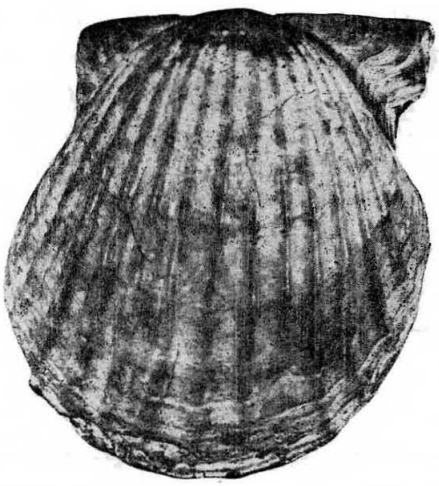
日本古生物学會報告・紀事

Transactions and Proceedings of the Palaeontological Society of Japan

New Series No. 63



日本古生物学会

Palaeontological Society of Japan
Sept. 30th, 1966

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TRANSACTIONS

All Communications relating to this Journal should be addressed to the
PALAEONTOLOGICAL SOCIETY OF JAPAN
Geological Institute, Faculty of Science, University of Tokyo, Japan

Trans. Proc. Palaeont. Japan, N. S., No. 63, pp. 261-293, Sept. 30, 1966

509. MOLLUSCAN FAUNA OF THE HIGASHI-INNAI FORMATION OF NOTO PENINSULA, JAPAN—I A GENERAL CONSIDERATION OF THE FAUNA*

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能登半島東印内層の軟体動物化石群—I：貝類化石群の一般的考察：本報は先に報告した「能登半島の中新世軟体動物」の第2報である。今回は先に報告した地域をも含めた，能登半島北東部に広く分布する東印内層の貝類化石群について研究を行つた。その結果，東印内層の貝類化石は4層準から産出することを明らかにし，各層準，産地毎の化石内容の変化，岩層変化，産状，採集の難易，成，幼貝の水平的変化，他の動物化石との関係その他についてくわしい考察を行なつた。

増田孝一郎

Introduction

Since the first report on the molluscan fossils from the Miocene Higashi-Innai Formation, Noto Peninsula, Ishikawa Prefecture (MASUDA, 1955, 1956), stratigraphical studies (ISHIDA and MASUDA, 1956, ISHIDA, 1959) have progressed and abundant specimens of molluscs and other fossils were collected from the formation.

The present article is the second report on the molluscan fauna of the Higashi-Innai Formation. In the present study an analysis was made on the molluscs which were associated with other fossils from the viewpoint of paleobiology. Thirty-four new species and one new subspecies are described.

The materials studied are preserved in the collections of the Department of Geology, Faculty of Education, Institute of Geology and Paleontology, Faculty of Science, both of the Tohoku University, of the Saito Ho-on Kai Museum, all in Sendai City and of the Geological Institute, Faculty of Science, University of Tokyo in Tokyo. Some specimens in the collection of the Kanmachi Primary School in Yanaida-mura, Fugeshi-gun, Ishikawa Prefecture were also studied.

* Received February 23, 1966; read September 25, 1965 at Nagasaki.

Acknowledgements

Appreciation is expressed to Professor Kotora HATAI of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, for his advice during the course of the present study and for reading the manuscript. Acknowledgements are due to Professor Yoshio ONUKI of the Department of Geology, Faculty of Education, Tohoku University, for his contiguous encouragement.

During the present study much support was received from the following persons to whom deep gratitude is expressed. Professor Motoki EGUCHI of the Department of Mining, Faculty of Technology, Tohoku University, for identification of the corals; Professor Rikizo IMAIZUMI of the Department of

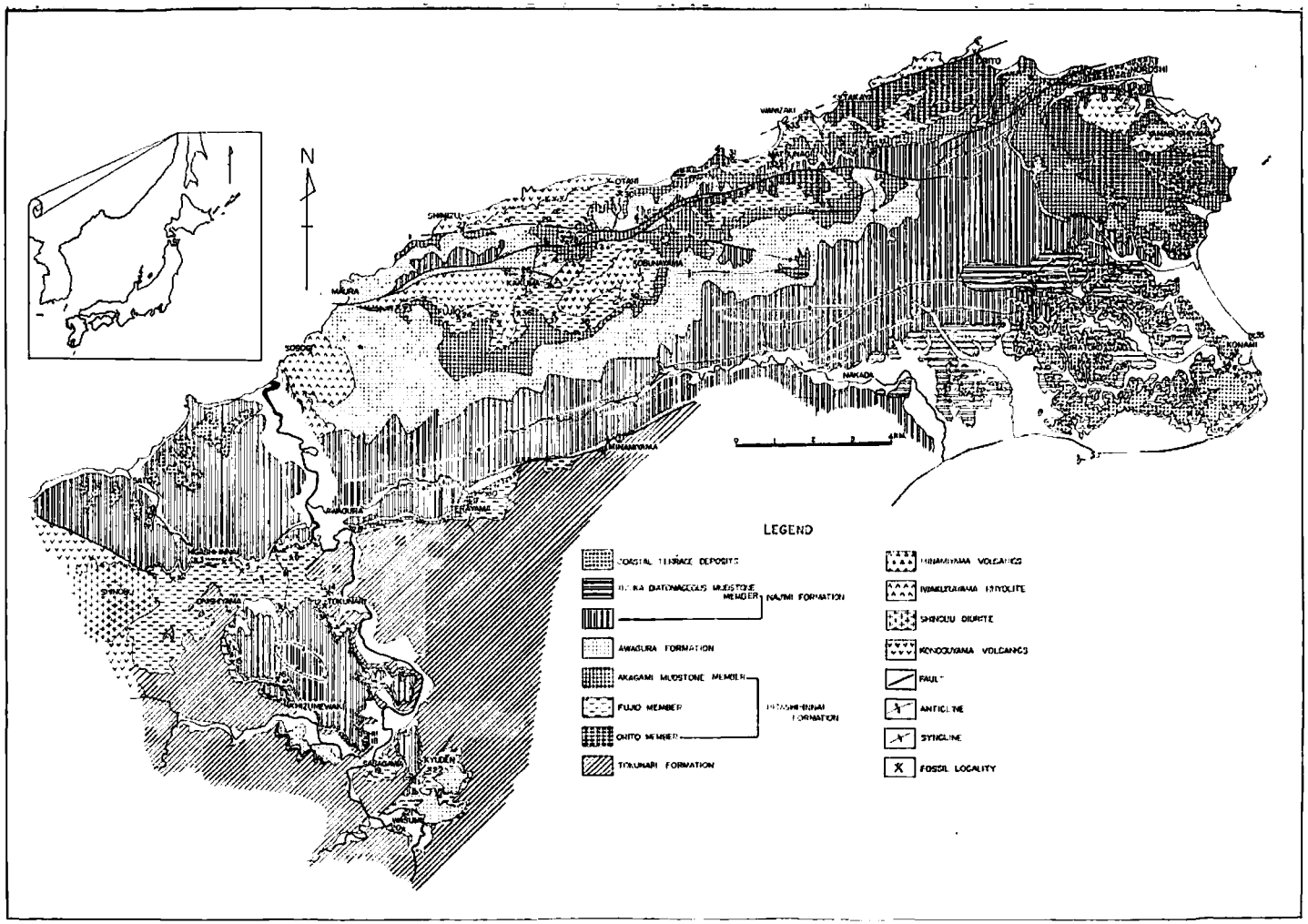

Fig. 1. Geological Map of the Northeastern Noto Peninsula.

Geology, Faculty of Arts and Sciences, Tohoku University, for identification of the crabs; Dr. Shiro ISHIDA of the Department of Geology and Mineralogy, Faculty of Science, Kyoto University, for his cooperation in the field; Drs. Shozo HAYASAKA and Hiroshi NODA of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, for their help in various ways. Messrs. Sûyû ÔHIRO, Yû SADA, Akio HAMADA, Tsuneichi TAKAGI, Shôichi SHIBANO, Hisanao HORI and their families, for kindly helping the writer in the field; Mrs. Setsuko MASUDA for her help in various ways.

Acknowledgements are also made to the Ministry of Education, for grants from the Scientific Expenditure funds.

Outline of the Geology

The strata (Fig. 1) distributed in the northeastern part of the Noto Peninsula were classified (MASUDA, 1954, ISHIDA and MASUDA, 1956) as described below in ascending order.

Kônosuyama Volcanics: Andesite, basalt intercalated with Shinobu Diorite, volcanic breccia and tuff breccia.

....(stratigraphic relation uncertain)....

Tokunari Formation: Green or gray massive rhyolitic tuff breccia and pumice tuff with andesite, basalt and dacite lavas.

.....(unconformity).....

Higashi-Innai Formation: Subdivided into the Orito, Fujio and Akagami Mudstone Members. The Orito Member consists of tuff breccia, lapilli tuff, pumice tuff, stratified fine tuff, tuffaceous mudstone and tuffaceous sandstone and yields the Orito Flora (ISHIDA, 1964) which is characterized by *Liquidambar*, *Comptonia*, *Alnus*, *Betula*, *Zelkova*, etc. The Fujio Member overlies the Orito Member and interfingers with its upper part in the northeastern area but thins out eastwards. It comprises conglomerate, sandstone and an alternation of sandstone and siltstone with molluscs, corals, echinoids, crabs, sponges, foraminifers, calcareous algae, etc. The Akagami Mudstone Member is the uppermost part of the Higashi-Innai Formation and consists of stratified mudstone. In the central to western areas the formation can not be subdivided as in the northeastern area.

.....(conformity).....

Awagura Formation and Iwakurayama Rhyolite: The former comprises stratified rhyolitic tuff breccia, pumice tuff, pumiceous fine tuff and sandy tuff, and the latter plagio-rhyolite which erupted during deposition of the formation.

.....(conformity).....

Najimi Formation: Tuffaceous mudstone and diatomaceous mudstone with a layer of glauconite in the lower part. The Iizuka Diatomaceous Mudstone Member occupies the upper part of the formation and is distributed in the eastern area. *Conchocele disjuncta* GABB, *Lucinoma* sp., etc. occur throughout the formation.

.....(unconformity).....

Minamiyama Volcanics: Trachytic dolerite and trachytic basalt. Considered to be products after the orogenic movements in the region.

.....(unconformity).....

Coastal Terrace Deposits: Deposits of sand, mud and gravel in several heights of 25 m to 150 m above sea level. The so-called Hiratoko Bed occupies the 25 m to 50 m high terrace, and abundant molluscs and foraminifers were recorded from the type locality.

The faults and folds in the present region have axis trending about east-west and are post-Najimi and pre-Hiratoko in age.

Stratigraphic Notes on the Higashi-Innai Formation

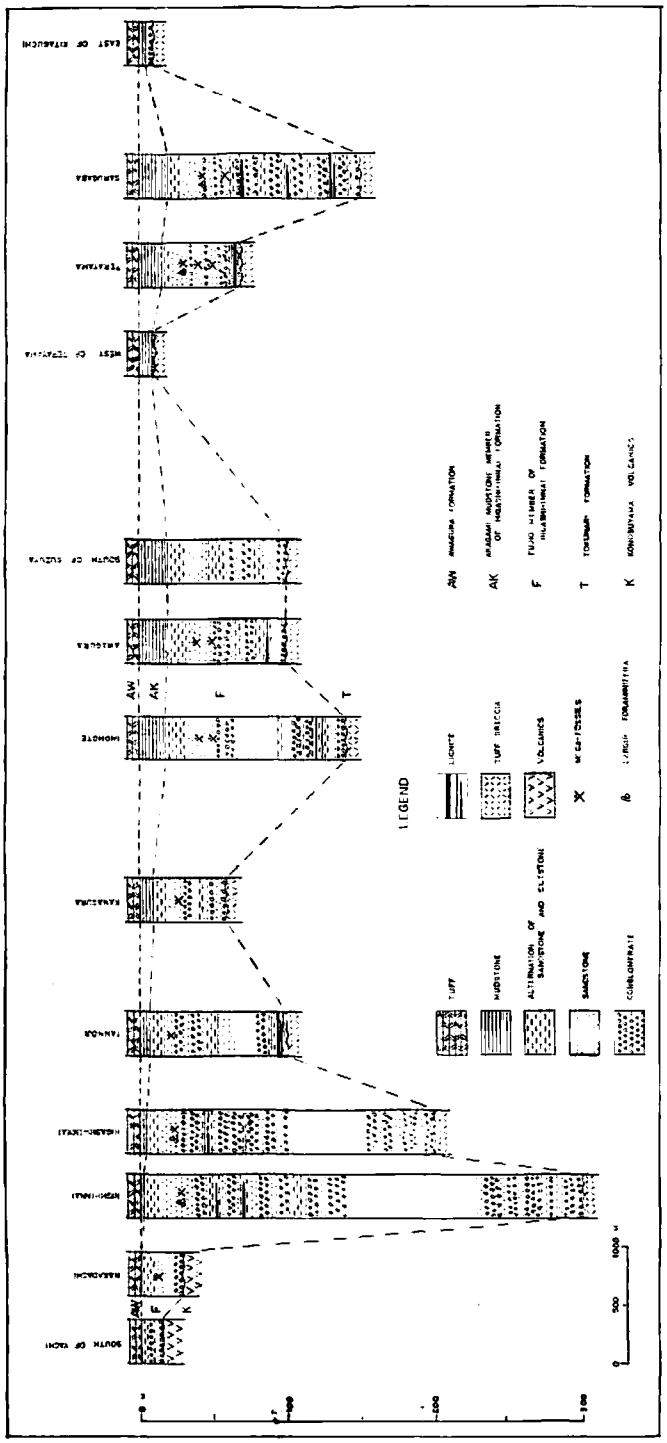

Fig. 2. Columnar sections in the Nishi-Innai—Kanagura —Terayama Area.

The Higashi-Innai Formation is distributed in the east of Wajima City, Suzu City and in a part of Yanaidamura, Fugeshi-gun, occupying an area of about 30 km in east to west direction and about 15 km in north to south. The formation is displaced by many folds and faults, most of which trend from east to west.

The lithological facies of the Higashi-Innai Formation are very variable and therefore they will be described according to area as follows.

(1) Nishi-Innai—Kanagura —Terayama Area (Fig. 2)

The Higashi-Innai Formation is about 200 m thick at Higashi-Innai. It comprises conglomerate intercalated with thin sandstone, siltstone and lignite seams, fossiliferous very coarse- to coarse-grained sandstone or conglomeratic sandstone, medium- to fine-grained sandstone and siltstone in upward sequence. The lower part of the formation is mostly of conglomerate which occupies about 2/3 of the whole thickness. It overlies with unconformity the green colored tuff breccia of the Tokunari Formation. The thin siltstone of the uppermost part attains only a few meters in thickness and is overlain by the white to gray colored

stratified fine tuff of the Awagura Formation with conformity; this may correspond to the Akagami Mudstone Member in the northeastern area. This siltstone gradually becomes thicker eastwards and near Kanagura it can be classified as a member.

This formation is thickest (about 300 m) at Nishi-Innai, west of Higashi-Innai (type locality of the formation), but it rather abruptly becomes thinner westwards and gradually thins out. In the western part of the area this formation overlies the Shinobu Diorite which intruded the Kônosuyama Volcanics.

In the eastern area the Higashi-Innai Formation overlies the tuff breccia of the Tokunari Formation and gradually becomes thinner and consequently the lower part consisting mainly of conglomerate also decreases its thickness.

At the west of Terayama this formation is about 10 m in thickness and comprises only siltstone and sandstone. However, at Terayama and Sarugaba the formation is composed of conglomerate, sandstone, siltstone, etc. and attains about 150 m in thickness, but eastwards it thins out.

The pebbles of the conglomerate are usually subangular andesite, basalt and diorite in the vicinity of Higashi-Innai but in general, the pebbles gradually become smaller and rounder eastwards. Diorite pebbles are common in the conglomerate and found distributed in the vicinities of Nishi-Innai and Higashi-Innai; these also tend to become smaller and gradually disappear eastwards.

Lignite layers are well developed in and around Terayama but elsewhere only thin lignite seams are found. Fossil shells are generally abundant but in the western part of Nishi-Innai, the vicinity of Suzuya, in the west of Terayama and the eastern part of Sarugaba none could be found. Small oysters attached to cobbles or boulders and drifted silicified woods are found in the lower conglomerate part of the formation in the vicinities of Terayama and Sarugaba. Drifted silicified woods are also found in the conglomerate near Nishi-Innai. A thin pumice tuff layer is intercalated in the lower part of the conglomerate at Tannoji and Kanagura.

(2) Southern Kanagura-Tokunari-Hizumewaki Area (Figs. 3, 4)

This area occupies the southern wing of the anticline which axis trends east to west through Kanagura. The Higashi-Innai Formation overlies with unconformity the uneven surface of the green colored tuff breccia of the Tokunari Formation and is overlain by the Awagura Formation with conformity. In this area it is composed of conglomerate, lignite layers, sandstone and an alternation of sandstone and siltstone. The siltstone in the upper part of the formation corresponds to the Akagami Mudstone Member in the northeastern area. As in the Nishi-Innai-Terayama area the Higashi-Innai Formation can not be subdivided into members.

Thick lignite layers occur in the lower part of the formation in the area south of Kanagura, Tokunari and Ônishiyama, but southwards from Tokunari and Ônishiyama the layers become thin. Comparing the formation in the Nishi-Innai-Terayama area with that in the present one, the thickness in the latter area is much less, especially the conglomerate in the lower part is very thin and the pebbles very small.

At Munehiro the Awagura Formation directly lies upon the tuff breccia of the Tokunari Formation with unconformity and the Higashi-Innai Formation is not developed.

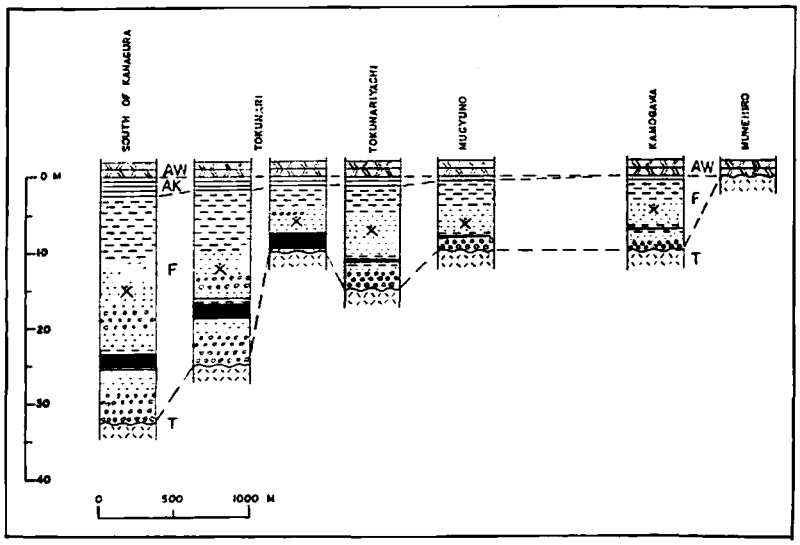

Fig. 3. Columnar sections in the southern Kanagura—Tokunari—Kamogawa Area (AW: Awagura Formation; AK: Akagami Mudstone Member of Higashi-Innai Formation; F: Fujio Member of Higashi-Innai Formation; T: Tokunari Formation).

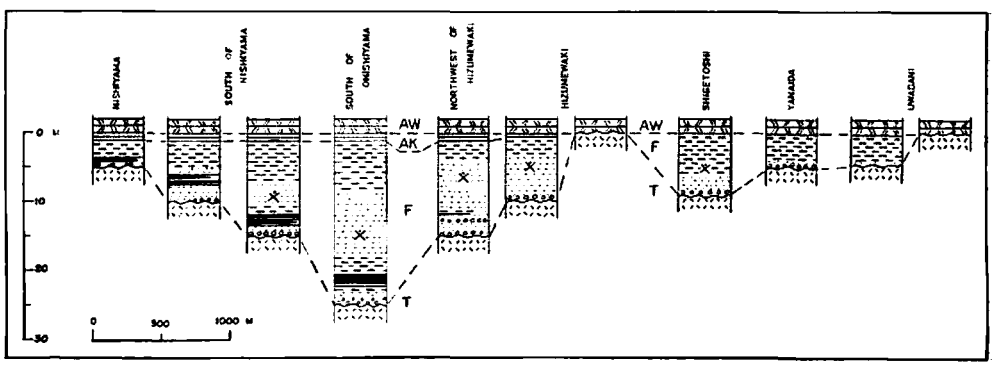

Fig. 4. Columnar sections in the Nishiyama—Hizumewaki—Uwadani Area (AW: Awagura Formation; AK: Akagami Mudstone Member of Higashi-Innai Formation; F: Fujio Member of Higashi-Innai Formation; T: Tokunari Formation).

Fossil shells are abundant in the carbonaceous sandstone to sandy siltstone overlying the conglomerate and lignite layers.

(3) Ishii-Sasagawa-Wasumi Area

This area is situated in the south of the Kanagura-Tokunari area. In this area the Higashi-Innai Formation attains only 15 m in thickness and overlies the tuff breccia of the Tokunari Formation with unconformity, and is composed of glauconite bearing tuffaceous medium- to fine-grained sandstone; its distribu-

tion is restricted to a small area. It is overlain with conformity by the Awagura Formation. Abundant sponges occur from the formation in association with molluscan shells in the glauconite bearing sandstone.

(4) Mukaiyama-Fujio-Ôtani-Wanizaki Area (Fig. 5)

The type locality of the Fujio Member is in the east of Fujio, Suzu City. It is about 110 m thick. The Fujio Member consists of conglomerate intercalated with carbonaceous siltstone and sandstone with drifted silicified woods and plant fragments, conglomerate and conglomeratic very coarse-grained sandstone, medium- to fine-grained sandstone and an alternation of sandstone and siltstone in upward succession. A thin pumice tuff layer is intercalated in the conglomerate forming the lower part of the Fujio Member which overlies the Kônosuyama Volcanics with unconformity. Molluscs, corals, crabs, foraminifers, echinoids, etc. are abundant in the conglomerate and conglomeratic very coarse- to coarse-grained sandstone. Fossil shells also occur in the carbonaceous medium- to fine-grained sandstone.

The Fujio Member is overlain by the rather thick Akagami Mudstone Member which is superposed with conformity by the Awagura Formation.

South of Mukaiyama, about 1.5 km west of the type locality, the Fujio Member is about 30 m in thickness, but at Maura, west of Mukaiyama, where the Higashi-Innai Formation is not developed, the Awagura Formation lies directly on the Kônosuyama Volcanics.

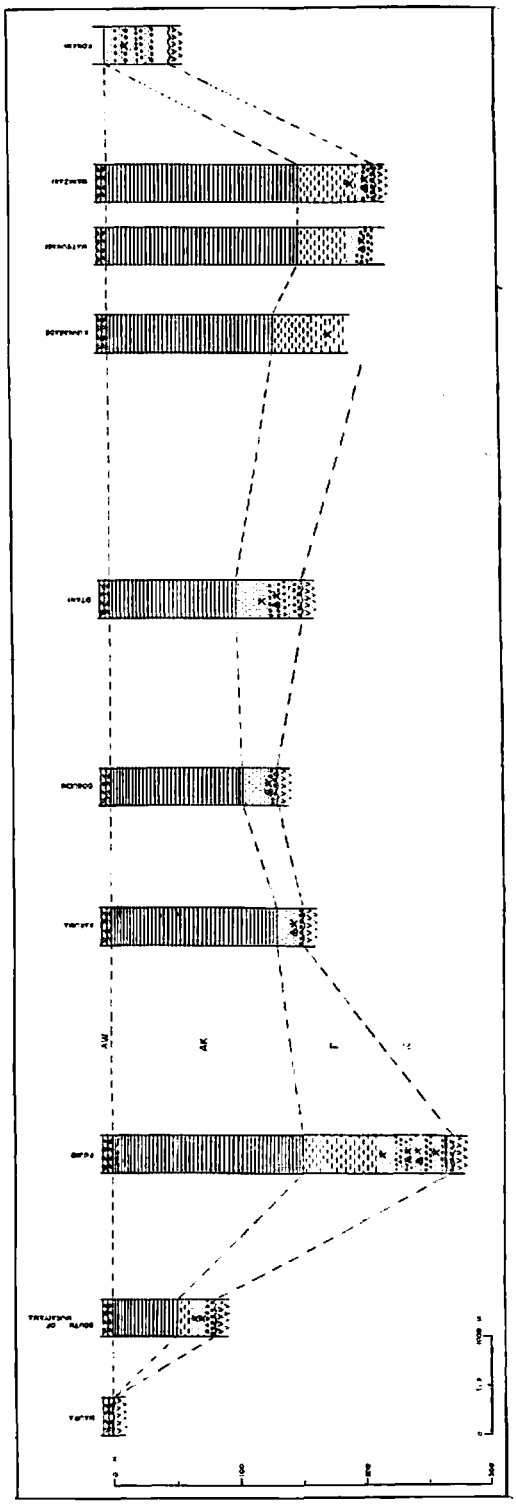

Fig. 5. Columnar sections in the Mukaiyama—Fujio—Ôtani–Wanizaki—Kônami Area (AW: Awagura Formation; AK: Akagami Mudstone Member of Higashi-Innai Formation; F: Fujio Member of Higashi-Innai Formation; K: Kônosuyama Volcanics).

At Kakuma, about 2 km east of the type locality, the Fujio Member is about 20 m in thickness and consists of conglomerate which covers with unconformity the Kônosuyama Volcanics and conglomeratic very coarse- to coarse-grained sandstone in which occur larger foraminifers, echinoids, calcareous algae and a few molluscs. At this place the alternation of sandstone and siltstone of the upper part of the member is not developed, but a glauconite bearing sandstone of about 1 m in thickness defines its uppermost part. The coarse-grained sandstone which yielded numerous *Miogypsina*, echinoids, calcareous algae, etc. is distributed in the west of Doguchi, about 1.5 km northeast of Kakuma, where at its basal part a boulder conglomerate overlies the Kônosuyama Volcanics with unconformity. The glauconite bearing sandstone mentioned above is developed at the upper part of the Fujio Member. At Ôtani, about 2 km northeast of Doguchi, the Fujio Member consists of boulder conglomerate intercalated with siltstone and sandstone, pebble to granule conglomerate, conglomeratic very coarse- to coarse-grained sandstone, medium-grained sandstone and thin glauconite bearing sandstone in upward succession. Abundant molluscs, corals, crabs, echinoid spines, *Operculina*, calcareous algae, balanids, etc. were found in the conglomerate and conglomeratic sandstone.

Eastwards from Ôtani the Fujio Member overlies and interfingers with the Orito Member and tends to become thin out.

(5) Kakuma-Sotonoyama-Kobunayama Area

This area is situated in the east of Kakuma. In this area the alternation of sandstone and siltstone of the upper part of the Fujio Member is usually better developed than the conglomerate and sandstone. In the south of Kakuma the Fujio Member overlies the Kônosuyama Volcanics with unconformity and is composed of conglomerate with lignite seams intercalated with siltstone and pumice tuff layers, conglomeratic sandstone, very coarse- to coarse-grained sandstone and an alternation of sandstone and siltstone in upward succession. The lower part is about 30 m in thickness and consists of sandstone and conglomerate. Larger foraminifers, bryozoans and molluscan shells are abundant in the conglomeratic very coarse-grained sandstone.

At Yoshiro and Sotonoyama molluscan shells were collected from the coarse-grained sandstone and a few oyster shells and silicified woods were found in the conglomerate.

Abundant larger foraminifers, echinoids and molluscs were found in the very coarse- to coarse-grained sandstone in the southwest of Kobunayama. The tuff breccia exposed at the just mentioned place may correspond to the Orito Member in which lower part is of the tuff breccia, whereas in the upper part is an alternation of sandstone and siltstone of ill development.

Lignite layers are found in the tuffaceous sandstone and siltstone of the Fujio Member in the vicinity of Nakao, about 2 km north of Sotonoyama.

(6) Kônami Area (Fig. 5)

At Kônami at the eastern end of the Noto Peninsula, about 13 km southeast of Matsunagi and about 20 km east of Sarugaba, abundant molluscan shells and corals are found in the conglomerate and conglomeratic very coarse- to coarse-grained sandstone, both of which are referable to the Fujio Member. These

are superposed on the volcanic breccia of the Kônosuyama Volcanics. The Akagami Mudstone Member is not developed in the present area.

(7) Remarks on the Sedimentary History

Judging from the extensive unconformity mentioned above it may be considered that the present field was subjected to intensive erosion before the marine transgression which lead to the deposition of the Higashi-Innai Formation. The lithologic features and Orito Flora of the Orito Member suggest deposition in a lake in the northeastern area.

The Higashi-Innai Formation was deposited on the Tokunari Formation and Kônosuyama Volcanics of tuff breccia, andesite, basalt, diorite and volcanic breccia. Considering from the variation of the sediments, thickness of the deposits and irregular unconformity surface of the Tokunari Formation and Kônosuyama Volcanics it is evident that the marine transgression was influenced by the physiographical features of the hinterland. The present field, judged from the distribution of the basement rocks of the Higashi-Innai Formation, may have been an area of irregular topography consisting of islands and indented coast line.

The development and distribution of the lignite in a limited area and the variation in the thickness of the deposits and in lithologic facies can be explained by the environmental conditions during the deposition.

From the distribution and thickness variation of the conglomerate in the lower part and the lateral changes of the lithology of the Higashi-Innai Formation, it is judged that the seas of that age flowed into the present field from the northwest towards the south to southeast as mentioned previously (MASUDA, 1954).

During the deposition of the Higashi-Innai Formation the brackish water environments are believed to have existed at places as is judged from the sulpher content in the lignite developed at Tokunari and Kanagura being less compared with that of Terayama and Ônishiyama.

The seas are considered to have gradually invaded the southern rather lowland from the northwest, while the northern area subsided gradually, resulting in the rather thick alternation of sandstone and siltstone and mudstone (Akagami Mudstone Member) in the northeastern area and thin glauconite bearing sandstone in the southern area.

Molluscan Assemblage

(1) General Statement

The living molluscan assemblage is composed of the species which are adapted to the physical and biological phenomena which constitute the environment. But the fossil assemblage of any locality may be the total accumulation composed of a biocoenosis and a thanatocoenosis. Therefore, to interpret the geological and paleoecological significances of the fossil assemblage it is necessary to made an analysis of the fossil composition from the view point of the presence or absence, abundancy, size-frequency distribution and their mode of occurrence in order to know the environmental conditions at the time of deposition.

(2) Fossil Locality

The following list includes the localities of molluscan shells of the Higashi-Innai Formation except for several

where only a few and imperfect specimens were found. The lithological characters, mode of occurrence, preservation, facility of sampling, representative species, important associated fossils and general remarks are given for each locality.

(a) Description of locality

1. Locality No. 1.

River cliff near the junction of two small roads, south of Nishi-Innai, Wajima City (Lat. 37°24′18″ N., Long. 137°02′43″ E.).

Lithology :—Calcareous granule conglomerate to very coarse-grained sandstone with some carbonaceous matter (Lower) ; medium-grained sandstone (Upper).

Occurrence :— Abundant and crowded : water worn and fragmental shells common (Lower) ; few and sporadic ; cojoined bivalves not rare : arranged parallel with the bedding plane (Upper).

Sampling :—Difficult (Lower) ; rather easy (Upper).

Representative species :— *Solariella* sp., *Littorinopsis miodelicatula* OYAMA, *Proterato minoensis* ITOIGAWA, *Mitrella notoensis*, n. sp., etc. (Lower) ; *Ostrea gravitesta* YOKOYAMA, *Dosinia tugaruana* NOMURA, etc. (Upper).

Associated fauna :—*Operculina complanata japonica* HANZAWA (C*), *Psopheticus* sp. (fragments—F), Bryozoa (C), Echinoid spine (C), Calcareous algae (C), etc.

Remarks :—The calcareous granule conglomerate of the lower part gradually changes to the medium-grained sandstone of the upper part. From the mode of occurrence it is evident that the lower molluscan assemblage was transported to the site of burial. The pelecypod shells of the lower part are characterized by the small shells. The upper molluscan assemblage may represent a life assemblage.

*—Abbreviation : A—Abundant : C—Common ; F—Few ; R—Rare.

2. Locality No. 2.

Right small river cliff near the outlet of a small tributary, about 500 m south of Nishi-Innai, Wajima City (Lat. 37°24′21″ N., Long. 137°02′38″ E.).

Lithology :— Medium-grained sandstone with some carbonaceous matter.

Occurrence :— Common and sporadic but partly crowded; shell materials dissolved.

Sampling :—Rather difficult.

Representative species :—*Anadara* cf. *makiyamai* HATAI and NISIYAMA, *Ostrea* sp., *Turritella* cf. *yoshidai* KOTAKA, etc.

Remarks :—This assemblage represents a death assemblage and may correspond to the upper part of Loc. No. 1.

3. Locality No. 3.

River floor and small road side exposure at Higashi-Innai, Wajima City (Lat. 37° 24′34″ N., Long. 137°03′00″ E.).

Lithology :— Very coarse- to medium-grained sandstone with some carbonaceous matter.

Occurrence :—Abundant and crowded ; apparently fresh but isolated bivalves common ; large shells usually arranged nearly parallel with the bedding plane.

Sampling :—Rather easy.

Representative species :—*Saccella saikaiensis*, n. sp., *Anadara makiyamai* HATAI and NISIYAMA, *Siratoria siratoriensis* (OTUKA), *Leukoma itoigawae* TSUDA, *Tellina hamadai* MASUDA, *Monilea hamadae*, n. sp., *Littorinopsis miodelicatula* OYAMA, *Neverita coticazae* (MAKIYAMA), *Cerithium ancisum* (YOKOYAMA), etc.

Associated fauna :—*Operculina complanata japonica* HANZAWA (C), Bryozoa (F), *Psopheticus* sp. (fragments—F), etc.

Remarks :—Among the molluscan shells the cojoined shells of *Felaniella ferruginata* (MAKIYAMA) and *Tellina hamadai* MASUDA are found. This molluscan assemblage may represent a death assemblage, although the shells were not transported from a remote place.

4. Locality No. 4.

River cliff, about 500 m west of Tannoji,

Wajima City (Lat. 37°24′33″ N., Long. 137°03′34″ E.).

Lithology :— Medium-grained sandstone with a few pebbles to coarse-grained sandstone with a few sandpipes.

Occurrence :—Common and crowded but partly sporadic; isolated bivalves and fragmental shells common.

Sampling :—Rather easy.

Representative species :—*Ostrea gravitesta* YOKOYAMA, *Clinocardium ogurai* (OTUKA), *Leukoma itoigawae* TSUDA, *Turritella yoshidai* KOTAKA, *Cerithidea sirakii* (MAKIYAMA), *Dentalium weinkauffi* DUNKER, etc.

Associated fauna :—Fish bone (R).

Remarks :—Cojoined valves of *Ostrea gravitesta* YOKOYAMA occur sporadically in the medium-grained sandstone in the rather upper part. The assemblage represents a death assemblage but the rather upper part may represent a life assemblage.

5. Locality No. 5.

River cliff of the Najimi-gawa at Tannoji, Wajima City (Lat. 37°24′26″ N., Long. 137°03′45″ E.).

Lithology :—Medium- to fine-grained sandstone.

Occurrence :—Few and sporadic; a few cojoined bivalves; irregularly arranged.

Sampling :—Rather easy.

Representative species :—*Acila* sp., *Ostrea* sp., *Dentalium weinkauffi* DUNKER, etc.

6. Locality No. 6.

Small road side exposure near the shrine, about 500 m north of Kanagura, Wajima City (Lat. 37°24′36″N., Long. 137°04′48″E.).

Lithology :—Medium- to fine-grained sandstone.

Occurrence :—Few and sporadic; shell materials dissolved; cojoined shells rare; irregularly arranged.

Representative species :—*Anadara* sp., *Clinocardium* sp., etc.

Sampling :—Difficult.

Remarks :—The molluscan shells are relatively small in size.

7. Locality No. 7.

Small road side cliff at Inomote, Wajima City (Lat. 37°24′48″N., Long. 137°05′13″E.).

Lithology :— Pebbles bearing calcareous fine-grained sandstone with some carbonaceous matter.

Occurrence :—Common and rather crowded; apparently fresh isolated bivalves and shell fragments common; irregularly arranged.

Sampling :—Difficult.

Representative species :—*Anadara makiyamai* HATAI and NISIYAMA, *Ostrea* cf. *denselamellosa* LISCHKE, *Teredo* sp., *Cerithidea sirakii* (MAKIYAMA), *Cerithium meisense* (MAKIYAMA), etc.

Remarks :—This assemblage represents a death assemblage but the shells may have not been transported from a remote place.

8. Locality No. 8.

Road side exposure, about 300 m SE of the shrine, Awagura, Wajima City (Lat. 37° 25′00″N., Long. 137°05′53″E.).

Lithology :—Medium-grained sandstone to carbonaceous coarse-grained sandstone.

Occurrence :—Rather common and crowded; fragmental and isolated bivalves common; irregularly arranged.

Sampling :—Difficult.

Representative species :—*Anadara makiyamai* HATAI and NISIYAMA, *Vicarya callosa japonica* YABE and HATAI, *Vicaryella notoensis* MASUDA, etc.

Remarks :—This assemblage represents a death assemblage.

9. Locality No. 9.

River cliff, about 100 m SE of Terayama Primary School, Terayama, Wajima City (Lat. 37°25′23″N., Long. 137°07′54″E.).

Lithology :—Coarse- to medium-grained sandstone with much carbonaceous matter (Lower); conglomeratic sandstone with a few silicified woods (Middle); calcareous very coarse-grained sandstone with shell fragments (Upper).

Occurrence :—Common and crowded; apparently fresh shells common (Lower); few and sporadic (Middle); few and sporadic; fragmental shells common (Up-

per).

Sampling :—Rather easy (Lower and Middle) : difficult (Upper).

Representative species :—*Joannisiella meisensis* MAKIYAMA, *Cyclina japonica* KAMADA, *Vicarya callosa japonica* YABE and HATAI, *Vicaryella notoensis* MASUDA, *Polinices meisensis* MAKIYAMA, etc. (Lower) ; *Polinices meisensis* MAKIYAMA (Middle) ; *Ostrea* sp. (Upper).

Associated fauna :—*Operculina complanata japonica* HANZAWA (F), Echinoid spine (C), etc. (Upper).

Remarks :—The shell fragments in the upper part can hardly be determined. They represent a death assemblage. The lower assemblage represents a death assemblage but it probably was not transported from a remote place considered from the preservation of fossils. The middle assemblage may represent a life assemblage.

10. Locality No. 10.

River cliff, about 600 m east of Terayama Primary School, Sarugaba, Wajima City (Lat. 37°25′30″ N., Long. Long. 137°08′10″ E.).

Lithology :—Silty fine- to medium-grained sandstone with much carbonaceous matter (Lower) ; conglomeratic very coarse-grained sandstone with boulders (Upper).

Occurrence :—Common but not crowded ; shell fragments and isolated bivalves common (Upper) ; common and sporadic ; cojoined valves of *Ostrea* not rare (Lower).

Sampling :—Rather easy (Lower) : easy (Upper).

Representative species :—*Ostrea* sp., *Teredo* sp., *Vicaryella notoensis* MASUDA, etc. (Lower) : *Chlamys iwamurensis* ITOIGAWA, *Ostrea* cf. *denselamellosa* LISCHKE, *Turbo ozawai* OTUKA, *Rissoina naomiae*, n. sp., *Cerithium ancisum* (YOKOYAMA), etc. (Upper).

Associated fauna :—*Operculina complanata japonica* HANZAWA (F), Echinoid spine (C), Calcareous algae (F), etc. (Upper).

Remarks :—*Vermetus* sp. attached to a pebble and cojoined *Katelysia nakamurai* IKEBE are found and the shell bearing conglomeratic sandstone fills the space between boulders in the upper part. The molluscan assemblage of the upper part may represent a mixture of the life and death assemblages. The molluses of the lower part may represent a life assemblage.

11. Locality No. 11.

Small road side exposure, about 700 m south of Kanagura, Wajima City (Lat. 37°23′57″N., Long. 137°04′37″E.).

Lithology :—Silty fine- to medium-grained sandstone with much carbonaceous matter.

Occurrence :—Few and sporadic ; shell materials dissolved ; arranged nearly parallel with the bedding plane.

Sampling :—Rather difficult.

Representative species :—*Anadara makiyamai* HATAI and NISIYAMA, *Vicarya callosa japonica* YABE and HATAI, *Vicaryella notoensis* MASUDA, etc.

12. Locality No. 12.

Northern cliff of the closed Machino Coal Mine, about 300 m west of Tokunari, Wajima City (Lat. 37°24′00″N., Long. 137°05′24″E.).

Lithology :—Sandy siltstone to silty fine-grained sandstone with much carbonaceous matter.

Occurrence :—Common and crowded but partly sporadic ; cojoined bivalves and apparently fresh shells common.

Sampling :—Rather easy.

Representative species :—*Anadara kurosedaniensis* HATAI and NISIYAMA, *Brachidontes* sp., *Clementia japonica* MASUDA, *Cyclina japonica* KAMADA, *Tellina hamadai* MASUDA, *Cultellus izumoensis* YOKOYAMA, *Littorinopsis miodelicatula* OYAMA, *Teinostoma yabei* MASUDA, *Vicarya callosa japonica* YABE and HATAI, *Vicaryella notoensis* MASUDA, *Nassarius notoensis* MASUDA, etc.

Remarks :—Judging from the occurrence the molluscan assemblage may represent

a life assemblage or it has been not subjected the transportation from a remote place.

13. Locality No. 13.

Small river cliff and river floor, near the closed Machino Coal Mine, southwest of Tokunari, Wajima City (Lat. 37°23′49″N., Long. 137°05′25″E.).

Lithology :—Silty fine-grained sandstone with much carbonaceous matter.

Occurrence :—Common and crowded; co-joined bivalves common; arranged nearly parallel with the bedding plane.

Sampling :—Rather difficult.

Representative species :—*Anadara kurosedaniensis* HATAI and NISIYAMA, *Vicarya callosa japonica* YABE and HATAI, *Vicaryella notoensis* MASUDA, etc.

Remarks :—The molluscan shells from this locality mainly consist of cojoined bivalves, apparently fresh isolated bivalves or apparently fresh shells. The molluscan assemblage of this locality consists of rather fewer number of species and rather larger number of individuals compared with that of Locality No. 12.

14. Locality No. 14.

Small road side exposure, about 500 m SWS of 210.8 triangle point, northwest of Tokunari, Wajima City (Lat. 37°24′08″N., Long. 137°05′25″E.).

Lithology :—Medium- to fine-grained sandstone with much carbonaceous matter.

Occurrence :—Rather common and sporadic; shell materials dissolved; arranged parallel with the bedding plane.

Sampling :—Rather difficult.

Representative species :—*Anadara* sp., *Soletellina minoensis* YOKOYAMA, *Vicaryella notoensis* MASUDA, etc.

Remarks :—This molluscan assemblage may represent a death assemblage but they were probably not transported from a remote place as the shells mainly consist of apparently fresh shells.

15. Locality No. 15.

Small cliff near stream, about 1.5 km SES of Onishiyama, Wajima City (Lat. 37°23′10″N., Long. 137°03′45″E.).

Lithology :—Coarse-grained sandstone with much carbonaceous matter.

Occurrence :—Common and crowded; shell materials dissolved; fragmental shells rather common.

Sampling :—Rather difficult.

Representative species :—*Anadara makiyamai* HATAI and NISIYAMA, *Ostrea* sp., *Clementia* sp., *Dentalium weinkauffi* DUNKER, etc.

Remarks :—Judging from the occurrence the molluscan shells may represent a mixture of the life and death assemblages.

16. Locality No. 16.

River floor, about 700 m northwest of Hizumewaki, Yanaida-mura, Fugeshi-gun (Lat. 37°22′57″N., Long. 137°04′34″E.).

Lithology :—Fine- to medium-grained sandstone.

Occurrence :—Few and sporadic; shell materials dissolved; isolated bivalves and fragmental shells common.

Sampling :—Rather difficult.

Representative species :—*Anadara makiyamai* HATAI and NISIYAMA, *Clementia* sp., etc.

17. Locality No. 17.

Small cliff, about 300 m west of Hizumewaki, Yanaida-mura, Fugeshi-gun (Lat. 37°22′36″N., Long. 137°04′49″E.).

Lithology :—Silty fine-grained sandstone with some carbonaceous matter.

Occurrence :—Few and sporadic; shell materials dissolved.

Sampling :—Difficult.

Representative species :— *Anadara* sp., *Vicaryella* sp., etc.

18. Locality No. 18.

Small road side exposure along the small stream at Ishii, Yanaida-mura, Fugeshi-gun (Lat. 37°22′05″N., Long. 137°06′08″E.).

Lithology :—Glauconite bearing tuffaceous coarse-grained sandstone.

Occurrence :—Common and crowded; shell materials dissolved; isolated and water worn shells common; arranged nearly

parallel with the bedding plane.
Sampling :—Rather easy.
Representative species :—*Ostrea* sp., *Crassatellites suyamensis* OINOMIKADO, *Clinocardium* sp., etc.
Associated fauna :—*Aphrocallistes* sp. (A), *Carcharodon megalodon* (CHARLESWORTH) (R), etc.

19. Locality No. 19.
Small river cliff near road extending from Sasagawa to Wasumi, Sasagawa, Yanaida-mura, Fugeshi-gun (Lat. 37°21′39″N., Long. 137°06′10″E.).
Lithology :—Glauconite bearing tuffaceous medium- to fine-grained sandstone.
Occurrence :—Few and sporadic; shell materials dissolved; isolated bivalves and fragmental shells common.
Sampling :—Rather difficult.
Representative species :—*Placopecten protomollitus* (NOMURA), *Delectopecten peckhami* (GABB), etc.
Associated fauna :—*Aphrocallistes* sp. (A), *Terebratulina honsyuensis* NOMURA and HATAI (F), etc.
Remarks :—Perfect sponges and sponge fragments arranged parallel with the bedding plane.

20. Locality No. 20.
Cliff of the Kanmachi Primary School ground and a small road side exposure, Wasumi, Yanaida-mura, Fugeshi-gun (Lat. 37°20′54″N., Long. 137°06′45″E.).
Lithology :—Glauconite bearing tuffaceous fine-grained sandstone.
Occurrence :—Common and sporadic but partly crowded; cojoined bivalves and apparently fresh shells common.
Sampling :—Easy to rather easy.
Representative species :—*Glycymeris direlicta* (YOKOYAMA), *Kotorapecten kagamianus moniwaensis* (MASUDA), *Limatula minoensis* ITOIGAWA, *Thyasira* sp., etc.
Associated fauna :—*Terebratulina honsyuensis* NOMURA and HATAI (F), *Otoliths* sp. (F), Fish scale (F), *Aphrocallistes* sp. (A), etc.
Remarks :—The molluscan assemblage of this locality may represent a life assemblage but the sponges were probably transported from elsewhere.

22. Locality No. 21.
River side cliff, Wasumi, Yanaida-mura, Fugeshi-gun (Lat. 37°20′58″N., Long. 137°06′52″E.).
Lithology :—Glauconite bearing tuffaceous fine-grained sandstone.
Occurrence :—Common and sporadic; isolated bivalves common but apparently fresh; arranged irregularly.
Sampling :—Easy.
Representative species :—*Ostrea* sp.
Associated fauna :—*Aphrocallistes* sp. (A), *Terebratulina honsyuensis* NOMURA and HATAI (C), *Coptothyris grayi* (DAVIDSON) (F), etc.
Remarks :—This molluscan assemblage is characterized by the small shells.

22. Locality No. 22.
Small river cliff near road, about 700 m south of Kyûden, Yanaida-mura, Fugeshi-gun (Lat. 37°21′42″N., Long. 137°09′02″E.).
Lithology :—Massive sandy siltstone with carbonaceous matter.
Occurrence :—Common and rather crowded; shell materials dissolved; cojoined bivalves not rare; arranged irregularly.
Sampling :—Rather easy.
Representative species :—*Anadara* sp., *Saxolucina k-hataii* (OTUKA), *Raeta* sp., *Macoma*. sp, etc.

23. Locality No. 23.
River cliff, about 1 km SES of Mukaiyama, Suzu City (Lat. 37°28′05″N., Long. 137°06′39″E.).
Lithology :—Granule conglomerate to very coarse-grained sandstone with lignite fragments (Lower); medium-grained sandstone (Upper).
Occurrence :—Abundant and crowded; isolated bivalves, water worn and fragmental shells common but apparently fresh and cojoined bivalves not rare (Lower); rare and sporadic; shell materials disolved (Upper).

Sampling :—Rather easy.

Representative species :—*Saccella saikaiensis*, n. sp., *Anadara makiyamai* HATAI and NISIYAMA, *Chlamys iwamurensis* ITOIGAWA, *Ostrea* cf. *denselamellosa* LISCHKE, *Pillucina yokoyamai* (OTUKA), *Clinocardium ogurai* (OTUKA), *Dosinia tugaruana* NOMURA, *Clementia japonica* MASUDA, *Leukoma itoigawae* TSUDA, *Paphia suzuensis*, n. sp., *Siratoria siratoriensis* (OTUKA), *Tellina hamadai* MASUDA, *Vicaryella ishiiana* (YOKOYAMA), *Cerithidea sirakii* (MAKIYAMA), *Batillaria toshioi*, n. sp., *Cerithium ancisum* (YOKOYAMA), *Pachycrommium japonicum* KANNO, *Neverita coticazae* (MAKIYAMA), *Phos notoensis*, n. sp., *Dentalium weinkauffi* DUNKER, etc. (Lower) ; *Paphia* sp., *Clinocardium* sp., etc. (Upper).

Remarks :—A large sized *Ostrea gravitesta* YOKOYAMA is found in the medium-grained sandstone immediately overlying the mollusc-rich bearing granule conglomerate to very coarse-grained sandstone. The molluscan shells of the lower part represent a death assemblage but may have not been transported from very remote places.

24. Locality No. 24.

River cliff, about 500 m east of Fujio, Suzu City (Lat. 37°27′59″N., Long. 137°07′40″E.).

Lithology :— Coarse- to medium-grained sandstone with abundant plant fragments (Uppermost) : conglomeratic very coarse-grained sandstone or pebble conglomerate (Upper) ; calcareous coarse- to medium-grained sandstone (Middle) ; medium- to fine-grained sandstone with much carbonaceous matter (Lower).

Occurrence :—Few and sporadic ; arranged parallel with the bedding plane (Uppermost) ; abundant and crowded ; apparently fresh shells not rare (Upper) ; abundant and crowded ; fragmental shells common (Middle) ; common and crowded but partly sporadic ; isolated bivalves common (Lower).

Sampling :—Rather easy (Uppermost, Upper and Middle) ; rather difficult (Lower).

Representative species :—*Ostrea* sp., *Macoma* sp., *Vicarya callosa japonica* YABE and HATAI, *Vicaryella notoensis* MASUDA, etc. (Uppermost) ; *Anadara makiyamai* HATAI and NISIYAMA, *Dosinia akaisiana* NOMURA, *Leukoma itoigawae* TSUDA, *Turbo ozawai* OTUKA (shell—F, operculum—A), *Littorinopsis miodelicatula* OYAMA, *Architectonica kurodae* TSUDA, *Cerithium ancisum* (YOKOYAMA), *Pachycrommium japonicum* KANNO, *Neverita coticazae* (MAKIYAMA), *Strigatella notoensis*, n. sp., *Oliva osawanoensis* TSUDA, *Conus tokunagai* OTUKA, *Dentalium weinkauffi* DUNKER, etc. (Upper) : *Chlamys iwamurensis* ITOIGAWA, *Ostrea* cf. *denselamellosa* LISCHKE, *Clinocardium ogurai* (OTUKA), *Dosinia akaisiana* NOMURA, *Leukoma itoigawae* TSUDA, etc. (Middle) ; *Ostrea* sp., *Anisocorbula peregrina* (YOKOYAMA), *Vicaryella ishiiana* (YOKOYAMA), *Nassarius notoensis* MASUDA, etc. (Lower).

Associated fauna :—*Protolobophyllia* sp. (F), *Meandera* sp. (F), *Operculina complanata japonica* HANZAWA (F), *Miogypsina kotoi* HANZAWA (C), *Psopheticus* sp. (fragment —F), Bryozoa (C), Echinoid spine (C), etc. (Upper) ; *Operculina complanata japonica* HANZAWA (C), Bryozoa (C), Echinoid spine (C), *Psopheticus* sp. (fragment—F), etc. (Middle).

Remarks :—The molluscan shells of the uppermost part may represent a life assemblage. Those of the lower part may represent a mixture of the life and death assemblages. From the field observation it is considered that the molluscan shells from the upper and middle parts represent a death assemblage.

25. Locality No. 25.

Small road side exposure, about 500 m south of Nekogatake mountain, Suzu City (Lat. 37°27′54″N., Long. 137°08′16″E.).

Lithology :—Medium- to fine-grained sandstone to sandy siltstone.

Occurrence :—Few and sporadic ; cojoined bivalves not rare ; shell materials disolved ; arranged nearly parallel with the

bedding plane.
Sampling :—Rather difficult.
Representative species :—*Acila* sp., *Crassatellites suyamensis* OINOMIKADO, *Leukoma itoigawae* TSUDA, etc.

26. Locality No. 26.
Road side cliff, about 500 m ENE of Kakuma, Suzu City (Lat. 37°28′30″N., Long. 137°08′50″E.).
Lithology :— Conglomeratic calcareous coarse-grained sandstone.
Occurrence :—Rare and sporadic.
Sampling :—Difficult.
Representative species :—*Ostrea* sp.
Associated fauna :—*Miogypsina kotoi* HANZAWA (C), *Astryclypeus manni minoensis* MORISHITA (C), Calcareous algae (A), etc.

27. Locality No. 27.
River cliff, about 250 m south of the Primary School, Shimizu, Suzu City (Lat. 37°29′12″N., Long. 137°07′46″E.).
Lithology :— Conglomeratic coarse- to medium-grained sandstone.
Occurrence :—Few and sporadic.
Sampling :—Difficult.
Representative species :—*Ostrea gravitesta* YOKOYAMA, *Leukoma itoigawae* TSUDA, etc.
Associated fauna :—*Miogypsina kotoi* HANZAWA (A), *Astryclypeus manni minoensis* MORISHITA (C), Echinoid spine (C), etc.

28. Locality No. 28.
River floor, about 500 m west of Doguchi, Suzu City (Lat. 37°29′00″N., Long. 137°09′35″E.).
Lithology :—Calcareous medium- to coarse-grained sandstone.
Occurrence :—Rare.
Sampling :—Difficult.
Representative species :—*Euchelus notoensis*, n. sp.
Associated fauna :—*Miogypsina kotoi* HANZAWA (A), *Astryclypeus manni minoensis* MORISHITA (C), Calcareous algae (C), etc.
Remarks :—*Miogypsina kotoi* HANZAWA is crowded in the sandstone and associated with calcareous algae and sporadically with *Astryclypeus manni minoensis* MORISHITA.

29. Locality No. 29.
Small exposure near the junction of two small roads near the summit, south of Sakaishiyama, Suzu City (Lat. 37°29′17″N., Long. 137°09′07″E.).
Lithology :—Conglomeratic coarse-grained sandstone.
Occurrence :—Rather common but sporadic : shell materials dissolved ; irregularly arranged ; cojoined bivalves rare.
Sampling :—Difficult.
Representative species :—*Ostrea* sp., *Felaniella ferruginata* (MAKIYAMA), *Leukoma itoigawae* TSUDA, etc.

30. Locality No. 30.
Road side cutting near Kôeiji Temple, Ôtani, Suzu City (Lat. 37°29′41″N., Long. 137°10′28″E.).
Lithology :—Granule to pebble conglomerate of subrounded pebbles or conglomeratic very coarse-grained sandstone filling the rounded boulders (Lower) ; medium-grained sandstone (Upper).
Occurrence :—Common and crowded ; water worn and fragmental shells common (Lower) ; few and sporadic (Upper).
Sampling :—Rather easy.
Representative species :—*Anadara makiyamai* HATAI and NISIYAMA, *Ostrea* cf. *denselamellosa* LISCHKE, *Ctena hataii*, n. sp., *Felaniella ferruginata* (MAKIYAMA), *Clinocardium ogurai* (OTUKA), *Leukoma itoigawae* TSUDA, *Turbo ozawai* OTUKA, *Nerita ishidae*, n. sp., *Littorinopsis miodelicatula* OYAMA, *Rissoina naomiae*, n. sp., *Cerithidea kanpokuensis* MAKIYAMA, *Cerithium ancisum* (YOKOYAMA), *Pachycrommium japonicum* KANNO, *Proterato minoensis* ITOIGAWA, *Conus tokunagai* OTUKA, etc. (Lower); *Ostrea gravitesta* YOKOYAMA (Upper).
Associated fauna :— *Protolobophyllia* sp. (C) ; *Dendrophyllia* sp. (F), *Montastrea* sp. (F), *Psopheticus* sp. (fragment—F), *Operculina complanata japonica* HANZAWA (C), Bryozoa (C), Balanids (F), Echinoid spine (C), Calcareous algae (C), etc.

(Lower) ; Calcareous algae (Upper).

Remarks :—The lithological facies at this locality are variable both laterally and vertically. The molluscan shells of this locality represent a death assemblage.

31. Locality No. 31.

Sea cliff facing the north, near main road at Kunnagade, Suzu City (Lat. 37°30′12″ N., Long. 137°12′ 28″E.).

Lithology :—Alternation of sandstone and siltstone with sporadic fossil bearing concretions.

Occurence :—Few and sporadic : arranged parallel with the bedding plane.

Sampling :—Rather easy.

Representative species :—*Solemya tokunagai* YOKOYAMA, *Mizuhopecten kimurai tiganouraensis* (NAKAMURA), *Teredo* sp., etc.

Associated fauna :—*Psopheticus* sp. (C).

32. Locality No. 32.

Small road side exposure, about 200 m south of the Primary School, Matsunagi, Suzu City (Lat. 37°30′12″N., Long. 137°13′14″ E.).

Lithology :—Pebble to granule conglomerate consisting of subrounded pebbles with subangular cobbles.

Occurrence :—Common and crowded but partly sporadic ; isolated bivalves, water worn and fragmental shells common.

Sampling :—Rather easy.

Representative species :—*Ostrea* cf. *denselamellosa* LISCHKE, *Felaniella ferruginata* (MAKIYAMA), *Leukoma itoigawae* TSUDA, *Turbo ozawai* OTUKA, *Nerita ishidae*, n. sp., *Serpulorbis* sp., *Conus tokunagai* OTUKA, etc.

Associated fauna :—*Protolobophyllia* sp. (F), *Montastrea* sp. (F), *Lobophyllia* ? sp. (R), *Operculina complanata japonica* HANZAWA (C). Echinoid spine (C), Bryozoa (C), Calcareous algae (F), etc.

Remarks :—The molluscan shells represent a death assemblage.

33. Locality No. 33.

Road cutting at Wanizaki, Suzu City (Lat. 37°30′36″N., Long. 137°13′28″E.).

Lithology :—Granule conglomerate to conglomeratic very coarse-grained sandstone filling the spaces among the boulders or cobbles (Lower) ; alternation of sandstone and siltstone with fossil bearing concretions (Upper).

Occurrence :—Few and sporadic : isolated bivalves common but cojoined bivalves not rare (Lower) ; few and sporadic ; arranged parallel with the bedding plane (Upper).

Sampling :— Rather difficult (Lower) ; rather easy (Upper).

Representative species :—*Glycymeris direlicta* (YOKOYAMA), *Ostrea* cf. *denselamellosa* LISCHKE, *Turbo ozawai* OTUKA, *Nerita ishidae*, n. sp., *Polinices meisensis* MAKIYAMA, etc. (Lower) ; *Portlandia* cf. *enaensis* KAMADA, *Modiolus wanizakiensis*, n. sp., *Lucinoma acutilineatum* (CONRAD), *Teredo* sp., *Shichiheia etchuensis* HATAI and NISIYAMA, etc. (Upper).

Associated fauna :—*Operculina complanata japonica* HANZAWA (F), Echinoid spine (F) (Lower) ; *Psopheticus* sp. (C) (Upper).

Remarks :— Small oysters are found attached to boulders. The molluscan shells of the lower part may represent a mixture of the life and death assemblages.

34. Locality No. 34.

Cliff facing the small road near Fushimigawa, about 500 m west of Fushimi, Suzu City (Lat. 37°27′33″N., Long. 137°21′01″ E.).

Lithology :—Very coarse-grained sandstone with pebble conglomerate layers.

Occurrence :— Few and sporadic ; shell materials dissolved ; isolated bivalves and water worn shells common.

Sampling :—Difficult.

Representative species :— *Anadara* sp., *Cerithidea* cf. *sirakii* (MAKIYAMA), etc.

35. Locality No. 35.

Sea coast, about 500 m north of the outlet of the Fushimi-gawa, Konami, Suzu City (Lat. 37°27′48″N., Long. 137°21′25″E.).

Lithology :—Alternation of pebble conglomerate with boulders and conglomeratic very coarse-grained sandstone with some fragmentel silicified woods and lignite

fragments.

Occurrence :— Common and crowded; isolated bivalves and fragmental shells rather common but cojoined bivalves and apparently fresh shells not rare.

Sampling :—Rather difficult.

Representative species :—*Anadara* cf. *daitokudoensis* (MAKIYAMA), *Ostrea* sp., *Clinocardium ogurai* (OTUKA), *Venerupis takagii* (MASUDA), *Anisocorbula peregrina* (YOKOYAMA), *Turbo ozawai* OTUKA, *Littorinopsis miodelicatula* OYAMA, *Cerithidea sirakii* (MAKIYAMA), *Pachycrommium japonicum* KANNO, *Mitrella notoensis*, n. sp., *Conus tokunagai* OTUKA, etc.

Associated fauna :—*Protolobophyllia* sp. (C), *Meandera* sp. (C), *Alveopola* ? sp. (F), *Oulastrea* ? sp. (F), etc.

Remarks :—*Turbo ozawai* OTUKA with the operculum in the shell is not rare. The molluscan shells from this locality may represent a mixture of the death and life assemblages.

36. Locality No. 36.

River cliff near small road, about 600 m SSE of Kakuma, Suzu City (Lat. 37°29′02″N., Long. 137°08′46″E.).

Lithology :—Very coarse-grained sandstone.

Occurrence :—Rather common and sporadic but partly crowded; isolated bivalves but apparently fresh shells common.

Sampling :—Rather difficult.

Representative species :—*Ostrea* cf. *denselamellosa* LISCHKE, *Aequipecten matsunagiensis*, n. sp., *Anisocorbula ohiroi*, n. sp., *Myadora suzuensis*, n. sp., *Dentalium weinkauffi* DUNKER, etc.

Associated fauna :—*Operculina complanata japonica* HANZAWA (A), *Miogypsina kotoi* HANZAWA (F), Bryozoa (A), Echinoid spine (C), *Psopheticus* sp. (fragment—F), etc.

Remarks :—The molluscan shells represent a death assemblage.

37. Locality No. 37.

Small road side exposure, about 500 m southwest of Kendaradake mountain, Yoshiro, Suzu City (Lat. 37°28′00″N., Long. 137°09′23″E.).

Lithology :— Coarse- to medium-grained sandstone with some carbonaceous matter.

Occurrence :—Common and sporadic; shell materials dissolved; isolated bivalves common.

Sampling :—Rather easy.

Representative species :—*Anadara makiyamai* HATAI and NISIYAMA, *Ostrea* sp., *Clinocardium ogurai* (OTUKA), *Paphia euglypta ohiroi*, n. subsp., *Leukoma itoigawae* TSUDA, *Macoma* sp., *Tellina notoensis* MASUDA, etc.

38. Locality No. 38.

Small exposure near the stream, about 300 m south of Sotonoyama, Suzu City (Lat. 37°27′52″N., Long. 137°09′58″E.).

Lithology :—Coarse-grained sandstone.

Occurrence :—Rather common and sporadic but partly crowded; shell materials dissolved; isolated bivalves and shell fragments common; arranged irregularly.

Sampling :—Rather difficult.

Representative species :—*Paphia euglypta ohiroi*, n. subsp., *Leukoma itoigawae* TSUDA, *Macoma* sp., *Dentalium weinkauffi* DUNKER, etc.

39. Locality No. 39.

Small river cliff, about 700 m SWS of Kobunayama, Suzu City (Lat. 37°28′12″N., Long. 137°10′45″E.).

Lithology :—Coarse-grained sandstone with granules and much carbonaceous matter (Lower); very coarse-grained sandstone with some carbonaceous matter (Middle); alternation of sandstone and siltstone (Upper).

Occurrence :—Common and crowded: shell materials dissolved (Lower); abundant and crowded; isolated bivalves and a little water worn shells common (Middle); few and sporadic; shell materials dissolved; cojoined bivalves not rare (Upper).

Sampling :— Rather difficult (Lower); rather easy (Middle and Upper).

Representative species :—*Pillucina yokoyamai* (OTUKA), *Cerithidea tokunariensis* MASUDA, etc. (Lower); *Ostrea*, sp. *Monilea yoshioi*, n. sp., *Vicaryella ishiiana*

(YOKOYAMA), *Batillaria toshioi*, n. sp., etc. (Middle); *Paphia euglypta ohiroi*, n. subsp., *Shichiheia etchuensis* HATAI and NISIYAMA, etc. (Upper).

Associated fauna:—*Operculina complanata japonica* HANZAWA (F), *Miogypsina kotoi* HANZAWA (C), *Astryclypeus manni minoensis* MORISHITA (F), Echinoid spine (C), etc. (Upper part of the Middle).

Remarks:—The molluscan shells of the lower and middle parts represent a death assemblage but those of the upper part may represent a life assemblage or at least they were not transported from a remote place. The associated fauna such as foraminifers, echinoids, etc. occur from the calcareous sandstone immediately overlying the middle part do not occur in association with the molluscs.

(b) Stratigraphic relations of the fossil localities

The fossil localities are widely distributed in the present field and can be classified into four stratigraphic positions which for the sake of convenience are called horizons in this work. At Fujio, the type locality of the Fujio Member, four fossil beds in sequence are recognized but at other localities the same number of fossil beds are not always observed. One fossil bed at a given locality may be represented by one to two or more fossil beds at another locality probably due to the differences in the conditions of deposition.

From the stratigraphic relations and the lateral and vertical changes of lithologic facies of the Higashi-Innai Formation the under mentioned four fossil horizons can be established and the fossil beds can be grouped into them. Here, the term horizon is used to denote the same or nearly same stratigraphic position or level.

1. First horizon

This is represented by the lower fossil bed at Fujio (Loc. No. 24) and is characterized by the carbonaceous sandstone or conglomerate with some molluscan shells and rather thick conglomerate intercalated with siltstone and sandstone in associated with lignite or much carbonaceous matter without molluscan shells. A thin pumice tuff layer is developed in the lower part.

The thickness of this horizon in the northern area usually exceeds that of the southern area, though there are some exceptions. The lignite beds are well developed in the vicinities of Terayama and Nakao, and the lignite seams of some other places may have been deposited during this stage.

The fossil beds of this horizon are rather narrowly distributed and only the lower part of Loc. Nos. 9, 10, 24 and 39 belong to this horizon.

2. Second horizon

This horizon is represented by the middle to upper fossil beds of Loc. No. 24 and is characterized by conglomerate, conglomeratic sandstone and very coarse- to coarse-grained sandstone. Abundant molluscan shells and other fossils such as corals, echinoids, bryozoans, larger foraminifers, calcareous algae, etc. were yielded from this horizon in the northern area. But in the southern area this horizon is characterized by conglomerate, sandstone and sandy siltstone associated with well developed lignite beds. Molluscan shells are abundant in the sandstone or sandy siltstone but larger foraminifers, corals and other fossils were not observed.

The fossil beds of this horizon are widely distributed and the main fossil beds in the present field belong to this horizon. The fossil beds of Loc. Nos. 1, 2, 3, 4, 5, 6, 11, 12, 13, 14, 15, 16, 17, 25,

26, 28, 29, 30, 32, 35, 36, lower part of Loc. Nos. 7, 8, 23, 33, upper and middle parts of Loc. No. 9, upper part of Loc. No. 10 and middle part of Loc. No. 39 belong to this horizon.

3. Third horizon

This horizon is represented by the uppermost part of Loc. No. 24 and is characterized by medium- to fine-grained sandstone in the lower part and in the upper part of an alternation of sandstone and siltstone. The uppermost fossil bed of Loc. No. 24, upper part of Loc. Nos. 7, 8, 23 and others belong to the lower part of this horizon but the upper part of Loc. Nos. 33 and 39 and Loc. No. 31 are included into the upper part of this horizon. Molluscan shells are usually found in the concretions in the alternation of sandstone and siltstone of the lower part of the horizon.

The molluscan shells of this horizon are usually very few in number of both species and individuals and other kinds of fossils are hardly found.

4. Fourth horizon

The fossil beds of Loc. Nos. 18, 19, 20, 21 and 22 are included into this horizon and are generally characterized by the glauconite bearing tuffaceous coarse- to medium-grained sandstone. Exceptionally the molluscan shells from Loc. No. 22 occur in the sandy siltstone with much carbonaceous matter.

The fossil beds of this horizon are restricted in their distribution to the rather narrow southern area and they correspond to the Akagami Mudstone Member in the northern area.

The molluscan shells are rather abundant in both species and individuals. The abundant occurrence of fossil sponges is characteristic in this horizon but other fossils such as corals, larger foraminifers, etc. do not occur.

(3) Faunal List

The molluscan shells and other fossils are listed in Tables 1, 2, 3 and 4 with remarks on their frequency, etc. From the Higashi-Innai Formation a total 124 determined species and 63 indeterminable species of molluscs (Pelecypods, Gastropods, Scaphopods) among which 34 species and one subspecies of pelecypods and gastropods were found to be new to science. Discriminated among the fossil fauna are two species of brachiopods, seven genera of corals, two species of larger foraminifers, one species of crabs, one species of sponges, one species of echinoids, one species of shark's teeth, fish bone, fish scale, otoliths, balanids and calcareous algae. The smaller Foraminifera known from this formation have been studied by ASANO (1953).

(4) Size-frequency Distribution of Some Species

Among the molluscan species the following one which have rather wide distribution and occur in abundance were studied with regard to their size-frequency distribution.

(a) *Anadara makiyamai* HATAI and NISIYAMA

This species occurs in the second horizon and its size-frequency distribution curve is shown in Fig. 6. The figure shows that the specimens are generally small in size compared with the type specimens from the Heirokudô Miocene of North Korea. The specimens from Loc. Nos. 7, 23 and 39 are usually about 12 to 22 mm in length of shell, but those from Loc. Nos. 3, 24 and 30 are usually

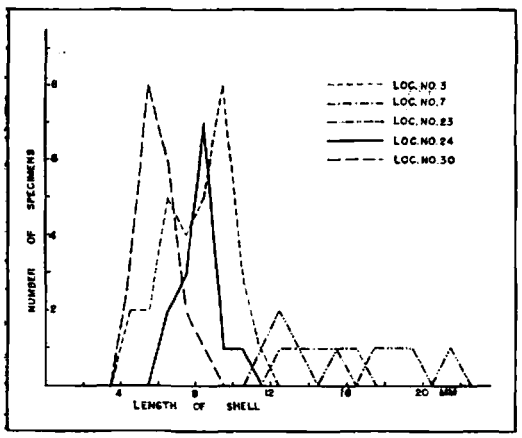

Fig. 6. Size-frequency distribution curves of *Anadara makiyamai* HATAI and NISIYAMA.

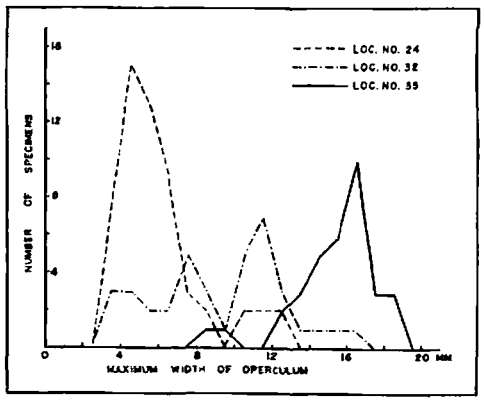

Fig. 7. Size-frequency distribution curves of *Turbo ozawai* OTUKA.

about 3 to 11 mm in length of shell. Cojoined valves are hardly found. The specimens from Loc. Nos. 24 and 30 show rather narrow range in length of shell, while those from Loc. Nos. 3, 7 and 23 a rather wide range.

The specimens from Loc. Nos. 24 and 30 occur in a conglomerate, while those from Loc. Nos. 3 and 23 are found in granule conglomerate to coarse-grained sandstone and their shells usually appear rather fresh. Considering from the size-frequency distribution curves and the lithological characters, the specimens from Loc. No. 24 and 30 seem to have been transported from a rather remote place but those from the other localities from only a short distance.

(b) *Leukoma itoigawae* TSUDA

The shells of this species from various localities are nearly equal in size and they are found in conglomeratic very coarse- to fine-grained sandstone. It is more common in the northern area than in the southern one.

(c) *Turbo ozawai* OTUKA

This species occurs from the second horizon and the size frequency distribution curve of its opercula is shown in Fig. 7. Its distribution is rather narrow. This species is represented by the shells and opercula. Usually both are found at the same locality but at Loc. No. 33 only the opercula occur and at Loc. Nos. 1 and 3 only the shells. In general the opercula are more abundant than the shells.

The opercula from Loc. No. 35 are larger than those from the other localities. The opercula from Loc. No. 21 are abundant and mostly of small size, and those from Loc. No. 32 range from large to small in size. The opercula from Loc. Nos. 30, 32 and 35 nearly correspond with the shells in size. The operculum still in the shell is sometimes found at Loc. No. 35.

From the statements just given it may be inferred that the specimens from Loc. Nos. 32 and 35 were probably buried in the environments in which they lived or at least they were not transported from a remote place. Those from the other localities form a thanatocoenosis.

(d) *Littorinopsis miodelicatula* OYAMA

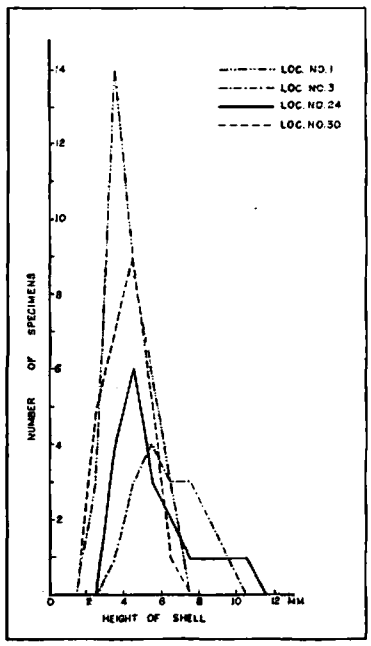

Fig. 8. Size-frequency distribution curves of *Littorinopsis miodelicatula* OYAMA.

This species is widely distributed in the present field. The size-frequency distribution curve shown in Fig. 8 shows that the specimens from Loc. Nos. 1 and 30 are nearly equal in size but those from Loc. Nos. 3 and 24 show wide range in size. The specimens from the latter two localities are well preserved compared with those from the former localities. This may suggest that the specimens from Loc. Nos. 1 and 30 were transported from a remote place, whereas those from the other localities from a nearer place.

(5) Relations between the Molluscs and other Fossils

The fossils from the Higashi-Innai Formation other than the molluscs consist of reef building corals, echinoids, brachiopods, bryozoans, sponges, crabs, balanids, foraminifers, calcareous algae, etc. Their distributions are shown in Tables 2-4 and Fig. 9.

The tables and figure indicate that the molluscan assemblage changes according to whether it is associated with the other fossils, and related therewith is the differences in the lithologic facies of those places. The molluscan assemblage associated with the fossil corals is restricted in distribution to a limited area, such as where the rocky or gravelly facies exist, because such an environment favors the growth of the corals and there the hard bottom dwelling molluscs are dominant. Calcareous algae are also found in the environment just mentioned. Loc. Nos. 24, 30, 32 and 35 which belong to the second horizon are typical localities of the reef building corals.

Echinoid spines were found almost all localities except for those of the third and fourth horizons, but *Astryclypeus manni minoensis* MORISHITA occurred only from the second horizon at Loc. Nos. 26, 27, 28 and 39 in association with *Miogypsina kotoi* HANZAWA or rarely with *Operculina complanata japonica* HANZAWA and *Miogypsina kotoi* HANZAWA.

Operculina complanata japonica HANZAWA and *Miogypsina kotoi* HANZAWA are widely distributed in the northern area of this field, whereas *Miogypsina kotoi* HANZAWA is found only at Loc. Nos. 26 and 28. When occurring in association with one of the two genera mentioned exceeds the other in individual number. Concerning the paleoecology of *Miogypsina* and *Operculina* in the Miocene Kurosedani Formation in Toyama Prefecture, TSUDA (1955) stated that *Miogypsina* may have been limited its distribution in marine water with

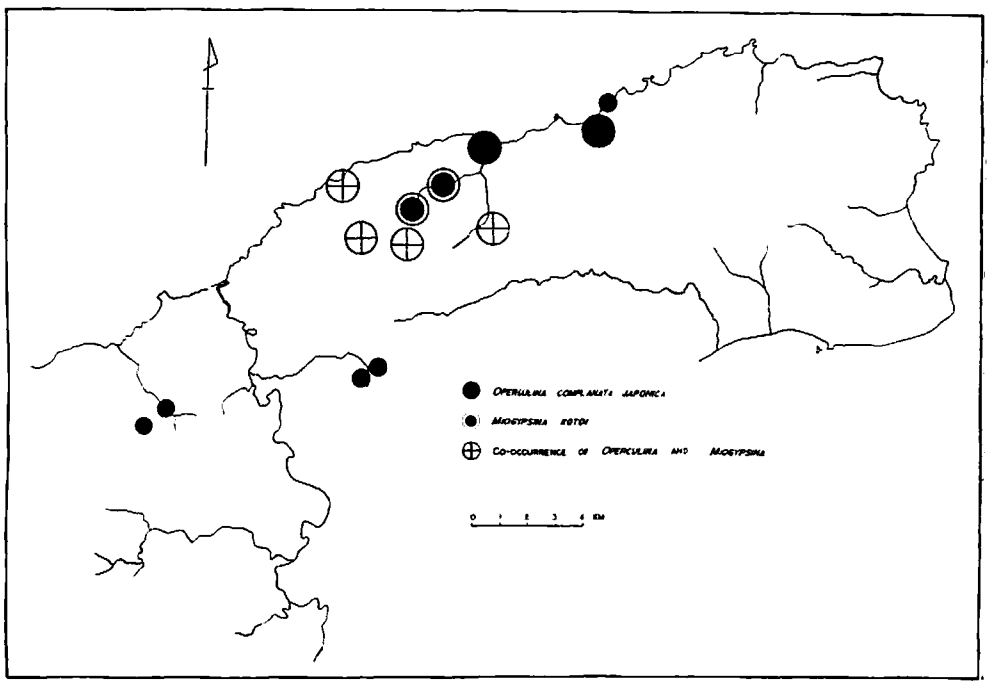

Fig. 9. Distributions of *Operculina complenata japonica* HANZAWA and *Miogypsina kotoi* HANZAWA (large circle: abundant to common occurrence of that species; small circle: few to rare occurrence of that species).

normal salinity but *Operculina* may have been lived in a water with a little lower salinity than that of *Miogypsina*.

Complete specimens and fragments of the chela of *Psopheticus* sp. (crab) were found from the first to third horizons of this formation. The complete specimens occurred from the alternation of sandstone and siltstone of the third horizon at Loc. Nos. 31 and 33, and the fragmental ones were found in the conglomeratic sandstone and conglomerate of the first and second horizons. From the wide distribution it can be considered that *Psopheticus* sp. lived in an environment of different conditions.

The sponges are restricted to the fourth horizon. They are found in sandstone associated with molluscs and some brachiopods. Complete sponge specimens were found only at Loc. No. 19.

The bryozoans are found in association with the larger foraminifers.

Table 1. Faunal list of the First horizon
(*—Illustrated ; **—specimens with cojoined shells)

Specific Name \ Locality / Sampling	9 E	10 E	24 D	39 D
Anadara kurosedaniensis HATAI and NISIYAMA			R	
Ostrea sp.		C**	C**	F
Felaniella sp.	R			
Joannisiella meisensis MAKIYAMA	F			
Pillucina yokoyamai (OTUKA)				C
Cyclina japonica KAMADA	F			R
Leukoma itoigawae TSUDA			R	R
Tellina hamadai MASUDA			R**	F
Macoma sp.			F	
Anisocorbula peregrina (YOKOYAMA)			F	
Cryptomya busoensis YOKOYAMA			R	R
Teredo sp.	R	F	R	
Monilea sp.				C
Littorinopsis miodelicatula OYAMA	R			R
Vicarya callosa japonica YABE and HATAI	F			
Vicaryella notoensis MASUDA	C	F		
Vicaryella ishiiana (YOKOYAMA)			F	
Batillaria toshioi MASUDA, n. sp.*			F	
Cerithidea tokunariensis MASUDA			R	C
Xenophora sp.	R			
Polinices meisensis MAKIYAMA	R		R	R
Nassarius notoensis MASUDA	R		R	R
Mitra cf. *ishidae* MASUDA, n. sp.			R	
Conus sp.			R	

Table 2. Faunal list of the Second horizon (*—Illustrated; **—specimens with cojoined shells)

Specific Name \ Locality / Sampling	1	3	4	5	7	8	10	12	15	17	23	24	29	30	32	33	35	36	37	38	39
	D	E	E	E	D	D	E	E	D	D	E	E	D	E	E	D	D	D	E	D	E
Acila sp.				R																R	
Saccella saikaiensis MASUDA, n. sp.*		C	F								C**										
Arca sp.																	R				
Barbatia uetsukiensis HATAI and NISIYAMA								F			R	R					R**				
Barbatia sp.														R							
Cucullaea toyamaensis TSUDA															R						
Anadara kakehataensis HATAI and NISIYAMA											F										
Anadara kurosedaniensis HATAI and NISIYAMA								C**													R
Anadara makiyamai HATAI and NISIYAMA	R	A	F		F	F	R				A	A		C	C			F	C	F	F
Anadara cf. *daitokudoensis* (MAKIYAMA)											F						C				
Anadara cf. *watanabei* (YOKOYAMA)			R																		
Anadara sp.									F	F											
Glycymeris direlicta (YOKOYAMA)										F					F	F					
Glycymeris vestitoides NOMURA												F			F			R			
Glycymeris cf. *cisshuensis* MAKIYAMA		R																			
Chlamys ishidae MASUDA														F						R	
Chlamys iwamurensis ITOIGAWA							C			F	C	C		C		F	F	F		R	
Aequipecten matsunagiensis MASUDA, n. sp.*		R													R			C			
Placopecten nomurai MASUDA			R														R				
Placopecten protomollitus (NOMURA)*															R						
Mizuhopecten kimurai murayamai (YOKOYAMA)		R																			
Spondylus sp.												R					F				
Lima sp.											R	R		C**							

Specific Name \ Locality	1	3	4	5	7	8	10	12	15	17	23	24	29	30	32	33	35	36	37	38	39
Sampling	D	D	E	E	D	D	E	E	D	D	E	E	D	E	E	D	D	D	E	D	E
Mantellum sp.							R										F				
Ostrea gravitesta YOKOYAMA	F**	F	F								F**			C**							
Ostrea cf. *denselamellosa* LISCHKE	F	F					C**				C	C		A	C	C					
Ostrea sp.				C	F			F	F				C				C	F	C	R	C
Anomia sp.											R										
Brachidontes sp.								F													
Myadora suzuensis MASUDA, n. sp.*												F						F			
Crassatellites suyamensis OINOMIKADO*		F	F	F										F	F	F		F	F	F	
Venericardia osawanoensis TSUDA		R										R		F	F		R				
Glans naomiae MASUDA, n. sp.*											R						R**			R	
Trapezium modiolaeformis OYAMA and SAKA*												R									R
Coralliophaga sp.															R						
Felaniella ferruginata (MAKIYAMA)		F**					F		F		F**	F	F	C**	C			R		F	R
Joannisiella meisensis MAKIYAMA								F			C										
Phlyctiderma cf. *japonica* (PILSBRY)																	F				
Thyasira sp.		R																			
Lucina meisensis MAKIYAMA												R									
Ctena hataii MASUDA, n. sp.*												F		C	R		F**	R			
Pillucina yokoyamai (OTUKA)											C										C
Saxolucina k-hataii (OTUKA)								C**				F									R
Clinocardium ogurai (OTUKA)		F	C		F		R	F	F		A	C		C	F		C		C	F	F
Fulvia sp.								R													
Laevicardium sp.							R					F									
Pitar itoi (MAKIYAMA)*											F										
Saxidomus sp.																	R				
Dosinia akaisiana NOMURA	R**										F	A		R	F						
Dosinia tugaruana NOMURA		C									C										
Dosinia sp.			F	R						R									F	F	

Cyclina japonica KAMADA								C**			F											
Cyclina lunulata MAKIYAMA*		F										F										
"Venus" sp.												R										
Leukoma itoigawae TSUDA*	R	A	A		R		R				C	C	C	A**	C**	R	R	F	F	R	R	
Protothaca tateiwai (MAKIYAMA)														F			R					
Katelysia nakamurai IKEBE							R**							R**		R						
Siratoria siratoriensis (OTUKA)*		C	F								C	F										
Venerupis takagii (MASUDA)*								F								R	C**					
Paphia euglypta ohiroi MASUDA, n. subsp.*																			C	C		
Paphia suzuensis MASUDA, n. sp.*		F									F			F								
Paphia sp.	R									R	F	F						R				
Clementia japonica MASUDA*		R			R			C**	F	F	A	R							F	R		
Raeta sp.								R														
Lutraria sp.		R						R**						F			R**					
Oxyperas sp.																	R					
Cardilia toyamaensis TSUDA*											C						R**		R			
Soletellina minoensis YOKOYAMA								R														
Psammotaea sp.	R						R				F											
Macoma sp.		R															R		C**	F	R	
Fabulina sp.	R						F		F													
Tellina hamadai MASUDA		A**	R					F**			A		F**				F			R		
Tellina notoensis MASUDA								R											R			
Cultellus izumoensis YOKOYAMA			R					C**														
Solen cf. *gouldi* CONRAD								R**		R	F										F	
Solen sp.		R	F									R			R				F			
Anisocorbula ohiroi MASUDA, n. sp.*									R			F**		F	F	R		F				
Anisocorbula peregrina (YOKOYAMA)*												F**					C**					
Cryptomya busoensis YOKOYAMA								F				R	R									
Jouannetia cf. *cumingi* (SOWERBY)							F															
Teredo sp.											R						F					
Thraciopsis sp.																	F			R	F	

Specific Name \ Locality	1	3	4	5	7	8	10	12	15	17	23	24	29	30	32	33	35	36	37	38	39
Sampling	D	E	E	E	D	D	E	E	D	D	E	E	D	E	E	D	D	D	E	D	E
Haliotis notoensis MASUDA, n. sp. *							F					R		F	R						
Tugali notoensis MASUDA, n. sp. *												R		R			R				
Diodora sp.																	F				
Collisella sp. *		R																			
Notoacmaea sp.	F						R							F				R			
Euchelus notoensis MASUDA, n. sp. *												F		F			R				
Calliostoma otaniensis MASUDA, n. sp. *														R							
Calliostoma simane NOMURA and HATAI				R																	
Calliostoma cf. *myonchonensis* HATAI and KOTAKA														R	R						
Cantharidus sp.											R										
Tegula sp.		R															F				
Trochus sp.															F		R				A
Solariella sp. *	C																				
Monilea hamadae MASUDA, n. sp. *		A									C	R					R				
Monilea yoshioi MASUDA, n. sp. *																					
Monilea sp.														A							
Protrotella depressa MAKIYAMA	F	F										F					F				
Protrotella shukuborensis ITOIGAWA *	F	R																			
Stomatia sp.											R										
Teinostoma yabei MASUDA								C													
Turbo ozawai OTUKA *	R	R					F					A		F	A	F	A				
Lunella cf. *kurodai* ITOIGAWA																	C				
Nerita ishidae MASUDA, n. sp. *	F	F					F				R	R		A	F	F	R	F			R
Lacuna japonica MASUDA, n. sp. *														R							
Littorinopsis miodelicatula OYAMA *	C	C	F					F			F	A		A	F		C		R		
Rissoina naomiae MASUDA, n. sp. *	F						C					F		A			F				
Pseudoliotia sp. *																	R				
Turritella yoshidai KOTAKA			C																		

Turritella sp.				R										F							
Architectonica kurodae TSUDA*												F		R							
Serpulorbis sp.							F								F		R				
Vermetus sp.	F	R					F					F		F	F						
Vicarya callosa japonica YABE and HATAI						F		C													
Vicaryella ishiiana (YOKOYAMA)*											A	R									C
Vicaryella notoensis MASUDA*						F		C	F	F											
Cerithidea kanpokuenssi MAKIYAMA*		R						R				F		A							
Cerithidea ohiroi MASUDA, n. sp.*		R										F		C	R						F
Cerithidea sirakii (MAKIYAMA)*			C		C						A		R				A				
Cerithidea tokunariensis MASUDA								F													F
Batillaria toshioi MASUDA, n. sp.*											A	C									A
Bittium sp.*	C	F					F	F			F			C							
Cerithium ancisum (YOKOYAMA)*		F					C				C	C		C	R						
Cerithium meisense (MAKIYAMA)*					F		R				R			F	R	R					F
Seila sp.												R									
Nodiscala suzuensis MASUDA, n. sp.*														R							
Turriscala sp.*		R																			
Epitonium sp.												R								F	F
Eulima hataii MASUDA, n. sp.*																	R				
Capulus sp.															R		R				
Calyptraea tubura OTUKA		R										R		R							
Polinices meisensis MAKIYAMA*							R	F			C	R				F					
Polinices otukai MASUDA								R													R
Neverita coticazae (MAKIYAMA)*	R	C	F		R						C	C		F	F		F				F
Pachycrommium japonicum KANNO*		F	R				R				C	C		A	R		F				
Sinum ineptum (YOKOYAMA)*											R	R									
Proterato minoensis ITOIGAWA*	C													A	R						
Cypraea ohiroi MASUDA, n. sp.*														F							
Phalium ? sp.											R			R	R						
Rimella toyamaensis TSUDA					R																

Specific Name \ Locality	1	3	4	5	7	8	10	12	15	17	23	24	29	30	32	33	35	36	37	38	39
Sampling	D	E	E	E	D	D	E	E	D	D	E	E	D	E	E	D	D	D	E	D	E
Apollon osawanoensis TSUDA*									R	R		F		C	R						
Chicoreus asanoi MASUDA					R		R	F				C			R		R				
Ergalatax sp.														F							
Purpura cf. *minoensis* ITOIGAWA														F							
Mitrella notoensis MASUDA, n. sp.*	C	R					F					C		C	R		C			F	
Siphonalia nisiyamai HATAI and KATAKA*														C							
Siphonalia sp.											R	R		C					F	F	
Pseudoneptunea notoensis (MASUDA)								F			C										
Phos notoensis MASUDA, n. sp.*			F		R				R		C									R	
Nassarius minoensis ITOIGAWA*	R	F	R				R					R		F	R					R	
Nassarius notoensis MASUDA								A			R	F									
Oliva osawanoensis TSUDA*												C									
Pusia sp.*																	R				
Strigatella notoensis MASUDA, n. sp.*												F									
Mitra hukusimana NOMURA and ZINBO*														F							
Mitra ishidae MASUDA, n. sp.*												R		F							
Vexillum setsukoae MASUDA, n. sp.*												R		F							
Sydaphera horii MASUDA, n. sp.*			R								F				R		R				
Cancellaria sp.		R	R		R										R						
Clavus sp.			R														F				
Philbertia sp.*							R							R							
Trigonophaera sp.												R									
Inquisitor shibanoi MASUDA, n. sp.*			R								R	F		R			R				
Surculites osawanoensis TSUDA												R									
Cythara sp.*												R		F							
Conus tokunagai OTUKA*											F	F			C		F				
Terebra osawanoensis TSUDA	R	F			R		R				F										
Menestho sp.*														R							

Odostomia sp.		F										R			R		R					
Syrnola notoensis MASUDA, n. sp.*											F												F
Syrnola sp.		F					R				R			R			R					
Cingulina sp.							R							F			R					
Turbonilla ishidae MASUDA, n. sp.*							R				R			R			R					
Turbonilla sp.								R															
Tiberia konamiensis MASUDA, n. sp.*																	R						
Pyramidella hataii MASUDA								R															
Acteon osawanoensis TSUDA*											F			R									
Ringicula minoensis TAKEYAMA*											R												
Bulla sp.																							R
Retusa tokiensis ITOIGAWA			R											R									
Decorifer sp.																							R
Volvulella tokiensis ITOIGAWA*														R									
Acteocina hamadai MASUDA								R															R
Adamnestia onukii MASUDA, n. sp.*											R	R											
Dentalium weinkauffi DUNKER		F	F	F					F		C	C				R		F	F	F			
Dentalium cf. *hexagonum* GOULD																		F					
Psopheticus sp.	F	F					F					F		C				F					
Astryclypeus manni minoensis MORISHITA																							F
Operculina complanata japonica HANZAWA	C	C					F					C		C	C	F		A					F
Miogypsina kotoi HANZAWA												F						F					C
Fish bone, gen. sp. indet.		F	R																				
Reef building corals												C		C	C		A						
Bryozoans	C	F										C		C	C			A					
Balanids												F		F	F								
Echinoid spine	C						C				F	C		C	C	F		C					C
Calcareous algae	C						F					F		A	F								F

Table 3. Faunal list of the Third horizon.
(*—Illustrated; **—specimens with cojoined shells)

Specific Name \ Locality	23	24	31	33	39
Sampling	E	E	E	E	E
Solemya tokunagai YOKOYAMA			F**	F**	
Portlandia cf. *enaensis* KAMADA			R**	F**	
Anadara sp.					R
Ctenamusium sp.				R	
Mizuhopecten kimurai tiganouraensis (NAKAMURA)			F**	R	
Ostrea sp.		C		F	R
Modiolus wanizakiensis MASUDA, n. sp.*				F**	
Lucinoma acutilineatum (CONRAD)				C**	
Lucina cf. *meisensis* MAKIYAMA				F	
Clinocardium sp.	F				
Paphia euglypta ohiroi MASUDA, n. subsp.*					F
Paphia sp.	F				
Macoma sp.	R	F			
Teredo sp.				F	C
Vicarya callosa japonica YABE and HATAI		F			
Vicaryella notoensis MASUDA*		F			
Shichiheia etchuensis HATAI and NISIYAMA				F	R
Pseudoneptunea notoensis (MASUDA)		F			
Clavus cf. *kurodae* TSUDA				R	
Dentalium sp.	F				
Psopheticus sp.			C	C	

Table 4. Faunal list of the Fourth horizon.
(*—Illustrated; **—specimens with cojoined shells)

Specific Name \ Locality	18	19	20	21	22
Sampling	E	D	E	E	E
Arca sp.			R		
Anadara sp.					F
Glycymeris direlicta (YOKOYAMA)	R		A**		
Tucetona sp.			R		
Limopsis sp.	R		F		
Delectopecten peckhami (GABB)		F			
Chlamys ishidae MASUDA			R		
Chlamys sp.		R	R		
Placopecten protomollitus (NOMURA)	R	F	F		
Kotorapecten kagamianus moniwaensis (MASUDA)			C**		
Limatula cf. *minoensis* ITOIGAWA		F	F		
Lima cf. *goliath* SOWERBY			R		
Ostrea sp.	C		C	C	
Crenella fornicata YOKOYAMA			F		
Crassatellites suyamensis OINOMIKADO	R		R		
Phlyctiderma cf. *japonica* (PILSBRY)			F**		
Thyasira sp.			F		
Saxolucina k-hataii (OTUKA)					R
Clinocardium sp.	C		R		
Leukoma sp.			F		
Pitar sp.	R		R		F
Clementia sp.	R				
Mactra? sp.		F			
Raeta sp.*					R
Lutraria sp.					R
Macoma sp.	R				C
Cuspidaria sp.	R				
Monilea? sp.		R			
Cerithidea sp.					R
Polinices sp.			R		
Mitrella sp.					R
Nassarius sp.					R
Conus sp.		R	R		
Syrnola sp.	R				F
Bulla sp.			R		
Dentalium yokoyamai MAKIYAMA			F		
Coptothyris grayi (DAVIDSON)			F	F	
Terebratulina honsyuensis NOMURA and HATAI		F	F	C	
Carcharodon megalodon (CHARLESWORTH)	R				
"*Otoliths*" sp.			R		
Aphrocallistes sp.	C	A	C	C	
Fish scale, gen. sp. indet.			F		

Abbreviation: D—Difficult; E—Easy; A—Abundant; C—Common; F—Few; R—Rare.

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 63, pp. 294-302, pl. 32, Sept. 30, 1966

510. NOTES ON *AMMONITES FLACCIDICOSTA* RÖMER FROM THE CRETACEOUS OF TEXAS

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テキサスの白亜系産 *Ammonites flaccidicssta* RÖMER：テキサス州の白亜系産化石を古く RÖMER (1852) が記載したが，その原標本はボンの大学に保管されている。その中で *Ammonites flaccidicosta* として記されていた2標本（シンタイプス）を再検討した結果，異なる2種を代表するものであることが判明した。1は *Nowakites flaccidicostus* であって，この論文でレクトタイプを指定して再記載する。他は *Pseudojacobites* の新種であって，ホロタイプの図を掲げて正確に記述する。2標本はチョーク質の基質をもつが，岩質の詳細が異なる。2種の産出層序上の正確な位置が将来の問題として残る。なおこの際 *Nowakites*・*Pseudojacobites* の両属についても整理し，特性や他との関連について記した。

松本達郎

Introduction

Ammonites flaccidicosta, from the Cretaceous of Texas, was described by RÖMER (1852, p. 33, pl. 1, fig. 1a, b) on the basis of two specimens. Although several specialists, such as SCHLÜTER (1872, p. 34), ADKINS (1928, p. 221), COLLIGNON (1955, p. 84) and YOUNG (1963, p. 55), have remarked on this species, its systematic position has remained uncertain.

I have recently had an opportunity of studying the two syntypes in the Palaeontological Museum of the University of Bonn and arrived at the conclusion that one specimen is probably to be referred to *Nowakites* and the other to *Pseudojacobites*. In this paper the two syntypes are redescribed and illustrated, with some remarks on the two genera.

Before going further I wish to record my debt of gratitude to Professor Dr. K. J. MÜLLER of Institut für Paläontologie der Rhein. Friedrich-Wilhelms Universität, Bonn, for offering me every facility of studying there. Thanks are also extended to Dr. H. REMIE, Curator of the Palaeontological Museum of the same university, Dr. J. SORNAY of the Muséum National d'Histoire Naturelle, Paris, and Mr. C. W. WRIGHT of London, who helped me in showing several interesting specimens for comparison and critical reading of the manuscript with valuable suggestions, and also to Professor K. YOUNG of the University of Texas, who gave me necessary information. Dr. I. HAYAMI of Kyushu University kindly assisted me in taking photographs of the type specimens on loan.

Read Jan. 24, 1966, at the 30th Annual Meeting, Sendai; Received March 15, 1966

Palaeontologic Descriptions

Family Pachydiscidae

Genus *Nowakites* SPATH, 1922

Type-species:—*Pachydiscus carezi* DE GROSSOUVRE, 1894, from the Coniacian of France, by original designation.

Generic diagnosis:—The shell does not seem to attain a large size, as far as the available material indicates. The whorl is oval in cross section and is slightly higher than broad. The umbilicus is moderate or rather narrow.

On the septate whorls constrictions are fairly frequent; they may be shallow or distinct. On the body whorl they may become very infrequent, indistinct or absent. In the immature stages the ribs are crowded, rather weak or fine, and of unequal length, some being branched at or near the umbilical tubercles and others intercalated. In the late growth-stage the ribs become distant and moderately strong; they are of unequal length, longer ones springing from the umbilical tubercles and shorter ones are intercalated with variable length. The ribs cross the venter with more or less strong projection.

The suture, which is obscurely known in the type-species and closely allied species, is of pachydiscid type, with trifid lateral lobe (L), and seems to be moderately incised, being less massive than the suture of *Lewesiceras* but not so deeply and so finely incised as that of *Canadoceras*.

Remarks:—Because the holotype of the type-species, *N. carezi*, is not perfectly preserved, there is some obscurity in the generic diagnosis of *Nowakites*. There are, however, several species which can be grouped with *N. carezi*, for instance, *Puzosia lemarchandi* DE GROSSOUVRE (1894, p. 173, pl. 22, fig. 5), from the Coniacian of France, *Ammonites paillettei* D'ORBIGNY (1841, p. 339, pl.102, figs. 3, 4), from the Santonian of France, and probably also *Ammonites tallavignesi* D'ORBIGNY (1850, p. 190; COLLIGNON, 1955, p. 30, pl. 9, fig. 3), from the Coniacian of France.

Pachydiscus jimboi KOSSMAT (1898, p. 92, pl. 14 [20], fig. 1) [=*Ammonites denisonianus* STOLICZKA, 1865, p. 130, pl. 45, fig. 2 only], from the Trichinopoly Group of India, has characters somewhat intermediate between *Lewesiceras* SPATH, 1922 and *Nowakites*. On studying its holotype (GSI. 263), I am rather inclined to refer it to *Nowakites*.

Ammonites draschei REDTENBACHER (1873, p. 123, pl. 30, fig. 1), from the Gosau beds (Santonian part according to BRINKMANN, 1935) is probably a species of *Nowakites*, apparently transitional to *Canadoceras* SPATH, 1922.

Ammonites dureri REDTENBACHER (1873, p. 118, pl. 28, fig. 2), another Gosau beds species, does not belong to *Nowakites* but to *Pseudokossmaticeras* SPATH, 1922, as I have already pointed out (MATSUMOTO, 1955a, p. 144).

The holotype of *Sonneratia savini* DE GROSSOUVRE (1893, p. 152, pl. 25, fig. 4), from the Santonian of France, may be referable to *Nowakites*, but a bituberculate paratype (GROSSOUVRE, 1893, p. 152, pl. 37, fig. 4) I regard as a species, probably new, of *Teshioites* MATSUMOTO, 1955, allied to *T. teshioensis* MATSUMOTO (1955, p. 174 and 178).

Pachydiscus linderi DE GROSSOUVRE (1894, p. 188, pl. 18) was referred to *Nowakites* by SPATH (1922, p. 124) and COLLIGNON (1955, p. 78). The large holotype of this species, from the Coniacian of France, and another similarly large example from the Upper Turonian of Madagascar, were later assigned to *Pachydesmoceras* SPATH, 1922, by COLLIGNON himself (1961, p. 41), and I agree with this attribution.

Nowakites denticulatus MARSHALL (1926, p. 189, pl. 25, fig. 3; pl. 38, fig. 5), from the Campanian of New Zealand, and *Pachydiscus bystrzycae* NOWAK (1913, p. 353, pl. 40, fig. 9, pl. 43, fig. 27; pl. 44, fig. 37), from the Campanian of

Poland, do not seem to be referable to *Nowakites*. Although I have not seen the original specimens, the former may be referred to *Gunnarites* of Kossmaticeratidae and the latter to *Pachydiscus* itself.

Affinities:—*Nowakites* is evidently allied to and probably derived from, or has a common ancestor (*Eopachydiscus* WRIGHT, 1955) with, *Lewesiceras* SPATH, 1922. The former has more compressed whorls with less cordate sections and more deeply incised, less massive sutural elements than the latter. Representative species of *Nowakites* have on the septate whorl weaker and more crowded ribs than those of *Lewesiceras* at corresponding growth-stage. Some, if not all, species of *Lewesiceras* attain a huge size at which the shell become smoothish. *Nowakites* is small or of moderate size, so far as the available material is concerned. *Lewesiceras* ranges from Upper Cenomanian to Coniacian, with the maximum abundance in the Turonian, while *Nowakites* occurs in the Coniacian and Santonian.

Canadoceras SPATH, 1922, from the Upper Santonian and Campanian, is closely related to and probably directly derived from *Nowakites*. In typical examples *Canadoceras* has more compressed whorls, more numerous and stronger ribs and more deeply and finely incised, narrower sutural elements than *Nowakites*. The multicostation and constriction in the immature stages of *Nowakites* seem to be extended to the later growth-stages in *Canadoceras*. The shell of *Canadoceras* in the middle or adolescent stage has stronger umbilical tubercles and stronger major ribs and more distinct constrictions than *Nowakites* of corresponding size. Some species of *Canadoceras* attain a large size in which the tubercles and constrictions are weakened. A few species, such as *Nowakites draschei* REDTENBACHER, 1873, from the Santonian of the Alps, and *Canadoceras yokoyamai* (JIMBO) (1894, p. 31, pl. 2, fig. 3) (see MATSUMOTO, 1954, 1959), from the Upper Santonian and Campanian of Japan and Pacific side of North America, have apparently intermediate characters between the two genera.

Distribution:—Several speices of *Nowakites* are known from the Coniacian and Santonian of France and Austria. In other areas very few examples of the genus have been described.

Nowakites flaccidicostus (RÖMER)

Pl. 32, Fig. 1a b, c; Text-fig. 1

1852. *Ammonites flaccidicosta* RÖMER, *Die Kreidebildungen von Texas und ihre organischen Einschlüsse*, p. 33, pl. 1, fig. 1a, b.

1928. *Nowakites* (?) *flaccidicosta*, ADKINS, *Univ. Texas Bull.* 2338, p. 221.

Lectotype:—The larger of the two syntypes, No. 47 of the Palaeontological Museum, University of Bonn, as illustrated in this paper, Pl. 32, Fig. 1a, b, c, is designated here as the lectotype. The other syntype is not referable to the present species.

Measurements in millimeters (in deformed condition):—

	Diameter	Umbilicus	Height	Breadth	B/H
No 47a	74.0	17.6(0.24)	34(+)	15×2	0.9
» (-1/4 vol.)	—	—	31.0	28.5	0.92

Description:—The lectotype is a somewhat deformed internal mould; the unillustrated side is poorly preserved. A half of the preserved last whorl is unseptate, representing a body-chamber.

The whorl enlarges fairly rapidly, embracing a rather narrow umbilicus. It is slightly higher than broad, having a proportion of about 10:9 between height and breadth, and is subelliptical in cross section, with the maximum thickness slightly below the middle of the flank.

The ribs are nearly radial around the umbilicus, broadly concave on the main part of the flank and fairly strongly projected on the venter. They are weak and crowded on the septate part but become gradually coarser and more distant on the body-whorl. As the septate whorl is weathered around the umbilicus the intensity of the umbilical tubercles and the mode of branching or intercalation of the ribs are not clearly shown. On the body whorl there is no branching of the ribs, the shorter ribs arise at about the middle of the flank, and the umbilical tubercles are low and bullate.

The suture, which is in part weathered, shows a general pachydiscid pattern, having a trifid lateral lobe (L) somewhat deeper than the ventral lobe (E). Auxiliary elements, including U2 and U4, are gently descending. The lobes and saddles are moderately incised and not extremely narrowed.

Remarks:—The illustration of RÖMER (1852, pl. 1, fig. la, b) (Fig. 1 of this

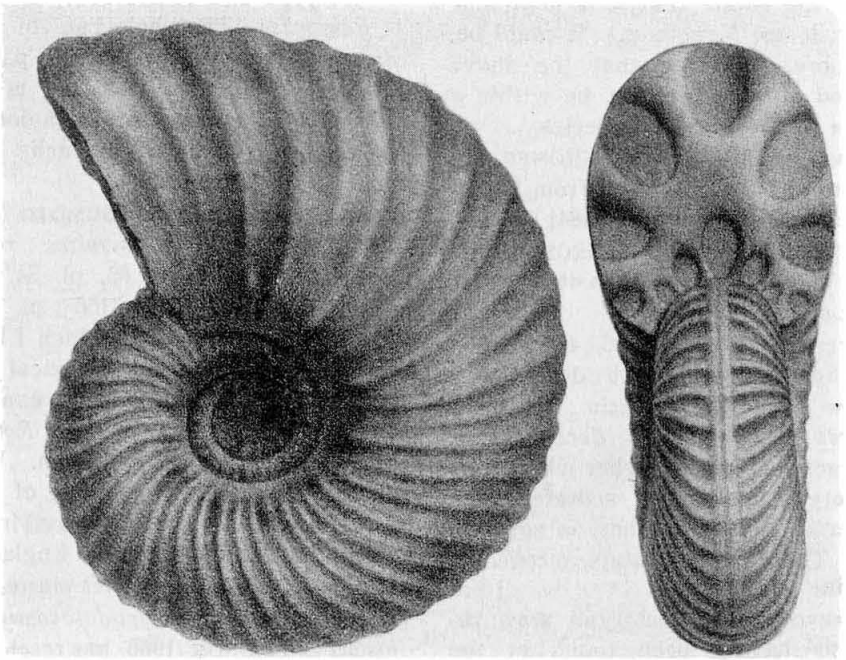


Fig. 1. *Ammonites flaccidicosta* RÖMER. Reproduction of the original illustration (RÖMER, 1852, pl. 1, fig. la, b). (Acknowledgements are extended to Professor Kotora HATAI of Tohoku University for this reproduction.)

paper) was obviously too much restored.

Affinities:—The described lectotype of *A. flaccidicosta* resembles in many respects the holotype of *Nowakites carezi* (DE GROSSOUVRE) (1894, p. 190, pl. 25, fig. 3), preserved in the Muséum National d'Histoire Naturelle, Paris. The former has a narrower umbilicus (24 as compared with 28 percent of diameter) and less compressed, septate whorl and somewhat stronger ribs than the latter. The two specimens have the same type of ribbing and their constrictions on the septate whorl are commonly shallow and weak. The suture of the French specimen was described as unknown but is actually incompletely exposed, showing a pachydiscid type.

To sum up the lectotype of *Ammonites flaccidicosta* is so close to the holotype of *Nowakites carezi* that it is justifiable to refer it to *Nowakites*. It could be, furthermore, suggested that the above mentioned difference might be within a variation of the identical species.

Nowakites flaccidicostus (RÖMER) is similar to but distinguished from *Nowakites paillettei* (D'ORBIGNY) (1841, p. 339, pl. 102, figs. 3, 4) (see also GROSSOUVRE, 1894, p. 149, pl. 37, fig. 2) in its weaker and non-sigmoidal ribs.

YOUNG (1963, p. 55, pl. 16, figs. 5, 6; pl. 76, fig. 5; text-fig. 10b) described a specimen from the Austin Chalk as *Nowakites* (?) sp. cf. *N.* (?) *flaccidicostus*. It is larger and has a higher whorl than the lectotype but is still septate. The character of its inner whorl is not well shown. Therefore I hesitate to conclude its specific identity.

Occurrence:—The lectotype was recorded as having been found at the Waterfall of Guadalupe below New-Braunfels, Texas. The matrix of the fossil is chalky rock containing abundant bioclastic fragments (mostly fragmentary, small pieces of *Inoceramus* shells and prisms) and some coarse-grained minerals.

Genus *Pseudojacobites* SPATH, 1922

Type-species:—*Pachydiscus farmeryi* CRICK, 1910, from the Turonian of England, by original designation.

Generic diagnosis:—The shell is rather small to moderate in size. The whorl is cordate or oval in cross section, with more or less inflated flanks. It is ornamented with radial ribs, umbilical tubercles and also in the late growth-stage ventrolateral and ventral tubercles. Constrictions may be rather weak.

In the type-species, the suture is not clearly known. In another species, *P. rotalinus* (STOLICZKA), it is of pachydiscid type and considerably incised.

Remarks:—The holotype of *Pachydiscus farmeryi* CRICK (1910, p. 345, pl. 27, figs. 1, 2), BM. C 12220, is indeed imperfectly preserved, but it does show particular characters which deserve generic distinction.

As WRIGHT and MATSUMOTO (1954, p. 124) remarked, *Ammonites rotalinus* STOLICZKA (1865, p. 65, pl. 34, fig. 2) (KOSSMAT, 1897, p. 91 [156], pl. 14 [20], fig. 3), the holotype of which I have recently studied at the Geological Survey of India, is probably another example of *Pseudojacobites*, of which *Rotalinites* SHIMIZU, 1935, is a synonym. WRIGHT showed me another example of *Pseudojacobites* recently collected by Mr. SMITH from the Chalk Rock of England. In addition to *Pseudojacobites masiaposensis* (COLLIGNON, 1955), *Pseudojacobites ankobensis* COLLIGNON (1965) has recently been described from the Upper Turonian of Madagascar. The latter seems to be characterized by having more precocious development of ventrolateral and siphonal

tubercles and smaller umbilical tubercles than the former, as WRIGHT (letter of March 3, 1966) has noted. I am going to describe below another new species from Texas.

Affinities:—*Pseudojacobites* resembles *Lewesiceras* and also *Nowakites*, but is distinguished by the presence of ventrolateral and ventral tubercles.

A transitional feature from *Lewesiceras* to *Pseudojacobites* is shown by such a species as *Pachydiscus anapadensis* (KOSSMAT) (1898, p. 90 [155], pl. 14 [20], fig. 2) [=*Ammonites peramplus*, STOLICZKA, 1865, p. 130, pl. 65, figs. 1, 2, *non* Mantell, 1822], which is close to *Lewesiceras mantelli* WRIGHT and WRIGHT (1951, p. 20 [=*Ammonites peramplus*, SHARPE, 1853, p. 26, pl. 10, fig. 3 (only), *non* MANTELL, 1822] but has strengthening and then incipient tuberculation of the ribs at the ventrolateral shoulders. This Indian species should be kept in *Lewesiceras*, since it has no siphonal tubercles.

Distribution:—The hitherto known species of *Pseudojacobites* have been recorded as occuring in the Turonian and Coniacian of England, India and Madagascar. A new species here described is presumed to be from the Senonian (?) of Texas, but its true stratigraphic and geographic range should be determined by further collecting.

Pseudojacobites texanus sp. nov.

Pl. 32, Figs. 2a, b, c, d

1852. *Ammonites flaccidicosta* RÖMER, *Die Kreidegebildungen von Texas und ihre organischen Einschlüsse*, p. 33 (parts.).

Holotype:—The smaller of the two syntypes of *Ammonites flaccidicosta* RÖMER, No. 47 of the Palaeontological Museum, University of Bonn.

Description:—The holotype is incompletely preserved, consisting of a half whorl, about 65 mm. in diameter. The umbilicus is estimated at about 28 percent of the diameter.

The whorl is rounded and rather cordate in cross section, being slightly higher than broad, with height of 26 mm. and breadth of 25 mm., and broadest at about one third of the height.

The ribs are numerous, slightly narrower than the interspaces, of moderate intensity, and of unequal length. Four longer ribs on a half whorl are provided with umbilical tubercles and accompanied by constrictions. They are concave on the flank and moderately projected on the venter. Some of the ribs have tubercles at the ventrolateral shoulder and on the siphonal line. On the minor ribs the tubercles are very small; the ventral one is double consisting of two tiny ones on either side of the siphonal line. On the major ribs the ventral tubercles are single, situated on the siphonal line, and these and ventrolateral tubercles are strengthened.

The suture, which is incompletely exposed and partly eroded, is of pachydiscid type, having a trifid lateral lobe (L), smaller U2 and still smaller U4. The sutural elements are moderately incised.

Affinities:—The specimen from the Chalk Rock (Upper Turonian) of England is closely similar to the present species in that the ventral tubercles are double on the septate whorl. The holotype of *Pseudojacobites farmeri* (CRICK), from the zone of *Holaster planus*, England, has apparently more compressed whorls but is secondarily deformed; it has finer and more numerous minor ribs, and larger umbilical tubercles which are higher up the side. *Pseudojacobites rotalinus* (STOLICZKA), from the "Utatur"

(?) Group of India and the Turonian (?) of Madagascar, has more depressed whorls, wider umbilicus, more frequent major ribs and stronger tubercles, of which the umbilical ones are shifted upward and the ventral ones are single. *Pseudojacobites ankobensis* COLLIGNON (1965, p. 10, pl. 380, fig. 1643), from the Upper Turonian of Madagascar, has also depressed whorls and stronger tubercles than the present new species.

Occurrence:—The single available specimen was recorded as being found at the Waterfall of Guadalupe below New-Braunfels, Texas. On the inner side of the body-chamber numerous small shells of *Exogyra* are attached. The matrix is fine limy rock with little bioclastic and mineral fragments.

Concluding Remarks

As a result of the restudy of the two syntypes of *Ammonites flaccidicosta* RÖMER, 1852, the following two species are distinguished:

Nowakites flaccidicostatus (RÖMER), represented by the lectotype, designated in this paper, and

Pseudojacobites texanus sp. nov., represented by the other syntype, which is designated in this paper as the holotype of this new species.

The two specimens were recorded to have been found at the Waterfall of Guadalupe below New-Braunfels, Texas. They could be, however, of different stratigraphic position, since they are dissimilar in the lithology of their rock matrix. To quote from kind information from Prof. K. YOUNG (letter of Dec. 6, 1965), "The fossil from the fine-grained limy rock with small shells of *Exogyra* (?) is probably from the Dessau Member, Lower Campanian, my zone of *Submortoniceras tequesquitense*. However, the zone of *Prionocyclus* does contain *Exogyra* sp. cfr. *columba* in this area. The fossil from the bioclastic formation should be from the Coniacian part of the Austin. This agrees with the reporting of *Nowakites* from the lower Austin by ADKINS and HAZZARD at many localities in the Rio Grande Valley." Anyhow, further collecting from better defined beds is necessary for more precise evaluation of these ammonites.

References Cited

ADKINS, W. S. (1928): Handbook of Texas Cretaceous fossils. *Univ. Texas Bull.*, 2838, 303p., 37 pls., index.

BRINKMANN, Roland (1935): Die Ammoniten der Gosau und des Flysch in den nördlichen Ostalpen. Beiträge zur Kenntnis der alpinen Oberkreide Nr. 2. *Mitt. geol. Staatsinst. Hamburg*, (15), 1-14.

COLLIGNON, Maurice (1955): Ammonites néocrétacées du Menabe (Madagascar). II.—Les Pachydiscidae. *Ann. géol. Serv. Mines, Madagascar*, 21, 1-98, pls. 1-28.

———, (1961): Ammonites néocrétacees du Menabe (Madagascar). VIII.—Les Desmoceratidae. *Ann. géol. Serv. Mines. Madagascar*, 31, 1-115, pls. 1-32.

———, (1965): *Atlas des Fossiles Caracteristiques de Madagascar (Ammonites)*. 12 (Turonien), 82p., pls. 376-413; 13 (Coniacien), 88p., pls. 414-454, Serv. Geol. Tananarive.

CRICK, G. C. (1910): Note on two cephalopods (*Pachydiscus farmeri* and *Heteroceras reussianum*) from the Chalk of Lincolnshire. *Geol. Mag.* [Dec. V], 6, 345-8.

GROSSOUVRE, Albert DE (1894): Recherches sur la Craie supérieure. II Paléontologie Les ammonites de la Craie superieure *Mém. Carte géol. dét. France* (1893), 264 p., 39 pls.

JIMBO, Kotora (1894): Beiträge zur Kenntniss der Fauna der Kreideformation von

Hokkaido. *Paläont. Abhandl.*, 6 [N. F 2], (3), 149-194 [1-46], pl 17-25 [18].

KOSSMAT, F. (1898) : Untersuchungen über die Südindische Kreideformation, III. *Beitr. Paläont. Geol. Österr.-Ungrans Orients*, 11, 89-152 [154-217], pls. 14-19 [20-25].

MANTELL, G. (1822) : *Fossils of the South Downs*, 320p., 43 pls., London.

MARSHALL, P. (1926) : The Upper Cretaceous ammonites of New Zealand. *Trans. N. Z. Inst.*, 56, 129-210, pls. 19-48.

MATSUMOTO, Tatsuro (1955a) : Family Kossmaticeratidae from Hokkaido and Saghalien. *Japan. Jour. Geol. Geogr.*, 26, 115-164, pls. 8-10.

———. (1955b) : The bituberculate pachydiscids from Hokkaido and Saghalien. *Mem. Fac. Sci., Kyushu Univ.* [D], *Geol.*, 5, (3), 153-184, pls. 31-37.

———. (1959) : Upper Cretaceous ammonites of California. Part II. *Mem. Fac. Sci., Kyushu Univ.*, [D], *Geol., Special* vol. 2, 1-172, pls. 1-41.

NOWAK, J (1913) : Untersuchungen über die Cephalopoden der oberen Kreide in Polen, III. *Bull. Acad. Sci., Cracovie*, [B], 1913, 335-415, pls. 40-45.

ORBIGNY, Alcide D' (1840-42) : *Paléontologie française. Terrains crétacés* 1, *Céphalopodes*, 662p., 148 pls. [1-120 (1840) ; 121-430 (1841) ; 431-662 (1942)]. Paris.

———. (1850) : *Prodrome de Paléontologie Stratigraphique Universelle des Animaux Mollusques et Rayonnés*, 2.

REDTENBACHER, A. (1873) : Die Cephalopoden fauna der Gosauschichten in den nördöstlichen Alpen. *Abhandl. Geol. Reichsanst.*, 5, 91-140, pls. 22-30.

RÖMER, F. A. (1852) : *Die Kreidebildungen von Texas und ihre organischen Einschlüsse &c.*, 100p., 11 pls., Bonn.

SCHLÜTER, Clement (1871-76) : Die Cephalopoden der oberen deutschen Kreide. *Palaeontographica*, 21, 24 (21, 1-24, pls. 1-8, 1871 ; 25-120, pls. 9-35, 1872 ; 24, 121-264, pls. 36-55, 1876).

SHARPE, Daniel (1853-57) : Description of the fossil remains of mollusca found in the Chalk of England. 1. Cephalopoda. *Palaeontogr. Soc.* (1853-57), 68p., 27 pls., [1-26, pls. 1-10, 1853 ; 27-36, pls. 11-16 1855 ; 37-68, pls. 17-27, 1857 ; index, 1909].

SHIMIZU, Saburo (1935) : The Upper Cretaceous cephalopods of Japan, Part I. *Jour. Shanghai Sci. Inst.* [II], 2, 159-226.

SPATH, L. F. (1922) : On the Senonian ammonite fauna of Pondoland. *Trans. Roy. Soc. South Africa*, 10, (3), 113-147, pls. 5-9.

STOLICZKA, Ferdinand (1863-66) : Ammonitidae, with revision of the Nautilidae, etc. *In* BLANFORD, M. F. & STOLICZKA, F., 1861-1866. The fossil cephalopoda of the Cretaceous rocks of southern India. *Mem. Geol. Surv. India, Palaeont. Indica*, [3], 41-216, pls. 26-94 [41-56, pls. 26-31, 1863 : 57-106, pls. 32-54, 1864 : 107-154, pls. 55-80, pl. 66a, 1865 ; 155-216, pls. 81-94, 1866]

WRIGHT, C. W. (1955) : Notes on Cretaceous ammonites.—II. The phylogeny of the Desmoceratacеae and the Hoplitaceae. *Ann. Mag. Nat. Hist.*, [12], 8, 561-575.

WRIGHT, C. W. and MATSUMOTO, Tatsuro (1954) : Some doubtful Cretaceous ammonite genera from Japan and Saghalien. *Mem. Fac. Sci., Kyushu Univ.* [D], *Geol.*, 4, (2), 107-134, pls. 7-8.

WRIGHT, C. W. and WRIGHT, E. V. (1951) : A survey of the fossil Cephalopoda of the Chalk of Great Britain. Primarily a nomenclatorial revision of Daniel SHARPE'S "Description of the fossil remains of mollusca found in the Chalk of England. Part I Cephalopoda" (1853-1857). *Palaeontogr. Soc.* (1950), 40p.

YOUNG, Keith (1963) : Upper Cretaceous ammonites from the Gulf Coast of the United States. *Univ. Texas Publ.*, 6304, ix+142p., incl. 82 pls. and 34 text-figs.

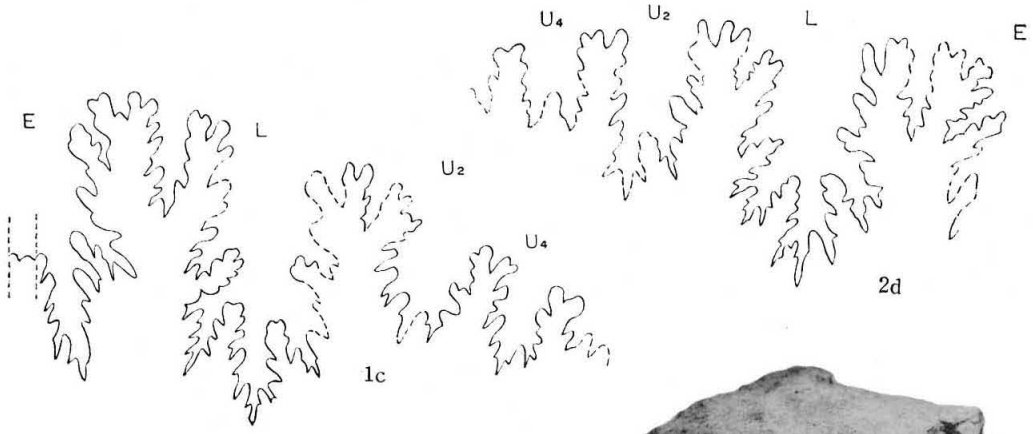
Explanation of Plate 32

Page

Fig. 1. *Nowakites flaccidicostus* (RÖMER) 296
Lectotype, No. 47 (a), Palaeological Museum, University of Bonn, from the Waterfall of Guadalupe beolw New-Braunfels, Texas. Lateral (a) and ventral (b) views, ×1, and external part of septal suture (c), ×2.

Fig. 2. *Pseudojacobites texanus* sp. nov. 299
Holotype, No. 47 (b), Palaeontological Museum, University of Bonn, from the Waterfall of Guadalupe below New-Braunsfels, Texas. Two lateral (a, b) and ventral (c) views, ×1, and external suture (d), ×2.

Kyushu University photo
Sutures are drawn by T. M., with some restoration (in broken line) of eroded parts.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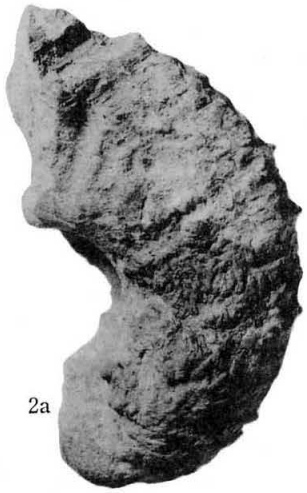
2a


1a


2c


1b


2b

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 63, pp. 303-315, pls. 33, 34, Sept. 30, 1966

511. UPPER PERMIAN FUSULINIDS FROM THE TAISHAKU LIMESTONE IN WEST JAPAN*

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and

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Onoda Cement & Co. Ltd.

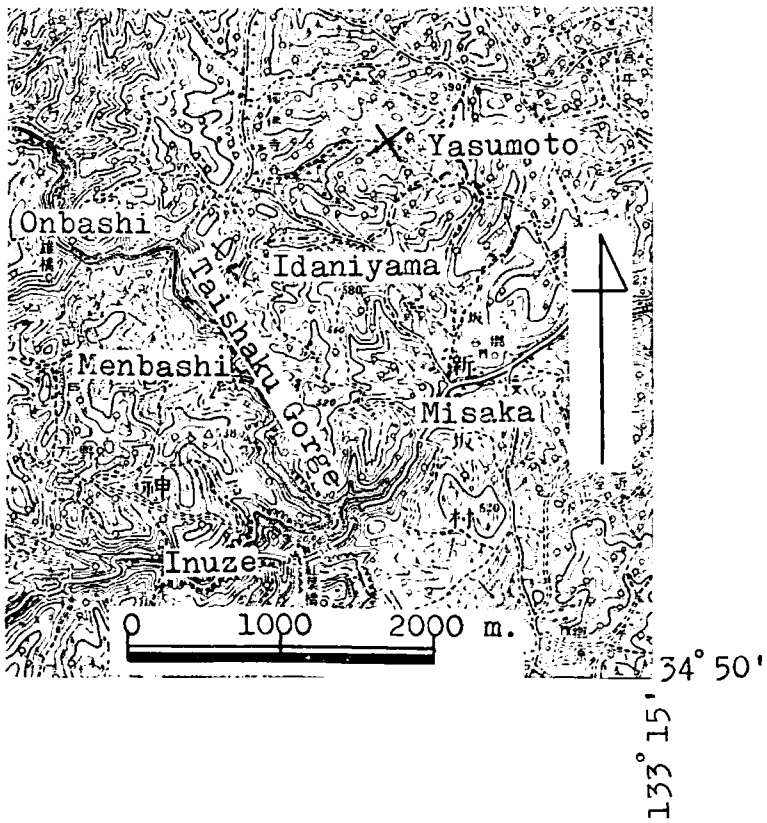
帝釈石灰岩台地産の上部二畳紀紡錘虫：帝釈石灰岩の上部二畳系、保元層から次の紡錘虫化石を識別したので、ここに記載・報告する。記載された種は次のとおりである。すなわち、*Yabeina multiseptata multiseptata* (DEPRAT)、*Y. m. shiraiwensis* OZAWA、*Y. elongata* (GUBLER)、*Y. minuta* THOMPSON & WHEELER、*Chusenella* sp. A の5種である。*Y. m. shiraiwensis* は本邦の上部二畳系にもっともよく知られる種であり、*Y. m. multiseptata* と *Y. elongata* としたものは Cambodia の上部二畳系から GUBLER (1935)、SKINNER & WILD (1954) および石井・野上 (1964) によつて報告されたものと同種である。*Yabeina minuta* は北米の British Columbia (THOMPSON & WHEELER, 1942) や Cambodia (石井・野上, 1964) 産のものに同定される。これらの紡錘虫類からなる保元層の化石群は本邦の上部二畳系の紡錘虫化石群のうちで特異な構成を示し、かつ Cambodia の化石群に対比される。

佐田公好・横山鶴雄

Introduction

The Taishaku Limestone, well exposed in the northern part of Hiroshima Prefecture belonging to the Inner Zone of West Japan, contains a large number of Carboniferous and Permian fusulinids supremely important for the purposes of zoning the limestone and expanding the regional and international correlations. The concise outline of the stratigraphy of this limestone has been known by the works of HANZAWA (1942) and FUJIMOTO (1944). However, Carboniferous and Permian fusulinids of the Taishaku Limestone have been remained undescribed. Recently one of the authors (YOKOYAMA, 1957, 1960) published the descriptions of Carboniferous and Permian corals from the limestone, and in 1959 gave a brief report concerning the occurrence of the *Yabeina* fauna in the Yasumoto formation distributed in the central part of this limestone plateau. A few years later, the authors reinvestigated the Yasumoto formation and examined a large number of available thin sections prepared by themselves. As a result of the study, *Yabeina multiseptata multiseptata* (DEPART), *Y. m. shiraiwensis* OZAWA, *Y. minuta* THOMP-

* Received March 16, 1966; read Nov. 7, 1965 at 92nd Meeting of the Paleontological Society of Japan, at Chiba.



Text-fig. 1. Map showing the fossil locality in the Taishaku Limestone Plateau, Hiroshima Prefecture.

SON & WHEELER, *Y. elongata* (GUBLER) and *Chusenella* sp. A were identified, among which the second was most abundant. Compared with the Upper Permian fusulinid faunas in various localities of Japan, the Yasumoto fauna is quite unique in containing *Y. elongata*, and it seems that the fauna corresponds closely in specific composition with the Cambodian faunas described by GUBLER (1935) and ISHII and NOGAMI (1964). In this paper the authors propose the name of *Yabeina elongata* zone to the Yasumoto formation characterized by the fusulinids listed above, and also give the complete descriptions of them. As to the detalis of the Permian stratigraphy of this limestone, the readers are requested to refer to the paper which will be described by YOKOYAMA in the nearest future.

Systematic Paleontology

Family Fusulinidae MÖLLER, 1878

Subfamily Neoschwagerininae DUNBER & CONDRA, 1928

Genus *Yabeina* DEPRAT, 1914

Yabeina multiseptata multiseptata (DEPRAT)

Pl. 33, figs. 4-5, 7-8

1912. *Neoschwagerina (Sumatrina) multiseptata* DEPRAT. *Mém. Serv. géol. Indochine*, Vol. 1, Fasc. 3, pp. 53-55, pl. 3, figs. 2-8.

1914. *Neoschwagerina (Sumatrina) multiseptata*, DEPRAT. *ibid.*, Vol. 3, Fasc. 1, pp. 34-35, pl. 5, figs. 7-11.

1922. *Neoschwagerina (Yabeina) hayasakai*, OZAWA. *Geol. Soc. Tokyo, Jour.*, Vol. 29, No. 348, pp. 369-370, pl. 4, fig. 2.

1924. *Neoschwagerina multiseptata*, COLANI. *Mém. Serv. géol. Indochine*, Vol. 11, Fasc. 1, pp. 154-155, pl. 15, fig. 1; pl. 24, figs. 12-13; pl. 25, figs. 1-8, 10-12, 14-15; pl. 26, figs. 1-2, 4, 6-18.

1935. *Neoschwagerina multiseptata*, GUBLER. *Mém. Soc. géol. France, Nov. Sér.*, T. 11, Fasc. 4, pp. 119-123, pl. 3, fig. 5; pl. 6, figs. 1, 3, 8-10; pl. 7, fig. 5.

1935. *Neoschwagerina megasphaerica*, GUBLER. *ibid.*, pp. 114-116, pl. 7, fig. 3; pl. 6, fig. 4.

1948. *Lepidolina multiseptata*, THOMPSON. *Protozoa, Art. 1, Univ. Kansas*, pp. 66-67, pl. 20, figs. 5-6; pl. 22, figs. 1-5.

1954. *Lepidolina multiseptata*, SKINNER & WILD. *Jour. Paleont.*, Vol. 28, No. 4, pp. 449-450, pl. 52, figs. 1-5.

1964. *Yabeina multiseptata multiseptata*, ISHII & NOGAMI. *Jour. Geosci., Osaka City Univ.*, Vol. 8, Art. 2, pp. 17-20, pl. 3, figs. 1-3; pl. 4, figs. 1-3; pl. 5, figs. 1-4.

Material:—The present specimens came from the Yasumoto formation at Loc. A52207 and illustrated ones are as follows: Rg. No. A52207-4, A52207-9, A52207-10 and A52207-11. Beside them, many specimens from the same locality were prepared.

Description:—The shell of *Yabeina multiseptata multiseptata* (DEPRAT) is large and inflated fusiform, with a straight axis of coiling. The lateral slopes are nearly straight to gently concave. The specimen (Rg. No. A52207-11) illustrated as fig. 7 on Pl. 33 is 7.75 mm. in length and 4.75 mm. in width, giving a form ratio of 1.6. The ratios of the half length to the radius vector of the 1st to the 14th volution of a specimen (Rg. No. A52207-11) are 0.95, 0.93, 0.94, 1.07, 1.14, 1.17, 1.24, 1.39, 1.47, 1.57, 1.59, 1.63, 1.73 and 1.65, respectively.

The proloculus is large and spherical. Its outside diameter ranges from 585 to 990 microns. The shell expands rapidly and almost uniformly throughout the growth. The radius vectors of a specimen (Rg. No. A52207-11) are 396, 528, 661, 922, 925, 1,020, 1,152, 1,303, 1,435 1,586, 1,775, 1,964, 2,096 and 2,455 microns, respectively, for the 1st to the 14th volution.

The spirotheca is thin and consists of a tectum and a very thin keriotheca with very fine alveoli. The thickness of the spirotheca at its thinnest point between the adjacent septula in a certain form (Rg. No. A52207-4) is 11-18 microns in the 1st to the 15th volution.

The septa and septula are present throughout the shell. One primitive secondary spiral septulum occurs in the 1st volution and two septula appear in the 5th or the 6th volution.

The foramina are small and circular in cross section.

Remarks:—*Yabeina multiseptata multiseptata* was originally described by DEPRAT (1912) from Sisophon in Cambodia under the name of *Neoschwagerina (Sumatrina) multiseptata*. Very recently ISHII & NOGAMI (1964) described this species from Battambang Province of Cambodia under the name of *Yabeina*, and then they divided it into three subspecies, namely, *Y. multiseptata multiseptata* (DEPRAT), *Y. m. gigantea* (GUBLER) and *Y. m. shiraiwensis* OZAWA, the last of which is to be described below. The specimens in authors' collection coincide with the Cambodian

Table 1. Measurements of *Yabeina multiseptata multiseptata* (DEPRAT)

Specimen		A52207-11	A52207-4
Pl. fig.		33-7	33-4
Length		7.75	—
Width		4.75	—
Form ratio		1.6	—
Prol.		0.623	0.585
	Vol.		
Radius vector	1	0.396	0.377
	2	0.528	0.510
	3	0.661	0.642
	4	0.922	0.755
	5	0.925	0.850
	6	1.020	0.963
	7	1.152	1.057
	8	1.303	1.190
	9	1.435	1.341
	10	1.586	1.511
	11	1.775	1.662
	12	1.964	1.832
	13	2.096	2.021
	14	2.455	2.229
	15		2.436
Ratio of Hl./Rv.	1	0.95	1.10
	2	0.93	1.00
	3	0.94	1.09
	4	1.07	1.17
	5	1.14	1.17
	6	1.17	1.33
	7	1.24	1.57
	8	1.39	1.58
	9	1.47	1.59
	10	1.57	1.61
	11	1.59	1.65
	12	1.63	1.71
	13	1.73	1.71
	14	1.65	1.70
Thickness of spirotheca	0	.023	.009
	1	.016	.011
	2	.023	.013
	3	.016	.013
	4	.023	.018
	5	.018	.016
	6	.016	.013
	7	.021	.011
	8	.016	.016
	9	.023	.011
	10	.023	.016
	11	.025	.011
	12	.016	.018
	13	.021	.013
	14	.018	.013
	15		.018

(Measurements in millimeters)

ones in the following respects, namely, the general shape of the shell, the size of the shell, the form ratio, the size of the proloculus, the radius vector and the essential internal biocharacters.

Yabeina multiseptata multiseptata resembles *Y. m. shiraiwensis* OZAWA more closely than any other known species. They are, however, distinguished from each other, for *Y. m. multiseptata* has the larger proloculus, somewhat thinner spirotheca and rather rapider expansion of the shell for the corresponding volution.

Occurrence:—Commonly found in the *Yabeina elongata* zone of the Yasumoto formation at Yasumoto (Loc. A52207) on the Taishaku Plateau; the associated fusulinids are *Yabeina multiseptata shiraiwensis*, *Y. minuta*, *Y. elongata* and *Chusenella* sp. A.

Yabeina multiseptata shiraiwensis OZAWA

Pl. 33, figs. 1-3

1925. *Yabeina shiraiwensis* OZAWA. *Jour. Coll. Sci., Imp. Univ. Tokyo*, Vol. 45, Art. 6, pp. 63-64, pl. 2, figs. 2b, 5c, 7b; pl. 10, figs. 1-2.
1936. *Yabeina shiraiwensis*, HUJIMOTO. *Sci. Rep. Tokyo Bunrika Daigaku, Geol. C*, Vol. 1, No. 2, pp. 122-123, pl. 26, figs. 1-7.
1942. *Yabeina shiraiwensis*, TORIYAMA. *Japan. Jour. Geol. Geogr.*, Vol. 18, No. 4, p. 245, pl. 24, figs. 1-6.
1942. *Yabeina yasubaensis*, TORIYAMA. *ibid.*, p. 246, pl. 25, figs. 8-13.
1954. *Yabeina yasubaensis*, KANMERA. *Mem. Fac. Sci., Kyushu Univ., Ser. D*, Vol. 4, No. 1, pp. 18-19, pl. 2, figs. 10-13; pl. 5, figs. 14-19.
1956. *Yabeina shiraiwensis*, CHEN. *Paleont. Sinica, New Ser. B*, No. 6, pp. 13, 64-65, pl. 16, figs. 8-10.
1956. *Yabeina shiraiwensis*, MORIKAWA. *Sci. Rep. Saitama Univ., Ser. B*, Vol. 2, No. 2, pp. 254-256, pl. 33, figs. 1-11; pl. 34, figs. 8-9.
1958. *Yabeina shiraiwensis*, TORIYAMA. *Mem. Fac. Sci., Kyushu Univ., Ser. D*, Vol. 7, pp. 236-241, pl. 45, figs. 1-11.
1958. *Yabeina yasubaensis*, TORIYAMA. *ibid.*, pp. 241-244, pl. 45, figs. 12-14.
1958. *Yabeina yasubaensis*, NOGAMI. *Mem. Coll. Sci., Univ. Kyoto, Ser. B*, Vol. 25, No. 2, pp. 102-103, pl. 1, fig. 8.
1958. *Yabeina shiraiwensis*, MORIKAWA et al. *Jub. Pub. Commem. Prof. H. Fujimoto Sixtieth Birth*, p. 89, pl. 6, fig. 9.
1960. *Yabeina shiraiwensis*, CHISAKA. *Coll. Art. Sci., Chiba Univ.*, Vol. 3, No. 2, pp. 248-249, pl. 5, figs. 1-10; pl. 6, fig. 5.
1960. *Yabeina shiraiwensis*, MORIKAWA. *Sci. Rep. Saitama Univ., Ser. B*, Vol. 3, No. 3, pp. 296-297, pl. 53, figs. 1-9.
1961. *Yabeina shiraiwensis*, NOGAMI. *Mem. Coll. Sci., Uinv. Kyoto, Ser. B*, Vol. 28, No. 2, pp. 186-190, pl. 8, figs. 1-8.
1962. *Yabeina shiraiwensis*, ISHII & NOGAMI. *Jour. Geosci., Osaka City Univ.*, Vol. 8, Art. 2, pp. 13-17.
1964. *Yabeina multiseptata shiraiwensis*, ISHII & NOGAMI. *Jour. Geosci., Osaka City Univ.*, Vol. 8, Art. 2, pp. 13-17.

Material:—A large number of specimens from Loc. A52207 were examined and among them three specimens (Rg. No. A52207-7, A52207-12 and A52207-5) are illustrated.

Description:—The shell of *Yabeina multiseptata shiraiwensis* OZAWA is large and inflated fusiform, having a straight axis of coiling and bluntly pointed poles. The lateral slopes are straight to gently concave. The largest specimen (Rg. No. A52207-5) illustrated as fig. 3 on Plate 33 is 8.25 mm. in length and 4.40 mm. in width, with a form ratio of 1.9. The first four volutions are nearly spherical to subspherical and following two are highly inflated fusiform. Beyond the 7th volution the shell attains nearly to its mature shape. The ratios

Table 2. Measurements of *Yabeina multiseptata shiraiwensis* OZAWA

Specimen		A52207-7	A52207-5	A52207-12
Pl. fig.		33-1	33-3	33-2
Length		6.85	8.25	6.25
Width		4.50	4.40	3.50
Form ratio		1.5	1.9	1.8
Prol.		0.396	0.264	0.321
	Vol.			
Radius vector	1	0.226	0.188	0.226
	2	0.302	0.283	0.283
	3	0.396	0.377	0.358
	4	0.510	0.453	0.434
	5	0.661	0.566	0.510
	6	0.850	0.698	0.623
	7	0.982	0.812	0.717
	8	1.152	0.963	0.812
	9	1.341	1.095	0.963
	10	1.548	1.265	1.190
	11	1.737	1.454	1.341
	12	1.964	1.624	1.473
	13	2.172	1.832	1.624
	14		2.021	1.794
Ratio of Hl./Rv.	1	1.42	1.20	0.92
	2	1.50	1.00	0.87
	3	1.57	1.05	0.95
	4	1.67	1.25	1.22
	5	1.63	1.46	1.44
	6	1.60	1.46	1.55
	7	1.67	1.60	1.61
	8	1.67	1.83	1.68
	9	1.69	2.08	1.65
	10	1.65	2.10	1.44
	11	1.68	2.14	1.48
	12	1.63	2.15	1.54
	13	1.65	2.14	1.51
	14			1.47
Thickness of spirotheca	0	.027	.029	.034
	1	.027	.027	.023
	2	.021	.023	.025
	3	.027	.029	.016
	4	.021	.027	.013
	5	.029	.021	.021
	6	.023	.027	.027
	7	.036	.013	.011
	8	.027	.016	.027
	9	.023	.016	.021
	10	.018	.023	.021
	11	.025	.016	.023
	12	.023	.023	.023
	13		.027	.023
	14		.025	.025
	15		.018	.025
	16			.021

(Measurements in millimeters)

of the half length to the radius vector of the 1st to the 13th volution of a specimen (Rg. No. A52207-5) are 1.20, 1.00, 1.05, 1.25, 1.46, 1.46, 1.60, 1.83, 2.08, 2.10, 2.14, 2.15 and 2.14, respectively.

The proloculus is moderate and spherical. Its outside diameter is ranging from 264 to 396 microns. The shell is tightly coiled in the inner five volutions and expands uniformly in the outer ones. The radius vectors of a specimen are 188, 283, 377, 453, 566, 698, 812, 963, 1,095, 1,265, 1,454, 1,624, 1,832, and 2,021 microns, respectively, for the 1st to the 14th volution.

The spirotheca is thin and composed of a tectum and a very thin keriotheca with very fine alveoli. The thickness of the spirotheca at its thinnest point between the adjacent septula in a specimen (Rg. No. A52207-5) measures 21-29 microns in the 1st to the 6th volution and 13-27 microns in the 7th to the 15th volution.

The septa are thin and composed of a tectum and the downward extension of the keriotheca. The axial septula present throughout the shell. The secondary spiral septula are very short and primitive in the inner two or three volutions, but they become distinct in the 4th volution. There is one septulum between the adjacent primary septula in the inner volutions, but two septula occur occasionally in the outer ones.

The foramina are very small and circular in cross section.

Remarks:—In the shell shape, the radius vectors, the proloculus diameter, the spirothecal thickness, and the internal modes, the present specimens quite agree with *Yabeina shiraiwensis* OZAWA (1925, pl. 10, fig. 2) from the Akiyoshi Limestone. Recently ISHII and NOGAMI (1964) made a comparative study of *Y. shiraiwensis* and *Y. multiseptata* (DEPRAT), the latter of which was collected from Cambodia, and they came to the conclusion that *Y. shiraiwensis* was only a subspecies of *Y. multiseptata*. The differences between *Y. multiseptata shiraiwensis* and *Y. m. multiseptata* in the characters of the shell and the measured values were fully discussed by them. Therefore, the further discussion is not necessary in this paper.

Occurrence:— Abundant in the *Yabeina elongata* zone of the Yasumoto formation cropping out at Yasumoto (Loc. A52207) on the Taishaku Plateau; the associated fusulinids are *Yabeina multiseptata multiseptata*, *Y. minuta*, *Y. elongata* and *Chusenella* sp. A.

Yabeina minuta THOMPSON & WHEELER

Pl. 34, figs. 3-4

1942. *Yabeina minuta* THOMPSON & WHEELER. *Jour. Paleont.*, Vol. 16, pp. 707-708, pl. 106, figs. 6-9, 10?

1964. *Yabeina minuta*, ISHII & NOGAMI. *Jour. Geosci., Osaka City Univ.*, Vol. 8, Art. 2, p. 22, pl. 4, figs. 4-7.

Material:—Several specimens were identified from Loc. A52207, among which the illustrated ones were Rg. No. A52207-3 and A52207-15.

Description:—The shell of *Yabeina minuta* THOMPSON and WHEELER is small and inflated fusiform shape with a straight axis of coiling and bluntly pointed poles. The lateral slopes are straight to slightly convex. The specimen (Rg. No. A52207-3) illustrated as fig. 3 on Pl. 34 is 7.85 mm. in length and 3.05 mm. in width, giving a form ratio of 2.6. The 1st to 2nd volutions are spherical and the 3rd to 7th are highly inflated fusiform. Beyond the 8th volution the shell becomes its mature shape.

Table 3. Measurements of *Yabeina minuta* THOMPSON and WHEELER

Specimen A52207-3: Pl. 34, fig. 3.

Length	Width	Form ratio	Prol.
7.85	3.05	2.6	0.250

Radius vector		Ratio of Hl./Rv.		Thickness of spirotheca	
Vol.		Vol.		Vol.	
				0	.011
1	0.207	1	1.00	1	.025
2	0.264	2	1.43	2	.018
3	0.321	3	1.85	3	.029
4	0.415	4	1.82	4	.023
5	0.491	5	2.12	5	.018
6	0.604	6	2.03	6	.023
7	0.698	7	2.16	7	.027
8	0.793	8	2.38	8	.027
9	0.944	9	2.50	9	.034
10	1.057	10	2.64	10	.025
11	1.227	11	2.60	11	.018
12	1.378	12	2.58	12	.021
13	1.605	13	2.35	13	.027

(Measurements in millimeters)

The ratios of the half length to the radius vector of the 1st to the 13th volution of a specimen (Rg. No. A52207-3) are 1.00, 1.43, 1.85, 1.82, 2.12, 2.03, 2.16, 2.38, 2.50, 2.64, 2.60, 2.58 and 2.35, respectively.

The proloculus is moderate and spherical. Its outside diameter measures 250 microns in one of the illustrated specimens. The shell is tightly coiled in the inner four volutions and expands uniformly in the outer ones. The radius vectors are 207, 264, 321, 415, 491, 604, 698, 793, 944, 1,057, 1,227, 1,378 and 1,605 microns, respectively, for the 1st to the 13th volution.

The spirotheca is thin and composed of a tectum and a very thin keriotheca with very fine alveoli. The thickness of the spirotheca at its thinnest point between the adjacent septula in a specimen is 18-34 microns in the 1st to the 13th volution.

The septa are thin and composed of a tectum and the downward extension of a keriotheca. Both the axial septula and the primary spiral septula are present throughout the shell. The secondary spiral septula are invisible in the inner three volutions, but they are observed in the 4th to 13th ones. In the 4th to 8th volutions they are very short and primitive, but beyond the 9th they become distinct.

The foramina are small and circular in cross section.

Remarks:—*Yabeina minuta* originally described and illustrated by THOMPSON and WHEELER (1942) from the Marble Canyon Limestone in Southern British Columbia shows a fairly wide range of variation in the size of the proloculus, the form ratio and the size of the shell. Compared with the syntypes, the specimens illustrated here assume the slightly larger form ratio and possess the slightly larger proloculus. Nevertheless, they are more closely allied to *Y. minuta*

than to any other known species.

The present species somewhat resembles *Yabeina packardi shimensis* YAMAGIWA & ISHII (1958) from the Omura Island, Mie Prefecture. However, the former species can be easily distinguished from the latter, having the fairly larger shell, the larger form ratio and the larger proloculus.

Occurrence:—Rarely found in the *Yabeina elongata* zone of the Yasumoto formation at Yasumoto (Loc. A52207) on the Taishaku Plateau.

Yabeina elongata (GUBLER)

Pl. 34, figs. 1, 5

1935. *Neoschwagerina elongata* GUBLER. *Mém. Soc. géol. France, Nov. Sér.*, T. 11, Fasc. 4, pp. 108-111, pl. 8, figs. 1-2, 5, 12.

1964. *Yabeina elongata*. ISHII & NOGAMI. *Jour. Geosci., Osaka City Univ.*, Vol. 8, Art. 2, p. 23, pl. 7, figs. 1-3.

Material:—Rg. No. A52207-1 and A52207-2 were collected from Loc. A52207 at Yasumoto on the Taishaku Limestone Plateau.

Description:—The shell of *Yabeina elongata* (GUBLER) is large and highly elongated fusiform to subcylindrical, having a straight to broadly curving axis of coiling. The lateral slopes are straight to gently concave. The speci-

Table 4. Measurements of *Yabeina elongata* (GUBLER)

Specimen A52207-1: Pl. 34, fig. 1.

Half length		Width		Form ratio	Prol.
9.40		5.50		—	—
Radius vector		Ratio of Hl./Rv.		Thickness of spirotheca	
Vol.		Vol.		Vol.	
				0	—
1	—	1	—	1	—
2	0.094	2	1.67	2	.011
3	0.151	3	2.00	3	.009
4	0.207	4	2.17	4	.005
5	0.264	5	2.46	5	.004
6	0.340	6	2.90	6	.005
7	0.472	7	2.64	7	.003
8	0.566	8	3.17	8	.005
9	0.680	9	3.00	9	.004
10	0.793	10	2.74	10	.006
11	0.944	11	2.72	11	.004
12	1.057	12	2.80	12	.004
13	1.265	13	2.80	13	.004
14	1.397	14	2.94	14	.004
15	1.567	15	2.98	15	.003
16	1.756	16	2.98	16	.004
17	1.945	17	2.76	17	.005
18	2.134	18	2.88	18	.003
19	2.342	19	2.97	19	.005
20	2.625	20	3.00	20	.006

(Measurements in millimeters)

men illustrated herein as fig. 1 on Pl. 34 (Rg. No. A52207-1) is 9.40 mm. in half length and 5.50 mm. in width. The first three volutions are spherical to subspherical and following two are inflated fusiform. Beyond the 6th volution the shell becomes its mature shape. The ratios of the half length to the radius vector of the 2nd to the 20th volution of a specimen (Rg. No. A52207-1) are 1.67, 2.00, 2.17, 2.46, 2.90, 2.64, 3.17, 3.00, 2.74, 2.72, 2.80, 2.80, 2.94, 2.98, 2.98, 2.76, 2.88, 2.97 and 3.00, respectively.

The proloculus is very small. The shell is very tightly coiled in the inner eight volutions and expands uniformly in the outer ones. The radius vectors are 94, 151, 207, 264, 340, 472, 566, 680, 793, 944, 1,057, 1,265, 1,397, 1,567, 1,756, 1,945, 2,134, 2,342 and 2,625 microns, respectively, for the 2nd to the 20th volution.

The spirotheca is thin and consists of a tectum and a very thin keriotheca with very fine alveoli. The thickness of the spirotheca at its thinnest point between the adjacent septula in a specimen is 3-11 microns in the 2nd to the 10th volution and 3-6 microns in the 11th to the 20th volution.

The septa and the septula are present throughout the shell. One primitive secondary spiral septulum between the adjacent primary septula first appears in the 3rd volution. In the 9th to 11th volutions there are occasionally two secondary spiral septula, which are usually observed in the 12th to 20th volutions.

The foramina are very small and circular in cross section.

Remarks:—*Yabeina elongata* described by GUBLER (1935) from Cambodia is characterized by its large and elongate shell, very tight coiling in the inner volution, very thin spirotheca, very thin septa and septula, very small size of proloculus and a number of volutions. Recently ISHII and NOGAMI (1964) described the same species from the Bak Limestone and the Phn. Sampou Limestone in Battambang of Cambodia. In the essential biocharacters and the statistical data of the shell, the Taishaku specimens quite agree with the Cambodian specimens described by them.

Occurrence:—Rarely found in the *Yabeina elongata* zone of the Yasumoto formation at Yasumoto (Loc. A52207) on the Taishaku Plateau.

Explanation of Plate 33

All ×10, except figs. 1 and 3.

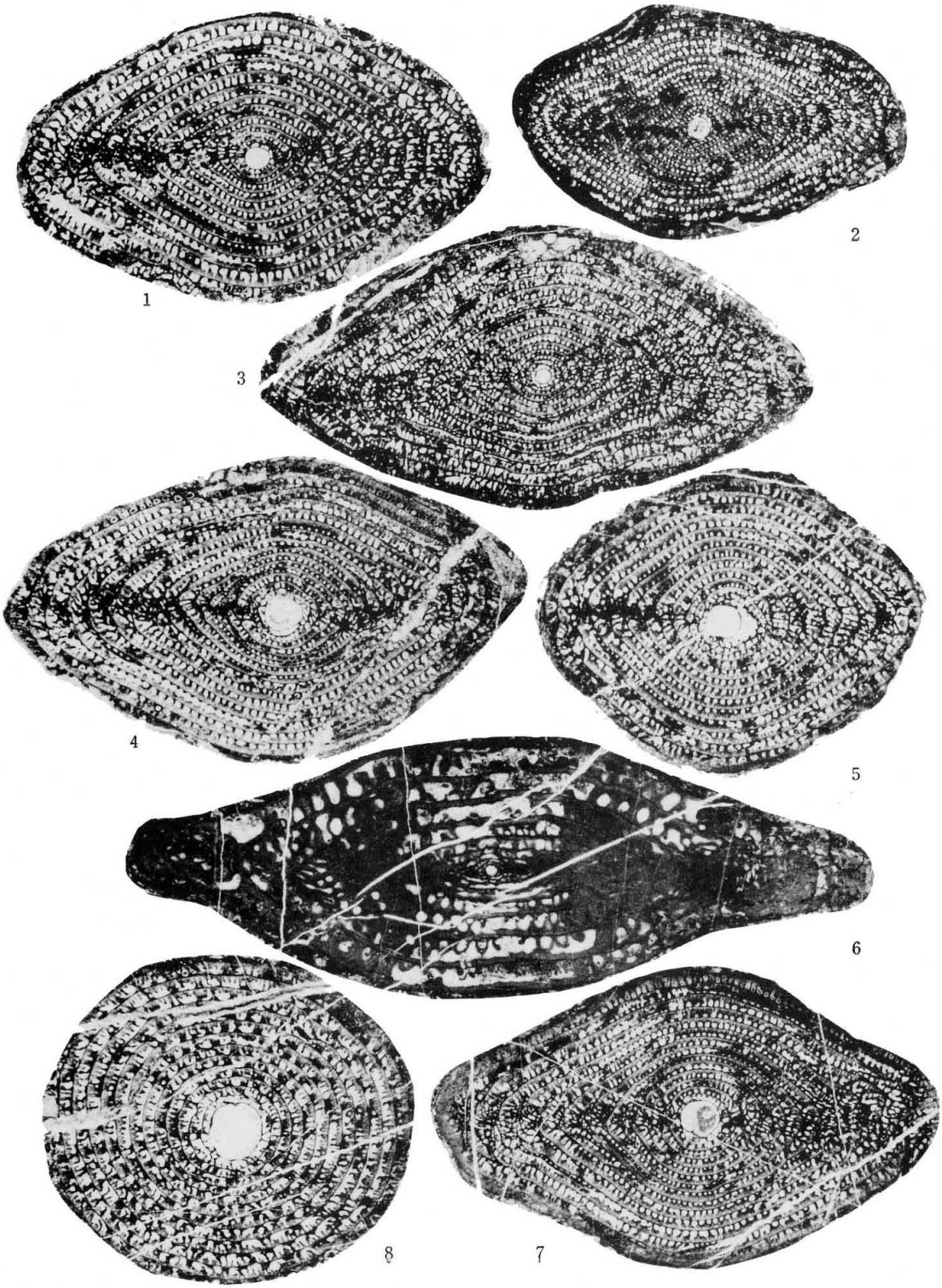
Figs. 1-3. *Yabeina multiseptata shiraiwensis* OZAWA, 1925.
1-3. Axial sections: Rg. No. A52207-7 (×10.9), A52207-12 and A52207-5 (×10.7), respectively. Loc. No. A52207.

Fig. 6. *Chusenella* sp. A (See also Pl. 34 fig. 2).
6. Axial section: Rg. No. A52207-6. Loc. No. A52207.

Figs. 4-5, 7-8. *Yabeina multiseptata multiseptata* (DEPRAT), 1912.
4-5 and 7. Axial sections: Rg. No. A52207-4, A52207-9 and A52207-11, respectively. Loc. No. A52207.
8. Sagittal section: Rg. No. A52207-10. Loc. No. A52207.

All from the Yasumoto formation of the Taishaku Limestone.

Photos by Kimiyoshi SADA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Subfamily Schwagerininae DUNBER and HENBEST, 1930

Genus *Chusenella* HSU, 1942; emend. CHEN, 1956

Chusenella sp. A

Pl. 33, fig. 6; Pl. 34, fig. 2

Material:—The specimens illustrated (Rg. No. A52207-6 and Rg. No. A52207-8) were collected from Loc. A52207.

Description:—The shell of *Chusenella* sp. A is large and conicocylindrical, having a straight to slightly curved axis of coiling and acutely pointed poles. The lateral slopes are slightly convex or occasionally depressed near the polar regions. The specimen illustrated as fig. 6 on Pl. 33 (Rg. No. A52202-6) is 11.50 mm. in length and 3.75 mm. in width, giving a form ratio of 3.1.

The proloculus is small and spherical. The outside diameter of the proloculus is 150 microns in one of the specimens. The shell is very tightly coiled in the inner four volutions and expands rather rapidly in the outer ones. The radius vectors of a specimen are 132, 188, 264, 377, 547, 774, 1,076, 1,454 and 2,002 microns, respectively, for the 1st to the 14th volution.

The spirotheca is thin in the inner four or five volutions, but in the outer five ones it becomes thick and is composed of a tectum and a keriotheca with coarse alveoli. The thickness of the spirotheca of the 1st to the 9th volution is 18, 27, 27, 29, 57, 94, 126, 103 and 142 microns, respectively.

The septa are thick and strongly fluted throughout the length of the shell. The rudimentary chomata are observed only in the inner volutions. The tunnel is low and its path is irregular. The heavy fillings occur in the chambers of the axial regions.

Remarks:—In the shape of the shell the present species resembles *Chusenella conicocylindrica* CHEN (1956, pl. 4, fig. 7) from the Chinghsichung Limestone, Hutien, Hunan Province, China. They are, however, distinguished from each other, for the former species has the larger shell, the larger proloculus, and

Table 5. Measurements of *Chusenella* sp. A

Specimen A52207-6: Pl. 33, fig. 6.

Length	Width	Form ratio	Prol.
11.50	3.75	3.1	0.150

Radius vector		Thickness of spirotheca	
Vol.		Vol.	
		0	.043
1	0.132	1	.018
2	0.188	2	.027
3	0.264	3	.027
4	0.377	4	.029
5	0.547	5	.057
6	0.774	6	.094
7	1.076	7	.126
8	1.454	8	.103
9	2.002	9	.142

(Measurements in millimeters)

the thicker spirotheca in the outer volutions where the shell expands more rapidly.

Chusenella sp. A is somewhat similar in the general shape and internal characters of the shell to *Chusenella globularis* (GUBLER) (1935, pl. 2, figs. 1, 12; pl. 1, fig. 5) which was discussed by STEWART (1936). However, *Chusenella* sp. A is more slender in the shell-shape and has the larger proloculus, the slower expansion of the shell for the corresponding volution and the heavier axial filling.

The present specimens agree in some respects with *Chusenella choshiensis* CHISAKA (1960, p. 245, pl. 3, figs. 1-6) better than any of the known species belonging to the genus, but more sufficient material is needed for the definite determination.

Occurrence:—Very rare in the *Yabeina elongata* zone of the Yasumoto formation at Yasumoto (Loc. A52207) on the Taishaku Plateau.

Concluding Remarks

The general conclusions of this study are compactly summarized as below.

The Yasumoto formation consisting of massive limestone contains the Upper Permian fusulinid fauna which is characterized by *Yabeina multiseptata multiseptata*, *Y. m. shiraiwensis*, *Y. minuta*, *Y. elongata* and *Chusenella* sp. A, and the formation is defined as the *Yabeina elongata* zone.

The Yasumoto fauna containing these fusulinids is quite unique among the Upper Permian fusulinid faunas in Japan. *Yabeina multiseptata shiraiwensis* has been well known in the Japanese Upper Permina and it has played an important role to advance the regional and international correlations. *Yabeina m. multiseptata*, *Y. elongata* and *Y. minuta*, the last of which was originally described by THOMPSON and WHEELER (1942) from the Marble Canyon Limestone in British Columbia, were described from the Bak Limestone and the Phn. Sampou Limestone of Cambodia (GUBLER, 1935; ISHII & NOGAMI, 1964). Taking all these facts into consideration, the Yasumoto fauna, as already discussed by SADA (1965), can be correlated with the Upper Permian fusulinid faunas which have hitherto been reported from various localities in the Outer and Inner Zones of Japan, and it is quite similar to those of Cambodia.

Explanation of Plate 34

All ×10

Figs. 1, 5. *Yabeina elongata* (GUBLER), 1935.
1, 5. Axial sections: Rg. No. A52207-1 and A51107-2, respectively. Loc. No. A52207
Figs. 3-4. *Yabeina minuta* THOMPSON and WHEELER, 1942.
3. Axial section: Rg. No. A52207-3. Loc. No. A52207
4. Sagittal section: Rg. No. A52207-15. Loc. No. A52207
Fig. 2. *Chusenella* sp. A. (See also Pl. 33, fig. 6)
2. Axial section: Rg. No. A52207-8. Loc. No. A52207.

All from the Yasumoto formation of the Taishaku Limestone.

Photos by Kimiyoshi SADA


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Acknowledgment:—The authors are grateful to Prof. Emeritus Sotoji IMAMURA of Hiroshima University, who gave them the helpful advice and encouragement. Thanks are also due to Prof. Akira HASE of the same University for his encouragement and reading the manuscript. The authors wish to extend their special acknowledgment to Prof. Hideyoshi TOYODA, Assist. Prof. Yoshiro TAI and Lecturer Mitsuo NAKANO of Hiroshima University for their constant encouragements.

References

CHISAKA, T. (1960): On some Permian Fusulinids from the Takagami Conglomerate, Choshi Peninsula, Chiba Prefecture, Japan. *Jour. Coll. Art and Sci. Chiba Univ.*, v. 3, n. 2, p. 235–254, pls. 1–9.

DEPRAT, J. (1913): Étude des Fusulinidés de Chine et d'Indochine et classification des calcaires à fusulines (II Mémoire). Les Fusulinides des calcaires carbonifériens et permiens du Tonkin du Laos et du Nord Annam. *Indochine Service géol., Mém.*, v. 2, fasc. 1, p. 1–74, pls. 1–10.

GUBLER, J. (1935): Les Fusulinidés du permien de l'Indochine, leur structure et leur classification. *Mém. Soc. géol. France, Nov. sér.*, tome 11, fasc. 4, n. 26, p. 1–173, pls. 1–8.

HANZAWA, S. & MURATA, M. (1963): The Paleontologic and Stratigraphic Considerations on the Neoschwagerininae and Verbeekininae with the Descriptions of Some Fusulinids Foraminifera from the Kitakami Massif, Japan. *Tohoku Univ., Sci. Repts.*, v. 35, n. 1, p. 1–31, pls. 1–20.

ISHII, K. & NOGAMI, Y. (1962): On *Yabeina shiraiwensis* OZAWA and *Yabeina yasubaensis* TORIYAMA. *Jour. Geosci., Osaka City Univ.*, v. 6, art. 2, p. 59–72, pls. 1–2.

ISHII, K. & NOGAMI, Y. (1964): Contributions to the Geology and Paleontology of Cambodia. Part 1. Permian Fusulinids. *Jour. Geosci., Osaka City Univ.*, v. 8, art. 2, p. 9–37, pls. 1–8.

KANMERA, K. (1954): Fusulinids from the Upper Permian Kuma Formation, Southern Kyushu, Japan—with Special Reference to the Fusulinid Zone in the Upper Permian of Japan. *Mem. Fac.Sci. Kyushu Univ., Ser. D. Geol.*, v. 4, n. 1, p. 1–38, pls. 1–6.

OZAWA, Y. (1925): Paleontological and Stratigraphical Studies on the Permo-Carboniferous Limestone of Nagato. Part II. Paleontology. *Tokyo Imp. Univ., Coll. Sci., Jour.*, v. 45, art. 6, p. 1–90, pls. 1–14.

SADA, K. (1965): Carboniferous and Permian Stratigraphy of the Atetsu Limestone in West Japan. *Jour. Sci. Hiroshima Univ., Ser. C*, v. 5, n. 1, p. 21–80.

SKINNER, J. W. & WILD, G. L. (1954): Fusulinid Wall Structure. *Jour. Paleont.*, v. 28, n. 4, p. 445–451, pls. 46–52.

STEWART, W. J. (1963): The Fusulinid Genus *Chusenella* and Several New Species. *Jour. Paleont.*, v. 37, n. 6, p. 1150–1163, pls. 155–158.

THOMPSON, M. L. (1948): Studies of American Fusulinids. *Univ. Kansas Paleontological Contributions, Protozoa*, art. 1, p. 1–184, pls. 1–38, text.fig. 7.

THOMPSON, M. L. & WHEELER, H. E. (1942): Permian Fusulinids from British Columbia, Washington and Oregon. *Jour. Paleont.*, v. 16, p. 700–711, pls. 105–109.

TORIYAMA, R. (1958): Geology of Akiyoshi. Part III. Fusulinids of Akiyoshi. *Mem. Fac. Sci. Kyushu Univ., Ser. D, Geology*, v. 7, p. 1–264, pls. 1–48.

YOKOYAMA, T. (1959): The Geology of Vicinity of Taishaku Gorge. (in Japanese). *Scientific Researched Reports of the Proposed Site National Park in Chugoku-Mountainland, Tottori, Shimane and Hiroshima Prefecture*, p. 29–42, pls. 12–14.

Taishaku Limestone 帝釈石灰石　　Yasumoto 保元

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第93回例会は，1966年6月18日（土）午前10時より東京教育大学理学部地質学鉱物学教室において開催された。（参加者40名）

個　人　講　演

A supplementary note on the Paleogene Li Fi Flora in North Thailand ..Seidô ENDÔ

Evolutionary Line of the Miocene miogypsinid populations .....Hiroshi UJIIÉ

登層の底棲有孔虫化石について .....栗原謙二

Fusulinids from the Funafuseyama Limestone in Yamagata-gun, Gifu Prefecture, Japan.....Kuniteru MATSUMARU

Three New Tertiary Foraminiferal Genera from Florida, Saipan and Guam (代読) ..... Shoshiro HANZAWA

ミンドロ島の含紡錘虫石灰岩礫礫層とその紡錘虫について....小池敏夫・橋本　亙・佐藤　正

阿哲台におけるコノドントについて ....小池敏夫

幌内層産 *Hubertschenckia* について .....

.....菅野三郎・手島　淳

いわゆる朝日動物群について..大原　隆・菅野三郎

Cretaceous Trigoniae from the Mifune Group in Kyushu, Japan (代読) .....

.. Minoru TAMURA & Masayuki TASHIRO

Notes on the myophorian sandstones in Malaya. II—*Myophoria*, s. l. in Malaya..

..Teiichi KOBAYASHI & Minoru TAMURA

二枚貝大分類の最近における傾向..... 速水　格

大型化石の模型製作について..速水　格・小畠郁生

A new species of *Conocardium* (s. s.) from the Carboniferous of Akiyoshi. (Molluscan paleontology of the Akiyoshi Limestone Group. I).....Tamio NISHIDA

On some species of Carboniferous pleurotomariaceans from Akiyoshi. (Molluscan paleontology of the Akiyoshi Limestone Group. II).....

..... Tamio NISHIDA & Tokio SHIKA A

Notes on *Ammonites bravaisianus* D'ORBIGNY from the Cretaceous of France (代読 .

..Tatsurô MATSUMOTO & Masayuki TODA

ミンドロ島のジュラ紀（予報)..佐藤　正・　日本　亙

栃木県葛生および東京都産馬歯化石につい　..

..... K沢譲次

shall call a Special Meeting at the written request of more than one-third of the members. The request shall be granted only if the written statement fully explains the reasons for assembly and items for discussion.

Article 19. Members unable to attend the General Meeting may give an attending member a written statement signed by himself trusting the bearer with the decision of business matters. Only one attending member may represent one absentee.

Article 20. The decison of the General Meeting shall be by majority vote. When the number of votes is equal, the President shall cast the deciding vote.

Article 21. The President and Councillors shall compose the Council. The dicision of the General Meeting concerning administration shall be considered and implemented by the Council.

Article 22. The Executive Council shall carry out the decisions of the Council.

Article 23. The fiscal year of the Society shall begin on the first of January each year and end on the thirtyfirst of December of the same year.

Article 24. The amendments to the Constitution of the Society shall be decided at the General Meeting and must be approved by more than two-thirds of those members who are in attendance.

Addendum 1) Voting in the Council shall be by unsigned ballot.

例　会　通　知

	開催地	開催日	講演申込締切日
第95回例会	名古屋大学	1966年11月13日	1966年10月10日
1967年総会・年会	東京大学	1967年1月21・22日	1966年12月20日

会　員　消　息

◎ 会員花井，郎君は Ostracoda 研究のため，米国ワシントンの U. S. National Museum へ1年間滞在の予定で，1月下旬に出発した。

News

◎ South Africa の有名な古生物学者 Dr. E. C. N. van Hoepen は，1966年5月2日81才の高齢をもって逝くなった。中生代の三角貝類・アンモナイト・Karoo 層群の化石に関する貢献のほか，考古学上の業績もあった。最近では Peroniceratinae に関する研究があり，なお遺稿が印刷中とのことである。

1966年9月25日　印　刷
1966年9月30日　発　行

日本古生物学会報告・紀事
新　篇　第63号
400円

東京大学理学部地質学教室内
日本古生物学会
編集兼発行者　花　井　哲　郎
（振替口座東京84780番）
印刷者　東京都練馬区豊玉北2ノ13
学術図書印刷株式会社　富　田　元

CONSTITUTION
of the
PALAEONTOLOGICAL SOCIETY OF JAPAN

Article 1. The Society shall be known as the Palaeontological Society of Japan.

Article 2. The object of the Society is to promote the study and popularization of palaeontology and related sciences.

Article 3. The Society, to execute Article 2, shall undertake the following business:

1. Issue the Society journal and other publications.
2. Hold or sponsor scientific lectures and meetings.
3. Popularize the science by field trips, scientific lectures and other projects.
4. Aid and encourage research work; award outstanding contributions to the Society; carry out the objectives stated in Article 2.

Article 4. To attain the object of the Society, the Society may, by decision of the General Meeting, establish within it research committees.

Article 5. The society shall be composed of members who are active or interested in palaeontology or related sciences.

Article 6. The members shall be known as Regular Members, Fellows. Patron and Honorary Members.

Article 7. Persons desiring membership in the Society are requested to fill out the necessary application forms and receive the approval of the Council.

Article 8. Fellows are persons who have held Regular Membership in the Society for more that ten years, have contributed to the science of palaeontology, have been nominated by five Fellows and approved by the Council.

Article 9. Patrons are organizations supporting Article 2 and recommended by the Council.

Article 10. Honorary Members are persons of distinguished achievement in palaeontology. They shall be recommended by the Council and approved by the General Meeting.

Article 11. The members of the Society shall be obliged to pay the annual dues stated in Article 12. Members shall enjoy the privilege of receiving the Society journal and participating in the activities stated under Article 3.

Article 12. The rates for annual dues shall be decided by the General Meeting. Rates for annual dues are: Regular Members, Yen 1,000; Fellows, Yen 1,500; and Foreign Members, $4.00; Patrons are organizations donating more than Yen 10,000 annually; Honorary Members are free from obligations.

Article 13. The budget of the Society shall be from membership dues, donations and bestowals.

Article 14. The Society, by decision of the Council, may expel from membership persons who have failed to pay the annual dues or those who have disgraced the Society.

Article 15. The officers of the Society shall be composed of one President and fifteen Councillors, among whom several shall be Executive Councillors. The term of office is two years and they may be eligible for re-election without limitation. The President may appoint several persons who shall be Secretaries and Assistant Secretaries. An Executive Council shall be nominated and approved by the Council. Councillors shall be elected from Fellows by vote of returned mail unsigned ballot.

Article 16. The President shall be a Fellow nominated and approved by the Council. The President shall represent the Society and supervise the business affairs. The President may appoint a Vice-President when he is unable to perform his duties.

Article 17. The Society may have the honarary President. The honorary President shall be recommended by the council and approved by the General Meeting. The honorary President may participate in the Council.

Article 18. The Society shall hold regularly one General Meeting a year. The President shall be Chairman and preside over the administrative affairs. The program for the General Meeting shall be decided by the Council. The President may call a special meeting when he deems it necessary. The General Meeting requires the attendance of more than one-tenth of the members. The President