs in the western part, and the basal conglomerate and sandstone of the Inai group with the strike of N 19~41° E and the dip of 44~50° SE are distributed in the eastern part. But their boundary can not be observed.

(C) In the south valley of Asadanuki, the black clayslate of the Toyoma group is found in the northern part with the strike of N 50° E and the dip of 50° SE, and the basal conglomerate of the Inai group in the southern part with the strike of N 63~68° E and the dip of 48° SE. Their contact point is not observed.

Although the key point can not be observed at the three localities (A), (B) and (C), the difference of strike and dip between the two groups is 0~23° and 0~8° respectively. As can be judged from the difference as well as the geological map, the crustal movement which occurred at the Permo-Triassic transition was no more than gentle undulations, although erosion took place in the emerged part.

Utazu and Shizugawa districts

In these districts the Permian Toyoma group is only distributed at the eastern part of Isadomae, Utazu-cho. It is represented by unfossiliferous black clayslate.

Y. ONUKI and Y. BANDO (1959) classified the Inai group as follows:

Hiraiso formation: 300 m thick; containing *"Pecten"* spp., *"Pecten" ussuricus* (BITTNER), *"Pecten" sichoticus* (BITTNER), *"Pecten" (Leptochondria?) alberti* var. *virgalensis* (WITTEMBURG), *"Pecten"* cf. *discites* (SCHLOTHEIM), *Avicula* sp., *Myalina* spp., *Pseudomonotis* (*Eumorphotis*) sp. and *Myophoria laevigata* ALBERT.

Osawa formation: about 250 m thick; containing plant remains.

Fukkoshi formation: 150~500 m thick.

Isadomae formation: about 800~1300 m thick; containing *Hollandites japonicus* (MOJSISOVICS), *Leiophyllites* cf. *pseudopradyumna* (WELTER), *"Danubites" shimizui* ICHIKAWA, *Sturia?* sp. indet., *"Posidonia" japonica* KOBAYASHI and HUKAZAWA, *Posidonia* sp. and *"Nucula"* sp.

At Tatenohama in the eastern part of Isadomae, the Toyoma black clayslate occurs in the east with the strike of N 11° E and the dip of 40° W, and the basal conglomerate and sandstone of the Inai group are distributed in the west with the strike of N 27° W and the dip of 40° SW, but they are separated by a fault.

In the western part of Isadomae, the Inai group is overlain by the Upper

Triassic Saragai group with clino-unconformity which indicates the break from Lower Ladinian to Middle Carnian. (ONUKI and BANDO, 1958)

The Saragai group is composed of basal conglomerate, coarse sandstone and alternation of sandstone and shale, and yields Norian and Upper Carnian fossils as follows (ONUKI, 1956, ONUKI and BANDO, 1958):

Entomonotis zabaikalica KIPARISOVA
E. z. intermedia KOBAYASHI & ICHIKAWA
E. ochotica var. *dentistriata* (TELL.)
E. multistriata K. & I.
E. scutiformis (TELL.)
E. s. var. *tenuicostata* K. & I.
E. s. var. *typica* KIPARISOVA
E. s. var. *kolymica* KIP.
E. ambigua (TELLER)
E. pachypleura (TELL.)
E. ochotica (KEYSERLING)
E. o. var. *eurachis* (TELL.)
E. tenuissima ICHIKAWA MS.
Oxytoma saragaiensis ICHIKAWA MS.
Parallelodon spp.
"Pteria" sp.
Lima (Plagiostoma?) sp.
"Mytilus" sp.
Tosapecten suzukii cf. Forma *hirogariformis* KOB. and ICHIK.
"Eopecten" aff. *infrequens* (KOB. and ICHIK.)
Pleuronectes sp.
Naticopsis sp.
"Pleurotomaria" sp.
Spiriferina sp.
Placites aff. *oxyphyllus* MOJSISOVICS
Arcestes aff. *oligosurcus* MOJSISOVICS
Dictyoconites nipponicus SHIMIZU and MABUTI

The restricted distribution and the littoral facies of the Saragai group, in contrast with the extensive distribution of the flysch-type Inai group, show the importance of clino-unconformity of the Utazu phase between the Saragai group and the Inai group.

Tsuya and Iwaizaki districts

S. HANZAWA (1954) divided the Permian system in these districts as follows:

Uppermost black clayslate—*Richthofenia* zone, containing *Scachinella* cf. *gigantea* SCHELLWIEN, *Richthofenia* sp., *Leptodus richthofeni* (KAYSER), *Fenestella* sp., *Productus* spp., *Shanshiella? altispiralis* var., *Spirifer* cf. *saranae* VERNEUIL var. *lita* FREDERIKS, *Zygopleura* sp., *Pleuronectites* cf. *interlineatus* MEEK and WORTHEM, *Porcellia* sp., *Phymatifer* sp., *Dentalium (Plaglypta) herculeum* de KONINCK, *Aviculopecten* sp., *Syringopora* sp., *Pleurotomaria* sp., *Camarophoria humbletonensis* HOWE, *Soleniscus?* sp., *Spiriferina cristata* SCHELLWIEN and *Anisopyge* sp.

Dark gray limestone—*Yabeina* zone, containing *Wentzelella iwaizakiensis* YABE and MINATO, *Wentzelella kitakamiensis* YABE and MINATO, *Waagenophyllum indicum* (WAAGEN and WENTZEL), *Yabeina* sp., *Verbeekina sphaera* OZAWA, *Parafusulina* spp. and *Mizzia velebitana* SCHUBERT.

Gray non-stratified limestone—(A) (B) *Neoschwagerina*—*Verbeekina* zone—*Waagenophyllum* zone—containing *Neoschwagerina* sp., *Verbeekina verbeeki* (GEINITZ), *Parafusulina* sp., *Waagenophyllum indicum* (WAAGEN and WENTZEL), *Wentzelella timorica* (GERTH) (C) *Parafusulina* zone—containing *Parafusulina wanneri* SCHUBERT.

Lowermost sandstone and conglomerate zone—containing *Stacheoceras iwaizakiensis* MABUTI.

The total thickness of the above beds attains about 200 m thick. Except for the uppermost black clayslate, the beds belong to the Kanōkura formation. The Toyoma black clayslate at the northeastern part of Tsuya yields *Conularia* sp., *Bellerophon* sp., *Pachypora* sp., *Leda* sp., *Yoldia* sp., *Anthraconeilo* sp. and *Nucula* spp. This fossil bed is correlated to the *Bellerophon* zone near Toyoma. (ONUKI, 1956)

Y. ONUKI and Y. BANDO (1959) classified the Triassic system in these districts (type locality) into four formations, in ascending order, as follows:

Hiraiso formation: lower part—basal conglomerate, dark green calcareous sandstone, 40 meters thick.
upper part—banded alternation of sandstone and clayslate, 130 meters thick.

The following fossils are found:

"*Pecten*" aff. *ussuricus* (BITTNER)
"*Pecten*" aff. *ussuricus* var. sichoticus (BITTNER)
"*Pecten*" cf. *minimus* (KIPARISOVA)
"*Pecten*" *discites* var. *microtis* (BITTNER)
"*Pecten*" *alberti virgalensis* (WITTENBURG)
"*Pecten*" spp.
Eumorphotis nipponicus ICHIKAWA (aff. *E. martima* KIPARISOVA)
Eumorphotis sp.
Myophoria aff. *ovata* GOLDFUSS
Myophoria aff. *laevigata* ALBERT
Myophoria sp.
Anodontophora aff. *fassaensis* WISSMANN
Anodontophora cf. *ovalis* WISSMANN
Anodontophora spp.
Gervilleia cf. *exporrecta* (LEPSIUS)
Gervilleia spp.
Nuculopsis (*Palaeonucula*) ? spp.
Palaeoneilo sp.
Pleurophorus sp.
Dentalium sp.
Worthenia? sp.
Isocrinus sp.
"*Pecten*" *discites* (SCHLOTHEIM)
"*Pecten*" cf. *ussuricus* (BITTNER)
"*Pecten*" cf. *alberti* (GOLDFUSS)
"*Pecten*" sp.
Pseudomonotis iwanowi (BITTNER)
Pseudomonotis sp.
Cardium sp.
Schizodus sp.

Osawa formation: banded alternation of sandstone and clayslate, 300 meters thick; containing "*Ophiceras*" sp., "*Xenodiscus*" 2 spp., Prohungaritoid gen. et sp. indet., Pseudoharpoceroid gen. et sp. indet., Ammonites gen. et sp. indet., *Eumorphotis* aff. *telleri* BITTNER, *Posidonia* sp. and *Nuculopsis* (*Palaeonucula*) ? sp.

Fukkoshi formation: pale green sandstone; banded alternation of sandstone and clayslate in the lower part, sandstone in the upper part, 300~350 meters thick.

Isatomae formation: dark gray sandy clayslate, 600~700 meters thick.

In the Tsuya district, the Inai group is unconformably overlain by the Upper Triassic Saragai formation.

The relation between the Toyoma and the Inai groups is typically observed at the seashore of Hiraiso. There the Toyoma group which is composed of thick black clayslate and alternation of sandy clayslate, sandstone and conglomerate sandstone (the pebble of igneous rock rare), 2 meters thick, shows the strike of N 25~39° E and the dip of 40~44° N, in the southern part and the Inai group which is composed of conglomeratic sandstone and the alternation of sandstone and conglomerate (abundant in the pebbles of igneous rocks, the diameter of pebble 1~5 centimeters and the single conglomerate bed 30 cm thick) shows the strike of N 40° E and the dip of 40° N in the northern part.

From these facts it is noticed that the boundary between the two groups indicates parallel unconformity. (See Pl. XIX, Fig. 1)

Karakuwa district

The Permian system in this district has been surveyed by I. SHIIDA (1940), Y. ONUKI (1956) and N. KAMBE (1961). It is divided into the Sakamotozawa, the Kanōkura and the Toyoma groups in ascending order. The Toyoma group is mainly composed of black clayslate, sandstone and the Usuginu conglomerate beds, the last of which is often intercalated also in the upper part of the Kanokura group.

On the eastern coast near Kowaragi, Karakuwa-cho, Motoyoshi-gun, occur thick black clayslate, sandstone and thick Usuginu conglomerate beds which are lithologically the members of Toyoma group, but the fossil zone of the formation extends from the *Parafusulina* zone to the *Bellerophon* fauni zone through the *Neoschwagerina* zone and the *Yabeina* zone, while the fossil zone of the Toyoma group is upper than the *Yabeina* zone in the western Karakuwa and other districts. The thickness of the Toyoma group attains 900~1400 m in the western part of Fuppuse in the northeastern part of the Kesennuma geological sheet-map area, where were found *Bellerophon* sp., *Calamites* sp., *Yabeina* sp., *Sumatrina* sp., *Schwagerina* sp., *Pseudodoliolina* sp., *Lepidolina* sp., and *Schubertella* sp.?

The Triassic system in this district is divided into four formations as follows:

Hiraiso formation: basal conglomerate and pale greenish calcareous sandstone; 100 m thick.

Osawa formation: banded clayslate, 450~550 m thick.

Fukkoshi formation: sandstone, clayslate and conglomerate, 350 m thick.

Isatomae formation: fine alternation of dark grayish calcareous clayslate and sandy clayslate, and conglomerate, 650~2000 m thick, containing *Hollandites* sp. cf. *H. japonicus* (MOJSISOVICS).

There the Inai group is unconformably overlain by the Lower Jurassic Karakuwa group.

It is noteworthy that the thickness of the Inai group varies in several sections.

The relation between the Toyoma and Inai groups is clearly observed at an outcrop of Aonozawa in the northern part of the Kesennuma geological sheet-map area. The Toyoma black clayslate shows the strike of N 55° W and the dip of 75° S, in the eastern part of the outcrop, and the Inai group, which is composed of medium- or coarse-grained gray-greenish sandstone with sporadic pebbles of chert, clayslate and granitic rock, 1 or 3 cm in diameter, shows the strike of N 75° W and the dip of 70° S in the western part of the outcrop. The two groups are in relation of subparallel unconformity and the subjacent formation was slightly tilted before the deposition of the superjacent formation. (See Pl. XIX, Fig. 2)

Uenodaira and Takizawatoge districts

It was previously known that the Toyoma group, mainly composed of black clayslate is extensive to the west of Uenodaira. Recently however, Y. BANDO (ONUKI and BANDO, 1959) has shown that most of the above Toyoma clayslate belongs to the Triassic system. The Triassic system in this district is divided into the following four formations, in ascending order. (ONUKI and BANDO, 1959)

The Hiraiso formation is not distributed owing to the fault.

The Osawa formation, the Fukkoshi formation and the Isatomae formation are probably as thick as 1100 m, 150~600 m and 1600 m respectively, although the existence of faults made one difficult to determine the true thickness.

Fossils found in the Osawa formation are *Pseudomonotis* (cf. *Eumorphotis*) sp., *Pseudomonotis* sp., *Eumorphotis* cf. *martini* KIPARISOVA, *Eumorphotis* cf. *multiformis* (BITTNER), *"Pecten" amuricus* (BITTNER) var., *Deltopecten*? sp., *Bellerophon* sp., Ammonite gen. et sp. indet. and Nautiloid? gen. et sp. indet. The Isatomae formation yields *Episageceras* sp.

In the north of Uenodaira in the western part of Tsuya-machi, Motoyoshi-gun, there are the Toyoma black clayslate on the southwestern side and conglomerate and sandstone of the Inai group on the northeastern side. The Toyoma group shows the strike of N 45° W and the dip of 30° E, and the Inai group, the strike of N 31° W and the dip of 40° E. The unconformity between them does not mean any conspicuous crustal movement but only a slight tilting of the subjacent formation. Of course the former deserved slight erosion. (See Pl. XVIII, Fig. 2)

At Takizawatoge in the northwestern part of Shizukawa-machi, Motoyoshi-gun, there are the Toyoma black clayslate in the lower part of the outcrop and conglomerate and sandstone of the Inai group in the upper part. The Toyoma group shows the strike of N 5~15° E and the dip of 26~32° E, and the Inai group, the strike of N 5~17° E and the dip of 28~30° E. (See Pl. XVIII, Fig. 1)

Summary

The Permian Toyoma and Triassic Inai groups are extensive in the southern Kitakami, where the latter overlies the former. The writer examined their boundary actually at eight points. The Aniso-Skytic Inai group always overlies the Upper Permian Toyoma group and there is nowhere the former overlies an older formation than the latter group or nowhere the Anisic formation directly overlies the latter group. The difference of the dip between the Inai and Toyoma groups is less than 10°, except at an outcrop where it attains to 16° at the maximum. Therefore, the gentle undulation, slight erosion and subsequent subsidence are recognizable in the interval between the two groups, but the crustal movement was by no means strong orogenic.

IV. 2 Maizuru zone

It was some ten years ago that the geological survey of the coal-fields around Maizuru City was carried out by K. NAKABAYASHI, K. NAKAZAWA, S. OKADA (1949, 1951) and N. KAMBE (1948, 1950, 1951). S. MATSUSHITA (1950, 1953) proposed the Maizuru zone for the zone extending from Tango to Harima where the Triassic and Permian systems and the Yakuno basic plutonic rocks occur in association. The stratigraphic and palaeontological studies were later developed in the zone by K. NAKAZAWA, T. SHIKI, D. SHIMIZU and Y. NOGAMI (1954, 1955, 1957, 1958, 1959), while the geological sheet-maps were surveyed by O. HIROKAWA, H. TOGO, N. KAMBE, S. IGI, H. ISOMI and K. KURODA (1954, 1957, 1958). Many new facts were discovered by them and it became evident how important for the geological history of Japan the Maizuru zone is.

Maizuru area

The Upper Permian Maizuru group in the environs of Maizuru City is mainly composed of black shale and clayslate but intercalates sandstone, conglomerate, schalstein and limestone. *Neoschwagerina* sp., *Fistulipora* sp., *Fenestella*? sp., *Batostomella* sp. ? and *Waagenophyllum indicum* (WAAGEN) are found in it. (NAKAZAWA and OKADA, 1949)

This group extends from east-north-east to west-south-west through Shidaka, Komori and Yakuno areas. It is in fault contact with the Ladino-Carnic Arakura formation. (NAKAZAWA, 1958)

It is presumed from the geologic structure that all of the Maizuru group, the Nabae group and the Arakura formation suffered from strong crustal movements, by which they were intensely folded or faulted, till they constructed the zonal arrangement.

The Ladino-Carnic Arakura formation is composed of black shale and sandy shale, and contains *"Monophyllites" arakurensis* NAKAZAWA, *Halobia*? sp., *Palaeoneilo* sp., *Lima* sp., *Nuculopsis* sp., *Psioidea* sp., *Spiriferina* sp., gastropods and bryozoans. (NAKAZAWA, 1958)

The Lower Carnic Nabae group is composed of sandstone, shale, conglomerate and coal-seams, and yields the following fossils (NAKAZAWA, 1958) :

Tosapecten nabaensis NAKAZAWA
T. okadai NAKAZAWA
T. teradensis NAKAZAWA
T. cf. *suzukii* (KOBAYASHI)
Chlamys mojsisovicsi KOBAYASHI and ICHIKAWA
Pseudolimea naumanni (KOBAYASHI and ICHIKAWA)
Halobia obsoleta KOBAYASHI and AOTI
H. kawadai YEHARA
H. sp. nov. indet.
H. cf. *austriaca* MOJSISOVICS
H. cf. *aotii* KOBAYASHI and ICHIKAWA
Anodontophora cf. *trapezoidalis* MANSUY
A. ? aff. *manmuensis* REED
A. ? aff. *minima* MANSUY
Minetrigonia hegiensis (SAEKI)
M. hegiensis obsoleta NAKAZAWA
M. katayamai KOBAYASHI and AOTI
Bakevellia matsushitai NAKAZAWA
B. oyogiensis NAKAZAWA
B. monobensis NAKAZAWA
B. hekiensis (KOBAYASHI and ICHIKAWA)
B. subhekiensis NAKAZAWA
B. aff. *hekiensis* (KOBAYASHI and ICHIKAWA)
Cardinioides japonicus KOBAYASHI and ICHIKAWA
C. cf. *subtriangularis* KOBAYASHI and ICHIKAWA
C. sp. nov. indet.
Pleuromya wakasana NAKAZAWA
P. aff. *forsbergi nipponica* KOBAYASHI and ICHIKAWA
Neoschizodus semicostatus NAKAZAWA
N. kawarensis NAKAZAWA
Schafhautlia cf. *astartiformis* (MÜNSTER)
Cardinia triadica KOBAYASHI and ICHIKAWA
C. misawensis KOBAYASHI and ICHIKAWA
"Cuspidaria" ayabensis NAKAZAWA
Oxytoma sp. indet.
Mytilus cf. *nasai* KOBAYASHI and ICHIKAWA
M. sp. nov. indet.
Parallelodon monobensis NAKAZAWA
P. sp. indet.
Camptonectes triadicus NAKAZAWA
Velata maizurensis NAKAZAWA
"Pecten" sp. indet.
"Ostrea" sp.
"Gryphaea" sp. aff. *keilhaui* KIPARISOVA
Nuculana sp. indet.

Palaeoneilo sp. indet.
Palaeopharus maizurensis KOBAYASHI and ICHIKAWA
P. paucicostatus NAKAZAWA
Lima yataensis NAKAZAWA
L. y. var. *kuredaniensis* NAKAZAWA
Volsella aff. *paronaiformis* KOBAYASHI and ICHIKAWA
Plicatula hekiensis NAKAZAWA
Cf. *Pinna* aff. *lima* BÖHM
Homomya matsuoensis NAKAZAWA
"*Megalodus*" sp.
Psioidea acutiplicata MS.
Mentzeliopsis ogawai MS.
M. wakasana MS.
Worthenia? sp.
Loxonema? sp.
Pleurotomaria? sp.
Spiriferina kawarensis NAKAZAWA MS.
Lingula sp.
Cyrtopleurites cf. *sakawanus* (MOJSISOVICS)
C. sp. indet.
Paratrachyceras sp. ?
Dimorphites sp.
Isocrinus-stem.
Plant fossils

Shidaka area

The coal-bearing Shidaka group occurs at Shidaka, 6 km. west of Maizuru. N. KAMBE (1948, 1950, 1951) divided it into five formations in descending order as follows:

Shidaka formation: 260 meters thick; coal-bearing sandstone, coal-bearing alternation of calcareous shale & sandstone and conglomerate; plants and shells locally present.

Okadashimo formation: 250~180 meters thick; alternation of shale & sandstone, and conglomerate.

Okadayuri formation: 430 meters thick; shale, alternation of sandstone & conglomerate, and conglomerate.

Humuro formation: 600 meters thick; reddish or greenish sandstone & conglomerate, alternation of fine conglomerate & sandstone, reddish or greenish shale, alternation of sandstone & conglomerate, and conglomerate.

Hannyaji formation: 180 meters thick; alternation of fine conglomerate & sandstone, reddish or greenish sandy shale & shale, and conglomerate & sandstone.

The Shidaka flora which is composed of *Cladophlebis nebbensis* (BRONGN.), *C. denticulata* (BRONGN.), *C. haiburnensis* (L. & H.), *C. Raciborskii* forma *integra* O. & T., Cf. *Zamites megaphyllus* (PHILLIPS), *Taeniopteris stenophylla* KRYSHT., *T. shitakaensis* OISHI, *Czekanowskia* sp., *Podozamites griesbachi* SEWARD and *P. lanceolatus* (L. & H.), belongs to the *Dictyophyllum series*. (OISHI, 1932, 1940)

The fauna found in the horizon a little below the plant bed comprises *Myophoria tangoensis* KAMBE, *M. shidakensis* K., *M.* α sp. nov. indet. (aff. *M. laevigata* v. ALBERTI in SCHMIDT), *M.* β sp. nov. indet. by KOBAYASHI and ICHIKAWA, 1949, Cf. *M. laevigata* (ZIETHEN) var. *elongata* PHIL., Cf. *M. l.* (Z.) var. *rotunda* PHIL., *Gervillia* spp., *Nucula*? spp., and *Palaeoneilo* sp. Beside these NAKAZAWA (1958, 1959, 1961) discovered *Bakevellia kambei* NAKAZAWA, *Palaeoneilo* (?) sp., *Nuculana*? sp., *Entolium* cf. *discites* (SCHLOTH), Michelinoceratoid? and a gastropod from the shale of the Okadashimo formation.

On the basis of the flora and fauna, the writer concluded that the geological age of the Shidaka group had to range from Upper Carnic to Noric. Lately NAKAZAWA (1954, 1958) expressed his opinion on its Lower Triassic age, but it is evidently improbable.

The Shidaka group lies on the disturbed Palaeozoic formation with a conspicuous clino-unconformity, and is cut by faults, forming a semi-basin by itself. On the east side of the basin, a limestone in the Permian formation yields *Neoschwagerina.* On the contrary, the Lower Carnic Nabae group and the Ladino-Carnic Arakura formation near Maizuru City are strongly disturbed together with the Upper Permian Maizuru group.

Komori area

There is the basal Maizuru group which is mainly composed of mudstone, sandstone and fine conglomerate accompanying limestone-lens. K. NAKAZAWA, T. SHIKI and Y. NOGAMI (1958) found in the Maizuru group in the Kawahigashi district *Cancrinella cancriniformis spinosa* HAYASAKA et MINATO, *Lyttonia nobilis* WAAGEN, *Yabeina columbiana* (DAWSON), *Y. yasubaensis* (TORIYAMA), *Y. gubleri* KANMERA, *Lepidolina kumaensis* KANMERA, *Pseudodoliolina pseudolepida gravitesta* KANMERA and *Reichelina matsushitai* NOGAMI. These fusulinids are known from the *Lepidolina-Yabeina* zone of the Kuma formation in western Kyushu. In the Kawanishi district (NAKAZAWA and NOGAMI 1958), there are *Neoschwagerina margaritae* DEPRAT, *N. douvillei* OZAWA (Upper of *Neoschwagerina* zone —*Yabeina globosa* zone), *Codonofusiella cuniculata* KANMERA, *Pseudodoliolina pseudolepida gravitesta* KANMERA, *Yabeina columbina* (DAWSON), *Y. yasubaensis* (TORIYAMA), *Y. gubleri* (KANMERA), *Lepidolina kumaensis* KANMERA and *L. toriyamai* KANMERA. (*Lepidolina-Yabeina* faunule).

The Middle and Lower Triassic Yakuno group lies on the Upper Permian Maizuru group with unconformity or they are cut by faults. Tectonically, however, they are so intimate that they form together the zonal structure.

The Yakuno group is divided into the Hirobatake formation and the Narawara formation in the Kawahigashi district, and into the Ichio formation and the Oro formation in the Kawanishi district. (NAKAZAWA, SHIKI and NOGAMI, 1958)

These formations are composed of conglomerate, sandstone, shale and limestone lens, and yield the following fossils (NAKAZAWA, 1958, 1959, 1960, 1961):

Neoschizodus cf. *laevigatus* (ZIETH.)
Neoschizodus (?) *shikii* NAKAZAWA
Bakevellia (*Maizuria*) *kambei* NAKAZAWA
B. okuyamensis NAKAZAWA
B. narawarensis NAKAZAWA
B. (*Neobakevellia*) *tsuzuradaniensis* NAKAZAWA
Claraia aff. *decidens* BITTNER
C. okuyamensis NAKAZAWA MS.
Eumorphotis tenuistriata BITTNER
"*Pecten*" *ussuricus* BITTNER
"*P.*" cf. *ussuricus* (BITTNER)
"*P.*" aff. *sojalis* WITTENBURG
Leptochondria (?) *minima* (KIPARISOVA)
L. (?) aff. *virgalensis* WITTENBURG
L. (?) cf. *bittneri* (KIPARISOVA)
L. (?) *okuyamensis* NAKAZAWA
Mysidioptera circularis NAKAZAWA
Promyalina minuta NAKAZAWA
Anodontophora cf. *fassaensis bittneri* FRECH
Anodontophora sp.
Entolium cf. *discites* (SCHLOTH.)
E. cf. *microtis* (BITTNER)
Pteria aff. *murchisoni* (GEINITZ)
Nuculana (*Dacryomya*) *nogamii* NAKAZAWA
N. (*D.*) n. *yakunoensis* NAKAZAWA
N. (*D.*) sp. *a*
N. sp. *a* aff. *excavata* GOLDFUSS

N. (*D.*?) sp. *β* cf. *Leda* sp. nov. in KIPARISOVA
Palaeoneilo sp. *γ*, new species?
P. sp. *δ* cf. *elliptica praecursor* (FRECH)
P. sp. *α* cf. *elliptica* in KIPAR.
P. sp. *ε*
Lima? sp.
Retzia sp.
Nuculopsis (*Palaeonucula*) sp. *α*
Pinna muikadaniensis NAKAZAWA
Daonella? sp.
Spiriferina spp.
Rhynchonella sp.
R. sp. *β* aff. *procreatrix* BITTNER
Lingula cf. *borealis* BITTNER
Dentalium sp.
Sisenna? *japonica* KOBAYASHI and ICHIKAWA
Meekoceras? sp.
Michelinoceras sp.
Paratirolites? sp.
Monophyllites cf. *sphaerophyllus* (HAUER)
Pleuronautilus sp.
Paranautilus? sp.
Isocrinus-stem
Echinoids

Yakuno and Miharaiyama areas

In the Yakuno district, to the west of the Komori area, there are the Upper Permian Nukada formation, the Middle and Lower Triassic Yakuno group and the Upper Triassic Heki formation.

The Upper Permian Nukada formation is mainly composed of black siltstone or mudstone, besides dark-grayish sandstone, fusulinids-bearing calcareous fine-grained conglomerate and limestone.

Its fossils are *Yabeina yasubaensis* TORIYAMA, *Y.* cf. *gubleri* KANMERA, *Lepidolina* cf. *toriyamai* KANMERA, *Pseudodoliolina pseudolepida gravitesta* KANMERA, *Schwagerina* aff. *acris* THOMPSON and WHEELER, *Chonetina* cf. *trapezoidalis* (WAAGEN), *Lyttonia nobilis* WAAGEN, *Orthotetes*? sp., *Cancrinella* sp., *Martinia* sp., *Productus* sp., *Reticularia*? sp., *Squamularia* sp., *Schizophoria* sp., *Camarophoria* sp., *Bucanopsis* cf. *kattaensis* (WAAGEN), *Pleurotomaria* sp., "*Dentalium*" sp., *Lophophyllidium* sp. and *Akiyoshiphyllum stylophorum* YABE et SUGIYAMA, *Stenopora* sp., *Fisturipora* sp., *Polypora* sp., Crinoid stem and Bryozoans. (KOBAYASHI, 1935, KOBAYASHI and ICHIKAWA, 1952, NAKAZAWA, SHIKI and SHIMIZU, 1957)

The Middle and Lower Triassic Yakuno group is divided into the Honodani formation in the lower and the Waruishi formation in the upper by K. NAKAZAWA, T. SHIKI and D. SHIMIZU (1957).

The Honodani formation consists mainly of sandstone, but is associated with shale, and is subdivided into three members. The Waruishi formation is mainly composed of shale and sandy shale, and is subdivided into two members.

The Yakuno fauna comprises the following fossils (NAKAZAWA, 1958, 1959, 1961):

Neoschizodus cf. *laevigatus* (ZIETH.)
Myophoria sp. ? indet.
Bakevellia (*Maizuria*) *kambei* NAKAZAWA?
B. okuyamensis NAKAZAWA
B. narawarensis NAKAZAWA?
Claraia pulchella NAKAZAWA
Eumorphotis aff. *multiformis* (BITTNER)
"*Pecten*" cf. *ussuricus* (BITTNER)
Nuculana nogamii yakunoensis NAKAZAWA
N. sp. *α* aff. *excavata* GOLDFUSS
Palaeoneilo sp. *β* cf. *P.* (?) *oviformis* (ECH.)
Nuculopsis (*Palaeonucula*) sp. *β*.
N. sp. *γ*
Anodontophora? sp.

Pinna muikadaniensis NAKAZAWA
P. sp. indet.
Propeamussium (*Variamussium*) n. sp. indet.
Spiriferina sp.
Retzia sp.
Lingula cf. *borealis* BITTNER
Sisenna? *japonica* KOBAYASHI and ICHIKAWA
"Dentalium" sp.
Hungarites sp. aff. *proponticus* TOULA
Danubites japonicus SHIMIZU
"D." kogai NAKAZAWA MS.
"Hollandites" torii NAKAZAWA MS.
"H." yakunoensis NAKAZAWA MS.
Pseudosageceras? sp.
Beyrichites sp.
Meekoceras sp.
"Xenodiscus" sp.
Michelinoceras sp.
Nautiloid? sp.
Isocrinus-stem
Brachiopod gen. et sp. indet.

The Carnic Heki formation in the Yakuno district is composed of medium- or coarse-grained sandstone, shale, sandy shale and conglomerate, and contains the following fossils (KOBAYASHI and ICHIKAWA, 1952, NAKAZAWA, 1958):

Velata maizurensis NAKAZAWA
Pseudolimea naumanni (KOBAYASHI and ICHIKAWA)
Lima yataensis NAKAZAWA
L. y. var. *kuredaniensis* NAKAZAWA
Bakevellia saekii (KOBAYASHI and ICHIKAWA)
B. hekiensis (KOBAYASHI and ICHIKAWA)
B. cf. *monobensis* NAKAZAWA
Minetrigonia hegiensis (SAEKI)
Plicatula hekiensis NAKAZAWA
Cf. *Pinna* aff. *lima* BÖHM
Palaeopharus maizurensis KOBAYASHI and ICHIKAWA
Parallelodon monobensis NAKAZAWA
Cardinia triadica KOBAYASHI *and* ICHIKAWA
"Gryphaea" aff. *keilhaui* KIPARISOVA
"Ostrea" sp.
Mytilus cf. *tenuiformis* KOBAYASHI and ICHIKAWA
M. t. var. *punctatus* KOBAYASHI and ICHIKAWA
Homomya matsuoensis NAKAZAWA
Oxytoma (?) sp. indet.
Cardinioides japonicus KOBAYASHI and ICHIKAWA
C. j. var. *elongatus* K. and I.
C. subtrigonalis K. and I.
C. splendidus K. and I.
C. sp. indet.
Pleuromya (?) sp. indet.
"Cuspidaria" ayabensis NAKAZAWA
Chlamys mojsisovicsi KOBAYASHI and ICHIKAWA
Spiriferina cf. *kawarensis* NAKAZAWA MS.
Lingula sp.
Sisenna (?) *japonica* KOBAYASHI and ICHIKAWA
Isocrinus sp.

The Yakuno group, the Nukada formation and the Heki formation generally strike to east-west and dip to north. Their boundaries are faults, although the detailed structure is obscure.

These formations are similarly folded and faulted to form the zonal arrangements.

In the geological sheet-map area of Tajimatakeda and Oyaichiba (scale 1 : 50,000), there are the Hikami formation (phyllitic clayslate, sandstone, chert and limestone), the Akenobe formation (phyllitic clayslate, black clayslate, sandstone, conglomerate and limestone), the Chihara formation (clayslate, sandstone, conglomerate and limestone), the Surugamine formation (green phyllite, black phyllite and sandstone), and the Oya formation (clayslate, sandstone and conglomerate), all striking from east-north-east to west-south-west and dipping to northwest or southeast.

The Akenobe, Chihara, Nukada and Oya formations are correlated to the Maizuru group from the rock-facies and the fossil-fauna, but the Hikami and the Surugamine formations are not correlated.

The Akenobe and Oya formations which form the basement of the Upper Triassic Miharaiyama group are mainly composed of silty shale but often intercalate fine- or medium-grained sandstone.

It is characteristic for these formations to contain fusulinid-bearing calcareous fine conglomerate, limestone and silty shale with small lenses or patches of black shale. They show the strike of N 60~75° E and the dip of 20~70° N and contain *Yabeina* sp. (cf. *Y. yasubaensis* TORIYAMA), *Y.* sp. (cf. *Y. columbiana* (DAWSON), *Lepidolina* sp. (cf. *L. kumaensis* KANMERA), *Pseudodoliolina* sp. (cf. *P. pseudolepida* (DEP.), *Codonofusiella* sp. and *Schwagerina* sp. (cf. *S. acris* THOMPSON and WHEELER). From these fusulinids the two formations can be correlated to the Upper Permian Kuma formation in western Kyushu (KANMERA, 1953, 1954). NAKAZAWA combined the Akenobe formation and the Oya formation into the Minamitani group. (NAKAZAWA and SHIKI, 1954)

The Miharaiyama group lies on the Minamitani group with conspicuous clino-unconformity at the northeastern part of the Oyaichiba geological sheet-map. NAKAZAWA and SHIKI (1954) divided the Miharaiyama group into two formations and five beds in descending order as follows:

Gannosudani formation	G3 bluish grey siltstone	200 m.
	G2 bluish grey sandstone	80~95 m.
	G1 conglomerate	50~80 m.
Niikuradani formation	N2 bluish grey sandstone	30 m.
	N1 basal conglomerate	15~30 m.

Most fossils were collected from the Gannosudani formation. N. KAMBE (1957) described *Myophoria tajimensis* KAMBE, *M. laevigata* (ZIETHEN), *M. l.* (Z.) var. *miharaiensis* KAMBE, *M.* cf. *l.* (Z.) var. *elongata* PHIL., *M. cardissoides* (Z.), *M.* aff. *nakajimensis* ICHIKAWA, *M. tangoensis* KAMBE, *M. shidakensis* KAMBE, *M.* sp. nov. indet. by KOBAYASHI and ICHIKAWA, 1949, *M.* γ sp. nov. indet. and *M.* δ sp. nov. indet. Subsequently NAKAZAWA (1958, 1959) reported *Neoschizodus* cf. *laevigatus* (ZIETHEN), *Bakevellia* (*Maizuria*) *kambei* NAKAZAWA and *Nuculana* sp. α aff. *excavata* GOLDFUSS, *Palaeoneilo* sp. cf. α aff. *elliptica* in KIPARISOVA, *Nuculopsis* (*Palaeonucula*) sp. from G3 bed, and *Neoschizodus* cf. *laevigatus* (ZIETHEN), *Bakevellia* (*Maizuria*) *kambei* NAKAZAWA, *Nuculana* sp. α aff. *excavata* GOLDFUSS, *Palaeoneilo* sp. α aff. *elliptica* in KIPARISOVA, *P.* sp. β, *Selenimyalina*? sp., *Terebratula* sp. α, *T.* sp. β aff. *margaritowi* BITTNER, *Rhynchonella* sp. δ aff. *griesbachi* BITTNER, *Sisenna*? sp. cf. *japonica* KOBAYASHI and ICHIKAWA and Ammonite gen. et sp. indet. from G2 bed. This fauna is characterized by *Myophoria* and *Bakevellia.* The Miharaiyama group (KAMBE, 1957) strikes N 20~30° W with the dip of 30~50° E. *Myophoria tangoensis, M. shidakensis, M.* sp. nov. indet. by KOBAYASHI and ICHIKAWA, 1949, and *M.* cf. *laevigata* (ZIETHEN) var. *elongata* are the Shidaka elements in the Upper Shidaka group the age of which is from Upper Carnic to Noric. *M. laevigata* (ZIETHEN) var. *miharaiensis,* new var., and *M.* γ sp. nov. indet. are also allied to certain Shidaka species, namely the former, to *M. laevigata* (ZIETHEN) var. *rotunda* and the latter, to *M. shidakensis, M. tajimensis,* new species and *M.* aff. *naka-*

jimensis are both related closely to *M. nakajimensis* from the middle Carnic *Halobia* beds of the lower Kochigatani group in the Sakawa basin in Kochi Prefecture. In addition, *M. laevigata, M. cardissoides* and *M.* δ sp. nov. indet. were procured from this group, where the first ranges from Upper Skytic to Noric and the second, from Anisic to Ladinic. In short, four Myophorian species are the Shidaka's species, two are allied to the Shidaka species and another two are related to the middle Carnic species of Sakawa. Putting aside *M. laevigata, M. cardissoides* and *M.* δ sp. nov. indet., the Myophorians suggest the geological age from middle Carnic to Noric for the Miharaiyama group. The Hirotani formation, which is composed of conglomerate, sandstone and clayslate and is distributed to the east, is quite similar to those of the Miharaiyama group in rock facies and geological structure, though no fossil is as yet discovered.

In the northwestern part of Kyoto Prefecture, the Lower Carnic Nabae group, the Heki formation and the Lower and Middle Triassic Yakuno group constitute the zonal structure with the Upper Permian Maizuru group. These Triassic sediments have the equatorial strike like the Palaeozoic sediments. There is no conspicuous unconformity between the Maizuru and the Yakuno groups. On the contrary, the Shidaka and Miharaiyama groups are quite discordant to the zonal structure. They are sediments in the basins in the already disturbed terrain.

It is important for the geological history of the Triassic period that there is the conspicuous clino-unconformity between the Miharaiyama and Shidaka groups on one side and the Upper Permian Maizuru and other formations.

Yamazaki and Sayo areas

Glyptophiceras japonicum NAKAZAWA which K. NAKAZAWA and D. SHIMIZU (1955) discovered at Nakanotani, Tomisumura, about 8 km to the east of Yamazaki-machi, Shiso-gun, Hyogo Prefecture indicates the earliest Triassic age but the ammonite was contained in a boulder.

There is the Upper Permian formation yielding *Lepidolina toriyamai* KANMERA and *Yabeina* cf. *yasubaensis* (TORIYAMA) at Nakanotani.

This area is important for the boundary problem.

There the presumed Palaeozoic Mikazuki group consists of black phyllite, sandstone, chert and schalstein. The Yamazaki group which consists of green sandstone and green clayslate occurs to the north of the Mikazuki group, at the southeastern part of the Sayo geological sheet-map area. The rock-facies of the Yamazaki group is similar to that of the Yakuno group, and the boundary between the Mikazuki and Yamazaki groups is an interesting subject to investigate.

Susai area

In the vicinity of Susai-machi in Okayama Prefecture, the Upper Permian Kose group, the Lower and Middle Triassic Fukumoto group, the Carnic Yanagi formation, the Noric Nakaiso conglomerate bed, the Cretaceous Inkstone group and the Tertiary conglomerate bed were investigated by K. NAKAZAWA, T. SHIKI and D. SHIMIZU (1954, 1958, 1959, 1961).

The Kose group is composed of black shale and sandy shale in addition to sandstone and lenses of conglomerate. Its thickness attains 350 m. Fossils contained are *Lepidolina* sp., *Yabeina* sp., *Nankinella*? sp. and *Schwagerina* sp..

From the rock-facies and the fauna, the group is correlated to the Upper Permian Kuma group in Kyushu.

The Fukumoto group is divided into three formations and the lower part is in fault contact with the Kose group.

Anisic Miyanooku formation: dark blue calcareous sandy shale with shale and fine-grained sandstone; 300 m. in thickness; containing *Palaeoneilo* sp. *β*, *Bakevellia miyanokuensis* NAKAZAWA MS., *Hollandites* sp. and *Michelinoceras* sp..

Skytic Kyogakubu formation: alternation of shale and sandstone, 270~300 m. in thickness; containing *Neoschizodus* cf. *laevigatus* (ZIETH.), *Bakevellia kambei* NAKAZAWA, *"Pecten" ussuricus* BITTNER, *Nuculana* sp. *α* aff. *excavata* GOLDFUSS, *Palaeoneilo* sp. *β* cf. *P.* (?) *oviformis* (ECH.) and *Rhynchonella* sp. *γ*.

Kusano formation: fine- to medium-grained sandstone with conglomerate, 175 m. in thickness; containing *Neoschizodus* cf. *laevigatus* (ZIETH.), *Bakevellia kambei* NAKAZAWA, *"Pecten" ussuricus* BITTNER, *Eumorphotis* aff. *maritima* KIPARISOVA, *E.* aff. *tenuistriata* (BITTNER), *Nuculana* sp. *α* aff. *excavata* GOLDFUSS, *Palaeoneilo* sp. *β*, *Pinna muikadaniensis* NAKAZAWA, *Selenimyalina* sp. *α*, *"Promyalina"* sp. *α*, *Spiriferina* sp., *Rhynchonella* sp. *γ*, *Retzia* sp., *Anakashmirites*? sp. and *Pseudosageceras* aff. *"intermontanum"* HYATT & SMITH.

The Carnic Yanagai formation, more than 70 m in thickness is composed of black shale and carbonaceous sandy shale, and contains *Velata maizurensis* NAKAZAWA, *Lima yataensis* NAKAZAWA, *Minetrigonia hegiensis* (SAEKI), *Parallelodon monobensis* NAKAZAWA and *Palaeopharus maizurensis* KOBAYASHI and ICHIKAWA. These fossils show that this formation is the correlative to the Nabae group. It is sandwiched between the Kose group and the Fukumoto group by faulting.

The Nakaiso conglomerate bed, more than 200 m. thick, lying on the Fukumoto and Kose groups with a remarkable unconformity. This bed is tentatively correlated to the Noric Nariwa group from lithology, but no fossil is yet discovered in it.

Summary

From the above facts, the followings are concluded for the Maizuru zone.

1. In the Inner Zone of Southwest Japan, the distribution of Aniso-Skytic formations is restricted to the Maizuru zone.

2. The Aniso-Skytic and Upper Permian formations are usually found side by side, although the exact relation is seldom observable.

3. In so far as can actually be seen, their relation is parallel unconformity or disconformity and no conspicuous clino-unconformity has yet been as well certained.

4. On the contrary the clino-unconformity at the base of the Shidaka group and its equivalence is conspicuous, and the Upper Triassic age of the Shidaka group is determined by plant and animal fossils.

5. Therefore the main crustal movement took place in the pre-Shidaka and pre-Miharaiyama age, while the Permo-Triassic movement was not stronger than what is meant by disconformity.

IV. 3 Outer Side of Southwest Japan

The Outer Side of Southwest Japan is divided into the Nagatoro belt, the Chichibu belt and the Shimanto-Nakamura belt from north to south by T.

KOBAYASHI (1941). The Permian and Triassic systems are extensive in the Chichibu belt. This belt makes many good displays to discuss the boundary between the two systems.

T. KOBAYASHI has pointed out that the Chichibu Palaeozoic continues to the older Mesozoic group in the southern part of the belt where they are combined in the Sambosan group. Though the distribution is restricted, the Lower Triassic system occurs in the Outer Side of Southwest Japan at several places; namely the Shionosawa limestone at Shionosawa in the northern Kwanto mountains, the Iwai formation at Itsukaichi in the southern Kwanto mountains, the Kurotaki and Tao formation in Kōchi Prefecture and the Kamura formation in Miyazaki Prefecture.

Kwanto mountains

Shionosawa district

At a place of the Sanchu Graben in the northern Kwanto mountains, the Lower Triassic Shionosawa limestone, about 2 meters thick, was found by H. OZAKI, T. SHIKAMA (1954), K. ICHIKAWA and Y. YABE (1955, 1956), and the following fossils are reported: *Eumorphotis multiformis* (BITTNER) *shionosawensis* ICHIKAWA et YABE, *Anodontophora canalensis* CATULLO var. *bittneri* ICHIKAWA and YABE, *A. fassaensis* WISSMANN, *A. canalensis* CATULLO, *Pteria* s.l. *ussurica yabei* NAKAZAWA, *Pecten* spp. and *Naticopsis* spp.

At Ohira at a distance of 1.7 km to the east of Shionosawa, there is the Lower Permian Ohira limestone, yielding the following fossils: *Parafusulina fountain* DUNBAR and SKINNER, *Schwagerina japonica* GÜMBEL, *Acervoschwagerina* sp. and *Codonofusiella* (?) sp.. The relation between the two limestones is, however, yet unknown.

Itsukaichi district

In the Itsukaichi district, there are the Ammonite bed (Iwai formation), the Brachiopod bed (Arai formation), *Halobia*-bearing formation and *Entomonotis*-bearing formation, where the first is Lower Triassic. This is divided by S. SAKAGAMI (1955) in ascending order into (1) black and partly bluish colored sandstone of more than 40 meters thickness, (2) 10 meters shale, (3) 10 meters sandstone and (4) 25 meters black colored shale. Fossils are found in the last in two horizons. Recently, fossils were studied by B. KUMMEL and S. SAKAGAMI (1960). The limestone lens of the lower fossil horizon or *Ophiceras* bed yields *Dieneroceras iwaiense* (SAKAGAMI), *Dieneroceras* sp. indet., *Owenites shimizui* (SAKAGAMI), *Paranannites* sp. indet., *Juvenites* sp. indet., *Aspenites* sp. indet., *Posidonia* sp. and *Palaeonucula*? sp., the marl lens of the upper fossil horizon or *Aspenites* bed contains *Aspenites* sp. indet., *Gervillia* cf. *exporrecta* LEPSIUS, *Myophoria* sp. and *Palaeonucula*? sp. They considered that the faunas of both fossiliferous beds belong to the *Meekoceras* zone (mid-Scythian).

The Iwai formation is separated from the fusulinid-bearing Chichibu Palaeozoic formation by faults.

Shikoku Island

Kurotaki district

E. NAUMANN was the first who payed attention to the Kurotaki limestone at Izumigadani of Kurotaki in the northern part of Kōchi Prefecture. The areal survey was carried out by S. MATSUSHITA (1926) and T. SUZUKI (1931). The latter combined the limestone with the surrounding sandstone and shale in the Kurotaki formation. It is separated from the surrounding Permian formation by faults. According to MATSUSHITA the limestone contains *"Pteria"* spp. nov., *Eumorphotis multiformis* (BITTNER) var., *E.* aff. *iwanowi* (BITTNER), *E.* sp. nov., *Posidonia* sp. nov., *"Pecten"* cf. *ussuricus* (BITTNER), *"P."* cf. *sichoticus* (BITTNER), *"Entolium" discites* v. SCHLOTH., *"E." discites* var. *microtis* (BITTNER), *Pleuronectites* spp. nov., *"Gervilleia"* cf. *exporrecta* (LEPS.), *Plagiostoma?* sp. nov., *Mysidioptera* sp. indet., *Myalina* ex. aff. *schamarae* (BITTNER), *Myophoria* aff. *laevigata* ALB., *Anodontophora canalensis* CAT. sp., *A. fassaensis* WISSM. sp., *Bellerophon* sp. indet., *Naticopsis* sp. indet. and *Productus* sp. indet.

Tao district

The Tao formation which is distributed at Tao in Uonashi village, Higashiuwa-gun, Ehime Prefecture, was investigated by S. EHARA, N. IKEBE (1936), S. SHIMIZU, O. ZIMBO and T. SUZUKI (1935). This Skytic Tao formation consists of sandstone and black shale with intercalation of pale grayish limestone and trends from east to west. This formation is in thrust relation to the surrounding Palaeozoic formation and Torinosu group, and occupies a narrow belt. The details of the Tao formation are unknown, but the limestone is known to contain *Gervilleia* cf. *exporrecta* LEPS., *Meekoceras* s. l. *japonicum* SHIMIZU & ZIMBO, *"M." kuharanum* YEH., *M. morianum* YEH., *M. shikokuense* YEH., *"M." orientale* SH. & J., *M. katoi* YEH., *M. sawatanum* YEH., *"M." tahoense* (YEH.), *Anasibirites multiplicatus* (YEH.), *A. onoi* (YEH.), *A. pacificus* (YEH.), *A. pacificus* var. *kotoi* (YEH.), *A.* sp. nov. aff. *"spiniger"* KRAFFT & DIENER, *Wyomingites* sp. nov. aff. *aplanatus* (WHITE), *Anodontophora canalensis* CAT. sp., *Eumorphotis shikokuensis* (YEH.), *E.* spp., *Pinna?* sp. indet. and *"Gervillia"* sp. indet.

The geological age of the Tao formation is Owenitan.

Sambosan zone

Along the southern part of the Chichibu belt in Shikoku island, there are the Chichibu Palaeozoic system and the Togano series, both of which form a zonal arrangement trending from east-north-east to west-south-west. These formations are known continuous and collectively called the Sambosan group.

The Togano basin and the surrounding area of the Sambosan in Kōchi Prefecture are the main district of the Sambosan group. According to T. KOBAYASHI (1941, 1952) and N. KURATA (1940) the group in the Togano basin consists of the followings:

(1) The Permo-Carboniferous composed of limestone, limestone conglomerate, chert, coarse-grained sandstone, shale, conglomerate and spilitic rocks, and containing *Lonsdaleia, Neofusulinella* (?), *Tetrataxis, Fusulina* (?) and *Neoschwagerina* or *Yabeina*.

(2) The Togano formation or alternations of sandstone and shale accompanying chert and limestone, and unfossiliferous except for indeterminable plant remains.

(3) The Nishiyama formation composed of coarse-grained or conglomeratic sandstone and chert.

(4) The Middle Jurassic Naradani formation composed of sandy shale, sandstone and muddy or sandy limestone yielding echinoids, corals and brachiopods (*Burmirhynchia japonica* TOKUYAMA, *Kallirhynchia* sp. indet., *Naradani-*

thyris kuratai TOKUYAMA, *N. kuratai* var. *radiatostriata* T., *Zeilleria naradaniensis* T. and "*Terebratella*" sp. indet.). (TOKUYAMA, 1957, 1958) The Naradani formation is disconformably covered by the Torinosu series.

T. KIMURA (1944) recognized the following radiolaria from chert of the lower Naradani formation in the southern part of the Sakawa basin: *Sphaerozoum* sp., *Cenosphaera* sp., *Carposphaera* sp., *Dorysphaera* sp., *Xiphosphaera* sp., *Staurolonchidium* sp., *Ellipsoxiphus* sp., *Porodiscus* sp., *Halicapsa* sp., *Dicolocapsa* spp., *Dictyomitra* cf. *haeckelli* (PANTANELLI) and *Dictyomitra* sp. and from chert of the Togano series in the southeastern part of the Sakawa basin: *Sphaerozoum* sp., *Cenosphaera* cf. *regularis* RÜST, *Cenosphaera tumida* HINDE, *Cenosphaera* sp., *Carposphaera* sp., *Dorysphaera* sp., *Xiphosphaera* sp., *Staurolonchidium* sp., *Cenellipsis* cf. *gigantea* RÜST, *Ellipsoxiphus* sp., *Porodiscus* sp., *Rhopalastrum* sp., *Halicapsa* sp., *Stenocapsa* sp., *Dicolocapsa* spp., *Tetrahedrina* sp., *Dictyomitra* cf. *haeckelli* (PANTANELLI), *Dictyomitra* sp. and *Stichocapsa* (?) sp. Moreover, he recognized the following radiolaria from chert of the Sambosan group (KIMURA, 1944): *Sphaerozoum* sp., *Cenosphaera* sp., *Staurolonchidium* sp., *Cenellipsis* cf. *gigantea* RÜST, *Ellipsoxiphus* sp., *Porodiscus* sp., *Cornutella* (?) sp., *Dicolocapsa inclusa* HINDE, *Dicolocapsa* spp., *Tricolocapsa pilula* HINDE, *Dictyomitra* cf. *haeckelli* (PANTANELLI), *Dictyomitra cretacea* RÜST, *Dictyomitra* sp. and *Lithostrobus* sp. In the neighbourhood of the Sambosan in the eastern part of the Togano basin, the Sambosan group consists of the alternation of shale, sandstone and chert, accompanying six limestone-lenses and schalstein. The molluscan fauna from the white Sambosan limestone, which T. SUZUKI (1931) discovered, contains *Spongiomorpha samposanensis* YABE and SUGIYAMA, *Spiriferina* sp. nov., *Rhynchonella sambosanensis* KOBAYASHI, *Terebratula* spp., *Cassianella* sp., *Eumorphotis* sp., *Daonella* cf. *kotoi* MOJSISOVICS var. *alta* YABE and SHIMIZU, *Daonella* sp., *Pecten* spp., *Cidaris* spines 2 spp. and Bryozoa gen. et sp. indet. (KOBAYASHI, 1931, 1952) The geological age of the fauna was first considered Ladino-Carnic by KOBAYASHI. Subsequently, in 1957, A. TOKUYAMA described "*Rhynchonella*" *noichiensis* TOKUYAMA and *Holchorhynchia sambosanensis* (KOBAYASHI) var. (=*Rhynchonella sambosanensis* KOBAYASHI) from the Sambosan limestone and suggested that the Sambosan limestone belongs to Carnic. Recently in 1959, T. KOBAYASHI and A. TOKUYAMA published that the above-listed "*Daonella*" is not warranted. At any rate a part of the Sambosan group must be Triassic and no stratigraphic discordance is known within the Sambosan group.

In the southern part of the Permian Yurugidake formation in the Chichibu belt of the Kuraoka geological sheet-map area, the southern part of the Permian formation in the Chichibu belt of the Mitai geological sheet-map area, the southern part of the Tawarazu formation in the Chichibu belt of the Iyotakayama geological sheet-map area and the southern part of the Chichibu belt in the Kōyasan geological sheet-map area, the limestone, schalstein, chert, sandstone, clayslate and conglomerate are widely distributed. These rock-facies are akin to that of the Sambosan group in the central part of Shikoku Island, although no fossil is as yet discovered. They have the same geological structure as the Permian formation.

Summary

While the Permian formations are widely distributed in the Outer Side of

Southwest Japan, the distribution of the fossiliferous Lower Triassic formation is very restricted. Although the fossiliferous Skytic limestones or formations are known from the Kwanto mountains, Shikoku and Kyushu Islands, they are mostly in fault contact with the Permian formation. But, at Takachiho-cho in Kyushu, as described in chapter II, the limestone of Upper Permian Iwato formation continues conformably to the limestone of Lower Triassic Kamura formation without either an unconformity or a fault. More precisely, the two formations have the same strikes and dips. Nevertheless, their boundary is sharp and the two limestones differ in lithology and at the same time their faunas are different from each other. Such differences probably mean the abrupt change in the environment or physical condition which is related to any kind of epirogeny, but there is no actual indication of erosion at the boundary.

In the Sambosan zone, it is considered that the Chichibu Palaeozoic formation continues conformably to the Togano group the age of which extends to Middle Jurassic at the latest. No unconformity is as yet reported between the Permian and Lower Triassic. In other words there is no evidence which indicates any cessation of sedimentation at the Permo-Triassic boundary in the Outer Zone of Southwest Japan.

V. On the correlation of the Lower Triassic system and boundary questions

Eumorphotis multiformis (BITTNER) and other pelecypods discovered from the Kamura formation, are widely known from the Skytic in Japan and other countries. Its ammonites belong to Flemingitan and Owenitan. It is probable that the non-fossiliferous part below the Flemingitan belongs to Otoceratan-Gyronitan. (SPATH, 1927, 1934)

Correlation: In the Kitakami mountains, there are the Lower and Middle Triassic Inai group and the Middle Triassic Rifu group. Of the Inai group, the Hiraiso and Osawa formations belong to the Lower Triassic. According to K. ICHIKAWA (1951), Y. ONUKI and Y. BANDO (1959), the middle and lower parts of the Hiraiso formation contain Otoceratan-Gyronitan fossils, and the upper part of the Osawa formation yields Prohungaritan fossils. Therefore the fossiliferous upper part of the Kamura formation can be correlated to the upper part of the Hiraiso formation and the lower part of the Osawa formation. The non-fossiliferous lower part of Kamura formation may be correlated to the lower part of the Hiraiso formation. But one part of the Kamura formation may extend to the upper part of the Osawa formation. For example, *Entolium discites* (SCHLOTHEIM), *Gervilleia* cf. *exporrecta* (LEPSIUS) and *Anodontophora* aff. *fassaensis* WISSMANN common in the Kamura formation are known from the Hiraiso formation, and *Eumorphotis* cf. *multiformis* (BITTNER) common in the Kamura formation is known from the Osawa formation. It is noteworthy that the total thickness of the Hiraiso and Osawa formations in the Kitakami mountains attains to 330~600 m, but the contemporaneous Kamura formation in Kyushu is no more than 160 m in thickness.

The Shionosawa Limestone of the Sanchu Graben and the Iwai formation of the Itsukaichi district are two Lower Triassic formations in the Kwanto mountains. The common species between the Kamura and Shionosawa faunae are *Eumorphotis multiformis shionosawensis* ICHIKAWA et YABE, *Anodontophora* *canalensis* CATULLO var. *bittneri* I. et Y., *A. fassaensis* WISSMANN, *A. canalensis* CATULLO, *Pteria ussurica yabei* NAKAZAWA and *Gervilleia* cf. *exporrecta* OZAKI et SHIKAMA. Because most of the Shionosawa fauna occur in the Kamura fauna, two faunas must be contemporaneous. It is remarkable that the Kamura fossils are larger in size than the same species in the Shionosawa Limestone.

Aspenites with which the *Aspenites* bed is distinguished in the Iwai formation occurs also in the Kamura formation. *Gervillia* cf. *exporrecta* (LEPSIUS) is another species common between them. Thus the *Aspenites* bed of the Iwai formation has its equivalence in the Kamura formation. In considering the presence of the nonfossiliferous lower part in the Kamura formation, the Kamura may be contemporaneous with the Iwai formation.

In Shikoku, the Kurotaki and Tao formations are Lower Triassic. *Pteria* sp., *Eumorphotis multiformis* (BITTNER) var., *Entolium discites* (v. SCHLOTH.), *Gervillia* cf. *exporrecta* (LEPSIUS), *Anodontophora canalensis* CATULLO and *A. fassaensis* WISSMANN are common between the Kurotaki and Kamura formations.

Therefore the Kurotaki formation is contemporaneous with the Kamura formation. The Kamura and Tao faunas are distinct if *Anodontophora canalensis* CATULLO and *Gervillia* cf. *exporrecta* LEPSIUS are excluded.

Meekoceras and *Anasibirites* of the Tao formation, *Aspenites* of the Kamura formation and *Clypites* and *Parahedenstroemia* of the formation indicate Owenitan, Lower Owenitan and Upper Flemingitan, respectively. (SPATH, 1927, 1934)

From these facts, it is concluded that the Kamura fauna is nearly contemporaneous with the Tao fauna or the former is somewhat older than the latter. The Kamura fauna belongs to Uonashian but the larger part of Kamura formation indicates Tatean and Uonashian, and one part of it may extend to Tsuyan.

The Sambosan group appears a Permo-Triassic formation without the break and therefore a part of the Togano formation must be the Lower Triassic.

In the Inner Side of Southwest Japan, there are the Lower and Middle Triassic Yakuno and Fukumoto groups. According to K. NAKAZAWA (1958), the Hōnōdani formation, the Ichio formation, lower part of the Oro formation, the Narawara formation and the Hirobatake formation are Lower Triassic.

Eumorphotis aff. *multiformis* (BITTNER) is the species common between the Kamura and the Hōnōdani formation. *"Entolium"* cf. *discites* v. SCHLOTH. is common among the Kamura and the lower part of the Oro formation. The species common between the Kamura and the Narawara formation is not yet discovered. By these species and other fossils contained, it is considered that the above-mentioned formations belong to Skytic, and that the Kamura formation is correlated to these formations. The species common between the Kamura formation and the Fukumoto group is not yet discovered. (See Tab. 1)

As to the foreign countries, the Lower Triassic in Ussuri was studied by A. BITTNER (1899), C. DIENER (1895), P. v. WITTENBURG (1909), L. KIPARISOVA (1938, 1945), etc. It is known that the Lower Triassic fauna in Japan is allied to the fauna in Ussuri. Recently, L. KIPARISOVA (1945) divided the Lower Triassic system in Ussuri into the Basal beds, the *Meekoceras* beds, the *Flemingites* beds and the *Subcolumbites* beds in ascending order.

The Basal beds cover the erosion-surfaces of the Permian system and the Palaeozoic granite. The species and genus common between the Kamura formation in Japan and the Lower Triassic formation in Ussuri are *Eumorphotis multiformis* (BITTNER), *Gervillia exporrecta* LEPS., *Entolium discites* (v. SCHLOTHEIM), *Eopecten minimus* (KIPARISOVA), *E. m.* var. *reticulatus* (KIPARISOVA), *Chlamys* (?) *kryshtofowichi* (KIPARISOVA), *Anodontophora canalensis* CATULLO, *A. c.* var. *bittneri* ICHIKAWA and YABE, *A. fassaensis* (WISSMANN), *Pteria ussurica yabei* NAKAZAWA (though this is a variety) and *Pseudosageceras*. These fossils are found in the Basal beds, *Meekoceras* beds and the *Subcolumbites* beds.

According to L. KIPARISOVA, the above-mentioned Basal beds, *Meekoceras* beds and *Flemingites* beds ranges from Otoceratan to Flemingitan judging from the fossils contained. The *Subcolumibites* beds are correlated to Prohungaritan. From these facts and the reason that the geological age of the Kamura formation ranges from Otoceratan to Owenitan, the larger part of the Kamura formation is correlated to Basal beds, *Meekoceras* beds and *Flemingites* beds.

The stratigraphy and palaeontology of Central and Southern China have been investigated by E. WIRTH (1936), P. Y. CHEN (1950), T. Y. HSÜ (1937), Y. S. CHI (1937), S. F. SHENG, K. CHAO (1959), etc. The Lower Triassic system in these regions is represented by the Feisienkuan Limestone, the Tayeh Limestone and the Chinglung Limestone. The species common between the Lower Triassic 2 or 6 beds of Lungyen and Ningyang in Fukien and the Kamura formation is *Eumorphotis multiformis* (BITTNER). The species common between the Chinglung Limestone and the Kamura formation is represented by *Pseudosageceras* sp. from the *Otoceras* beds Lungtan, Chüyang, Kiangsu, *Anodontophora fassaensis* (WISSMANN) from the *Meekoceras* zone at Tameishan, Changhsing, Chekiang and *Anodontophora* sp. from Changshuichiao, W. of Chihsienkuan, Huaining, Anhui. In Western Kwangsi, the common species are *Pseudosageceras* and *Aspenites* from the Flemingitan age, *Pseudosageceras* from the Owenitan age in the Naliling section, Linglo district, Flemingitan *Pseudosageceras* in Tiengno district, and *Pseudosageceras* and *Aspenites* from the *Meekoceras* bed in Tientung district. The fossiliferous bed of the Kamura formation is correlated to Flemingitan and Owenitan of the Chinglung Limestone, but the lower unfossiliferous part of the Kamura formation may extends as far as Otoceratan. The Permian and Triassic formations are considered conformable in Fukien and Szechuan. In the Lower Yangtze Valley, the Chinglung limestone overlies the Permian Changhsing Limestone and Lungtan coal series disconformably and no conspicuous discordance is known between them. The Permian and Triassic formations are disconformable in Kwangsi.

Anodontophora tonkinensis MANSUY (1916) which is allied to *A. canalensis* CATULLO from the Kamura formation is reported from the Triassic formation of Na Cham, Tonkin.

The Chocolate Limestone in Himalaya, probably belonging to the horizon of *Flemingites Rohilla* yields the following fossils (KRAFFT and DIENER, 1909):

Hedenstroemia byansica v. KRAFFT, *Parahedenstroemia* (*Hedenstroemia*) *acuta* (v. KRAFFT) and *Pseudohedenstroemia himalayica* (SPATH) (=*Hedenstroemia Mojsisovics* DIENER). These fossils are allied to *Clypites japonicus* KAMBE from the Kamura formation. Moreover, *Parahedenstroemia acuta* (c. KRAFFT) occurred from the Chocolate Limestone, and this species is allied to *P. α* sp. nov. indet. and *P. β* sp. nov. indet. from the Kamura formation. *Heden-*

stroemia (*Clypites*) *lilangensis* v. KRAFFT et DIENER from the horizon of *Meekoceras lilangense* and *M. varaha*, are allied to *Clypites japonicus* KAMBE.

In the Salt Range of Pakistan (WAAGEN, 1895), *C. Kingianus* WAAGEN, *C. evolvens* W. and *C. typicus* W. were found in the *Ceratite* Marls, and these species are very allied to *Clypites japonicus* KAMBE. By this fact, the fossil-bearing bed of the Kamura formation is correlated to the *Ceratite* Marls.

In the Alps (BITTNER, 1901), from the Skytic "Werfener Schiefer", *Myasites canalensis* BITTNER, *M. fassaensis* B. =*Anodontophora fassaensis* (WISSMANN) which are the species common to the Kamura formation, are discovered.

In North America (SMITH, 1932), *Aspenites acutus* HYATT and SMITH which is an ally to *A. kamurensis* KAMBE, occurs in the Lower Triassic *Meekoceras* zone in Wood Canyon, near Soda Springs, Idaho and the *Owenites* subzone of the *Meekoceras* zone in Union Wash, near Union Spring, in the Inyo Range, about 15 miles southeast of Independence, Inyo County, California. Moreover, *Hedenstroemia* (*Clypites*) *tenuis* HYATT and SMITH which is allied to *Clypites japonica* KAMBE is known from the Lower Triassic *Meekocceras* zone, 9 miles east of Wood Canyon, Aspen-Ridge, Idaho.

In Greenland (SPATH, 1935), the species common to the Kamura formation is *Eumorphotis multiformis* SPATH (=*Eumorphotis multiformis* subspecies nov. indet. in the Kamura formation) discovered from the *Ophiceras* zone.

According to the recent study by O. H. SCHINDEWOLF (1953) the boundary between the Upper Permian Upper Productus Limestone and the Lower Triassic system is conformable in the Salt Range of Pakistan. On the contrary the difference of the rock-facies between them is conspicuous and the remarkable extinction and development of the animals at the boundary between them are observable. For instance, *Enteletes, Derbyia, Chonetes, Chonetella, Productus* (*Dictyoclostus, Linoproductus, Waagenoconcha*), *Marginifera, Stacheoceras, Cyclolobus, Medlicottia* are extinct at the end of Permian, and *Ophiceras, Pseudosageceras, Gyronites, Koninkites, Pseudoceltites* are developed at the beginning of Triassic. Rarely, there are some animals ranging from Permian to Triassic such as *Pseudomonotis, Stachella, Naticopsis.* (See Tab. 2)

It is a result of the palaeontological study worked out at the boundary between the Iwato and Kamura formations that the boundary between the Permian and Triassic systems is indicated in Japan. Namely, the boundary is seen on the Saraito forest-road, between the dark grayish limestone of the Iwato formation and the white grayish limestone of the Kamura formation. On the basis of the palaeontological and stratigraphical facts the boundary is conformable and neither the unconformity nor the fault.

These studies lead to the conclusion that the lower limit of the Triassic period is shown at the base of the *Otoceras-Ophiceras* bed, and there is a great faunal change between the Permian and Triassic systems.

VI. Conclusion

1. Inner Zone of Southwest Japan (Maizuru zone)

In the Inner Zone of Southwest Japan, the Permian Maizuru and Middle-Lower Triassic Yakuno groups are found together only in the Maizuru zone. At a few outcrops where their relation is observable, it is parallel unconformity or disconformity and not clino-unconformity, although the faunas of the two formations are quite different. They are strongly disturbed to make a zonal arrangement. The intense crustal movement which produced this geological structure, is shown by the conspicuous clino-unconformities at the base of the Upper Triassic Shidaka and Miharaiyama groups.

2. Southern Kitakami mountains

The Upper Permian Toyoma and Middle-Lower Triassic Inai groups are widely distributed in the mountains. The boundary between the two groups is indicated by not a conspicuous clino-unconformity, but a disconformity. The Toyoma group is always distributed with close relation to the Inai group. On the contrary the Upper Triassic Saragai group has a restricted distribution and overlies the Inai group with low angled unconformity. The stratigraphic break ranges from Lower Ladinian to Middle Carnian. Namely, the crustal movement which occurred between the Inai and Saragai groups was stronger than that occurred between the Toyoma and Inai groups.

3. Outer Zone of Southwest Japan

The actual relation between the Permian and Triassic systems is seldom observable in the Outer Zone. At Takachiho-cho and Tsukumi City in Kyushu, however, it can be actually ascertained that the Upper Permian Iwato formation appears to continue conformably to the Lower Triassic Kamura group without an unconformity or a fault, although the faunal change is conspicuous at the Permo-Triassic boundary. It is known further in the Outer Zone along the Butsuzo Line in Shikoku that the Chichibu Palaeozoic formations continues conformably to the Togano group. Therefore these formations are combined in the Sambosan group.

4. The bearing of boundary questions between the Permian and Mesozoic systems in Japan may be as follows.

Because the boundary between the Permian and Triassic systems is indicated by parallel unconformity or disconformity in the Inner Zone of Southwest Japan and the southern Kitakami mountains, the movement at the transition between the two periods must have been a gently undulatory upheaval followed by a little erosion and then a gradual subsidence and by no means an orogenic movement. On the contrary, there was an orogenic movement before the accumulation of the Saragai, Shidaka and Miharaiyama groups. It was strong enough for the Maizuru, Yakuno, Nabae groups and the Hegi, Arakura and some other formations to form the zonal arrangements in the Maizuru zone. The Toyoma, Inai groups and Rifu formations have also suffered the crustal movement but it was not so strong in the southern Kitakami mountains as in the preceding region.

The relation between the Permian and Triassic systems is conformable in the Outer Zone of Southwest Japan where neither upheaval nor erosion can be actually recognized.

From these facts, it cannot be deduced on the Pacific side of Japan that the sedimentation was interrupted at the Permo-Triassic transition but on the continental side of Japan there is a stratigraphic break which indicates an epirogenic movement. The crustal movement before the Saragai, Shidaka and Miharaiyama groups was on the contrary orogenic and very important for the Inner Zone.

In spite of the weakness of crustal deformation at the Permo-Triassic boundary in Japan, the difference between the faunas of the two systems is conspicuous.

5. The Lower Triassic system is known to exist in Central and South China, Southeast Asia, the Himalayas, the Salt Range, the Alps, North America, Greenland and the Ussuri district. In the last district which is to the north of Japan, the Lower Triassic system overlies unconformably the Permian system and the Palaeozoic granite. On the contrary, it is known in China that the relation between the Permian and Triassic formations is conformable in Szechuan and Fukien, and is disconformable in the Lower Yangtze valley and Kwangsi. In the Salt Range, the relation between them is perfectly conformable, but the faunal change at the transition is very conspicuous.

It is remarkable that the main faunal change at the Permo-Triassic boundary is world wide, while the relation between the two formations is conformable or disconformable in Central and South China and the Salt Range as well as in Japan.

VII. Description of the Lower Triassic Kamura fauna

Phylum Mollusca

Class Pelecypoda

Family Aviculopectinidae ETHERIDGE, emend. NEWELL
Genus *Eumorphotis* BITTNER, 1901

1. *Eumorphotis multiformis* (BITTNER)
(Plate I, Figures 1~11; Plate II, Figures 1~7)

1899. *Pseudomonotis (Eumorphotis) multiformis* BITTNER; Mém. Com. Géol., Vol. VII, No. 4, S. 10, taf. II, figs. 11~22.

1938. *Pseudomonotis (Eumorphotis) multiformis* KIPARISOVA; Trav. Inst. Géol. Akad. Sci. USSR. Vol. VII, p. 224, pl. 11, figs. 4, 9, 12; pl. III, figs. 2~4.

1950. *Pseudomonotis (Eumorphotis) multiformis* CHEN; Quart. Jour. Taiwan Mus., Vol. III, No. 2, p. 91, pl. I, fig. 10.

Materials:—Eleven left valves and thirteen right valves, mostly imperfect.

Description:—Shell inequivalve, thin, medium to large sized, right valve flatter than left. Left valve about 28 to 52 mm. high, probably higher than long, slightly inequilateral, slightly prosocline, a little elongated postero-ventrally. Right valve about 32 to 42 mm. high, a little higher than long, slightly inequilateral; umbo nearly orthogyre.

Left valve elongated ovate in outline, moderately convex, maximum convexity lying at about dorsal two-fifths of height; position of maximum length obscure. Umbo lying a little anteriorly, slightly prosogyrate, narrow, convex, curving inward, projecting above hinge line. Dorsal margin inobservable; anterior and posterior margins arcuate; ventral margin well rounded. Anterior wing probably smaller than posterior wing, though the latter is not well preserved. Anterior wing subtriangular in form, moderately convex. Weak concavity present below anterior wing along anterior margin of shell body; boundary between wing and shell body slightly sulcated internally, but more weakly sulcated externally. Posterior wing not clearly seen. Shell surface and anterior wing covered with radial ribs of first and second orders and fine radial striae. Ribs and striae weak, and narrowly spaced near umbo, but strong, and broadly spaced near ventral margin. Surface formulas of ribs and striae near ventral margin at intervals of 4 mm. or 8 mm.: 132313231 or 143424341. Very fine growth lines or concentric striae form lattice with fine radial ribs and striae in later stage of growth. Surface of posterior wing ill-preserved. Ligament area unknown.

Right valve slightly convex, maximum convexity lying at about mid-height. Dorsal margin nearly straight; posterior margin slightly arcuate; postero-ventral, ventral, antero-ventral and anterior margins subrounded; antero-dorsal margin almost straight but slightly concave near umbo. Posterior wing small, triangular in shape, slightly projected, shallowly sinuated below wing; posterior wing forming angle of about 120~135° with dorsal margin. Anterior wing semicircular in shape, separated from shell body by a very narrowly byssal-notch. Like left valve surface of shell body covered with fine numerous radial ribs and striae. Concentric fine growth lines and striae observed.

Table 3 Dimensions of *Eumorphotis multiformis* (BITTNER) (in mm)

Specimen Number	Registered Number	Valve	Height	Length	Height/Length	Thickness	Surface Formulas
68	F-3369	left	indet.	indet.	—	8 mm	132313231
69	F-3370	left	indet.	indet.	—	7 mm	143424341
70	F-3371	left	indet.	34 mm	—	11 mm	132313231
71	F-3372	left	indet.	indet.	—	8 mm	143424341
73	F-3374	left	indet.	indet.	—	7 mm	143424341
74	F-3375	left	indet.	indet.	—	7 mm	143424341
75	F-3376	left	indet.	indet.	—	8 mm	13231
76	F-3377	left	indet.	indet.	—	8 mm	13231
77	F-3378	left	indet.	indet.	—	indet.	143424341
81	F-3382	left	indet.	indet.	—	indet.	13231
82	F-3383	left	indet.	indet.	—	indet.	1332331
80	F-3381	right	indet.	indet.	—	5 mm	143424341
84	F-3385	right	indet.	indet.	—	6 mm	13231
85	F-3386	right	41 mm	46 mm	0.89	indet.	—
86	F-3387	right	indet.	indet.	—	indet.	—
87	F-3388	right	indet.	indet.	—	indet.	—
88	F-3389	right	indet.	indet.	—	indet.	—
89	F-3390	right	indet.	indet.	—	indet.	—
90	F-3391	right	32 mm	indet.	—	5 mm	—
91	F-3392	right	indet.	indet.	—	indet.	—
92	F-3393	right	indet.	indet.	—	indet.	—
93	F-3394	right	39 mm	39 mm	1.00	3 mm	—

Comparison:—Because the thirteen right valves are inseparable from either *Eumorphotis multiformis* BITTNER or *Eumorphotis multiformis shionosawensis* ICHIKAWA et YABE in the shell-shape, aspects of the umbo and wings, convexity of the valve and the surface sculptures, all of them are referred to *Eumorphotis multiformis* BITTNER. Especially, the surface-sculptures of the valve confirms their coincidence with *E. multiformis* BITTNER.

2. *Eumorphotis multiformis shionosawensis* ICHIKAWA et YABE
(Plate II, Figure 8)

1955. *Eumorphotis multiformis shionosawensis* ICHIKAWA et YABE; Trans. Proc. Pal. Soc. Japan, New Ser., No. 17, p. 5~12, pl. 2, figs. 1~15.

Materials:—Two left valves.

Description:—Shell thin, fairly large, left valve being about 64 mm. high, higher than long, a little inequilateral, slightly prosocline, more or less elongated postero-ventrally. Left valve elongated ovate in outline, moderately convex, maximum convexity lying at about dorsal two-fifths of height; position of maximum length indeterminable. Umbo lying a little anteriorly, slightly prosogyrate, narrow, convex, curving inward, projecting above hinge line. Dorsal margin subrounded; anterior margin arcuate; posterior margin not seen. Anterior wing smaller than posterior, subtriangular in form; weak concavity present at its junction with anterior margin of shell body; boundary between wing and shell body slightly sulcated in interior. Posterior wing protracted behind, but never extending beyond posterior extremity of shell, its margin forming a shallow concavity with posterior margin of shell body. Shell surface covered with radial ribs of first and second orders and fine radial striae. Ribs and striae weak and crowded near umbo, but strong and separated by broad intervals near ventral margin. Surface formulas of rigs and striae near ventral margin at intervals of 7 mm. or 8 mm.: 132323231 or 15453545254535451. Very fine growth lines or concentric striae form lattice with fine radial ribs and striae in later growth stage. Surface sculpture unpreserved on wings. Ligament area unknown.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height	Length	Height/Length	Thickness	Surface Formulas
72	F-3373	left	64 mm	60 mm	1.07	11 mm	132323231
78	F-3379	left	indet.	indet.	—	indet.	15453545-254535451

Comparison:—The specimens at hand are identified with *Eumorphotis multiformis shionosawensis* ICHIKAWA et YABE by the shell-shape, modes of the umbo, wings, convexity of the valve and the surface sculptures, especially the surface sculptures of the valve and the height-length proportion of the valve which coincide with those of *Eumorphotis multiformis shionosawensis* ICHIKAWA et YABE.

3. *Eumorphotis multiformis* subspecies nov. indet.
(Plate II, Figure 9; Plate III, Figure 1)

1935. *Eumorphotis multiformis* SPATH; Medd. om Grönland, Bd. 98, No. 2, p. 74, pl. XXII, fig. 8.

Materials:—Two ill-preserved left valves, but their surfaces are well observable.

Description:—Shell thin, moderately convex. Shell surface covered with radial ribs of first and second orders and fine radial striae. Ribs and striae weak, narrowly spaced near umbo, but strong, broadly spaced near margin; their surface formula at interval of 3 mm, on ventral margin; 13231. Growth lines or striae very fine, form lattice with radial ribs and striae in later stage of growth. Lattice shown in figure on plate.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height	Length	Height / Length	Thickness	Surface Formulas
79	F-3380	left	indet.	indet.	—	indet.	13231
83	F-3384	left	indet.	indet.	—	indet.	13231

Comparison:—The surface formula and the concentric sculptures are characteristics of these specimens, by which this subspecies is distinguished from *Eumorphotis multiformis* BITTNER and *E. multiformis shionosawensis* ICHIKAWA et YABE. *E. multiformis* described by SPATH (1935) is identified with this new subspecies. K. ICHIKAWA (1955) already noted that SPATH's *E. multiformis* might be separated subspecifically from *E. multiformis* s. str.

4. *Eumorphotis* sp.
(Plate II, Figure 10; Plate III, Figures 2~19;
Plate IV, Figures 1~16)

Shell inequivalve, thin, small to medium sized, right valve flatter than left. Left valve slightly broader than height, slightly inequilateral, slightly prosocline, a little elongated posteroventrally. Right valve, slightly broader than high, slightly inequilateral; umbo nearly orthogyre. Left valve circular in outline, moderately convex. Umbo lying a little anteriorly, slightly prosogyrate, a little convex, curving inward. Dorsal margin arcuate; anterior, posterior and ventral margins well rounded.

Anterior wing probably smaller than posterior wing. Anterior wing not well preserved. Posterior wing subtriangular in form, nearly flattened. Shell surface, posterior wing and probably anterior wing covered with radial ribs of first and second orders and fine radial striae. Ribs and striae weak, and narrowly spaced near umbo, but strong, and broadly spaced near ventral margin. Surface formula of ribs and striae near ventral margin at intervals of 2 mm: 1332331. But this formula variable among specimens.

Very fine growth lines or concentric striae form lattice with fine radial ribs and striae in later stage of growth. Ligament area unknown.

Right valve slightly convex. Dorsal margin nearly straight: posterior margin arcuate; postero-ventral and ventral margins subrounded, antero-ventral and anterior margins not well preserved. Posterior wing small, triangular in shape, shallowly sinuated below wing; anterior wing elongated triangular in shape, with intimate relation to shell body.

Fine numerous radial ribs and striae on surface of shell body developed more on right than left valve. Concentric fine growth lines and striae observed.

Table 4 Dimensions of *Eumorphotis* sp. (in mm)

Specimen Number	Registered Number	Valve	Height	Length	Thickness
94	F-3395	left	20 mm	21 mm	4 mm
95	F-3396	right	?	?	3.5 mm
96	F-3397	left	21 mm	22 mm	3 mm
97	F-3398	right	?	11 mm	2 mm
98	F-3399	right	?	?	3 mm
99	F-3400	right	? 23 mm	?	3 mm
100	F-3401	left	?	?	3 mm
101	F-3402	right	?	?	3 mm
102	F-3403	right	? 20 mm	?	3 mm
102	F-3403	left	? 21 mm	?	3.5 mm
103	F-3404	right	?	?	?
104	F-3405	right	26 mm	?	4 mm
104	F-3405	left	?	?	4 mm
105	F-3406	right	?	?	2 mm
106	F-3407	right	?	?	4 mm
107	F-3408	? left	27 mm	?	3 mm
108	F-3409	? left	31 mm	?	5 mm
109	F-3410	right	? 9 mm	11 mm	1.5 mm
110	F-3411	right	?	?	2.5 mm
111	F-3412	right	?	?	4 mm
112	F-3413	? right	20 mm	22 mm	3 mm
113	F-3414	right	? 25 mm	?	4 mm
114	F-3415	right	?	?	4 mm
115	F-3416	right	?	?	2 mm
116	F-3417	left	?	?	4 mm
117	F-3418	left	16 mm	?	3 mm
118	F-3419	left	?	?	3 mm
119	F-3420	left	?	?	3 mm
122	F-3421	left	10 mm	?	2.5 mm
123	F-3422	left	16 mm	18 mm	3 mm

Family Pteriidae MEEK

Genus *Pteria* SCOPOLI, 1777 (sensu lato)

5. *Pteria ussurica* (KIPARISOVA) *yabei* NAKAZAWA

(Plate IV, Figures 17~30; Plate V, Figures 1~8)

1899. *Gervilleia* cf. *exporrecta* BITTNER; Mém. Com. Géol., Vol. VII, No. 4, S. 16, taf. 3, figs. 1~5.

1938. Subsp. *Gervillia ussurica* KIPARISOVA; Trav. Inst. Géol. Akad. Sci. USSR, Vol. VII, pl. 6, figs. 5~8. (in Russian)

1956. *Bakevellia ussurica* KIPARISOVA var. *rostrata* Y. YABE; Sci. Rep. Tokyo Kyoiku Daigaku, Sec. C, No. 39, p. 288~290, pl. XVII, figs. 1~10.

1959. *Pteria ussurica yabei* NAKAZAWA; Mém. Coll. Sci. Univ. Kyoto, Ser. B, Vol. XXVI, No. 2, p. 196~197, text-fig. 2.

Description:—Shell small or medium sized, inequilateral, slightly inequivalve, pteriform, subtriangular or subrhomboidal in shape of outline, prosocline strongly postero-ventrally, convexity of left valve stronger than that of right.

In left valve anterior margin semi-circular; antero-ventral nearly convex; ventral arcuate; postero-ventral or posterior rounded; postero-dorsal arcuate. Maximum convexity of the valve lying a little below hinge-line in mid-umbonal region. Umbo prominent forward and situated at one-third of hinge-length from anterior end. Anterior auricle comparatively narrow, pointed anteriorly, acute in front and triangular in shape, defined from main-shell by a strong depression with remarkable antero-ventral sinuation; posterior wing large, moderately inflated, pointed posteriorly, acute backward and broadly triangular in shape, defined from main-shell by a strong depression with remarkable postero-dorsal sinuation. Ligamental area not observed. Shell surface covered with numerous concentric growth lines, some of which are stronger and undulated.

In right valve, anterior, antero-ventral and ventral margins all arcuate; postero-ventral semi-circular or rounded; posterior near straight. Inflation much weaker than that left valve. Umbo pointed forward, weak and situated at one-fourth of hinge-length from anterior end. Anterior auricle narrow, small, pointed anteriorly, acute in front and triangular in shape, poorly defined from main shell by a weak depression with remarkable antero-ventral sinuation; posterior wing large, comparatively flat, pointed posteriorly, acute backward, broadly triangular in shape, and poorly defined from main-shell by a weak depression with remarkable postero-ventral sinuation. Ligamental area not seen. Shell surface covered with numerous concentric growth lines, some of which are stronger and show undulations, but more weakly than on left valve.

Comparison:—This species is most abundant in the Kamura formation. They are closely allied to *Bakevellia ussurica* KIPARISOVA var. *rostrata* Y. YABE (1956) from the early Triassic Shionosawa formation in the Sanchu Graben, Kwanto Mountains, in the external and internal shape of the shell exclusive of the ligamental area which is unknown. KIPARISOVA pointed out by the observa-

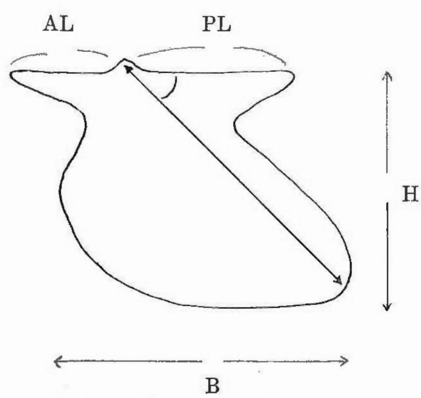

Figure 7 Text-figure showing the terms concerning the dimensions of *Pteria ussurica* (KIPARISOVA) *yabei* NAKAZAWA

tion of the ligamental area that *B. ussurica* KIPARISOVA belongs to *Avicula ussurica* KIPARISOVA (1954). Recently, K. NAKAZAWA (1959) noted that "*Bakevellia*" from the Shionosawa formation belongs to *Pteria ussurica yabei* NAKAZAWA. The Kamura specimens are undoubtedly allied to *P. ussurica yabei* NAKAZAWA.

Table 5 Dimensions of *Pteria ussurica* (KIPARISOVA) *yabei* NAKAZAWA

(in mm)

Specimen Number	Registered Number	Valve	Height (H)	Broadness (B)	Anterior Length (AL)	Posterior Length (PL)	Longitudinal Length (L)	$\alpha°$
15	F-3315	right	12	15	? 5	15	16	47°
16	F-3316	right	18	24	9	17	24	43°
17	F-3317	right	13	14	7	10	16	44°
18	F-3318	right	9	10	5	10	13	45°
19	F-3319	right	indet.	indet.	indet.	indet.	indet.	48°
20	F-3320	right	indet.	indet.	indet.	indet.	indet.	45°
21	F-3321	right	indet.	indet.	indet.	indet.	indet.	46°
22	F-3322	right	indet.	indet.	indet.	indet.	indet.	44°
23	F-3323	right	14	15	5	14	19	44°
24	F-3324	right	indet.	indet.	indet.	indet.	indet.	46°
25	F-3325	left	indet.	indet.	indet.	indet.	indet.	46°
26	F-3326	left	10	12	7	11	11	47°
27	F-3327	left	indet.	indet.	indet.	indet.	indet.	40°
28	F-3328	left	13	indet.	indet.	12	18	42°
29	F-3329	left	13	15	indet.	13	17	40°
30	F-3330	left	13	indet.	indet.	12	16	40°
31	F-3331	left	15	16	6	13	17	47°
32	F-3332	left	11	13	indet.	10	14	46°
33	F-3333	left	17	20	9	indet.	20	47°
34	F-3334	left	10	12	indet.	12	14	50°
35	F-3335	left	8	9	3	8	10	50°
36	F-3336	left	13	15	6	14	16	46°
37	F-3337	right	indet.	indet.	indet.	17	indet.	46°

Family Bakevellidae KING, 1850, emend. COX, 1954

Genus *Gervillia* DEFRANCE, 1820

6. *Gervillia* cf. *exporrecta* (LEPSIUS)

(Plate V, Figures 9~11)

1899. cf. *Gervilleia* cf. *exporrecta* BITTNER; Mém. Com. Géol., Vol. VII, No. 4, S. 16, taf. 3, figs. 6~16.

1937. cf. *Gervillia exporrecta* KIPARISOVA; Trans. Arct. Inst., Vol. 91, pl. 7, figs. 4~6.

1938. cf. *Gervillia exporrecta* KIPARISOVA; Trav. Inst. Géol. Akad. Sci. USSR, Vol. VII, pl. 5, figs. 22~23. (in Russian)

1954. cf. *Gervilleia* cf. *exporrecta* OZAKI & SHIKAMA; Bull. Nat. Sci. Mus., Vol. 1, No. 2, p. 44, figs. 1~3.

Description:—Three specimens, partly broken. Shell small or medium sized, inequilateral, slightly inequivalve, subrhomboidal in outline, strongly prosocline postero-ventrally; left valve more convex than right.

In left valve, shell margin broken; maximum convexity lying in mid-umbonal region. Umbo moderately protracted forward. Both wings and hinge-part inobservable. Mid-umbonal region moderately broad and inflated. Shell surface covered with concentric growth lines.

In right valve, anterior margin arcuate or nearly straight; antero-ventral broken off, but probably arcuate or rounded; ventral, semi-circular; postero-ventral rounded; posterior almost straight. Inflation weaker than in left valve, but one specimen inflated as much as left valve. Umbo moderately protracted forward. Both wings and hinge-part not observed. Mid-umbonal region moderately broad and inflated. Shell surface covered with concentric growth lines.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height (H)	Broadness (B)	Anterior Length (AL)	Posterior Length (PL)	Longitudinal Length (L)	$\alpha°$
38	F-3338	left	indet.	indet.	indet.	indet.	22 mm	42°
39	F-3339	right	indet.	indet.	indet.	indet.	indet.	41°
40	F-3340	right	18 mm	15 mm	indet.	indet.	20 mm	44°

Comparison:—Although the specimens are not well preserved, the moderately inflated mid-umbonal region and the ratio of breadth to height are different from *Pteria ussurica yabei* NAKAZAWA. Judging from the aspect of the moderately inflated mid-umbonal region. These specimens are identifiable with *Gervillia exporrecta*.

Family Amusiidae RIDEWOOD
Genus *Entolium* MEEK, 1865
(=*Syncyclonema* MEEK, 1864; *Protamussium* VERRILL, 1897)

7. *Entolium discites* (v. SCHLOTHEIM)
(Plate V, Figures 12~13)

1899. *Pecten discites* BITTNER; Mém. Com. Géol., Vol. VII, No. 4, S. 3, taf. I, fig. 19.

1926. *Pecten (Entolium) discites* MATSUSHITA; The Globe (Chikyu), Vol. 5, No. 5, p. 15, p. 18, fig. 3.

1928. *Pecten (Entolium) discites* SCHMIDT; Die Lebewelt unserer Trias, S. 157, fig. 336.

Description:—Shell small, nearly equilateral, subovaloid in outline except for auricles, subvertically elongated, higher than broad; margins arcuate or rounded, nearly flat or not much inflated. Auricles small, subequal, triangular, clearly defined from shell body, elevated above hinge; byssal notch absent; umbo small; a pair of internal ridges running symmetrically from umbonal region to anterior and posterior peripheries. Shell surface ornamented by weak radial and concentric lines.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height	Length
51	F-3351	right ?	13 mm	12 mm
51′	F-3352	right	13 mm	11 mm

Comparison:—The shape, inflation, and ornamentation of the shell and the form auricles are almost identical to those of *Pecten* (*Entolium*) *discites* SCHMIDT.

8. *Entolium* sp. indet.
(Plate V, Figure 14)

Description:—Shell small. Right valve higher than broad (Specimen number 48, registered number F-3348, 14 mm in height, 12 mm. in breadth), nearly equilateral, subovaloid in outline except for auricles; margins rounded, moderately convex. Posterior auricle small, triangular, clearly defined from shell body; anterior auricle unknown; posterior internal ridge weak, anterior one inobservable. Concentric growth-lines and radial lines weak.

Family Pectinidae LAMARCK

Genus *Chlamys* RÖDING, 1798

9. *Chlamys* (?) *kryshtofowichi* (KIPARISOVA)
(Plate V, Figures 15~16)

1938. *Pecten* (*Chlamys*?) *kryshtofowichi* KIPARISOVA; Trav. Inst. Géol. Akad. Sci. USSR, Vol. VII, p. 291~292, pl. 5, figs. 7~10. (in Russian)

Description:—One right valve and two valves at hand. Shell, small, obliquely ovate in outline, slightly inequivalve, inequilateral, strongly prosocline toward postero-venter; convexity or two valves moderate and almost equal; umbo moderately convex and prosogyrous; shell margin rounded as seen in ovate form. In left valves, radial sculptures apparently absent; growth lines fine and numerous, four or six conspicuous ones of which are at intervals of 2 or 3 mm. Little is known of ears.

In right valve, growth lines fine and numerous; radial sculptures almost absent; conspicuous growth ridges found at intervals of 2 or 3 mm, though weaker than those of left valve.

Anterior ear moderately large; byssal notch conspicuous; posterior ear unknown.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height	Length	Length / Height
49	F-3349	left	19 mm	18 mm	0.95
50	F-3350	right	19 mm	17 mm	0.89
54	F-3355	left	18 mm	16 mm	0.89

Comparison:—These specimens are closely identified to *Pecten* (*Chlamys*?) *kryshtofowichi* in outline, size of shell, aspect of anterior ear and distinct byssal notch.

Genus *Eopecten* DOUVILLÉ, 1897
=*Velata* QUENSTEDT (1859) non GRIFFITH (1834), *Velopecten* PHILIPPI (1898)

10. *Eopecten minimus* (KIPARISOVA)
(Plate V, Figures 17~21)

1899. *Pecten* (*Leptochondria*?) ex. aff. *albertii*, BITTNER; Mém. Com. Géol., Vol. VII, No. 4, S. 6, taf. II, figs. 4, 7, 9.

1907. *Pecten* (*Velopecten*) cf. *alberti* FRECH; Resultate d. Wiss. Erf. d. Balatonsees, I/I, Paleont. Anhang., S. 35, taf. 4, fig. 8.

1938. *Pecten* (*Velopecten*) *minimus* KIPARISOVA; Trav. Inst. Géol. Akad. Sci. USSR, Vol. VII, pl. 4, figs. 10, 12, a, b, pl. 5, figs. 4~6. (in Russian)

Description:—Shell small, more or less equilateral and subcircular; left valve strongly convex; right valve flat; auricles ill-preserved; umbo moderately convex; shell surface ornamented with many concentric growth lines with different grades of sharpness, yielding undulations; growth lines generally stronger in left than right valve. Radial costation weak or indiscernible. In internal moulds of 46 specimens, a pair of internal ridges running symmetrically from umbo to anterior and posterior peripheries.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height	Length
41	F-3341	right	8 mm	indet.
43	F-3343	left	14 mm	14 mm
44	F-3344	left	9 mm	10 mm
45	F-3345	left	indet.	indet.
46	F-3346	left	16 mm	16 mm

Comparison:—From the shape, ornamentation and inflation of the shell, these specimens are identified to this species.

11. *Eopecten* cf. *minimus var. reticulatus* (KIPARISOVA)
(Plate V, Figure 23)

1938. cf. *Pecten* (*Velopecten*) *minimus* var. *reticulatus* KIPARISOVA; Trav. Inst. Géol. Akad. Sci. USSR, Vol. VII, pl. 5, figs. 1 a, b, 2. (in Russian)

Description:—One left valve in collection. Shell small, slightly inequilateral, flat or moderately convex, more or less prosocline postero-ventrally, subcircular in outline; auricles not observed; growth lines numerous and different in strength, producing undulations; radial costation fine. (Specimen Number 42, Registered Number F-3342, 13 mm in height, 13 mm. in breadth)

Comparison:—By the distinct fine radial costation, this specimen may belong to the variety.

12. *Pecten* (s. l.) sp. indet.
(Plate V, Figure 22)

Description:—One internal left valve, small, moderately inequilateral, ovaloid without auricles, prosocline postero-ventrally; anterior and posterior auricles small triangular, pointed laterally. (Specimen Number 47, Registered Number F-3347, 12 mm in height, 11 mm in breadth)

Family Anthracosiidae AMALITZKY
Genus *Anodontophora* COSSMANN, 1897

13. *Anodontophora canalensis* CATULLO
(Plate V, Figures 24~25)

1899. *Anodontophora canalensis* BITTNER; Mém. Com. Géol., Vol. VII, No. 4, S. 23, taf. 3, figs. 37~38.
1901. *Myasites canalensis* BITTNER; Result. d. Wiss. Erforsch. d. Balatonsees, Bd. I, T.I., S. 85, taf. IX, figs. 11, 12.
1926. *Anodontophora canalensis* MATSUSHITA; The Globe (Chikyu), Vol. 5, No. 5, p. 16, pl. 8, fig. 12.
1956. *Anodontophora canalensis* YABE; Sci. Rep. Tokyo Kyoiku Daigaku, Sec. C, No. 39, p. 287~288, pl. XVI, figs. 12a, b.

Description:—Two left valves before hand. Shell about 21~24 mm. in height, 39 mm. or longer in length, moderately convex, inequilateral, elongate elliptical in outline, length-height proportion being 1.86. Postero-dorsal margin nearly straight; posterior semicircular; postero-ventral broken; ventral arcuate or nearly straight; antero-ventral rounded; anterior margin straight. Umbo located at about anterior two-fifths of shell-length, partly broken, but probably prominent, convex, slightly prosogyrous, distinctly projected above hinge-line.

Posterior ridge blunt, arcuate, extending from umbo to postero-ventral extremity, in dividing posterior area from main part, angle between the two parts being acute near umbo and obtuse near margin. Posterior area mytiliform, slightly concave, and narrow behind umbo, but become flat and broad near postero-ventral margin. Lunule not observed; escutcheon distinct, narrowly lanceolate. Shell surface covered with many fine growth lines, some of which are stronger than the others.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height	Length	Thickness	Apical angle	Apical angle exclusive of the area	Length / Height
1	F-3301	left	21 mm	39 mm	8 mm	126°	102°	1.86
2	F-3302	left	24 mm	?	8 mm	?	?	?

Comparison:—One specimen is larger than the other.

The posterior part of the larger specimen is broken, but it belongs surely to *Anodontophora canalensis* CATULLO.

The Kamura collection of *Anodontophora* comprises the three forms as does the Shionosawa limestone in the Sanchu Graben, Kwanto mountains (Y. YABE (1956)); namely, *Anodontophora canalensis* var. *bittneri* and *A. fassaensis* beside

A. canalensis.

The anterior situation of the umbo, length-height proportion and the elongated elliptical outline are most characteristics of the two specimens. From these features, they are allied to *Anodontophora* (*Myacites* aut.) *canalensis* CATULLO by A. BITTNER (1899) (1901) in outline, umbonal aspect, and the posterior ridge, and to *Anodontophora canalensis* from the Shionosawa limestone (YABE, 1956). *Anodontophora canalensis* from the Kurotaki limestone (MATSUSHITA, 1926), is more inflated than the Kamura's specimens. In 1956, ICHIKAWA & YABE changed *Anodontophora canalensis* by OZAKI and SHIKAMA (1954) from the Shionosawa formation into *A. canalensis* var. *bittneri*. Kamura specimens closely resemble *A.* aff. *borealis* SPATH from Russki Island by L. KIPARISOVA (1938). The Lower Triassic Pelecypod of the Ussuriland, pl. VI. fig. 16) in the greater length and to *A. tonkinensis* MANSUY from the Triassic formation of Na Cham, Tonkin (1919, *Mém. Serv. Géol. l'Indochine, Vol. VI, Fas. 1*) in the elongation of the shell, the posterior ridge and the umbo.

14. *Anodontophora* cf. *canalensis* CATULLO
(Plate V, Figure 26)

Represented by one small left valve, in an immature stage. (Specimen Number 3, Registered Number F-3303)

Shell about 10 mm. in height, 18 mm. in length; apical angle 126 degrees, moderately convex, inequilateral, elongated elliptical in outline, length-height proportion being 1.8.

Anterior margin nearly straight; antero-ventral rounded; ventral slightly arcuate; postero-ventral rounded; posterior semicircular; postero-dorsal straight. Umbo at about anterior two-fifths of shell-length, prominent, well convex, slightly prosogyrous, distinctly projected above hinge-line. Posterior ridge indistinct, but broadly elevated, dividing posterior area from main part; angle between the two areas obtuse.

Lunule and escutcheon not observed. Surface covered by many fine growth lines.

Comparison:—The characteristic features of this specimen are the elongated elliptical outline, anterior position of the umbo, large length-height proportion and the roundness of the antero-ventral and postero-ventral margins. Judging from these features, it is probably an immature specimen of *Anodontophora canalensis.*

15. *Anodontophora canalensis* var. *bittneri* ICHIKAWA and YABE
(Plate V, Figure 27)

1899. *Anodontophora canalensis* BITTNER; Mém. Com. Géol., Vol. VII, No. 4, S. 23, taf. 3, figs. 34~36.

1954. *Anodontophora canalensis* OZAKI and SHIKAMA; Bull. Nat. Sci. Mus., N.S. Vol. I, No. 2, (No. 35) p. 44, figs. 4~5.

1956. *Anodontophora canalensis* CATULLO var. *bittneri* ICHIKAWA and YABE; Sci. Rep. Tokyo Kyoiku Daigaku, Sec. C, No. 39, p. 284~286, pl. XVI, figs. 1~7.

One left valve, about 24 mm. in height, 42 mm. in length, moderately convex, inequilateral, roundly subtrapezoidal in outline, length-height proportion being

1.75. Postero-dorsal margin nearly straight; posterior obliquely truncated, forming 129 degrees with postero-dorsal; postero-ventral subrounded; ventral almost straight or subarcuate; antero-ventral subrounded; anterior nearly straight.

Umbo located at about anterior one-third of shell-length, convex, prominent, pointed forward, slightly prosogyrous, distinctly projected above hinge-line. Posterior ridge blunt, arcuate, extending from umbo to postero-ventral extremity, separating posterior-area from main shell, forming a slightly concave are near umbo, but a little convex near postero-ventral margin. Posterior area mytiliform, slightly concave behind umbo, tending to be flat, broad near postero-ventral margin. Angles between main-shell and posterior area rectangular or acute behind but become obtuse near postero-ventral margin.

Lunule and escutcheon unknown. Shell surface covered with many fine growth lines, often assembled together forming gentle elevations eight or more in number. Gentle depressions observed on each elevation. These elevations and depressions are conspicuous near blunt posterior ridge.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height	Length	Thickness	Apical angle	Apical angle exclusive of the area	Length / Height
4	F-3304	left	24 mm	42 mm	8 mm	139°	117°	1.75

Comparison:—This subspecies was described by ICHIKAWA and YABE (1956) from the Shionosawa limestone. Its characteristics are the less elongate outline and more anterior position of the umbo than in typical *Anodontophora* (*Myacites* aut.) *canalensis* (A. BITTNER, 1899) as noted by ICHIKAWA and YABE. According to ICHIKAWA and YABE, *A.* (*Myacites* aut.) *canalensis* (A. BITTNER, 1899) and *A. canalensis* (OZAKI and SHIKAMA, 1954) belong to this subspecies. The expansion of the posterior area, elongation of the shell, position of the umbo, outline of the shell and the proportion of length and height, show that the Kamura specimen belongs unquestionably to this subspecies.

16. *Anodontophora fassaensis* (WISSMANN)
(Plate V, Figures 28~32; Plate VI, Figures 1~2)

1899. *Anodontophora fassaensis* BITTNER; Mém. Com. Géol., Vol. VII, No. 4, S. 22, taf. 3, figs. 28~33.

1901. *Myasites fassaensis* BITTNER; Result. d. Wiss. Erforsch. d. Balatonsees, Bd. I, T.I., S. 80.

1907. *Anoplophora fassaensis* FRECH; Res. Wiss. Erf. Balatonsees Palaeont. Anhang. Bd. I, T.I., S. 41, taf. 7, fig. 3 f.

1916. Aff. *Anodontophora* (*Myacites*) cf. *fassaensis* MANSUY; Mém. Serv. Géol. l'Indochine, Vol. V, Fas. IV, p. 64, pl. VIII, fig. 23.

1920. Aff. *Anodontophora* sp. ? aff. *A.* (*Myacites*) *fassaensis* MANSUY; Mém. Serv. Géol. l'Indochine, Vol. VII, Fas. 1, p. 28, pl. IV, fig. 1.

1926. Cf. *Anodontophora fassaensis* MATSUSHITA; The Globe (Chikyu), Vol. 5, No. 5, p. 16, pl. 8, fig. 11.

1935. Aff. *Anodontophora* aff. *fassaensis* SMITH; Medd. om Grönland, Bd. 98,

Nr. 2, p. 70, pl. XXII, fig. 5.
1936. Aff. *Anaplophora fassaensis* WIRTH; N.J.f. Min. usw., Beil.-Bd. 75, Abt. B, Heft 3, S. 438, fig. 10.
1937. Cf. *Anodontophora fassaensis* HSÜ; Bull. Geol. Soc. China, Vol. 16, No. 1, p. 317, pl. I, figs. 15, 16.
1956. *Anodontophora fassaensis* YABE; Sci. Rep. Tokyo Kyoiku Daigaku, Sec. C, No. 39, p. 386~387, pl. XVI, figs. 8~11.

Description:—Three right valves and three left valves at hand. Shell about 19-25 mm. in height, 28-38 mm. in length, moderately convex, inequilateral, subtrapezoidal in outline, length-height proportion being 1.47-1.55. Anterior margin almost straight; antero-ventral arcuate or rounded; ventral nearly straight or slightly arcuate; posterior arcuate, subrectangular with ventral margin and obliquely truncated, forming 130 degrees with postero-dorsal; postero-dorsal slightly arcuate or nearly straight. Umbo at about mid-length, anterior one-third or two-fifths of shell-length, prominent, well convex, broad, slightly prosogyrous and strongly projected above hinge-line. Posterior ridge blunt, defining posterior area from main part of shell, strongly arcuate behind umbo. Angle between posterior area and main part of shell a little acute, but becomes gradually obtuse toward posterior end. Shell most inflated in middle age of growth. Posterior area compressed in form of a triangle. Growth lines fine and numerous, of which three or more lines close set to form a gentle elevation. A gentle depression observed between two elevations, through growth stages.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height	Length	Thickness	Apical angle	Apical angle exclusive of the area	Length / Height
5	F-3305	left	25 mm	38 mm	9 mm	134°	102°	1.52
6	F-3306	right	20 mm	30 mm	9 mm	134°	102°	1.50
7	F-3307	right	22 mm	indet.	9 mm	indet.	indet.	indet.
8	F-3308	left	19 mm	28 mm	8 mm	129°	112°	1.47
9	F-3309	left	22 mm	34 mm	10 mm	135°	112°	1.55
10	F-3310	right	20 mm	indet.	7 mm	indet.	indet.	indet.

Comparison:—The characteristic features of this species from the Kamura formation are the greater posterior situation of the umbo and the smaller length-height proportion in comparison with the two other species. The posterior ridge is stronger than in *A. canalensis* var. *bittneri* and weaker than in *A. canalensis*, although it is broadest and most blunt in this species. Its umbo is broadest and strongest. Though the writer has no access to the original paper of *A. fassaensis*, the above characteristics show that this form most resembles *A. fassaensis* from the Shionosawa formation (1956) to which it is identified. This belongs to *A. fassaensis* from the Triassic of South-Ussuri (1899). The Kamura form has the ventral margin more straight and the posterior ridge stronger and more blunt. Though BITTNER (1901) has described *Myasites fassaensis* BITTNER from the Werfener Schiefer des Bakonyerwaldes, but there was no illustration. In 1907, FRECH described *Anoplophora fassaensis* (*Res. Wiss. Erf. Balatonsees Palaeont.*

Anhang. Bd. I.T.I.) which is identified to the Kamura form. MANSUY (1916) reported *A.* (*My.*) cf. fassaensis from the Triassic in East Tonkin. It has a more arcuate ventral margin and narrower and weaker umbo than Kamura's specimen. MANSUY described *A. myophorioides* n. sp. from the Triassic of Tonkin (1919, *Mém. Serv. Géol. l'Indochine, Vol. VI. Fas. 1*). It resembles the Kamura's species. MANSUY's *Anodontophora* sp. ? aff. *A.* (*Myacites*) *fassaensis* (1920) from the Triassic of Northeast Laos is not clearly illustrated. In 1920, MANSUY described *Anodontophora* (*Anoplophora*) *convexa*, new. sp. and *Anodontophora* sp. ? (*Mém. Serv. Géol. l'Indochine, Vol. VII, Fas. 1*) which are allied to the Kamura form. *Anodontophora fassaensis* MATSUSHITA (1926) from the Kurotaki formation of Shikoku Island is imperfect. In 1936, E. WIRTH described *Anoplophora fassaensis* from the Triassic formation of Provinz Szechuan, the umbo of which is allied to the species by MANSUY in 1916 but the ventral margin is more arcuate. In 1937, TE YOU HSÜ described *Anodontophora fassaensis* HSÜ from the *Meekoceras* zone of Chinglung limestone of Chekiang which is longer than Kamura form and rather allied to *A. canalensis.*

17. *Anodontophora* cf. *fassaensis* (WISSMANN)
(Plate VI, Figures 3~5)

1899. cf. *Anodontophora fassaensis* BITTNER; Mém. Com. Géol., Vol. VII, No. 4, S. 22, taf. 3, figs. 28~33.

1901. cf. *Myasites fassaensis* BITTNER; Result. d. Wiss. Erforsch. d. Balatonsees, Bd. I, T.I., S. 80.

1907. cf. *Anodontophora fassaensis* FRECH; Res. Wiss. Erf. Balatonsees Palaeont. Anhang Bd. I, T.I., S. 41, taf. 7, fig. 3f.

1956. cf. *Anodontophora fassaensis* YABE; Sci. Rep. Tokyo Kyoiku Daigaku, Sec. C, No. 39, p. 286~287, pl. XVI, figs. 8~11.

Two right valves and one left valve at hand.

Shell about 7-14 mm. high, 11-12 mm. long, moderately convex, inequilateral, subtrapezoidal in outline, length-height proportion being 1.50-1.57. Anterior margin nearly straight; antero-ventral rounded; ventral nearly straight or slightly arcuate; postero-ventral and posterior rounded; postero-dorsal nearly straight. Umbo at about mid-length, convex, slightly prosogyrous and strongly projected above hinge-line. Posterior ridge blunt, dividing posterior area and main part, forming slightly arcuate behind umbo. Angles between the two areas slightly acute or rectangular, but becoming gradually obtuse toward the posterior end. Posterior area triangular. Surface with numerous fine growth lines.

(Measurement in mm)

Specimen Number	Registered Number	Valve	Height	Length	Thickness	Apical angle	Apical angle exclusive of the area	Length / Height
11	F-3311	right	7 mm	11 mm	3 mm	120°	103°	1.57
12	F-3312	right	11 mm	17 mm	4 mm	128°	101°	1.55
13	F-3313	left	14 mm	21 mm	5 mm	indet.	indet.	1.50

Comparison:—The characteristic features of the specimens are the subtrapezoidal outline, the mesial umbo, 1.50-1.57 of the length-height proportion. Judging from these features, they are allied to *A. fassaensis* and probably in the immature stages.

18. *Anodontophora* sp.
(Plate VI, Figure 6)

This is represented by an imperfect left valve (Specimen Number 14, Registered Number F-3314).

Shell about 18 mm. in height, 30 mm. or longer in length, flat, inequilateral, sub-ovaloid, length-height proportion being 1.67. Anterior margin nearly straight; antero-ventral broken; ventral subarcuate; postero-ventral, posterior and postero-dorsal not observed. Umbo about anterior one-third of shell-length, broad, strong; posterior ridge indiscernible. Surface with many fine growth lines.

Class Gastropoda

19. Gastropod, gen. et sp. indet.
(Plate VI, Figures 7~11)

Shell comparatively small, trochoid, composed of four or five volutions, higher than broad, its apical angle about 45°. Spire moderately high; body whorl large, orbicular, apparently smooth; periphery of whorls rounded, smooth; aperture not observed.

(Measurement in mm)

Specimen Number	Registered Number	Broadness	Height
61	F-3362	3.5	6.0
62	F-3363	4.0	indet.
63	F-3364	indet.	indet.
64	F-3365	5.0	indet.
65	F-3366	4.0	7.0
66	F-3367	3.0	5.0
67	F-3368	5.0	8.0

Class Cephalopoda

Family Sageceratidae HYATT
Genus *Pseudosageceras* DIENER, 1895

20. *Pseudosageceras* sp.
(Plate VI, Figures 12~14)

Material:—One specimen from gray-white limestone at Kamura, only the right side of shell is exposed. (Specimen Number 56, Registered Number F-3357)

Description:—Shell of moderate size very acute on venter, smooth on surface. Suture-lines ceratitic; external lobe divided into three or more adventive lobes, but becomes obscure near siphonal part; first small, short, non-denticulated adventive lobe, second narrower adventive lobe with two denticulations at its bottom, third broadly developed adventive lobe with three denticulations, middle denticulation larger than the two others. All of adventive saddles narrow and rounded at upper termination. First lateral saddle tongue-shaped, moderately broad; first lateral lobe broad with four short denticulations at its bottom; second lateral saddle broad, rounded at upper termination; second lateral lobe broad, with four or more denticulations at its bottom. Only above-described suture-lines are preserved. (See. Plate VI, Figure 14)

Dimension:—D=about 60 mm, U=indet., A=indet., C=more than 8 mm. I=indet.

D=shell diameter from a siphonal edge to another siphonal edge.

U=umbilical diameter from an umbilical suture to another of the last whorl.

A=height of last whorl above umbilical suture.

C=greatest thickness of the last whorl.

I=involution, viz. width of overlap by which the last whorl embraces penultimate volution.

Comparison:—Although the suture-lines can not be observed completely, this species is referred to the genus *Pseudosageceras*, by the multisellate suture-lines.

Family Hedenstroemiidae WAAGEN
Subfamily Hedenstroemiinae WAAGEN
Genus *Clypites* WAAGEN, 1895

21. *Clypites japonicus* KAMBE, new species
(Plate VI, Figures 15~18)

Material:—One specimen from gray-white limestone at Kamura of which only the left side of shell is exposed and the apertural margin broken. (Specimen Number 55, Registered Number F-3356)

Description:—Shell medium sized, discoidal slightly higher than broad, moderately flattened on sides, completely involute; whorl section narrowly tabulate; shell surface almost smooth; suture-line ceratitic, forming spiral lines. Suture-lines are shown in Figure 6 on Plate VII. External lobe broad, divided into two lateral branches which are short, pointed, non-denticulated, one on each lateral flank.

These branches are followed by a narrowly rounded adventive saddle.

Adventive lobe, narrow and terminates at bottom with three denticulations. Its lateral sides are subparallel, and a little slant towards bottom. First lateral saddle much higher than adventive saddle, broad, gently rounded at upper termination. First lateral lobe very broad laterally, very short in height, with sloping sides, descending slightly below adventive lobe, with four denticulations at its bottom, first and second denticulations larger and stronger than the third and fourth ones. Second lateral saddle broad, as strong as first lateral saddle, broadly rounded at upper termination.

Second lateral lobe slightly narrower with sloping sides and a little shorter than first lateral lobe, with three denticulations at its bottom; first denticulation smaller than the two others.

Third lateral saddle smaller and shorter than second one, subangular at upper termination. This is followed by a number of small lobes, which can be considered as auxiliary ones, smaller than the above lateral lobes. First small, short with sloping sides with two denticulations at its bottom; second triangular, small, short, angular at its bottom; third small, short, slightly rounded at its bottom. Saddles small, short, arcuate or tabulate at upper termination.

Dimensions:—D=32 m., U=0 mm., A=21 mm., C=6 mm., I=3 mm.

Comparison:—The most characteristic features of this species are the laterally compression of shell, its complete involution without any umbilicus, with narrowly tabulate venter and the ceratitic sutures. From these features, especially the suture-lines, this species is referred to genus *Clypites*. It is closely allied to the genus *Pseudohendenstroemia*, and genus *Mesohedenstroemia*, in the tabulate venter but it differs from these genera in the more simple suture-lines.

This species is allied to *Hedenstroemia byansica* v. KRAFFT from Chocolate Limestone, probably from the horizon of *Flemingites Rohilla*, (KRAFFT and DIENER, *Pal. Indica, Ser. XV, Vol. VI, Mem. No. 1, pl. VIII*, figs. 2a, b, c, d, pl. XXX, figs. 8a, b, 9a, b, 1909) in its tabulate venter, but differs from the species in its large umbilicus and more complex suture-lines. It is a little allied to *Parahedenstroemia* (*Hedenstroemia*) *acuta* (v. KRAFFT) from Chocolate Limestone, probably from the horizon of *Flemingites Rohilla*, at the Kuti Yangti Valley, Byans (KRAFFT and DIENER, *Pal. Indica, Ser. XV, Vol. VI, Mem. No. 1*, pl. IX, figs. 2a, b, c, d, 1909) in its suture-lines but differs from that species in the shape of venter which is tabulate in this species but acute in *H. Acuta*. In the suture-lines this is somewhat allied also to *Pseudohedenstroemia himalayica* (SPATH) (=*Hedenstroemia Mojsisovicsi* DIEN.) from the horizon of *Flemingites Rohilla* (*Hedenstroemia* beds), S. E. of Muth. Spiti, 5 miles S. of Ensa, 1 mile N. of Lilang, and from the Chocolate Limestone, Kuti Yangti Valley, Byans, (ditto, pl. IX, figs. 3, 4, 5, 6, pl. X, figs. 1, 2, 3, pl. XX, fig. 1) but differs from *H. Mojsisovicsi* in its large umbilicus.

Its close ally is *Clypites kingianus*, WAAGEN from Virgal in the Ceratite Marls (WAAGEN, *Pal. Indica. Ser. XIII, Vol. II*, pl. XXI, fig. 8a, b, pl. XXII, fig. 3, 1895) in its shell-shape and suture-lines, but the adventive lobe is divided into four denticulations, the second lateral lobe is divided into two denticulations and the auxiliary is irregular in *C. kingianus*. Other close allies are *Clypites evolvens*, WAAGEN from Virgal in the Ceratite Marls (ditto, pl. XXII, figs. 2a, b, c) and *Hedenstroemia* (*Clypites*) *lilangensis* v. KRAFFT et DIENER from the horizon of *Meekoceras lilangense* and *M. Varaha*, I mile N. of Lilang, Spiti (KRAFFT and DIENER, *Pal. Indica. Ser. XV, Vol. VI, No. 1*, pl. IX, fig. 1, 1909) and *Hedenstroemia* (*Clypites*) *tenuis* HYATT and SMITH from the Lower Triassic *Meekoceras* zone, 9 miles east of Wood Canyon, Aspen Ridge, Idaho (SMITH, *U. S. G. S. Prof. Pap. 167*, pl. 1, figures 4~8, 1932).

The present species, however, differs from *C. evolvens* in its entire apertural margin, complex suture-line, from *H.* (*C.*) *lilangensis* in its complex suture-lines and from *H.* (*C.*) *tenuis* in its complex suture-lines.

Clypites typicus WAAGEN from the Ceratite Marls at Nanga (WAAGEN, *Pal. Indica, Ser. XIII, Vol. II*, pl. XXI, figs. 7a, b, 1895) is the closest ally to this species in the shell outline and the suture-lines. In *C. typicus* the adventive lobe is divided into two denticulations and the second lateral lobe into four denticulations, but in this species the adventive lobe is divided into three denticulations and the second lateral lobe into three denticulations. The auxiliary saddles and lobes are slightly different from one another. In this the shell is more compressed than *C. typicus*. From the above distinction, *Clypites japonicus*, new species, is created.

Genus *Parahedenstroemia* Spath, 1934

22. *Parahedenstroemia* α sp. nov. indet.
(Plate VII, Figures 1~3)

Material:—Represented by one specimen from gray-white limestone at Kamura. Its left flank is only observed; aperture broken. (Specimen Number 57, Registered Number F-3358)

Description:—Shell rather small, higher than broad, discoidal involute; no umbilicus; flanks fairly flattened; whorl section oxynote; shell surface almost smooth; suture-lines ceratitic, forming spiral-lines. (See figure 9 on plate VII)

External lobe broad with two short, pointed, non-denticulate siphonal notches. These notches are followed by a rounded adventive saddle. Adventive lobe, that follows, narrow and terminates with two denticulations at its bottom. Its lateral sides subparallel, but a little sloping towards its bottom which is lower than siphonal notch. First lateral saddle much higher than adventive saddle, broad, gently rounded at upper termination. First lateral lobe very broad laterally, very short in height, with sloping sides, descending slightly below adventive lobe, with four denticulations at its bottom; second denticulation larger and longer than another three denticulations.

Second lateral saddle broad, slightly stronger than first lateral saddle, broadly rounded at upper termination. Second lateral lobe slightly narrower with sloping sides, higher than first lateral lobe, with three denticulations of equal size. Auxiliary lobe and saddle simple, small.

Dimensions:—D=21 mm., U=0 mm., A=indet., C=4 mm., I=indet.

Comparison:—The discoidal involute form without any umbilicus, the oxynote whorl section, the smooth surface and the ceratitic suture-lines are the characteristics of this species.

From these features, it is referred to either the genus *Parahedenstroemia* Spath or the Genus *Aspenites* Hyatt & Smith.

In my opinion this species belongs *Parahedenstroemia*, in view of the more complex suture-lines. It differs from *Parahedenstroemia acuta* (v. Krafft) from Chocolate Limestone, probably from the horizon of *Flemingites Rohilla*, Kuti Yangti Valley, Byans (Krafft and Diener, *Pal. Indica. Ser. XV, Vol. VI, Mem. No. 1*, pl. IX, fig. 2, 1909) in the suture-lines. In *P. acuta*, the adventive lobe is divided into four denticulations, the first lateral lobe into six denticulations and the second lateral lobe into six denticulations. The denticulations are less developed, in this species.

23. *Parahedenstroemia* β sp. nov. indet.
(Plate VII, Figures 4~7)

Material:—One specimen from gray-white limestone at Kamura whose left flank is only exposed and the apertural edge is broken. (Specimen Number 54, Registered Number F-3355)

Description:—Shell medium sized, discoidal moderately flattened on lateral sides, involute; no umbilicus; whorl section oxynote; surface almost smooth;

suture-lines ceratitic, forming spiral lines shown in figure 12 on plate VII. External lobe broad, with adventive lobe with two denticulations at its bottom.

Its sides are not quite parallel, but slightly sloping towards bottom. First lateral saddle narrow, rounded at upper termination. First lateral lobe very broad laterally, short in height with slightly sloping sides, descending below adventive lobe, with three or four denticulations at its bottom, first denticulation smaller than the others. Second lateral saddle slightly broader and stronger than first lateral saddle, broadly rounded at upper termination. Second lateral lobe slightly narrower and shorter than first lateral lobe, with slightly sloping sides, higher than first lateral lobe, with four equal sized denticulations. Third lateral saddle broadly rounded, short. Third lateral lobe narrow, short with four denticulations, a little higher than second lateral lobe. Auxiliary lobe and saddle simple, short, small.

Dimenstions:—D=indet., U=0 mm., A=indet., C=6 mm., I=2 mm.

Comparison:—In the oxynote venter the compressed discoidal form, the flattened sides, the involute shell devoid of umbilicus, smooth test and ceratitic suture-lines, this species is compared with the genus *Parahedenstroemia* SPATH and the genus *Aspenites* HYATT & SMITH.

In seeing the more complex suture-lines, *Parahedenstroemia* is considered the better reference. This differs from *Parahedenstroemia acuta* (v. KRAFFT). (1909, A. v. KRAFFT and C. DIENER, *Pal. Indica, Ser. XV, Vol. VI, Mem. No. 1,* pl. IX, fig. 2) in the suture-lines. In *P. acuta* the suture-lines are more complicated. From *P. a* sp. nov. indet., this species differs in the shape of venter, in the suture-lines; *P. a* sp. nov. indet. has broadly oxynote venter, two small siphonal notches, and second lateral lobe with three denticulations, while this species is provided with narrowly oxynote venter, without siphonal notches, and with second and third lateral lobes both with four denticulations.

Subfamily Aspenitinae SPATH, 1834

Genus *Aspenites* HYATT and SMITH, 1905

24. *Aspenites kamurensis* KAMBE, new species

(Plate VII, Figures 8~12)

Material:—One specimen from gray-white limestone at Kamura. Its left flank is only observable and the aperture chamber broken. (Specimen Number 58, Registered Number F-3359)

Description:—Shell fairly small, higher than broad, compressed discoidal, involute; moderately flanks flattened; no umbilicus; whorl section oxynote; surface with many fine radial folds; suture-lines ceratitic as in figure 14, on plate VII. External lobe broad, divided by small rounded adventive saddle into one pointed, short, strong siphonal notch and one adventive lobe with two short denticulations in its bottom; first lateral saddle, moderately broad, rounded at upper termination, with steep sides, higher than adventive saddle.

First lateral lobe very broad, with four denticulations of different size on bottom; first and second denticulations small; third and fourth longer or larger, with steep sides, lowering below adventive lobe. Second lateral saddle broad, rounded at upper termination, slightly higher than first lateral saddle, with steep sides. Second lateral lobe very broad, with two short rounded denticulations, higher than first lateral lobe. Auxiliary lobe and saddle very simple.

Dimensions:—D=20 mm., U=0 mm., A=12 mm., C=4 mm., I=1.5 mm.

Comparison:—The oxynote venter, compressed discoidal form, flattened sides, involute shell without any umbilicus, fine, strong radial folds in the surface and the simple suture-lines show that this species belongs to the genus *Aspenites* HYATT and SMITH and not to the genus *Parahedenstroemia* SPATH.

In its shape of shell and suture-lines it is most related to *Aspenites acutus* HYATT and SMITH from the Lower Triassic *Meekoceras* zone of Wood Canyon, near Soda Springs, Idaho and the *Owenites* subzone of the *Meekoceras* zone in Union Wash, near Union Spring, in the Inyo Range, about 15 miles southeast of Independence, Inyo County, California (1932, J.P. SMITH, *U.S.G.S., Prof. Paper 167*). But it has the adventive lobe with two denticulations in its bottom and the most simplified auxiliary lobe and saddle. Especially from the difference of the auxiliary lobe and saddle, I create *Aspenites kamurensis*, new species.

25. *Aspenites* ? sp.
(Plate VII, Figure 13)

Shell small sized, imperfect in preservation, oxynote venter, involute without any umbilicus, surface of shell with many fine, radial folds. Suture-lines unknown. Judging from these characters, I consider it to be a member of the genus *Aspenites* HYATT & SMITH. (Specimen Number 59, Registered Number F-3360)

26. Ammonite gen. et sp. indet.
(Plate VII, Figures 14~15)

An imperfect specimen whose shell is largely destructed has an oxynote venter and smooth surface; suture-line unknown. (Specimen Number 60, Registered Number F-3361)

Postscript 1

A New Observation at Kawahigashi, Oe-cho, Kasa-gun, Kyoto Prefecture.

In the Inner Zone of Southwestern Japan, only two localities are so far known where the Permo-Triassic boundary is actually observable, namely the southern parts of Narabara and Okuyama in Kawahigashi, Oe-cho, Kasa-gun, Kyoto Prefecture. In 1958, K. NAKAZAWA stated that the relation between the Maizuru and Yakuno groups is clino-unconformity at these two localities. The writer's observation is however quite different from his statement, as follows:

At Sangokudani in the southern part of Hirobatake, it can actually be seen that the sandstone of the Narabara formation which represents the base of the Yakuno group parallel-unconformably, overlies the black clayslate belonging to the Maizuru group and having the strike of N 10° W, the dip of 70° N or the strike of N 40° W, the dip of 60° N.

At Okuyamahondani the writer could not find out the outcrop as shown in K. NAKAZAWA's sketch in figure 5 (1958), but in the neighbourhood, the writer could confirm that the strike and dip are little different between the Triassic sandstone and the Permian clayslate. Therefore the writer concludes that the relation between the two groups is almost parallel-unconformable.

Postscript 2

In spring, 1962, Professor KLAUS J. MÜLLER of the Technische Universitaet Berlin has visited Japan for searching conodonts. Through etching the Kamura limestone in my collection he discovered several specimens of conodonts. This is indeed the first instant that conodonts were found in Japan. The writer is obliged Dr. MÜLLER for the honour of anouncing this news.

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日本における二畳系・三畳系間の境界について

一宮崎県高千穂町における二畳三畳紀層ならびにスキティック含有化石の記載に関して一

神戸　信和

要　旨

日本においては二畳系ならびに三畳系は多くの地質学者や古生物学者により詳細に研究されてきたが，両系間の境界についてはまだ多くの問題が残されている。しかしながらすでに20年前に小林貞一は二畳系登米層群と三畳系稲井層群間の館造陸運動を提唱し，西南日本外側の三宝山層群は一連の二畳三畳紀層であると主張している。

筆者は昭和27年に実施した5万分の1地質図幅「三田井」の調査に際し，宮崎県西臼杵郡高千穂町上村の北西方にて，二枚貝，菊石および巻貝の化石に富んだ灰白色石灰岩(上村層の最下部)と紡錘虫および珊瑚の化石に富んだ暗灰色石灰岩(岩戸層の最上部)の2種の石灰岩を識別し，二枚貝の化石は高知県の下部三畳系黒滝層の化石および山中地溝帯の下部三畳系塩沢層の化石に同定されることが判明してきた。さらに昭和32年に斉藤正次は同町皿糸林道に沿う切割で，貝化石を含む灰白色石灰岩が北側に紡錘虫を含む暗灰色石灰岩が南側に相接する露頭を観察し，両種石灰岩の境界には不整合も断層もないことを認めた。

さらに筆者は昭和34年に同町上村および皿糸周辺の調査を実施する機会があり，含貝化石石灰岩も含紡錘虫石灰岩も数kmないし10数kmにわたり連続して分布し，前者は二畳紀後期に，後者は三畳紀前期にそれぞれ属し，両種石灰岩は一連のもので，不整合は全くないことが判明した。

本論文では第1章に筆者が行なってきた日本における二畳系および三畳系の研究概略を紹介し，第2章では昭和34年における高千穂町上村および皿糸周辺の調査結果を報告した。すなわち，上村層は上村の断面では下位から上位に向かって，灰白色石灰岩(35m)・粘板岩および砂岩(数m)・暗灰色チヤート(3～5m)が重畳し，皿糸の断面では下位から上位に向かって，灰白色石灰岩(30m)・粘板岩および砂岩(20m)・チヤート(30m)・砂岩(20m)・珪質粘板岩・砂質粘板岩および砂岩互層(60m)が重畳し，石灰岩は第7章に記載したように菊石として *Clypites japonicus* KAMBE および *Aspenites kamurensis* KAMBE の2新種を含み，*Pseudosageceras, Parahedenstroemia, Aspenites,* 二枚貝として ***Eumorphotis, Pteria, Gervillia, Entolium, Chlamys, Eopecten, Pecten, Anodontophora*** および巻貝等の化石を豊富に含み，黒滝層および塩沢層の化石と共通し三畳紀スキティックに属することが判明し，菊石類はスキティックの Flemingitan から Owenitan に及ぶもので，上村層の基底の約15～23mの無化石層を考慮に入れるならば，上村層はさらに下位に及ぶものである。上村層は北部の二畳系中部の土呂久層とは衝上断層で境される。上村層の南部には進化した *Yabeina, Neoschwagerina* を含む60～100mの暗灰色石灰岩を始め，砂岩・粘板岩・チヤートからなる二畳系中部より上部に及ぶ岩戸層が分布し，岩戸層および上村層はおよそ8kmにわたり認められ，構造的に差異がなく境界には不整合も断層もなく整合であると考えられる。第3章では大分県津久見市西方の

山地にも井上秀雄の貝化石の発見を端緒として上村層および岩戸層の東方延長が認められるに至ったことを述べた。

第4章では北上山地，舞鶴地帯および西南日本外帯において認められる二畳系三畳系間の境界に関する地質学的事実を記述し，第5章では日本ならびに諸外国における下部三畳系の対比を試み，二畳系との関係を論じた。第6章では地質学的事実を基として次のように日本における二畳系と三畳系との境界ならびにその地史学的意義を論じた。

1. 西南日本内帯(舞鶴帯) 二畳系舞鶴層群と中下部三畳系夜久野層群との境界には著しい傾斜不整合はなく，平行不整合ないし非整合関係である。さらに両者は構造上，帯状配列を形成しており，舞鶴・夜久野両層群はともに上部三畳系志高・御祓山両層群の基底に見られる著しい傾斜不整合の示す著しい地殻変動により帯状配列を形成するに至ったものである。

2. 北上山地南部 上部二畳系登米層群と中下部三畳系稲井層群との境界には著しい傾斜不整合はなく，非整合関係である。上記の両層群が密接な関係で広く分布しているのに反し，上部三畳系の皿貝層群は局部的に限られ，稲井層群を傾斜不整合に被覆し，登米・稲井両層群間には著しい地殻変動はなく，皿貝層群堆積前に登米・稲井両層群はかなりの地殻変動をうけたものである。

3. 西南日本外帯 九州高千穂町および津久見市では中上部二畳系岩戸層から下部三畳系上村層との間には不整合も断層もなく整合一連で，四国では秩父古生層から斗賀野層群まで一連整合であるといわれ，三宝山層群と呼ばれている。

以上のことを要約し，地史を結論する。二畳系と三畳系との境界は西南日本内帯および北上山地南部では平行不整合ないし非整合と認められ，その間の地殻運動は緩やかな波曲陸化，それに伴なう若干の浸食とそれに続く沈降を意味するものであり，造山性の運動ではない。これに反し，皿貝前，志高前，御祓山前において，著しい造山性の地殻運動があり，この運動により舞鶴帯では舞鶴層群・稲井層群・難波江層群・日置層・荒倉層等は帯状構造を形成するに至ったものと考えられる。北上山地南部では登米層群・稲井層群・利府層の各地層がかなり著しく変動を受けたものと考えられる。西南日本外帯では二畳系と三畳系との関係は整合と認められ，内帯・北上山地で認められるような波曲陸化，若干の浸食すらもなかったものと考えられる。しかしながら岩戸層から上村層へかけて，その境界を境として石灰岩の岩質が急激に変化していることは堆積環境の何らかの変化を意味するものかも知れない。さらに要約すると日本では二畳系と三畳系とを境として，太平洋側では沈降，堆積が間断なく続けられたが，大陸側では緩やかな波曲陸化と若干の浸食を伴なった造陸性の運動が行なわれたことが証明されたのである。これに反し，皿貝前，志高前，御祓山前の地殻変動は少なくとも内帯・北上山地南部，特に前者の地帯では造山性の運動としてきわめて重要なものであることを強調する。さらに日本では二畳系・三畳系の境界の運動はきわめて軽微なものであるにもかかわらず，これを境とする動物界の変遷はきわめて顕著である。第7章では上村層から産出する二枚貝類7属18種，巻貝類，菊石類4属6種および未確定種1種を記載した。

PLATES AND EXPLANATIONS

(with 19 Plates)

Plates I—VII are the photographs of Skytic fossils discovered from the Kamura formation at the Kamura valley in Takachiho-cho, Nishiusuki-gun, Miyazaki Prefecture, Japan and all of these specimens are kept in the Geological Survey of Japan.

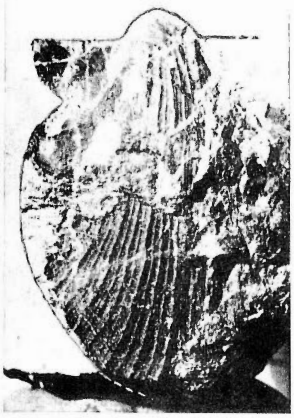
Plates VIII—XIX are the photographs showing the important stratigraphical and tectonic relations of the formations in Kyushu and the Kitakami mountains.

PLATE I

Plate I

Eumorphotis multiformis (BITTNER)

Fig. 1. Left valve, (Sp. No. 73, Reg. No. F—3374) ×1.0
Fig. 2. Right valve, (Sp. No. 80, Reg. No. F—3381) ×1.0
Fig. 3. Internal mould of the right valve, (Sp. No. 93, Reg. No. F—3394) ×1.1
Fig. 4. Left valve, (Sp. No. 71, Reg. No. F—3372) ×1.1
Fig. 5. Left valve, (Sp. No. 76, Reg. No. F—3377) ×1.0
Fig. 6. Left valve, (Sp. No. 68, Reg. No. F—3369) ×1.0
Fig. 7. Left valve, (Sp. No. 82, Reg. No. F—3383) ×1.1
Fig. 8. Left valve, (Sp. No. 69, Reg. No. F—3370) ×1.1
Fig. 9. Right valve, (Sp. No. 87, Reg. No. F—3388) ×0.9
Fig. 10. Showing surface ornamentation of the left valve in fig. 4, (Sp. No. 71, Reg. No. F—3372) ×2.5
Fig. 11. Right valve, (Sp. No. 84, Reg. No. F—3385) ×1.0



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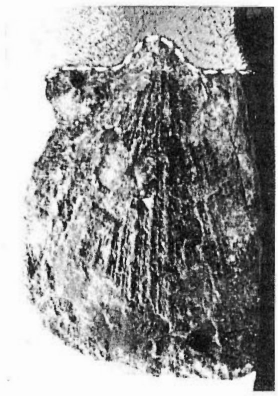
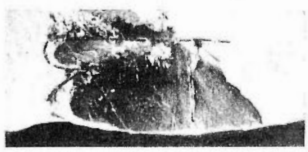


7



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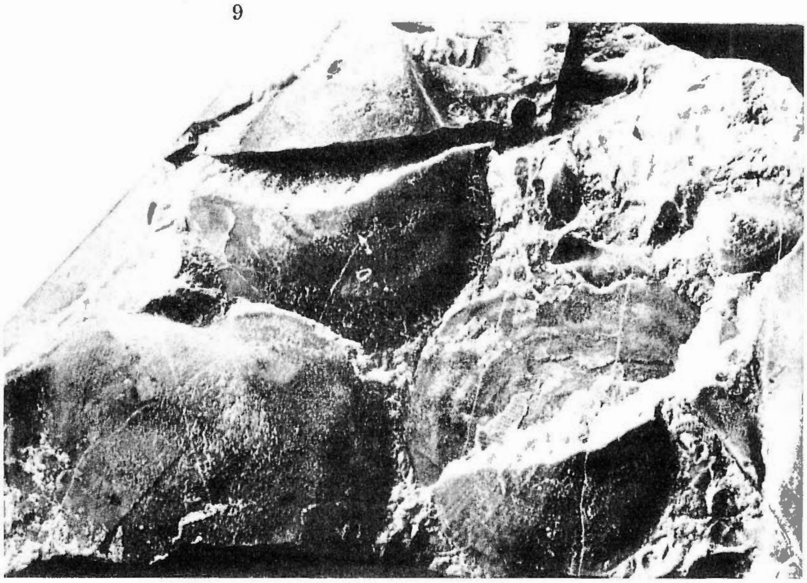

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PLATE II

Plate II

Eumorphotis multiformis (BITTNER)

Fig. 1. Internal mould of the right valve, (Sp. No. 90, Reg. No. F—3391) ×1.2
Fig. 2. Right valve, (Sp. No. 91, Reg. No. F—3392) ×1.1
Fig. 3. Internal mould of the right valve, (Sp. No. 89, Reg. No. F—3390) ×1.1
Fig. 4. Left valve, (Sp. No. 70, Reg. No. F—3371) ×1.1
Fig. 5. Left valve, (Sp. No. 74, Reg. No. F—3375) ×1.0
Fig. 6. External mould of the right valve, (Sp. No. 85, Reg. No. F—3386) ×1.1
Fig. 7. Replica of the right valve, (Sp. No. 92, Reg. No. F—3393) ×0.9

Eumorphotis multiformis shionosawensis ICHIKAWA et YABE

Fig. 8. Left valve, (Sp. No. 72, Reg. No. F—3373) ×1.0

Eumorphotis multiformis subspecies nov. indet.

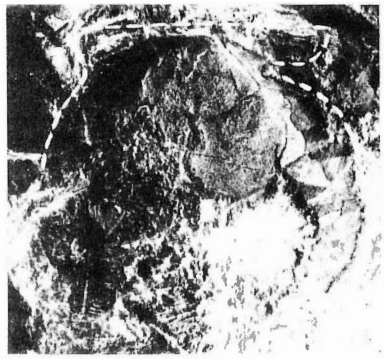
Fig. 9. Left valve, (Sp. No. 79, Reg. No. F—3380) ×1.1

Eumorphotis sp.

Fig. 10. Showing surface ornamentation of the left valve in fig. 8 of pl. IV, (Sp. No. 104, Reg. No. F—3405) ×2.5


1


2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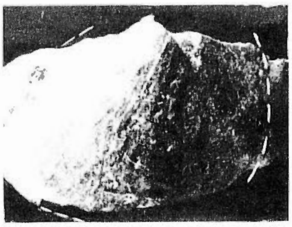
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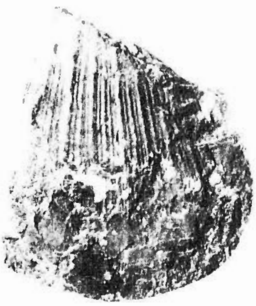
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PLATE III

Plate III

Eumorphotis multiformis subspecies nov. indet.

Fig. 1. Replica of the left valve, (Sp. No. 83, Reg. No. F—3384) ×1.1

Eumorphotis sp.

Fig. 2. Left valve, (Sp. No. 96, Reg. No. F—3397) ×1.5
Fig. 3. Right valve, (Sp. No. 97, Reg. No. F—3398) ×3.0
Fig. 4. Left valve, (Sp. No. 94, Reg. No. F—3395) ×2.0
Fig. 5. Right valve, (Sp. No. 98, Reg. No. F—3399) ×1.6
Fig. 6. Right valve, (Sp. No. 110, Reg. No. F—3411) ×1.0
Fig. 7. Replica of the above-figured specimen, (Sp. No. 111, Reg. No. F—3412) ×1.0
Fig. 8. Right valve, (Sp. No. 113, Reg. No. F—3414) ×1.0
Fig. 9. Replica of the above-figured specimen, (Sp. No. 114, Reg. No. F—3415) ×1.0
Fig. 10. Left valve, (Sp. No. 96, Reg. No. F—3397) ×1.5
Fig. 11. Replica of the right valve, (Sp. No. 99, Reg. No. F—3400) ×1.0
Fig. 12. Replica of the right and left valves, (Sp. No. 102, Reg. No. F—3403) ×1.0
Fig. 13. Left valve, (Sp. No. 104, Reg. No. F—3405) ×1.0
Fig. 14. Left valve, (Sp. No. 100, Reg. No. F—3401) ×1.1
Fig. 15. Right valve, (Sp. No. 109, Reg. No. F—3410) ×3.0
Fig. 16. Right valve, (Sp. No. 95, Reg. No. F—3396) ×1.0
Fig. 17. Replica of the above-figured specimen, (Sp. No. 125, Reg. No. F—3423) ×1.0
Fig. 18. Right valve, (Sp. No. 104, Reg. No. F—3405) ×1.0
Fig. 19. Replica of the right valve, (Sp. No. 105, Reg. No. F—3406) ×3.0

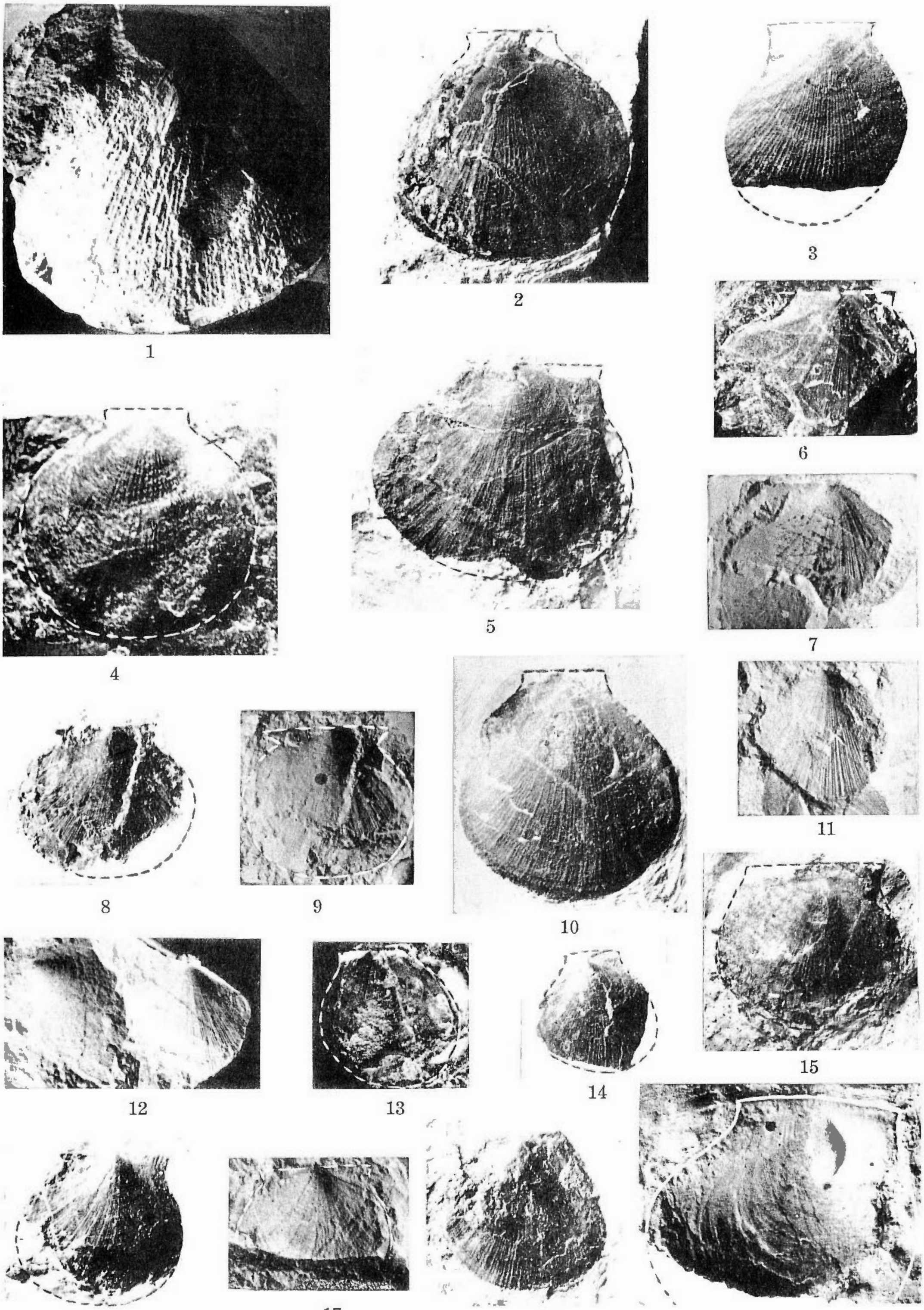
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PLATE IV

Plate IV

Eumorphotis sp.

Fig. 1. Right valve, (Sp. No. 106, Reg. No. F—3407) ×1.5
Fig. 2. Left valve ?, (Sp. No. 108, Reg. No. F—3409) ×1.0
Fig. 3. Left valve ?, (Sp. No. 107, Reg. No. F—3408) ×1.0
Fig. 4. Left valve, (Sp. No. 119, Reg. No. F—3420) ×1.5
Fig. 5. Replica of the right valve in fig. 1, (Sp. No. 106, Reg. No. F—3407) ×1.0
Fig. 6. Left valve, (Sp. No. 116, Reg. No. F—3417) ×1.1
Fig. 7. Replica of the above-figured specimen, (Sp. No. 116, Reg. No. F—3417) ×1.0
Fig. 8. Left valve, (Sp. No. 104, Reg. No. F—3405) ×0.9
Fig. 9. Right valve, (Sp. No. 115, Reg. No. F—3416) ×1.6
Fig. 10. Right valve ?, (Sp. No. 112, Reg. No. F—3413) ×1.0
Fig. 11. Left valve, (Sp. No. 118, Reg. No. F—3419) ×1.0
Fig. 12. Left valve, (Sp. No. 122, Reg. No. F—3421) ×2.0
Fig. 13. Left valve, (Sp. No. 117, Reg. No. F—3418) ×2.0
Fig. 14. Right valve, (Sp. No. 101, Reg. No. F—3402) ×1.1
Fig. 15. Left valve, (Sp. No. 123, Reg. No. F—3422) ×1.0
Fig. 16. Replica of the internal mould of right valve, (Sp. No. 103, Reg. No. F—3404) ×1.0

Pteria ussurica (KIPARISOVA) *yabei* NAKAZAWA

Fig. 17. Right valve, (Sp. No. 15, Reg. No. F—3315) ×1.0
Fig. 18. Right valve, (Sp. No. 17, Reg. No. F—3317) ×1.1
Fig. 19. Right valve, (Sp. No. 16, Reg. No. F—3316) ×1.5
Fig. 20. Internal mould of the right valve, (Sp. No. 18, Reg. No. F—3318) ×1.0
Fig. 21. Right valve, (Sp. No. 23, Reg. No. F—3323) ×1.0
Fig. 22. Right valve, (Sp. No. 37, Reg. No. F—3337) ×1.5
Fig. 23. Left valve, (Sp. No. 27, Reg. No. F—3327) ×1.5
Fig. 24. Internal mould of the left valve, (Sp. No. 28, Reg. No. F—3328) ×1.5
Fig. 25. Right valve, (Sp. No. 24, Reg. No. F—3324) ×1.5
Fig. 26. Left valve, (Sp. No. 26, Reg. No. F—3326) ×1.0
Fig. 27. Replica of the right valve in fig. 25, (Sp. No. 24, Reg. No. F—3324) ×1.0
Fig. 28. Left valve, (Sp. No. 29, Reg. No. F—3329) ×1.0
Fig. 29. Right valve, (Sp. No. 22, Reg. No. F—3322) ×3.0
Fig. 30. Internal mould of the right valve, (Sp. No. 19, Reg. No. F—3319) ×3.0

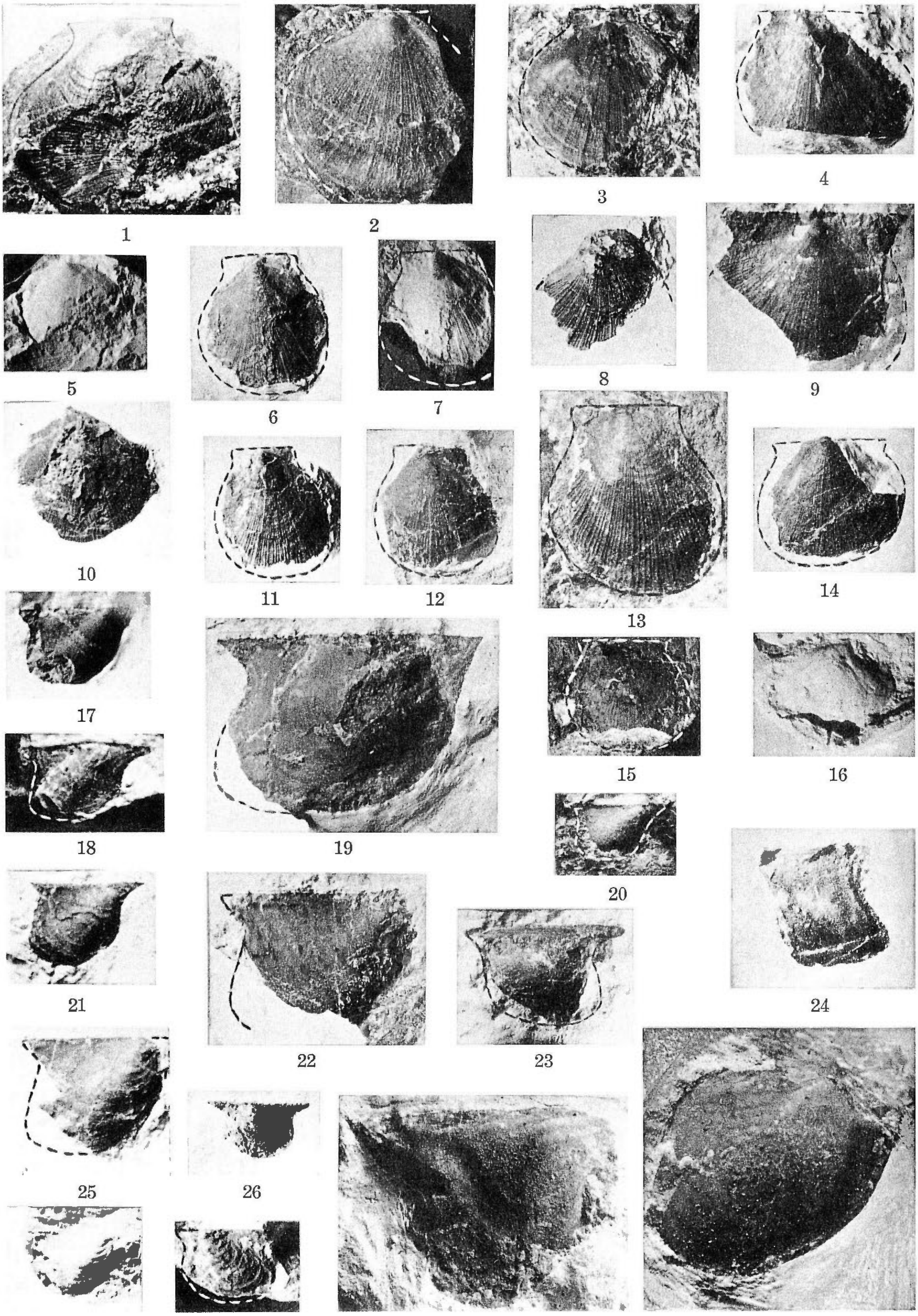
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PLATE V

Plate V

Pteria ussurica (KIPARISOVA) *yabei* NAKAZAWA

Fig. 1. Left valve, (Sp. No. 25, Reg. No. F—3325) ×1.6
Fig. 2. Left valve, (Sp. No. 30, Reg. No. F—3330) ×1.9
Fig. 3. Internal mould of the left valve, (Sp. No. 31, Reg. No. F—3331) ×0.9
Fig. 4. Left valve, (Sp. No. 34, Reg. No. F—3334) ×1.0
Fig. 5. Internal mould of the left valve, (Sp. No. 36, Reg. No. F—3336) ×1.6
Fig. 6. Left valve, (Sp. No. 33, Reg. No. F—3333) ×0.9
Fig. 7. Left valve, (Sp. No. 35, Reg. No. F—3336) ×0.9
Fig. 8. Internal mould of the left valve, (Sp. No. 32, Reg. No. F—3332) ×0.9

Gervillia cf. *exporrecta* (LEPSIUS)

Fig. 9. Left valve, (Sp. No. 38, Reg. No. F—3338) ×0.9
Fig. 10. Right valve, (Sp. No. 40, Reg. No. F—3340) ×0.9
Fig. 11. Internal mould of the right valve, (Sp. No. 39, Reg. No. F—3339) ×1.0

Entolium discites (v. SCHLOTHEIM)

Fig. 12. Right valve ?, (Sp. No. 51, Reg. No. F—3351) ×1.0
Fig. 13. Right valve, (Sp. No. 51', Reg. No. F—3352) ×1.0

Entolium sp. indet.

Fig. 14. Internal mould of the right valve, (Sp. No. 48, Reg. No. F—3348) ×1.0

Chlamys (?) *kryshtofowichi* (KIPARISOVA)

Fig. 15. Internal mould of the left valve, (Sp. No. 49, Reg. No. F—3349) ×1.0
Fig. 16. Right valve, (Sp. No. 50, Reg. No. F—3350) ×1.0

Eopecten minimus (KIPARISOVA)

Fig. 17. Left valve, (Sp. No. 44, Reg. No. F—3344) ×1.8
Fig. 18. Left valve, (Sp. No. 46, Reg. No. F—3346) ×1.0
Fig. 19. Right valve, (Sp. No. 41, Reg. No. F—3341) ×1.0
Fig. 20. Left valve, (Sp. No. 43, Reg. No. F—3343) ×1.0
Fig. 21. Left valve, (Sp. No. 45, Reg. No. F—3345) ×1.5

Pecten (s.l.) sp. indet.

Fig. 22. Internal mould of the left valve, (Sp. No. 47, Reg. No. F—3347) ×1.0

Eopecten cf. *minimus* var. *reticulatus* (KIPARISOVA)

Fig. 23. Left valve, (Sp. No. 42, Reg. No. F—3342) ×1.0

Anodontophora canalensis CATULLO

Fig. 24. Left valve, (Sp. No. 2, Reg. No. F—3302) ×1.0
Fig. 25. Left valve, (Sp. No. 1, Reg. No. F—3301) ×1.1

Anodontophora cf. *canalensis* CATULLO

Fig. 26. Left valve, (Sp. No. 3, Reg. No. F—3303) ×1.7

Anodontophora canalensis var. *bittneri* ICHIKAWA and YABE

Fig. 27. Left valve, (Sp. No. 4, Reg. No. F—3304) ×0.9

Anodontophora fassaensis (WISSMANN)

Fig. 28. Left valve, (Sp. No. 5, Reg. No. F—3305) ×1.0
Fig. 29. Replica of the above-figured specimen, (Sp. No. 5, Reg. No. F—3305) ×1.0
Fig. 30. Right valve, (Sp. No. 6, Reg. No. F—3306) ×1.0
Fig. 31. Right valve, (Sp. No. 7, Reg. No. F—3307) ×1.0
Fig. 32. Left valve, (Sp. No. 8, Reg. No. F—3308) ×1.1

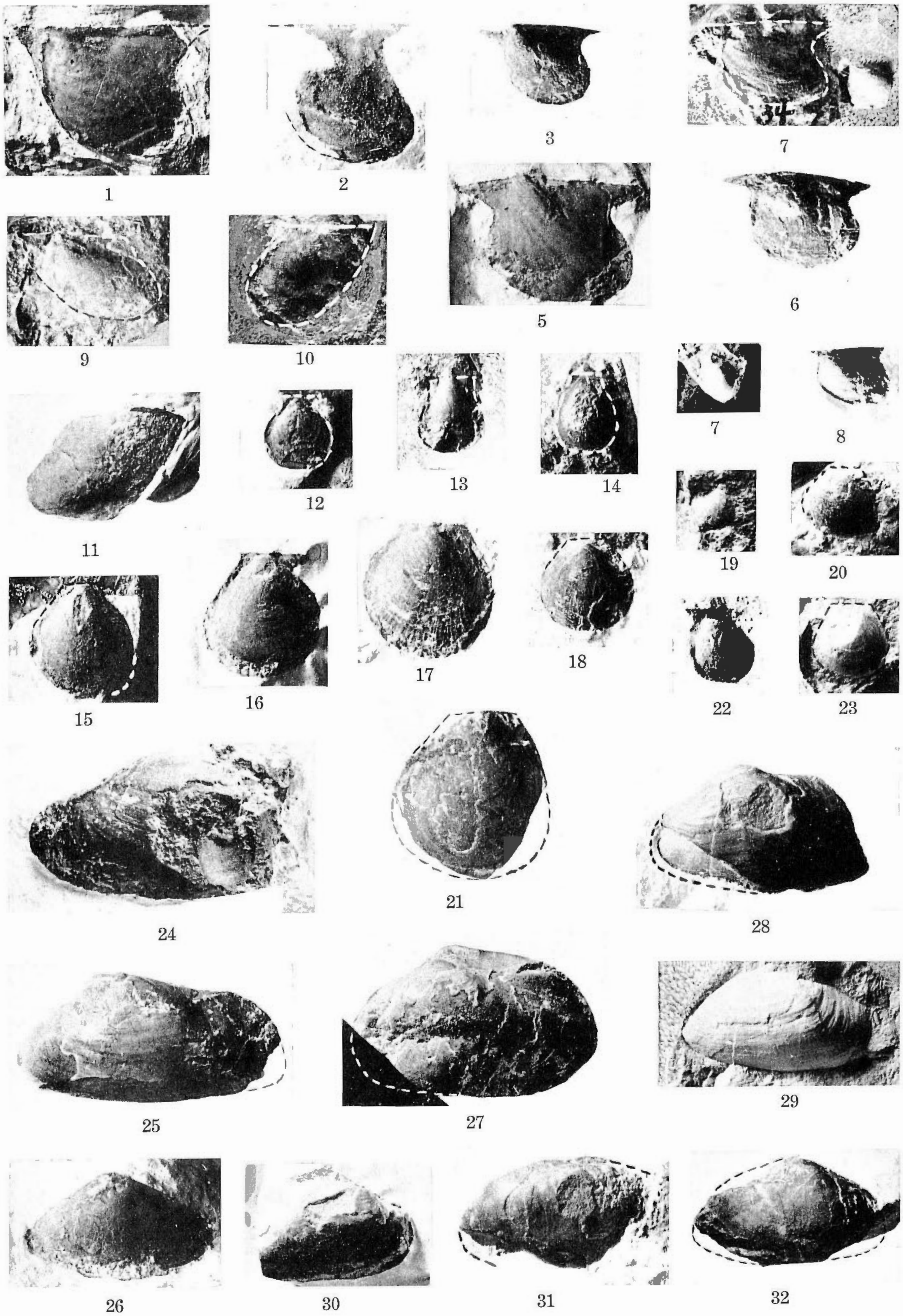
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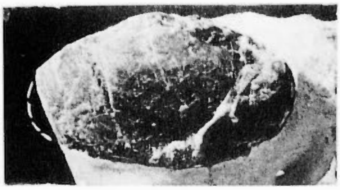
PLATE VI

Plate VI

Anodontophora fassaensis (WISSMANN)
Fig. 1. Left valve, (Sp. No. 9, Reg. No. F—3309) ×1.0
Fig. 2. Right valve, (Sp. No. 10, Reg. No. F—3310) ×1.0
Anodontophora cf. *fassaensis* (WISSMANN)
Fig. 3. Right valve, (Sp. No. 11, Reg. No. F—3311) ×2.7
Fig. 4. Left valve, (Sp. No. 13, Reg. No. F—3313) ×1.1
Fig. 5. Right valve, (Sp. No. 12, Reg. No. F—3312) ×1.5
Anodontophora sp.
Fig. 6. Left valve, (Sp. No. 14, Reg. No. F—3314) ×1.0
Gastropod, gen. et sp. indet.
Fig. 7. Side view, (Sp. No. 65, Reg. No. F—3366) ×2.8
Fig. 8. Side view, (Sp. No. 66, Reg. No. F—3367) ×4.0
Fig. 9. Side view, (Sp. No. 67, Reg. No. F—3368) ×3.0
Fig. 10. Side view, (Sp. No. 62, Reg. No. F—3363) ×3.0
Fig. 11. Side view, (Sp. No. 61, Reg. No. F—3362) ×3.0
Pseudosageceras sp.
Fig. 12. Lateral view, (Sp. No. 56, Reg. No. F—3357) ×0.9
Fig. 13. Whorl-section of the above-figured specimen, (Sp. No. 56, Reg. No. F—3357) ×0.9
Fig. 14. Suture-line of the above-figured specimen, ×3.0
Clypites japonicus KAMBE, new species
Fig. 15. Lateral view of the holotype, (Sp. No. 55, Reg. No. F—3356) ×1.1
Fig. 16. Frontal view of the holotype, (Sp. No. 55, Reg. No. F—3356) ×1.1
Fig. 17. Suture-line of the holotype, ×5.0
Fig. 18. Showing suture-line of the holotype, (Sp. No. 55, Reg. No. F—3356) ×2.9



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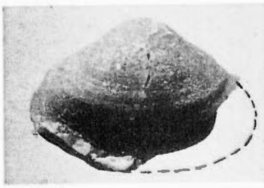

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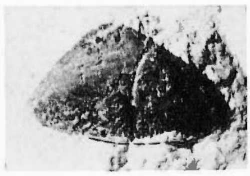

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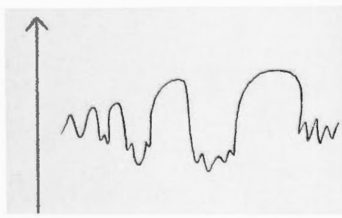

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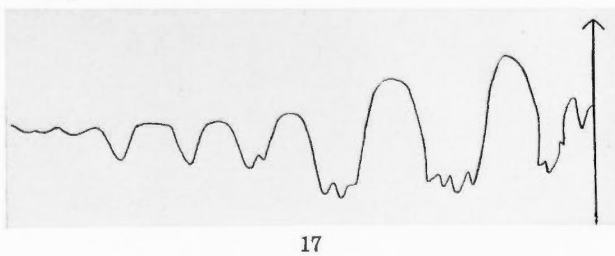

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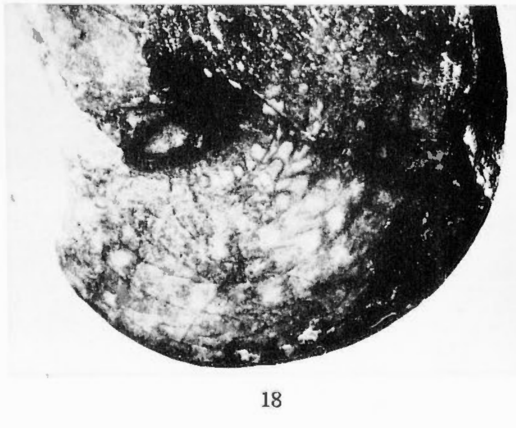

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PLATE VII

Plate VII

Parahedenstroemia α sp. nov. indet.

Fig. 1. Lateral view, (Sp. No. 57, Reg. No. F—3358) ×2.0

Fig. 2. Outline of whorl-section of the above-figured specimen, ×2.0

Fig. 3. Suture-line of the above-figured specimen, ×5.0

Parahedenstroemia β sp. nov. indet.

Fig. 4. Lateral view, (Sp. No. 54, Reg. No. F—3355) ×1.0

Fig. 5. Outline of whorl-section of the above-figured specimen, ×2.0

Fig. 6. Suture-line of the above-figured specimen, ×5.0

Fig. 7. Showing suture-line of the above-figured specimen, ×3.0

Aspenites kamurensis KAMBE, new species

Fig. 8. Outline of whorl-section of the holotype, ×2.5

Fig. 9. Frontal view of the holotype, (Sp. No. 58, Reg. No. F—3359) ×1.9

Fig. 10. Lateral view of the holotype, (Sp. No. 58, Reg. No. F—3359) ×1.9

Fig. 11. Showing suture-line of the holotype, (Sp. No. 58, Reg. No. F—3359) ×5.0

Fig. 12. Suture-line of the holotype, ×5.0

Aspenites ? sp.

Fig. 13. Lateral view, (Sp. No. 59, Reg. No. F—3360) ×3.0

Ammonite gen. et sp. indet.

Fig. 14. Lateral view, (Sp. No. 60, Reg. No. F—3361) ×1.0

Fig. 15. Lateral view of the above-figured specimen, (Sp. No. 60, Reg. No. F—3361) ×3.0

Plate VII

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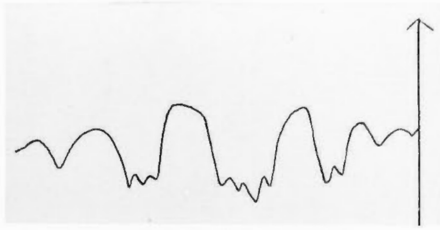

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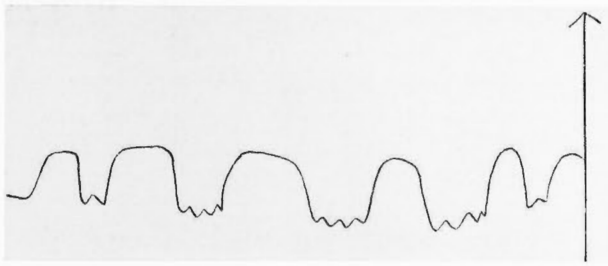

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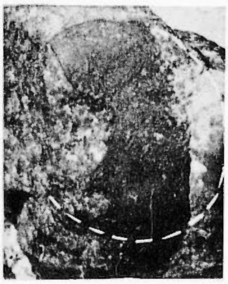

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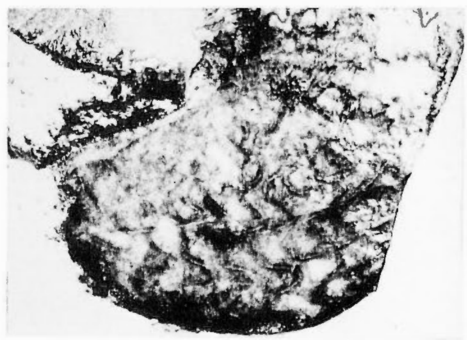

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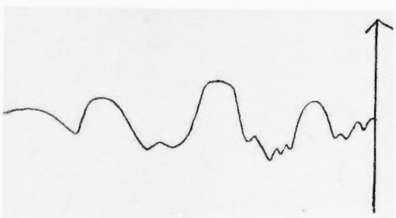

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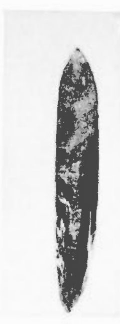

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PLATE VIII

Plate VIII

This photograph shows the topography around Shirodake (S). The molluscan limestone of the Kamura formation (K) is well seen along the road through Kamura to Shioinouso and reaches to Shirodake. The fusulinid limestone of the Iwato formation (I) is typically distributed at the mid-slope of Shirodake. (Takachiho-cho, Miyazaki Prefecture)

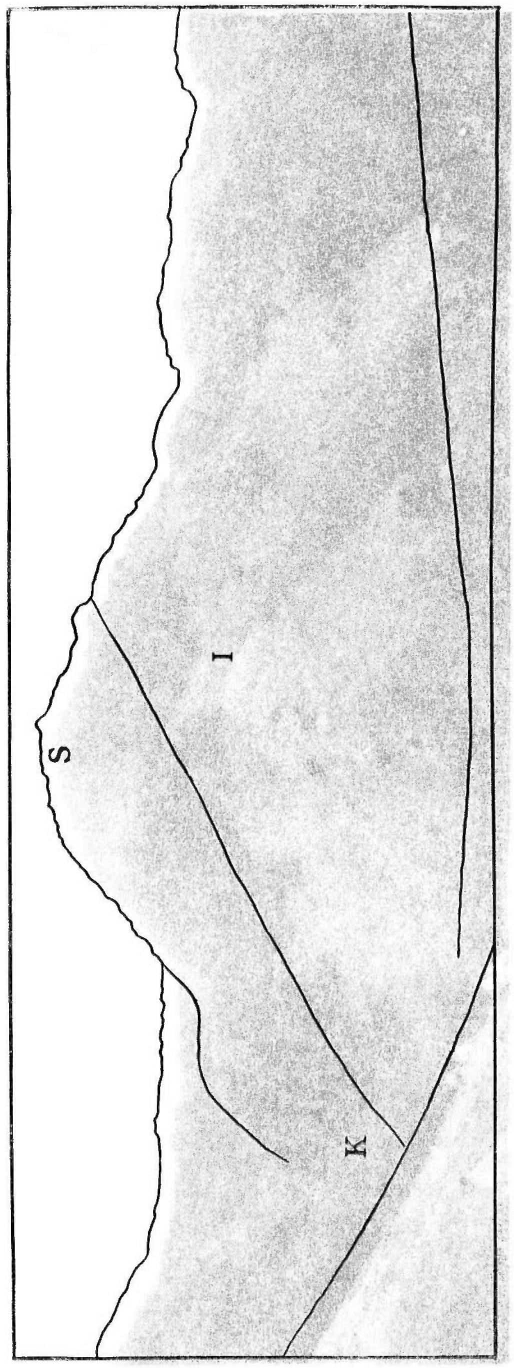
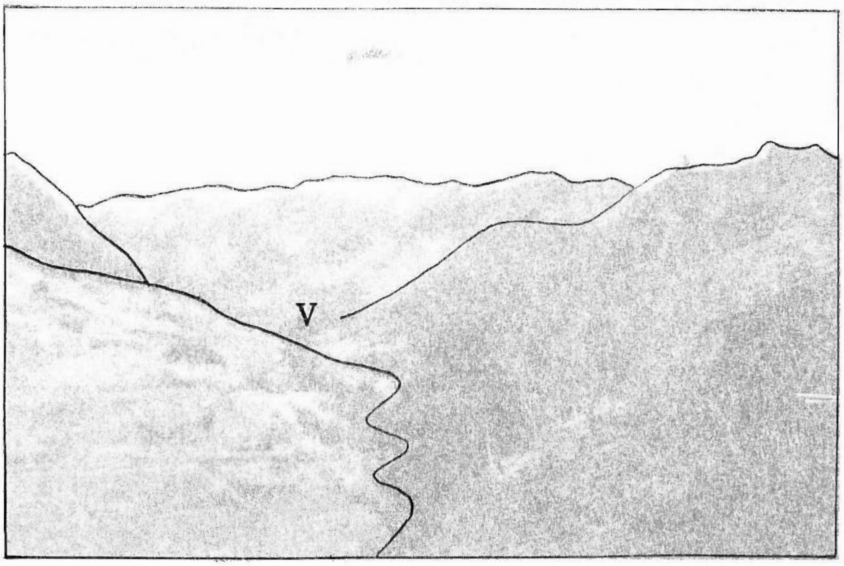

S
I
K

PLATE IX

Plate IX

Fig. 1. Photograph showing the Kamura valley (V). (Takachiho-cho, Miyazaki Prefecture)

Fig. 2. Photograph showing the conspicuous thrust fault between the Kamura formation (K) and the Toroku formation (T) at the southern part of Toroku. (Takachiho-cho, Miyazaki Prefecture)



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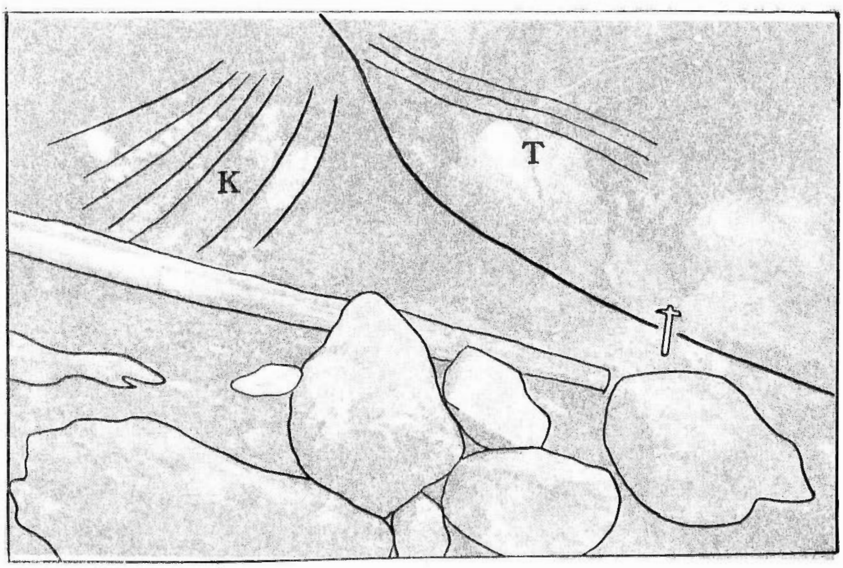

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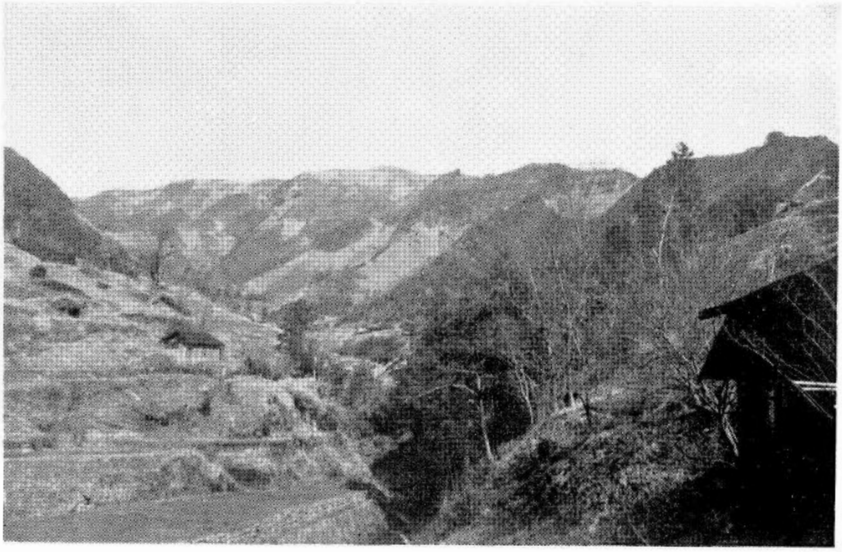

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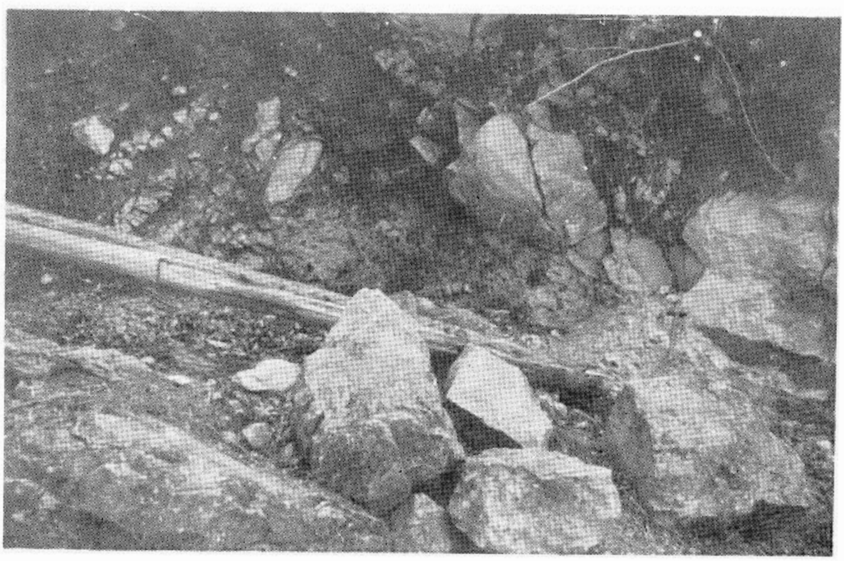

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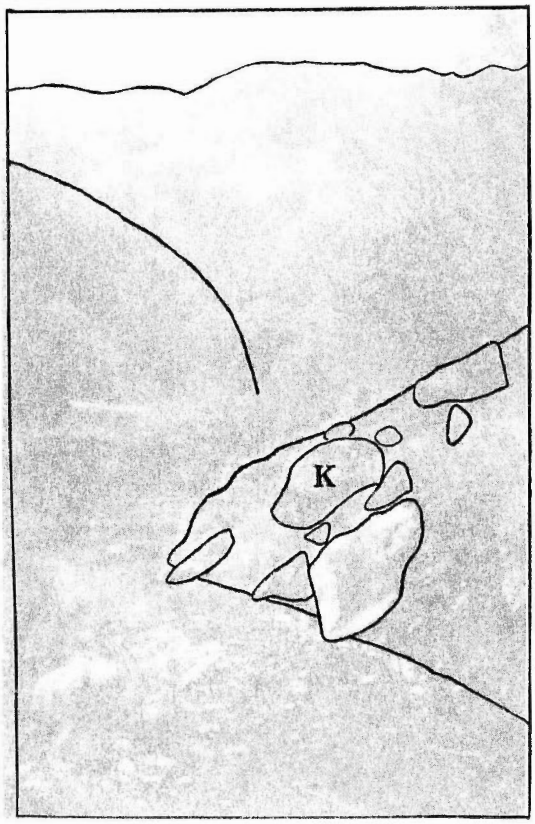
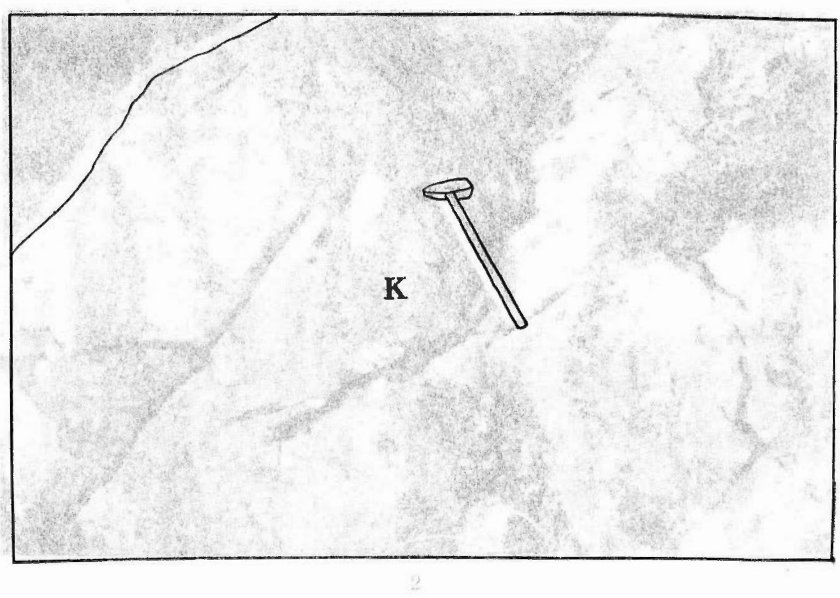
PLATE X

Plate X

Fig. 1. Photograph showing the outcrops and the large boulders of the molluscan white grayish limestone belonging to the Kamura formation (K) along the road through Kamura to Shioinouso. (Takachiho-cho, Miyazaki Prefecture)

Fig. 2. Photograph showing the outcrop of the molluscan white grayish limestone belonging to the Kamura formation (K) along the Saraito forest-road. (Takachiho-cho, Miyazaki Prefecture)





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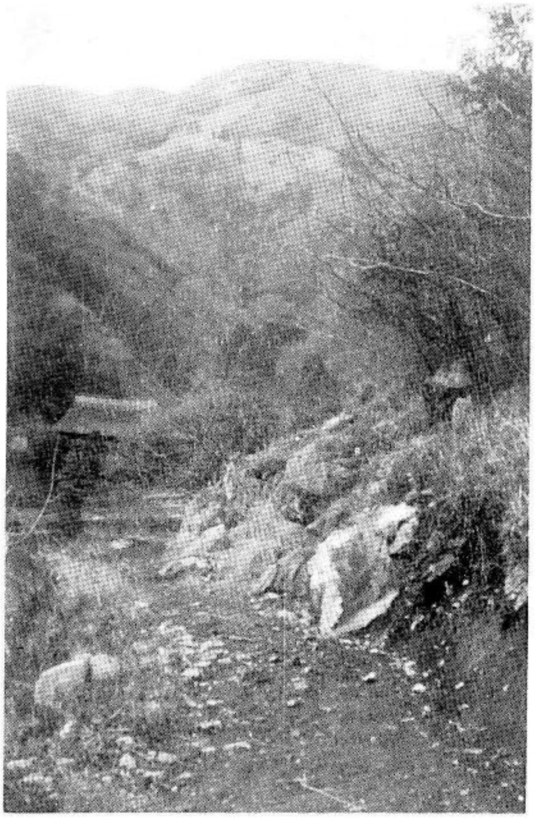

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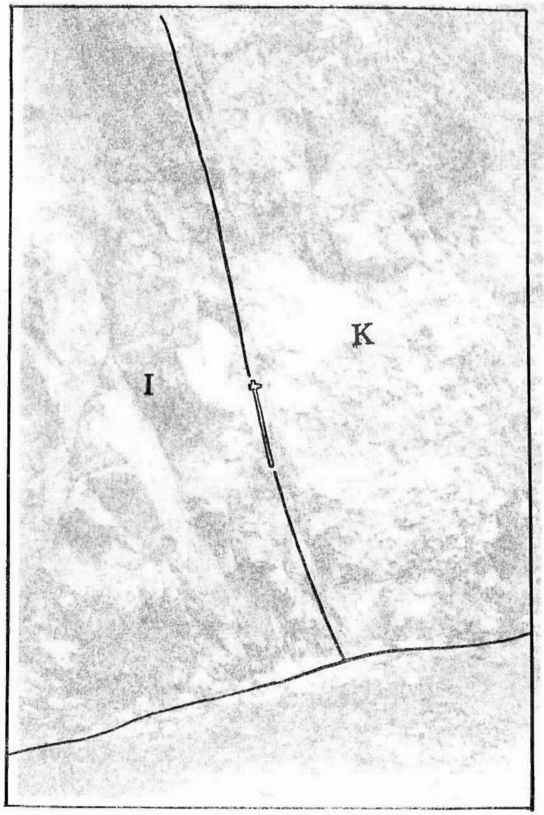
PLATE XI

Plate XI

Fig. 1. Photograph showing the boundary between the Kamura formation (molluscan white grayish limestone) (K) and the Iwato formation (fusulinid dark grayish limestone) (I), along the Saraito forest-road. (Takachiho-cho, Miyazaki Prefecture)

Fig. 2. The distant view of the Saraito forest-road (S). (Takachiho-cho, Miyazaki Prefecture)



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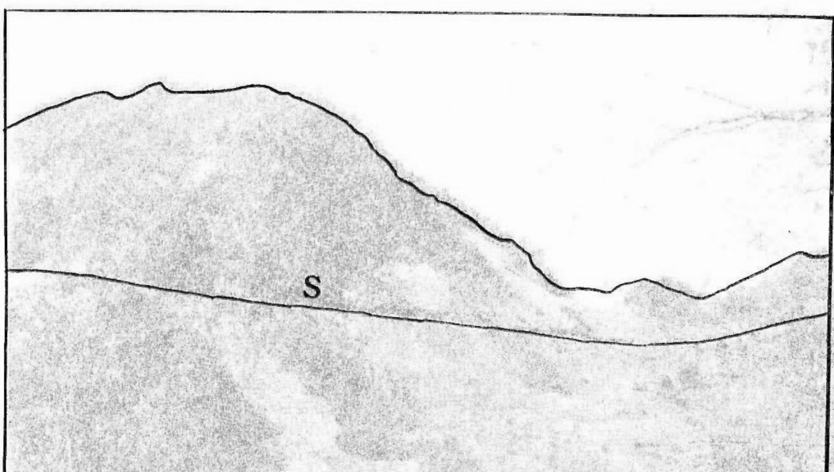

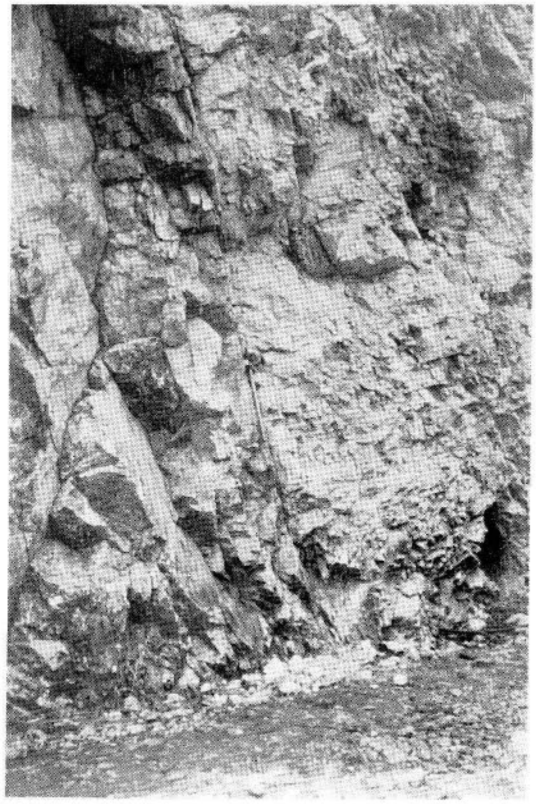

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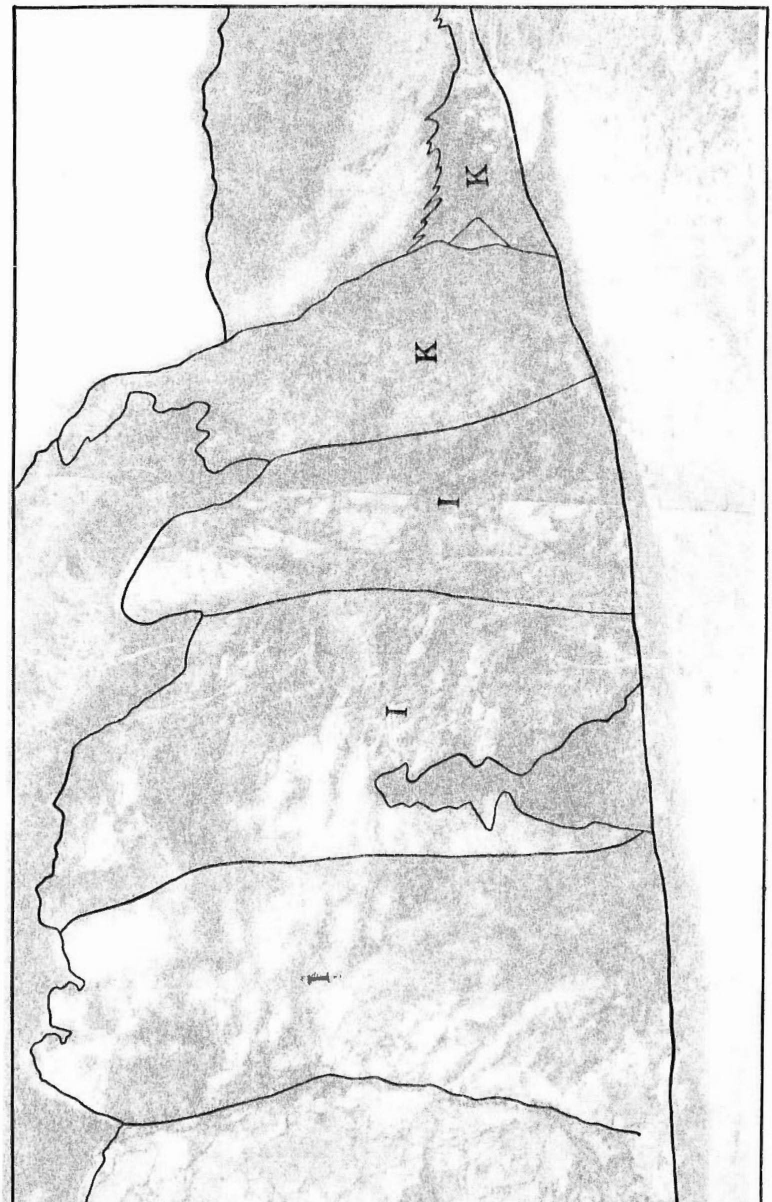
PLATE XII

Plate XII

Photograph showing the boundary between the Kamura formation (molluscan white grayish limestone) (K) and the Iwato formation (fusulinid dark grayish limestone) (I), along the Saraito forest-road. (Takachiho-cho, Miyazaki Prefecture)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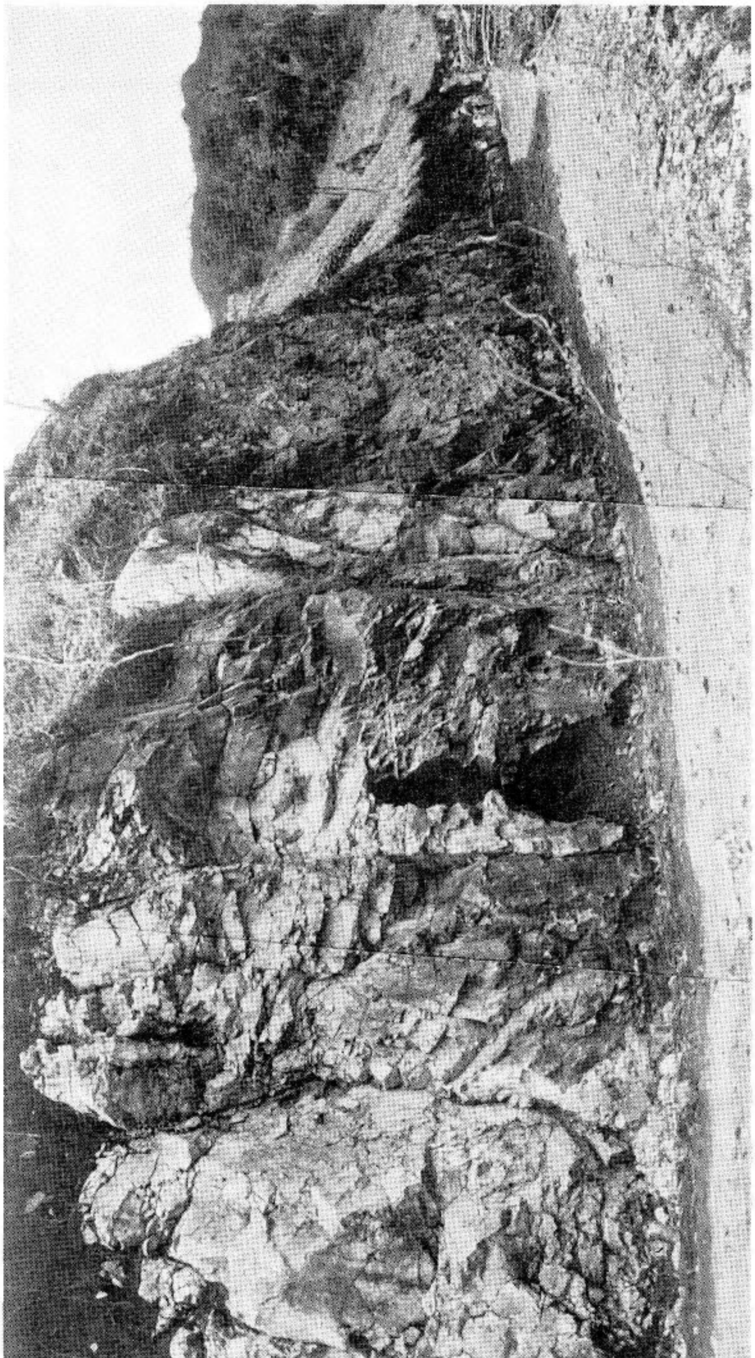

PLATE XIII

Plate XIII

Photograph showing the outcrops of the fusulinid dark grayish limestone belonging to the Iwato formation (I), along the Saraito forest-road. (Takachiho-cho, Miyazaki Prefecture)

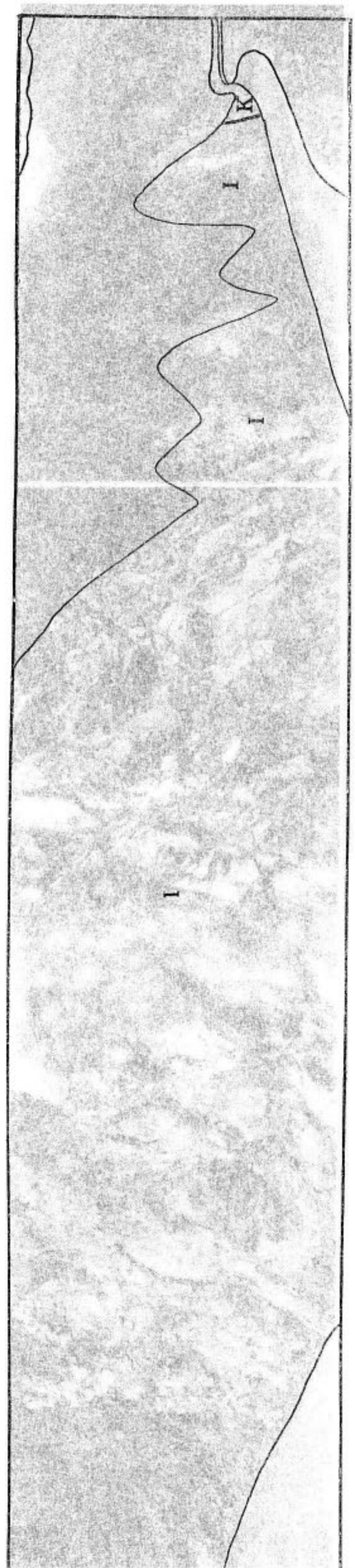
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PLATE XIV

Plate XIV

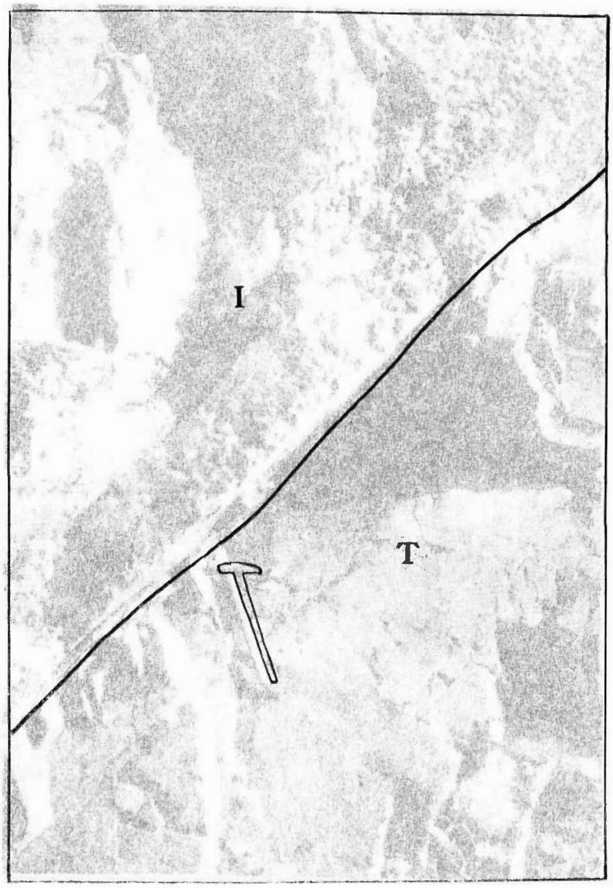
Photograph showing the outcrop of the alternation of sandstone and clayslate belonging to the Iwato formation (I), along the Saraito forest-road. (Takachiho-cho, Miyazaki Prefecture)

PLATE XV

Plate XV

Fig. 1. Photograph showing the boundary between the Inai group (basal conglomerate of the Hiraiso formation) (I) and the Toyoma group (black clayslate) (T), along the road to the east of Karakuwa in Ogatsu-machi, Miyagi Prefecture.

Fig. 2. Photograph showing the boundary between the Inai group (basal conglomerate of the Hiraiso formation) (I) and the Toyoma group (black clayslate) (T), along the road to the west of Karakuwa in Ogatsu-machi, Miyagi Prefecture.



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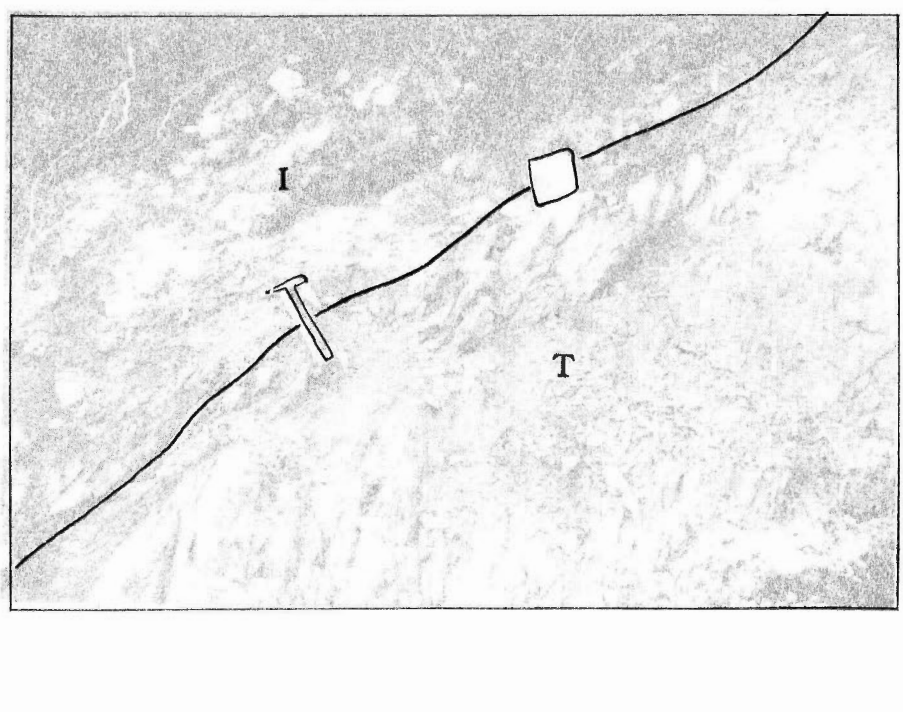

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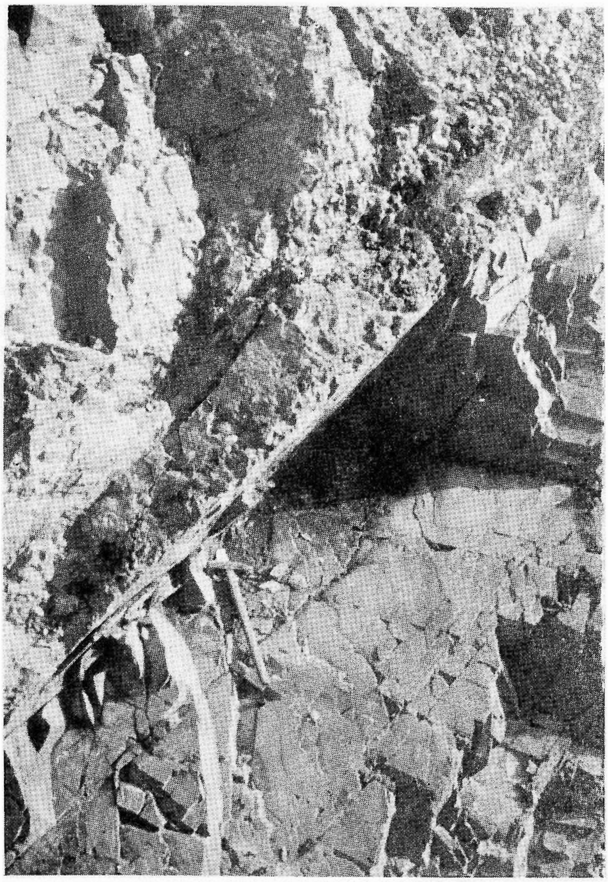

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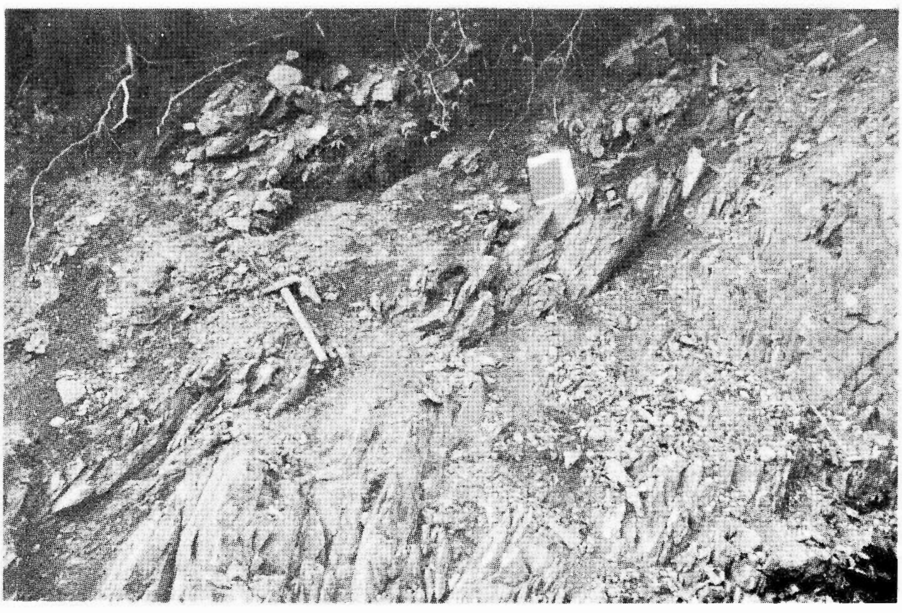

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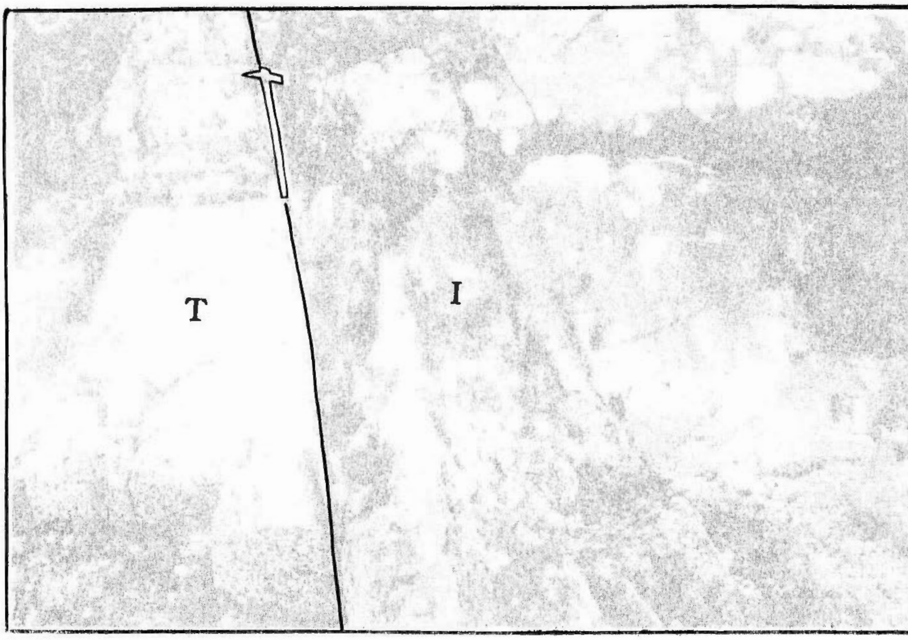
PLATE XVI

Plate XVI

Fig. 1. Photograph showing the boundary between the Inai group (basal conglomerate of the Hiraiso formation) (I) and the Toyoma group (black clayslate) (T), along the seashore to the west of Karakuwa in Ogatsu-machi, Miyagi Prefecture.

Fig. 2. Photograph showing the boundary between the Inai group (basal conglomerate of the Hiraiso formation) (I) and the Toyoma group (black clayslate) (T), at an exposure to the south of Myojin-yama in Ogatsu-machi, Miyagi Prefecture.



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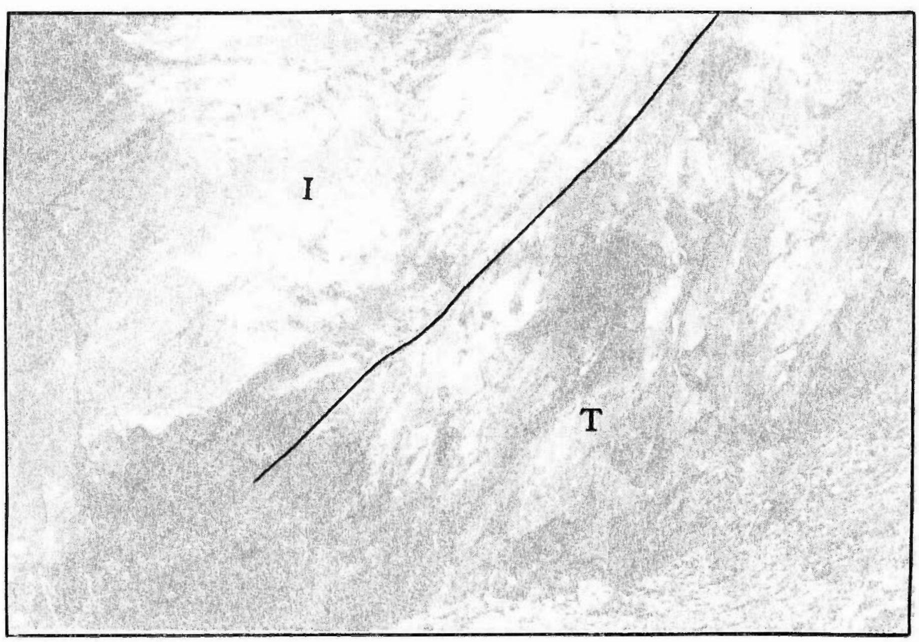

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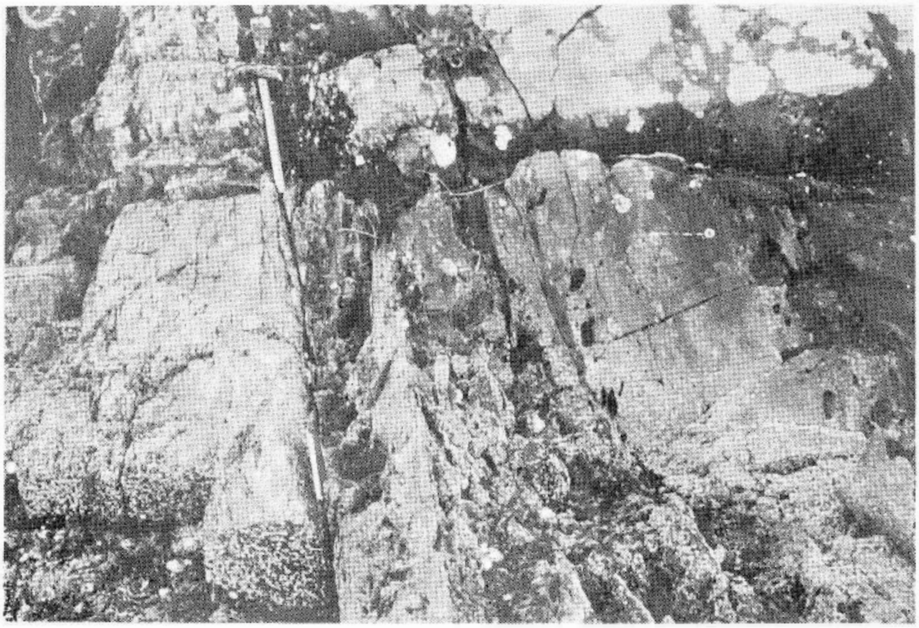


1

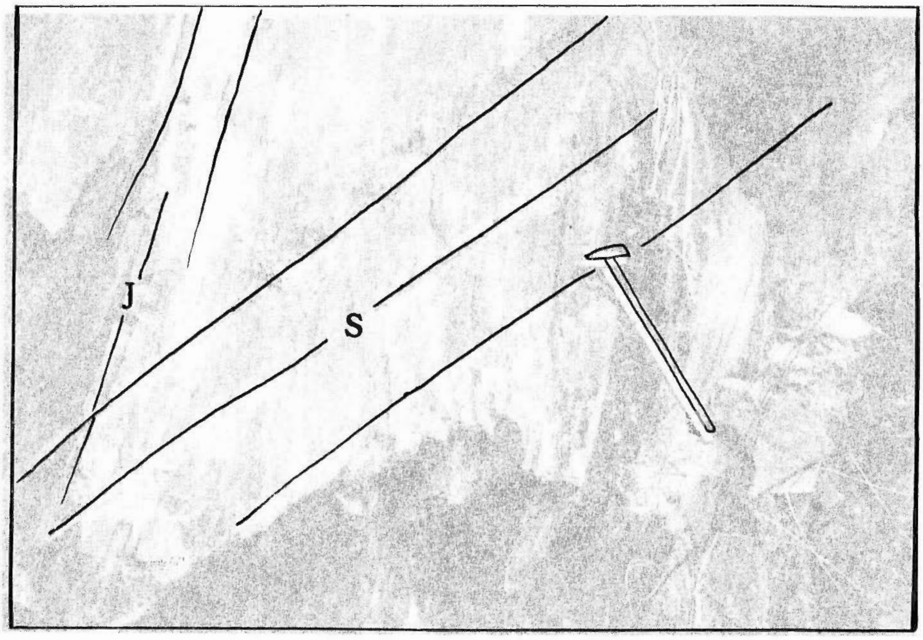
2

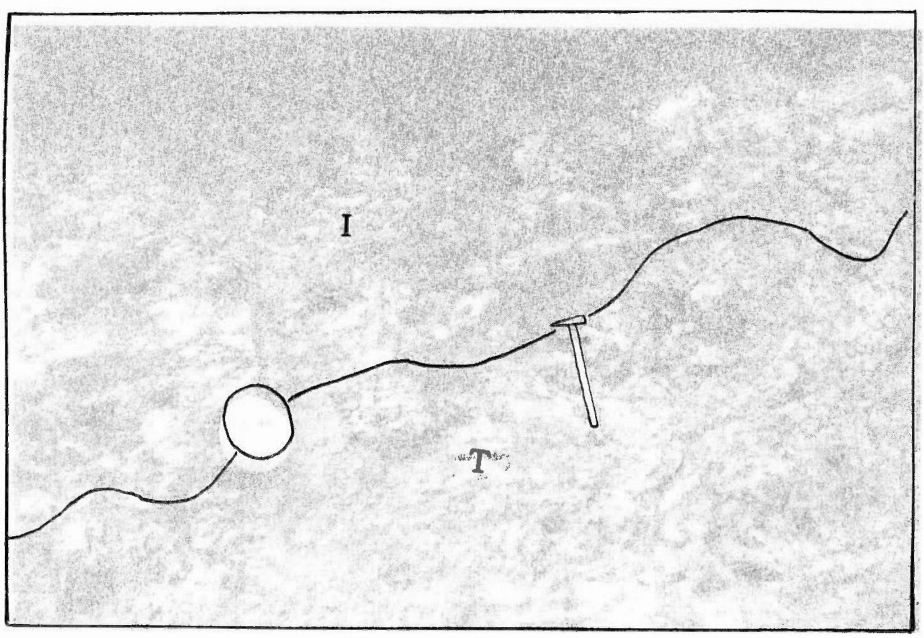
PLATE XVII

Plate XVII

Fig. 1. Photograph showing the stratigraphy (S) and the joints (J) in black clayslate belonging to the Toyoma group, at an exposure to the south of Myojin-yama in Ogatsu-machi, Miyagi Prefecture.

Fig. 2. Photograph showing the boundary between the Inai group (basal conglomerate of the Hiraiso formation) (I) and the Toyoma group (black clayslate) (T), along the road to the north of Kojima in Ogatsu-machi, Miyagi Prefecture.


J
S


I
T

1

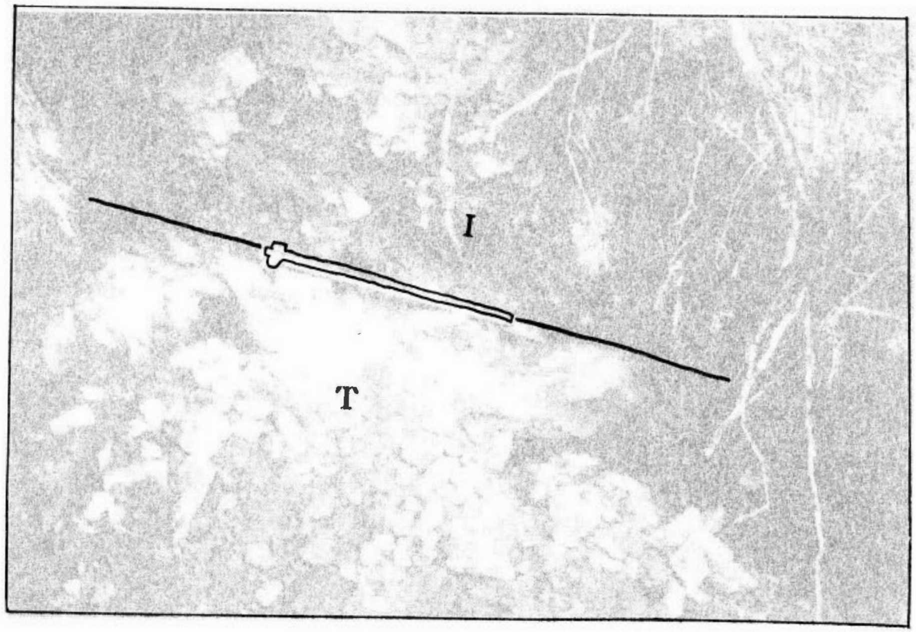
2

PLATE XVIII

Plate XVIII

Fig. 1. Photograph showing the boundary between the Inai group (basal conglomerate of the Hiraiso formation) (I) and the Toyoma group (black clayslate) (T), at Takizawa-toge to the northwest of Shizukawa-machi, Miyagi Prefecture.

Fig. 2. Photograph showing the boundary between the Inai group (basal conglomerate of the Hiraiso formation) (I) and the Toyoma group (black clayslate) (T), at Ueno-daira to the west of Motoyoshi-machi, Miyagi Prefecture.



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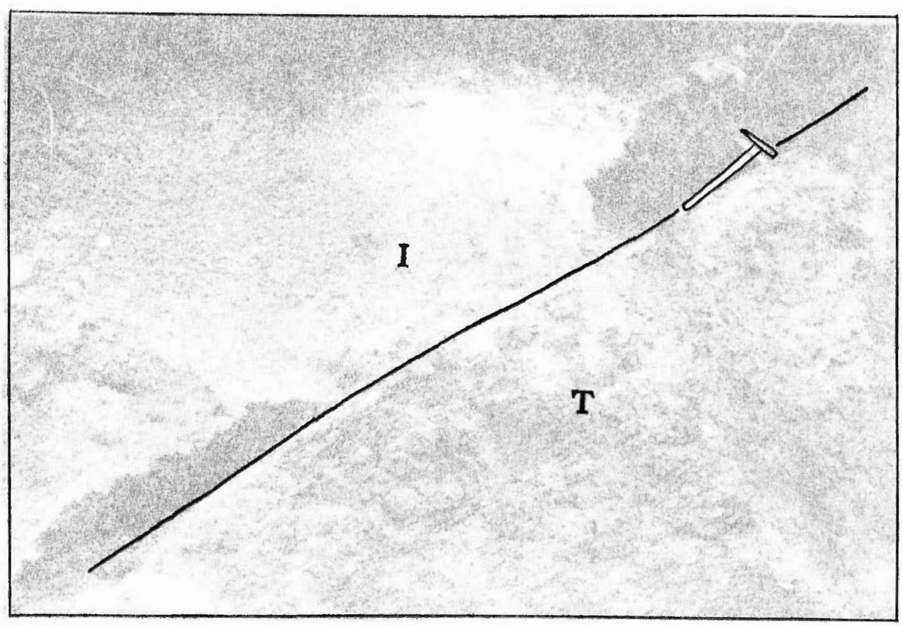

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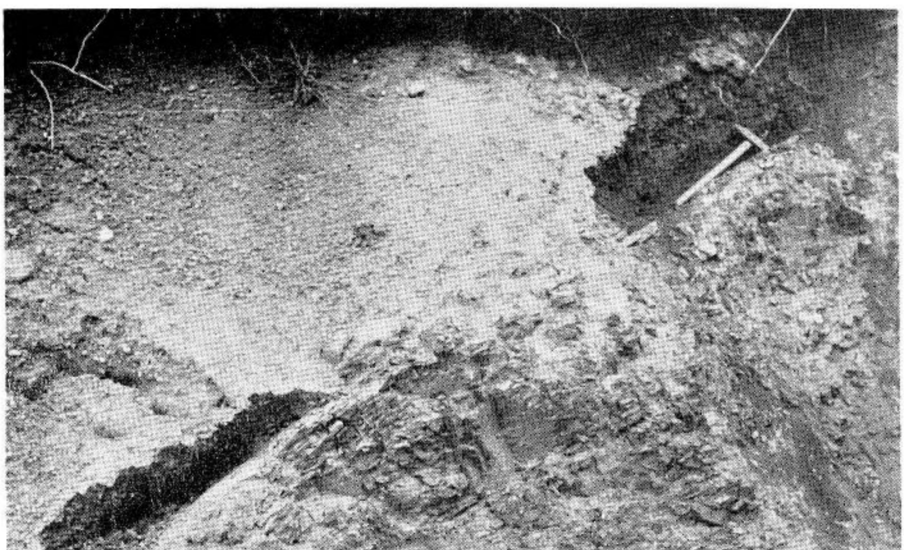

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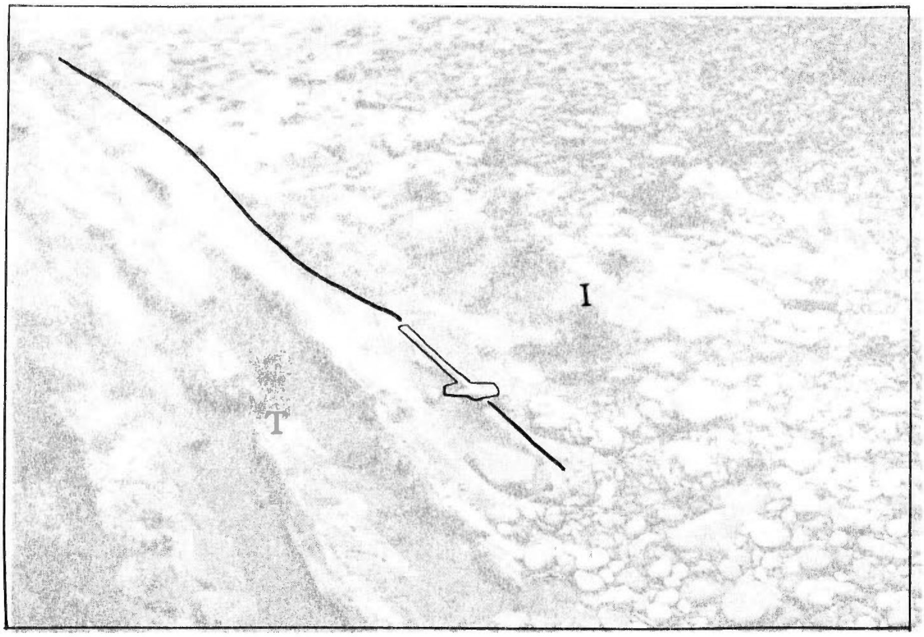
PLATE XIX

Plate XIX

Fig. 1. Photograph showing the boundary between the Inai group (basal conglomerate of the Hiraiso formation) (I) and the Toyoma group (black clayslate) (T), at the seashore of Hiraiso, in Motoyoshi-machi, Miyagi Prefecture.

Fig. 2. Photograph showing the boundary between the Inai group (basal conglomerate of the Hiraiso formation) (I) and the Toyoma group (black clayslate) (T), at Aono-zawa to the north of Karakuwa-machi, Miyagi Prefecture.



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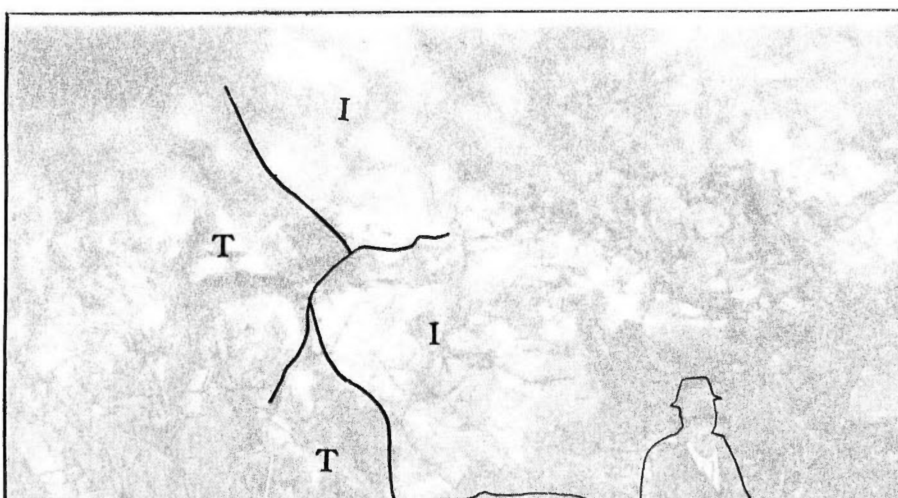

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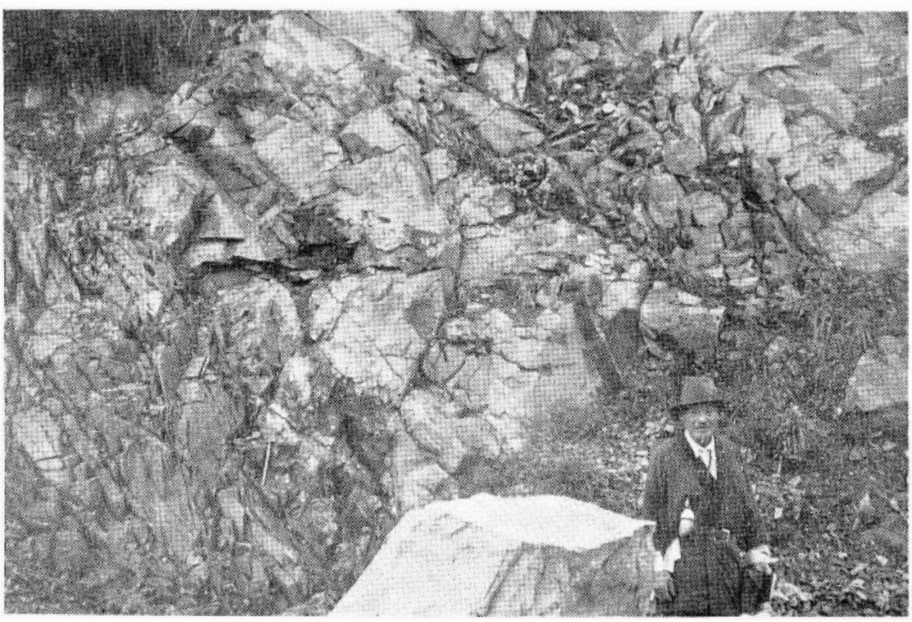

2

地質調査所報告は１報文につき報告１冊を原則とし，その分類の便宜のために次のようにアルファベットによる略号を附ける．

A．地質およびその基礎科学に関するもの
- a．地　質
- b．岩石・鉱物
- c．古生物
- d．火山・温泉
- e．地球物理
- f．地球化学

B．応用地質に関するもの
- a．鉱　床
- b．石　炭
- c．石油・天然ガス
- d．地下水
- e．農林地質・土木地質
- f．物理探鉱・化学探鉱および試錐

C．そ の 他

D．事業報告

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A. Geology & allied sciences
- a. Geology
- b. Petrology and Mineralogy
- c. Paleontology
- d. Volcanology and Hot spring
- e. Geophysics
- f. Geochemistry

B. Applied geology
- a. Ore deposits
- b. Coal
- c. Petroleum and Natural gas
- d. Underground water
- e. Agricultural geology
Engineering geology
- f. Physical prospecting
Chemical prospecting & Boring

C. Miscellaneous

D. Annual Report of Progress

地 質 調 査 所 報 告

第 193 号

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REPORT, GEOLOGICAL SURVEY OF JAPAN

No. 193

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No. 196

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No. 197

Tanaka, K.: A study on the Cretaceous sedimentation in Hokkaido, Japan, 1963 (in English)

Kambe, N.

On the Boundary between the Permian and Triassic Systems in Japan with the Description of the Permo-Triassic Formations at Takachiho-cho, Miyazaki Prefecture in Kyushu and the Skytic Fossils Contained

Nobukazu Kambe

地質調査所報告, No. 198, p. 1~68, 1963
7 illus., 19 pl., 5 tab.

In this study, the geological and structural relations between the Permian Iwato formation and the Triassic Kamura formation at Takachiho-cho, Miyazaki prefecture in Kyushu, were precisely investigated and the fossil-fauna contained in the Skytic Kamura formation was described. Moreover, the boundary problem between the Permian and the Triassic systems in Japan was discussed.

551.736+551.761 (522.7):550.85/.86

昭和 38 年 2 月 15 日 印刷
昭和 38 年 2 月 20 日 発行

工業技術院地質調査所

印刷者 笠 井 朝 義
印刷所 笠井出版印刷社

KASAI PUBLISHING & PRINTING CO.
(Pan-Pacific Press)
Minato-ku, Tokyo, Japan

地質調報
Rept. Geol. Surv. J.
No. 198, 1963