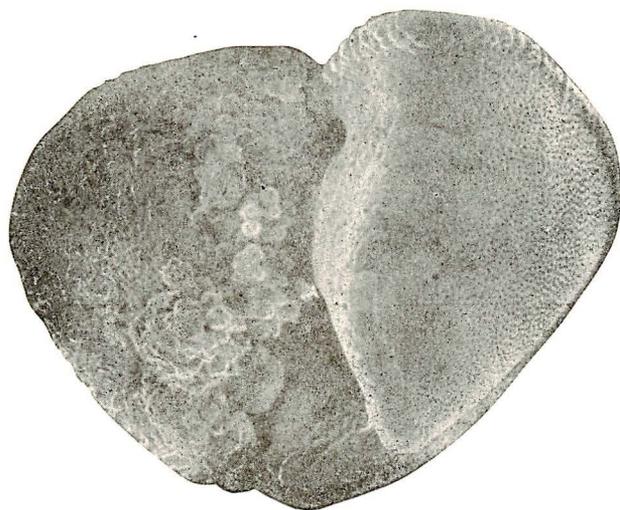


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Fossils on the cover is *Globorotalia truncatulinoides* (D'ORBIGNY, 1839).
The photograph was taken on a scanning electron microscope, JEOL-JSM-2, $\times 100$.

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PALAEONTOLOGICAL SOCIETY OF JAPAN
Geological Institute, Faculty of Science, University of Tokyo, Tokyo 113, Japan
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561. A MIOCENE MOLLUSCAN FAUNA IN THE PHILIPPINES

YASUHIDE IWASAKI

Department of Geology, University Museum, University of Tokyo

フィリピン群島産の中新世貝化石群：1966年初頭にルソン島 Tayabas 地区の地質構造調査を行った木村敏雄・徳山明両氏は、保存は良くないが種々検討する価値があると思われる貝化石標本を、2ヶ所から採集し持ち帰った。産出層は下部 Gumaca 層の上部で中新統の由であった。さて標本類は二枚貝 20 種、巻貝 16 種が識別され、不確定の 11 種を除いてすべて既知の化石種・現生種に同定されている。特徴的な種として、*Vicarya callosa*, *Anadara multiformis*, *Joannisiella cumingi*, *Paphia exarata* などを含み、且って MARTIN, SMITH 等によって指摘されたフィリピン及びインドネシア方面に広く分布する中新統下部の夾炭層に伴う浅海棲貝化石群に属すると見做し得る。一方の産出地 Pitogo 付近の 2 層から得られた標本類については、不十分な材料ではあるが露頭における産出状態から自生の種群構成を復元することができる。この結果、現地生に近い *Dosinia-Anadara* 群集と運搬されたと思われる *Batillaria* 群集の両要素の混合したものと推定される。更に、この仮称“Pitogo fauna”は日本の黒瀬谷層などにみられる *Vicarya* を含む貝化石群と古生態的にも極めてよく類似している。両者を種群構成の上から比較すると、両地の緯度の違いを反映して個々の群集の構成種の入替りは、門ノ沢型における奥尻島と種子ヶ島両地産の差よりも大きい。まったく同一の生物地理区に属するとみて矛盾はない。従っていわゆる“門ノ沢型動物群”と比較できる。はるか南方延長上に存在する貝化石群として古生物地理の観点から見落せない。少なくとも中新統下部の日本の貝化石群の古生物地理学的吟味は、東南アジア地域をも対象にする必要があろう。本報告では層序は KIMURA *et al.* (1968) に基いた。また貝化石群としてみた場合は、終始日本のそれと比較するという立場で取扱っている。岩崎泰顕

Introduction

In early 1966, a geological survey was made jointly by Japanese and Philippine geologists to contribute to the knowledge of geology and paleontology of Southeast Asia. The surveyed area is the Tayabas Isthmus district in the southern part of Luzon Island, the Philippines, where the marine Neogene sediments are distributed widely and cover the pre-Tertiary rocks with unconformity. The ages of these sediments ranges from the lower Miocene to Pleistocene. The result obtained from their field survey has been

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summarized with special emphasis on stratigraphy and geological structure (KIMURA, T., TOKUYAMA, A., GONZALES, B. A. & ANDAL, D. R., 1968). Marine molluscan fossils were collected from the lower Gumaca formation of the lower Miocene near Pitogo and the Hondagua formation at southeast of Hondagua, and were forwarded to the writer for paleontological study.

The fossil specimens are not well preserved and to some extent decalcified. However, 36 species of gastropods and bivalves are recognized; 25 of them are identifiable with species already known but 11 are remained indeterminable. As already pointed out by DICKERSON, R. E.

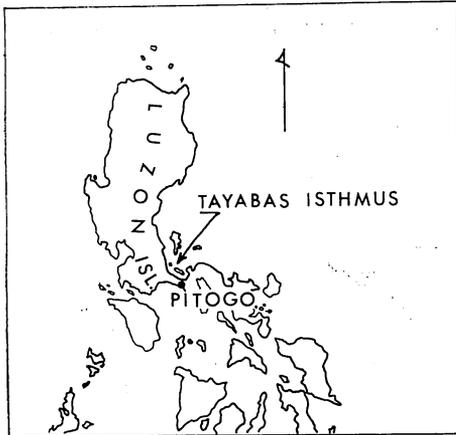


Fig. 1. Location of Pitogo and Tayabas Isthmus district in the Philippines.

(1921), all species are either identifiable to the living species of neighbourhood of the Philippines or common to the fossil species of the Miocene of Java. Some of these species or their allied forms such as *Vicarya callosa* JENKINS, *Anadara multiformis* (MARTIN) and *Joan-nisiella cumingi* (HANLEY) are found also in a certain Japanese Neogene fauna which has tropical type species association. Thus the Philippine fauna, here called the Pitogo fauna provisionally, provides rare opportunity for comparative study of the Japanese lower Miocene fauna with the Philippine fauna in species to species basis.

The discussions on paleoecology of the Pitogo fauna may be no more than mere general remarks because the record on species association is available only at one locality, and the mode of occurrence, which is not autochthonous, does not permit any further inference on the association of species. Monographs of the Tertiary molluscs of Java by MARTIN, K. (1879), those of the Gáj Miocene of Pakistan by VREDENBURG, E. (1928), and discussions on biostrati-

graphy and faunal lists of the Philippine Tertiary by SMITH, W. D. (1913, 1924), DICKERSON (1921, 1922) and CORBY, G. W. *et al.* (1951) are referred fully for ecological evaluation as well as for taxonomical comparison. The knowledge obtained from the study of the Japanese Miocene formations such as recognition of four assemblages in the Kadonosawa-type fauna (CHINZEI, K. & IWASAKI, Y., 1967) is applicable in all probability to assemblage analysis of the Pitogo fauna.

The species association of the Pitogo fauna can be regarded as a mixture of two paleoecological elements, the *Batillaria* and the *Anadara-Dosinia* assemblages. The *Ostrea* assemblage may not be found near the locality of this fauna, but the Pitogo fauna is, in conclusion, similar in ecological and taxonomical nature to the Japanese Kadonosawa-type fauna. In the early Miocene age, the same faunal province covered both the Japanese and Philippine Islands where the molluscs consist of the similar species association found in sediments in the similar environment. The Pitogo fauna is of shallow embayment facies, which corresponds to the coal-measure facies of CORBY *et al.* (1951), and makes a contrast with the fauna of reef or calcareous facies.

Such species as *Strombus tjilonganensis* MARTIN and *Oliva cf. funebris* LAMARCK are absent or rare in the Kadonosawa-type fauna. This difference can be regarded as geographical within the province and seems to represent the difference between northern margin and near center of a faunal distribution. Species association found in the Miocene formation of Tanegashima Island, southern Japan, which is the southernmost record of the Kadonosawa-type fauna, still shows a considerable difference from that of the

Pitogo fauna. In future, however, the occurrence of " *Vicarya*-bearing fauna" will connect the Kadonosawa-type and the Pitogo faunas and will make clear the outline of geographical variations within one faunal province.

**Fossil molluscs from the lower
Gumaca formation in the
Tayabas Isthmus district**

i) General remarks.

It has been well known that the Neogene molluscan fossils occur from various localities in the Philippines and adjacent regions such as the Indonesia and Burma. JENKINS, H. M. (1863) reported the Tertiary, probably Miocene, fossil molluscs from Java. The fauna described in the report is composed of 24 species containing *Conus*, *Oliva*, *Murex*, *Vicarya* and others. MARTIN (1879) described fossil molluscs from many localities of Java and discussed the Tertiary stratigraphy. He proposed more than a hundred of "species", including several "new species" of genera *Conus*, *Terebra*, *Strombus*, *Anadara*, *Corbula*. Since then, voluminous monographs of molluscan fossils had been published continually by MARTIN (1881-1910). Materials that he treated are chiefly of the Neogene molluscs and other shelly fossils occurred from Java and Sumatra (1881-1910) and the Philippines (1901), these include more than 1,000 species. Contemporaneously NOETLING, F. (1895, 1901) described the molluscan faunas and associated shelly remains of the Miocene formations from Burma. His report (1901) treated both systematic descriptions and stratigraphical zonings. These were later revised by VREDENBURG (1921). SMITH, W. D. (1913) summarized the Tertiary biostratigraphy of

the Philippines making a correlation with the Tertiary of Java, and described approximately 60 species of gastropods and bivalves chiefly from the Neogene and Pleistocene formations. SMITH (1924) and DICKERSON (1922) made further discussions on biostratigraphy of the Philippines. Three molluscan faunas of the different ages i. e. fauna of the Miocene Vigo group or Batan formation, of the Pliocene Malumbang formation and of the Pleistocene formations were recognized; and the similarity of the molluscan faunas between the Philippines and the Indonesia was also pointed out. DICKERSON (1924) presented a paper on the paleogeographical change of the Philippine Islands during the Neogene. HAYASAKA, I. (1943, 1944), in his reports on some Neogene molluscan fossils from the Philippines, recorded the associate occurrence of *Anadara multififormis* and *Vicarya* sp. in the Philippine Miocene. Thus the Neogene molluscan fossils of the Philippines and the Indonesia had been described and their stratigraphical value had also been discussed already in the late 19th and early 20th centuries.

Recently CORBY *et al.* (1951) published the reconnaissance report on geology of the Philippines. Although the main subject of their report is description and correlation of stratigraphy of the Republic of Philippines, they summarized briefly the standard sequence of molluscan fossil occurrences in chronological order and made check lists concerning localities and range of appearance of each species.

Since *Vicarya callosa* had been described originally by JENKINS from Java, its occurrence has recorded from many other localities in the Philippines and Japan as well as in the Indonesia, and its stratigraphical significance has also been discussed by several paleontolo-

gists. Consequently, the species has been regarded as an index fossil of the lower Miocene. MARTIN's report on the stratigraphy of Java (1879), that of the Philippines (1901) and SMITH's reports of the Philippine Tertiary (1913, 1924) discussed the stratigraphical occurrence of *Vicarya callosa*. Significance of occurrence of *V. callosa* is also discussed in the CORBY *et al.*'s report. According to MARTIN, SMITH and CORBY *et al.* this species occurs from several Miocene localities throughout the Philippines, i. e. Mindanao, Cebu, Batan of Albay and northern Luzon.

The knowledge of the Pitogo fauna may be fragmental and most of its species are identifiable to those described in the classical monographs. However, apart from chronological discussion, the Pitogo fauna renders an interesting problem to the study of paleoecology and of the extent of a faunal province.

ii) List of fossils.

Species identified include 20 spp. of bivalves and 16 spp. of gastropods as listed in p. 208 and 209. Among bivalves, venerids are the most abundant in species number occupying 7 species. Stromboids are abundant among gastropods. In addition, the materials consist of considerable amounts of shell fragments hardly determining their taxonomic position. *Corbula* sp. is the most abundant and exceeds 20 in individual number. Species whose individual number is more than 10 are *Corbula* sp., *Joannisiella cumingi*, *Paphia exarata*, *Tellinella virgata*, *Gari?* sp., *Vasticardium* sp. have their individual number around 10. Species whose individual number exceed 5 are *Anadara multiformis*, *Strombus tjilonganensis* and *Vicarya callosa*. *Dosinia* sp., *Katelysia hiantina*, *Lutraria arcuata*, *Glauconome virens*,

Cultellus sp., *Globularia?* sp., *Apollon* sp., *Conus generalis*, *Voluta?* sp. and *Primovula rhodia* are represented by only a single specimen.

No corals, bryozoans, brachiopods, barnacles and other shelly groups exclusive of molluscs are included in the Pitogo fauna. Smaller foraminifers cannot be found in the sediments containing the Pitogo fauna.

Collection of the specimens was made at road side cliff along the road from Pitogo to Gumaca, about 4 km north from Pitogo. The outcrop is irregular alternation of sandstone and sandy mudstone of the upper part of the lower Gumaca formation, which corresponds to Loc. 11-3 of KIMURA *et al.* (1968). The other locality is the path side small outcrop of the Hondagua formation at Loc. 18-12, about 2.5 km southeast from Hondagua, where *Strombus* cf. *vittatus* and one specimen of *Clementia papyracea* were collected (see * in the list).

Bivalvia

Anadara multiformis (MARTIN)

Joannisiella cumingi (HANLEY)

Vepricardium multispinosum

(SOWERBY)

Vasticardium sp.

Circe intermedia REEVE

Dosinia sp.

Paphia exarata (PHILIPPI)

Callista (Costacallista) erycina (LINNÉ)

Katelysia hiantina (LAMARCK)

Sunetta concinna DUNKER

**Clementia papyracea* (GRAY)

Macra antiquata SPENGLER

Lutraria arcuata REEVE

Azorinus scheepmakeri (DUNKER)

Cultellus sp.

Glauconome virens (LINNÉ)

Macoma sp.

Tellinella virgata (LINNÉ)

Gari? sp.

Corbula sp.

Gastropoda

Cerithidea sp.

Vicarya callosa JENKINS

Strombus (*Laevistrombus*?)

tjilonganensis MARTIN

S. cf. isabella LAMARCK

**S. cf. vittatus* LINNÉ

Natica cf. lineata LAMARCK

Globularia? sp.

Primovula rhodia (A. ADAMS)

Apollon sp.

Bursa (*Gyrineum*) *margaritula*

(DESHAYES)

Nassarius crenulatus (LINNÉ)

Oliva cf. funebris LAMARCK

Voluta (*Volutocorona*)? sp.

Vexillum sp.

Conus (*Leptoconus*) *generalis* LINNÉ

C. (Cleobula) minimus LINNÉ

iii) Taxonomical remarks.

Anadara multiformis (MARTIN)

Pl. 23, figs. 6a, 6b, text-fig. 2.

Seven isolated (six left and one right) valves are examined. Shell is small to medium in size, thick and strongly inflated. It appears equilateral and is inaequivalve judging from the asymmetry of marginal crenulation on ventral side. Length is almost equal to height, thus the shell form is globose in outline. Beak is prominent. Hinge plate is well developed, wide, but not very long, shorter than shell length. Outer surface has 24 to 27 non-bifurcated radial ribs on which granulation is distinct at least in left valve.

The individuals, which have morphological characters mentioned above, are referable either to *Anadara multiformis* (MARTIN), *A. myöensis* (NOETLING), *A.*

submultiformis (VREDENBURG), *A. batanensis* (HAYASAKA) or even to some other living species. *A. multiformis* is named on a Neogene fossil occurred from Java. The species is characterized by globose and considerably variable shell form; often associated with shallow sea fauna like the Pitogo. *A. myöensis* was described from the Miocene of Burma. *A. submultiformis* was known from the Gáj Miocene of Pakistan and the Miocene formation of Burma. The species is characterized by more or less longitudinally elongated shell form. *A. batanensis* was reported from the Miocene formation of Batan Island, Albay, the Philippines. This species is associated with *A. multiformis*. *A. submultiformis* and *A. batanensis* were morphologically distinguished from *A. multiformis* by the original authors. However, their shell forms resemble well with one another and the discrimination is often difficult owing to the overlapping nature in shell morphology, for example, shell outline, number of radial ribs, ornamentation on shell surface etc. Further, their ecological characteristics including faunal association are closely similar with one another. In general, *Anadara* species having such a globose shell show considerable morphological variation probably due to the environmental modification. The Neogene shallow marine associations with *Vicarya* species frequently include such a globose form as *A. multiformis* in the Indonesia, Philippines and adjacent regions.

Three living species, *A. rhombea* (BORN), *A. pilula* (REEVE) and *A. sabinæ* IREDALE, which occur also from the Pliocene and Pleistocene formation of the Philippines and adjacent areas, are morphologically similar to *A. multiformis*. However, they are different in such ecological characters as biogeographical distribution and

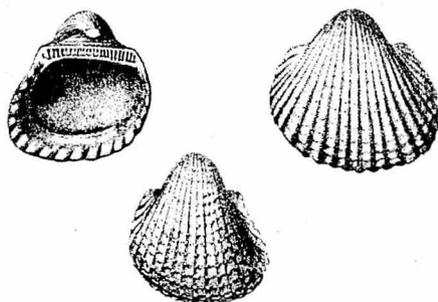


Fig. 2. *Anadara multiformis* (MARTIN)
after MARTIN, 1879 $\times 3/5$.

faunal association. Habitat of *A. multiformis* appears to be similar to that of the living *A. granosa* (LINNÉ). In conclusion, the specimens concerned are assigned temporarily to *A. multiformis* which includes the similar fossil "species" mentioned above, rather than to recent *A. rhombea*, *A. pilula* or *A. sabinae*. Further examination, however, may demonstrate the close relationship between *A. pilula*, *A. rhombea* and *A. multiformis*.

A similar case can be seen in the relations among the following Japanese "species": *A. daitokudoensis* (MAKIYAMA), *A. kakehataensis* HATAI & NISIYAMA, *A. kurosedaniensis* HATAI & NISIYAMA, *A. takayamai* NODA and *A. yatsuoensis* NODA. *Vicarya-Anadara* fossil association is also found in the Japanese lower Miocene. Here again the *Anadara* species is called such various names as mentioned above. Shell form of the Philippine *Anadara multiformis* is different slightly from the Japanese *Anadara daitokudoensis* in shell morphology, but the two species or species groups are considered to be quite similar in ecological characters.

Measurements in mm.—A (Left); 30.0 (length), 29.8 (height), 14.4 (depth), 25ca (number of radial ribs). B (Left); 27.5, 27.0, 14.0; 27. C (Left); 26.8, 30.0, 15.3,

27. D (Left); 27.9, 28.4, 14.7, 26. E (Left); 27.8, 28.3, 13.1, 24ca. F (Left); 22.1, 22.6, 11.5, 25. G (Right); 23.4, 22.1, 11.6, 26.

Joannisiella cumingi (HANLEY)

Pl. 23, fig. 4.

More than 11 specimens are examined, most of them are inner mold. Ten specimens are bivalved. Shell is thin, strongly inflated, and nearly round in its outline. Posterodorsal margin is straight from beak, and bents with obtuse angle at posterior end. Lunule is absent. Beak is prominent and antero-dorsal margin is concaved markedly in front of beak. Ventral margin is round. Shell surface has no prominent sculpture except weak growth striations. Hinge plate is narrow, cardinal teeth is not stout.

The specimens at hand are identifiable easily with *Joannisiella cumingi* (HANLEY) or its allied species. *J. cumingi* is living in the southeast Asia and Japan and is also found as fossils in the Neogene and Quaternary sediments. The difference between the present specimens and the fossil and recent *J. cumingi* from Japan can be found in the following characteristics: Large size in adult; strongly inflated shell; strong convexity of postero-dorsal margin. The form characterized by the above mentioned features is differentiated occasionally from *J. cumingi* and is assigned to such different species as *J. oblonga* (HANLEY) or *J. alata* (ADAMS & REEVE) or *J. semiasperoides* NOMURA. However, these morphological differences among four species seem to be not essential. Unlike *Anadara multiformis*, variations of shell form cover much smaller range in *J. cumingi*, *J. oblonga*, *J. alata* or in *J. semiasperoides*. However, a considerable

morphological variation is detectable in the present specimens. Actually it is, therefore, difficult to assign the present specimens to one of these four "species". *J. cumingi* in the sense applied here includes four "species", *J. cumingi*, *J. oblonga*, *J. alata* and *J. semiasperoides*.

Morphological variation of fossil *J. cumingi* from the Miocene Miyazaki group of the southern Kyushu was discussed by SHUTO (1957b). It shows considerable variation in shell morphology. *J. cumingi* from Pitogo have more convex shell form than that from Miyazaki, but the range of variation is much smaller.

Recent form of *J. cumingi* from the Philippines is large and inflated in comparison with the Japanese forms. There is a tendency that the species becomes consistently small and flat in shell form northwardly throughout the Miocene and the recent.

Cytherea (Callista) everwijnii described by MARTIN (1883) from the Neogene of Java is regarded as the same species with *J. cumingi*.

Measurements in mm.—A. (Right & Left); 27.2 (length), 23.6 (height), 17.4 (depth bivalved). B (R & L); 32.9, 29.0, 21.5. C (R & L); 25.4, 21.6, 16.8. D (R & L); 27.2, 22.5, 18.5ca. E (R & L); 28.9, 25.3, 21.0. F (R & L); 26.0, 22.5, 17.7. G (R & L); 22.9, 19.3, 14.9. H (R & L); 27.4, 23.6, 17.5. I (R & L); 26.9, 23.0, 19.1. J (R & L); 22.6, 21.1, 17.5. K (Right); 26.1, 24.5, ?.

Paphia exarata (PHILIPPI)

Pl. 23, figs. 14, 15.

Nine specimens are examined. Four of them are bivalved. They are inner mold, and therefore surface ornamentations and hinges are observed on silicon

rubber cast. Shell is small in size, elongated oval in outline and inflated in comparison with other species of *Paphia*. Test is thin. Anterior margin is smoothly rounded and ventral margin is broadly arcuate. Shell surface is ornamented with fine and regularly spaced concentric striations. Striations are not undulated. They are, in general, indistinct in umbonal area. Lunule is present but no escutcheon is observed. Pallial sinus is moderately deep.

This species is smaller in size and finer in surface sculpture than most living species of *Paphia* from the northwestern Pacific except for *P. exarata* (PHILIPPI). However, several fossil species, such as *P. protolirata* (NOETLING), *P. pseudoliratus* (VREDENBURG), *P. exilis* SHUTO, *P. grata tsumaensis* SHUTO and *P. suzuensis* MASUDA, have small shell in adult and fine concentric ribs without weak undulations. SHUTO (1957a, c, 1961) noted on *P. exilis* a wide range of variation in size and in surface ornamentation. Several subspecies was proposed based on the differences of shell outline, and of surface ornamentation. Size variation of the present specimens is small and falls in the domain of SHUTO's *P. exilis exilis*, *P. exilis takaokaensis* and *P. grata tsumaensis*. However, the shell ornamentation of the present specimens is similar to that of *P. exilis abbreviata* and *P. grata tsumaensis*, but closest to that of *P. exarata* and *P. lirata* (PHILIPPI). *P. lirata* is a living species of the southeast Asia. *P. protolirata*, *P. pseudoliratus*, *P. grata tsumaensis*, *P. exilis* and *P. suzuensis* are the same at least in shell morphology with *P. exarata* and *P. lirata*. *P. lirata* was proposed originally for an intermediate form between *P. exarata* and *P. amabilis* (PHILIPPI) in shell size and in distinctness of concentric ornamentation. The present speci-

mens are identified temporary to *P. exarata*. *P. suzuensis* described by MASUDA (1966) from the Miocene Higashi-Innai formation is in all probability to conspecific with the present species. The differences among the above mentioned species are found only in their stratigraphical horizons and geographical distributions.

Both *Cytherea lilacina* LAMARCK illustrated by MARTIN (1883) from Sumatra and *P. tatrix* DESHAYES illustrated by DICKERSON (1922, pl. 7) of the Vigo fauna will be conspecific with the present species.

Measurements in mm.—A (Right & Left); 42.6 (length), 26.5 (height), 17.1 (depth bivalved). B (R & L); 32.1, 20.5, 12.9. C (R & L); 33.6, 20.0, 12.5 D (Left); 32.0, 18.4, ?. E (Right); 33.8, 20.4, ?. F (R & L); 30.3, 19.7, 10.3. G (Right); 30.0, 18.5, ?. H (Right); 41.1, 24.2, ?. I (Left); 32.5, 20.5, ?.

Callista (Costacallista) erycina (LINNÉ)

Pl. 23, figs. 1, 8.

Four specimens are collected. All except one specimen are very small in size. Shell is oval shaped and is not thick. Anterior margin is regularly rounded and posterior margin is sharply rounded. Beak is pointed. Lunule is distinctive. Shell surface is ornamented with roughly spaced concentric grooves. Hinge teeth are *Callista-Pitar* type. Ventral margin is not crenulated. One inner mold specimen is medium sized, 41 mm in length. This is much larger than the rest.

Shell form and surface sculpture of the present species are very much like those of *Callista erycina* (LINNÉ). There is, however, another allied species *C. phasianella* (DESHAYES) which is distin-

guished from *C. erycina* solely by its small shell size. Therefore, three small specimens could be identified to *C. phasianella*. However, there is no definite reason to identify small specimens with *C. phasianella* and large one with *C. erycina*. These four specimens are thus regarded as members of one species *C. erycina*. *Cytherea ventricola* and *C. macra* described by MARTIN (1880) from the Miocene of Java are in all probability conspecific with *Callista erycina*. *Venus sumatrana* and *V. astartaeformis* described also by MARTIN (1883) from Sumatra are possibly the same with this species.

Measurements in mm.—A (Left); 41 (length), 29 (height), 7.5ca (depth). B (Left); 14.5, 10.3, ?. C (Right); 12, 9.5, 2. D (Right); 15ca, 10.5, 3.5.

Sunetta concinna DUNKER

Pl. 23, fig. 9.

One bivalved specimen and an inner mold of right valve are at hand. Shell is small sized, oval in shape and not strongly inflated. Test is rather thin. Beak is pointed at slightly anterior to the middle of dorsal margin. Shell surface is smooth with no distinct sculpture. There is no lunule but escutcheon is prominent. Hinge plate is narrow, cardinal teeth is distinct. Pallial sinus is shallow. Inner ventral margin cannot be observed exactly. Stout marginal crenulations seems to be absent.

The present species can be identified with *Sunetta concinna* DUNKER in shell outline especially by well developed escutcheon. *S. solanderii* (GRAY) is different from *S. concinna* in having stout marginal crenulations. *S. menstrualis* (MENKE) has round and flat shell outline, and, therefore, can be discriminated

from this species. *S. ovalis* MARTIN is another close species, which is likely to be conspecific with *S. concinna*.

Measurements in mm.—A (Right & Left); 25.2 (length), 18.6 (height). B (Right); 25.8, 19.8.

Clementia papyracea (GRAY)

Pl. 23, fig. 5.

Two specimens of medium size are examined. One occurred from Loc. 11-3 in association with most of other species, and the other bivalved specimen occurred from Loc. 17-12 in the Hondagua formation. The Hondagua specimen which consists of outer cast and inner mold is preserved comparatively well. It is characterized by remarkable concentric undulation of shell surface. This undulation is well developed in its adult stage. The former specimen from the lower Gumaca formation is a left valve slightly deformed. Undulation of shell surface is found in its younger stage. Outline is elongate-oval in shape and inflated well. Test is thin. Postero-dorsal margin is straight. Beak is prominent. These features of shell form easily permit to identify the present specimens to *Clementia papyracea* (GRAY).

Measurements in mm.—Hondagua specimen; 41.0 (length), 31.5 (height), 10.5 (depth bivalved). Gumaca specimen; 40ca, 29.5, 7.0 (Left valve).

Mactra antiquata SPENGLER

Pl. 23, fig. 7.

Three specimens are examined. Shell is sub-equilateral, medium size, thin and compressed triangular in lateral outline. Beak is nearly orthogyrous, pointed at

middle part of dorsal margin. Shell is well inflated, its anterior and posterior ends are arched narrowly. Surface is smooth near beak without any distinct sculpture, but is slightly undulated concentrically in ventral area. Hinge is, at least, mactrid type, but its definite sculpture is unknown.

The present species has a shell outline close to *Mactra* (*Coelomactra*) *antiquata* SPENGLER. It is very difficult to discriminate *M. adansoni* PHILIPPI, *M. cumingi* REEVE and *M. contraria* REEVE from the present species especially in the case of fossils. Based on surface ornamentation and shell size, however, the present form may be regarded as young shell of *M. antiquata*.

Measurements in mm.—A (Left); 38 (length), 28 (height), 9 (depth). B (Right); 30ca, 19ca, 8.5. C (Left); 33, 25.5, 9.5.

Lutraria arcuata REEVE

Pl. 23, fig. 12.

Only one specimen is available for study. Shell surface is slightly dissolved. Laterally elongate outline is characteristic. Shell is somewhat swollen and not thick. Beak is situated at anterior one-fourth of the length. Maximum shell height is measured at posterior one-third of the length. Postero-dorsal margin is nearly straight or slightly concaved. Shell surface is nearly smooth but fine concentric striation is observable. Inner surface and detail of hinge plate are not observed.

The present specimen is identifiable *Lutraria arcuata* REEVE by its shell outline. *L. sieboldi* REEVE and *L. maxima* JONAS differ slightly in shell size and outline. Comparable species in shell outline may also be found in genera *Phaxus* and *Cultellus*.

Measurements in mm.—Right; 60 (length), 28 (height), 6.5 (depth).

Tellinella virgata (LINNÉ)

Pl. 23, fig. 16.

Several specimens are examined. Most of them are outer cast or inner mold and are incomplete fragments. Shell is medium in size, elongated oval in shape. Test is not thick. Anterior end of shell is rounded while posterior end is curved sharply. Beak is situated at slightly anterior to the middle. Posterior end bends right-ward slightly. Shell surface is ornamented with moderately spaced concentric rib which becomes sometimes platy. A weak ridge runs from beak to posterior end. Observable on inner surface are the cardinal teeth and a weak impression which corresponds to the ridge observed on outer surface. Depth of pallial sinus cannot be confirmed. Cardinal teeth is small, weak; two pieces are found in right valve. Both anterior and posterior lateral teeth are distinct in right valve. Ligamental plate is short and narrow.

The present species is, no doubt, a tellinid, and is most likely to be conspecific with *Tellinella virgata* (LINNÉ), although recent form has more round shell outline, that is, short in length. Outline of cardinal teeth and surface ornamentation coincide well with those of *T. virgata*. *Macoma* sp. which occurs associated with the present species has a shell form somewhat similar to *T. virgata*, but the differences can be found in shell outline and surface sculpture. *Tellina (Phylloda) foliacea* REEVE reported from the Miocene of Burma by NOETLING (1901) is so similar in outline to the present species that it is difficult to distinguish the difference between the

present species and Burmese *T. foliacea* of NOETLING's sense.

Measurements in mm.—Right; 56 (length), 31.5 (height), 5ca (depth), illustrated specimen.

Vicarya callosa JENKINS

Pl. 23, fig. 17.

Five incomplete specimens are examined. All specimens are broken in their apical and basal ends. They are small in size. Shell form is elongated conspiral with small apical angle, 27 to 33°. Number of spires are estimated at nine to 13 in complete specimens. Strong tubercles, eight to ten on one whorl, arrange close to upper suture. They become weaker adaptically. Two rows of spiral striae are present. Upper row corresponds with a row of tubercles, and runs connecting the tip of tubercles. The other row runs at middle of upper and lower sutures. A weak spiral ridge runs just below the lower striae. Weak and fine striations on shell surface are prosoclinal in the upper half and opisthoclinal in the lower half of a whorl.

These specimens are identical with *Vicarya callosa* JENKINS, a species which is well known from the upper Paleogene to lower Neogene formations of south-east Asia and Japan. Difference of this species from *V. callosa semperi* described from the Philippines by MARTIN (1901) and SMITH (1913) in having strong tubercles and flattened whorl is hardly discernible. In Japan, several endemic "species" and "subspecies" have been reported by TAKEYAMA (1933), YABE & HATAI (1938) and KAMADA (1960). Discrimination among these species has been made by the slightest difference in shape of cone or in surface ornamentation. Morphological differences

among the Japanese "species" seem to be not significant. It is said that at least two species, *V. callosa japonica* YABE & HATAI and *V. verneuili yokoyamai* TAKEYAMA exist in the Japanese Miocene. The present species is closer in shell form and surface ornamentation to *V. callosa* from the type locality in Java, than that from Japan.

V. callosa occurs commonly from the lower Miocene coal-measure horizon of the Philippines, i. e., the Batan formation of SMITH (1913) or the Vigo group of DICKERSON (1921). Several localities are known as follows: The Cagayan and Ifgao districts of northern Luzon, the Batangas district of central Luzon, Bondoc Peninsula, Batan Island of Albay, eastern side of Cebu Island and the Zamboanga district of Mindanao Island.

Measurements in mm.—A; 57.5 (90) (shell height), 27.7 (36) (maximum diameter), 27° (apical angle). B; 60.6 (80), 31.2 (34), 33°. C; 37.7 (58), 19.8 (24), 28°. D; 45.5 (86), 24.6 (34), 28°. (): Estimated dimensions.

*Strombus (Laevistrombus?)
tjilonganensis* MARTIN

Pl. 23, figs. 2, 3; text-fig. 3

Five specimens are examined. Shell is strombiform with very thick test. Six spires are observable in two comparatively well preserved specimens. Base of shell is slightly arcuated. Aperture is compressed laterally. Outer lip is flared but not so prominent as those of *Lambis* and *Eustrombus*. Test of outer lip is thickened extraordinarily. Striations are not present on inner surface of the outer lip. Stromboidal notch exists near adapical end of the outer lip. Anterior siphonal canal bents obtusely. Each whorl has nine to 11

remarkable tubercles on shoulder of shell surface. Color pattern is not preserved.

The present species is most likely to be included in subgenus *Laevistrombus* or *Labiostrombus*, because of its similar shell morphology. Medium sized shell, row of tubercles on shoulder and simple outer lip characterize this species, and are identical with those of *Strombus tjilonganensis* MARTIN, a fossil species described from Java (Text-fig. 3). Other morphological characters appeared in the original description coincide fairly well with those of the Philippine specimens. There are no morphologically comparable recent species living in the southeast Asia. Mode of volutions ob-

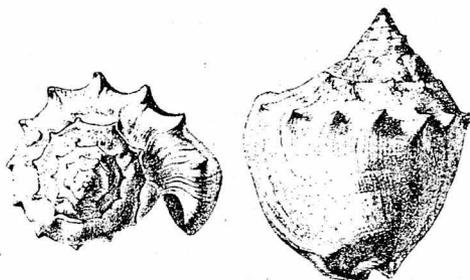


Fig. 3. *Strombus tjilonganensis* MARTIN after MARTIN, 1879 $\times 3/5$.

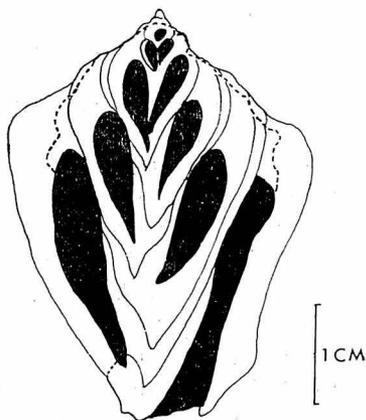


Fig. 4. Axial section of *Strombus tjilonganensis* MARTIN.

served in axial section of this species resembles that seen in *S. isabella* LAMARCK (Text-fig. 4).

Measurements in mm.—A; 42ca (shell height), 35.0 (apertural height), 31.5 (maximum diameter). B; 39.0, 31.5, 26.5. C; 35ca, 27.5, 25.5. D; 37.0, 29.5, 25ca. E; 35ca, 29.0, 22ca.

Strombus cf. isabella LAMARCK

Two incomplete specimens are at hand. Test is thick, but the surface is dissolved away. Only casts and molds are at our disposal. Shell is small and slender in its outline in comparison with that of the former species. Spire is rather high. Shoulder is round distinctively. Suture line is distinct and a narrow band runs along adapical margin of whorl. Siphonal canal is not observable. Outer lip is well developed and is lacking spines or tubercles. Adapical end of outer lip overlaps to adapical suture of the spire. No striation or ornament is found inside of the lip. Shell surface is smooth and no tubercles are found.

Specimens at hand are characterized by small size, and lack of spines and tubercles on shell surface. Above mentioned morphological characters are similar to but not completely coincide with those of the recent specimens of *S. isabella* LAMARCK in having rather slender form and smaller size. Fossil specimens described by MARTIN (1879) as *S. isabella* are very close to the present form. MARTIN'S *S. isabella* var. *thersites* and its allied form, *S. varin-ginensis*, have a certain resemblance to the specimens at hand in having slender shell form and high spire. There remains some doubt in identification of the present form to *S. isabella*, but overall shell outline is comparable with

that of *S. isabella* especially of its fossil form. The present specimens have close morphological resemblances to *S. canarium* LINNÉ illustrated by DICKERSON (1922, pl. 5), but the DICKERSON'S *S. canarium* is more slender in having high spire.

Measurements in mm.—A (6 spires); 34.0 (shell height), 23.5 (apertural height), 20ca (maximum diameter). B (5 spires); 33.0, 21.5, 18.0.

Bursa (Gyrineum) margaritula

(DESHAYES)

Pl. 23, fig. 15.

Two specimens are examined, but one of them has some doubt in species identification. Shell is small in size, rather thin and fragile. General outline is compressed fusiform. Whorls are five in number and high. Shoulder is prominently arcuated. Surface is ornamented with many spiral ribs especially at lower half of whorl. There is a row of tubercles on the periphery of body whorl, eight tubercles in one whorls. Another more or less indistinct row of nodes which are smaller than tubercles is found below periphery. Two varices can be observed on the body whorl. They are wide and well developed. One is located at opposite side of the other. Anterior canal bents slightly. Details of aperture and posterior canal are not observable.

The present specimens are regarded as young individuals of *Bursa*, judging from shell size and development of varix. They bear a certain resemblance to *Bursa rana* (LINNÉ), *B. margaritula* (DESHAYES) and "*Ranella nobilis* REEVE" of MARTIN (1889). MARTIN (1899) described also *B. margaritula* as *R. margaritula*. Difference between *R. mar-*

garitula and "*R. nobilis*" is represented by number of spiral ribs, which is difficult to count in the ill preserved specimens. Surface ornamentation of fossil and recent *B. margaritula* is, in spite of their slender shell outline, similar to that found on the present specimens. *B. rana* has prominent tubercles on its varix.

Measurements in mm.—A; 31ca (shell height), 18.0 (maximum diameter). B; 22.5, 13.5.

Oliva cf. funebris LAMARCK

Pl. 23, fig. 10.

Four ill preserved specimens are at hand. They are olivid gastropods with relatively high spiral slope and narrow basal inductula and are small in shell size. Four to five whorls are observed. Apex is projected. The color pattern which is useful for identification of olivid gastropods is not preserved.

The outline resembles that found in *Oliva funebris* LAMARCK. High spire and basal inductula suggest alliance of the present specimens with *O. annulata* GMELIN and *O. episcopalis* LAMARCK. Absence of color pattern does not permit definite species identification. *O. funebris* illustrated by MARTIN (1895) from Java differs considerably from the present specimens in shell outline.

Measurements in mm.—A; 23.0 (shell height), 19.5 (apertural height), 10.0 (maximum diameter). B; 20.5, 17.5, 10.5. C; 17.5, 15.5, 8.0. D; ?, ?, ?.

Voluta (Volutocorona) ? sp.

A fairly heavy coniformed shell is found. Preservation is incomplete and body whorl is broken. However, characteristic features of *Voluta* such as

prominent apex, columella foldings and heavy test are still remained for examination. The present specimen bears similar shell outline to that found in *Voluta scapha* var. *ponderosa* described by MARTIN (1885) from the Neogene of Java, but is too incomplete to be identified with this species.

Conus (Cleobula) minimus LINNÉ

Pl. 23, fig. 11.

Five specimens are at hand. Beside the shell outline, section through axial plane is examined in one specimen (Text-fig. 5). Shell is rather small and cone-shaped not so tall. Test is thick. Side is convex slightly. Spire is low and spiral side is elevated slightly toward apex. Apex is projected abruptly and pointed. Suture is smooth. Shoulder is rounded smoothly. Several faint spiral striations are found near base. Aperture is narrow. In axial section, test appears to be thick, and heavy in its outer part, but columella is comparatively slender. Secondary callus is well developed in parietal region, thus whorls of young stage are completely filled with shell material. Protoconch is not observable. Color pattern on shell surface which is

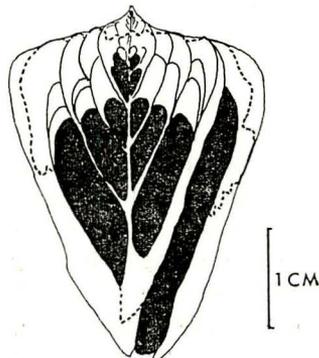


Fig. 5. Axial section of *Conus minimus* LINNÉ.

a significant key for specific identification of conid gastropods is not preserved in fossil specimens at hand.

If one disregards the color pattern, the present specimens are identifiable with *Conus betulina* LINNÉ or *C. minimus* LINNÉ because they have similar shell form especially in spiral slope and round shoulder. Profile through axial plane also suggests the same conclusion. Only a reason why the present form is identified with *C. minimus* is the difference in size. *C. minimus* is smaller in general than *C. betulina*. *C. striatellus* JENKINS of MARTIN (1879) and *C. glaucus* LINNÉ of MARTIN (1895), both from Java also have shell outline which is close to *C. minimus*. *C. lorisii* KIENER illustrated by DICKERSON (1922, pl. 2) is closely similar to the present species. Further, the faunal association of *C. lorisii* listed by DICKERSON is very close to the association of the present species.

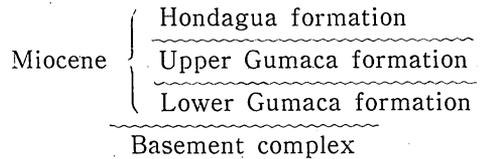
Measurements in mm.—A; 35.5 (shell height), 24.2 (maximum diameter). B; 40.3, 28.5. C; 32.5, 22.5.

Geological outline

The Tayabas Isthmus district, a narrow land extending from east to west with width of less than 15 km, is located at the southern part of Luzon Island, and connects the northern main part of Luzon with the southern volcano-rich region. Topographically the district is a low land consisting of the widely distributed Neogene and Quaternary sediments. Strikes of strata and trends of folding axes are approximately parallel to the extension trend of the Isthmus.

Stratigraphically, these Neogene marine and non-marine sediments overlies the pre-Tertiary metamorphic complex. There are no coverings of Quaternary

volcanic deposits, that are widely developed in the middle to southern region of Luzon Island. Stratigraphy surrounding fossil localities is as follows according to KIMURA *et al.* (1968):



The basement complex is composed of older metamorphic rocks, and younger non-metamorphosed effusive rocks, sandstone and cherts, latter of which are thought to be the Cretaceous in age.

The lower Gumaca formation covers unconformably the basement and consists of sandstone, mudstone, conglomerate, limestone and tuff. The lower part of the succession is siliceous and fine, but the upper part becomes coarser. Tuffaceous sediments and andesite lava are found in the middle part. The *Eulepidina* bearing reef limestone characterized by dominance of corals is a distinct horizon marker of the middle part. Fine sandstone which contains molluscan fossils at the Locality 11-3 is upper in horizon than the *Eulepidina* limestone. The upper part is rich in coarse sediments and coal seams. This formation is widely distributed in the Tayabas Isthmus district, and is characterized by frequent lateral changes of lithological facies and total thickness.

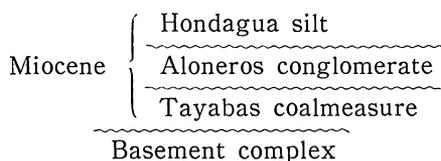
The *Nephrolepidia* limestone and calcareous sediments laying unconformably over the lower Gumaca formation are generally called the upper Gumaca formation. The formation is distributed along the synclinal axis of the Isthmus, and runs almost parallel to the middle zone of the district.

The Hondagua formation is distributed in the eastern area of the district. A

fault running in northwest to southeast direction which is main trend of the Philippine fault zone separates the area of the Hondagua formation from that of underlying formations. The lower part is characterized by conglomerate, sandstone and siltstone, while tuffaceous beds and clean sands characterize the upper part. In the middle part, shell beds are intercalated. The second fossil locality of this report, the Locality 17-12 of KIMURA *et al.* (1968), is in the middle part.

The Neogene formations, especially the lower Gumaca formation, are gently undulated into a syncline and an anticline. At the western area, the middle part of the lower Gumaca formation, the *Eulepidina* limestone, is not undulated, on the other hand, at the eastern side, even the overlying Hondagua formation is involved in gentle folding.

In this report, the stratigraphical divisions and the formational names are adopted from those of KIMURA *et al.* There is, however, at least another stratigraphical divisions proposed by CORBY *et al.* (1951). CORBY *et al.*'s study on stratigraphy and on oil possibilities covers whole areas of the Republic of Philippines. The stratigraphical division of the Tayabas Isthmus district as appeared in CORBY *et al.*'s report is to a certain extent different from that of KIMURA *et al.*



The Tayabas coalmeasure is composed chiefly of carbonaceous sand, silt, black shales and limestone layers. Well-preserved molluscan shells found from this horizon are of marine origin. The Alo-

neros conglomerate is composed of coarse sand, conglomerate and large amount of clay and silt with sediments of volcanic origin. Most part of the formation is considered to be non-marine origin and marine shell fossils are scarcely found. Hondagua silt consists of bedded gray silt intercalating with massive sandstone.

The columnar sections presented by KIMURA *et al.* and CORBY *et al.* do not correspond exactly to each other because of the different interpretation on the geological structure of the district. KIMURA *et al.*'s lower Gumaca formation includes most of the non-calcareous facies and *Eulepidina* limestone of CORBY *et al.*'s Tayabas coalmeasure and Aloneros conglomerate. KIMURA *et al.*'s upper Gumaca formation which is characterized by the *Nephrolepidina* limestone seems to be equivalent to several limestones of the Tayabas coalmeasure of CORBY *et al.* Upper silty part of the Hondagua formation of KIMURA *et al.* may correspond to the Hondagua silt.

According to CORBY *et al.*, occurrence of the larger foraminifers in the Philippines usually indicates W stage of the letter classification. *Lepidocyclina* including *Nephrolepidina* and *Eulepidina*, or *Miogypsina* characterizes the calcareous member of the limestone-coalmeasure facies of the upper W stage. *Vicarya callosa* is said to occur from the coalmeasure facies, and is characteristic in calcareous member of the late Paleogene to the early Neogene in the Philippines as well as in the Indonesia. Thus the lower Gumaca formation which yields the Pitogo fauna is likely to be older Miocene in age, corresponding to upper W and/or lower X, and the age of the Hondagua formation is younger Miocene corresponding to the upper X and/or Y of the Philippine's letter classification.

In his descriptions of generalized stratigraphy of the Philippines, SMITH (1924) classified the Miocene sedimentary succession into the Batan formation, the Vigo shale and Canguinsa sandstone in ascending order. These formations are distributed widely in northern to southern Luzon, Batan of Albay, Cebu and Mindanao Islands. The Batan formation is a coal-measure consisting of gray shale, sandstone and coal seams, and occupies generally the basal part of the thick Neogene succession. This formation is considered to be deposited in near shore to brackish environment, thus accompanied with *Vicarya callosa*, *Vermetus javanus* MARTIN, *Corbula* sp. and other molluscan fossils. Limestone facies of the formation yields *Lepidocyclus* sp. The overlying Vigo shale is composed chiefly of thick shale which also yields molluscan fossils such as *Conus ornatissimus* MARTIN and *Cerithium jenkinsi* MARTIN.

The lower Gumaca formation, at least molluscan bearing sandstone and siltstone alternation, seems to be equivalent to the SMITH's Batan formation and the rest of the formation are probably to a part of the Vigo shale.

KIMURA *et al.* discussed briefly the paleogeography or sedimentary environment of the Neogene formations based on lateral and vertical changes of lithofacies. Their conclusion is that the sedimentary basin of the lower Gumaca formation had been reduced especially in later stage into an embayment of the southern area whereas the brackish to non-marine environment dominates in the northern area. The Hondagua formation, at least its upper part, deposited in shallow embayment near littoral zone.

In the study of the Philippine Tertiary, DICKERSON (1924) presented the paleogeographical map of the Philippines

during the Miocene Vigo stage. A narrow land extends north to south covering an area to the east of the Tayabas Isthmus district of Luzon Island and the eastern part of Mindanao Island. The other two islands were situated, one at an area to the west of Luzon Island and the other at an area extending from Marinduque to Panay Islands. Thus, the Philippines were an archipelago in the Vigo stage. The Tayabas Isthmus, especially neighbourhood of Pitogo, occupied a part of inland seas.

Notes on occurrence of the Pitogo fauna

The large outcrop of Loc. 11-3 consists of steeply dipped alternation of sandstone and siltstone which belongs to the upper part of the lower Gumaca formation. Two layers yielding fossils are found on the outcrop. The upper layer is found in the sandstone and the layer itself consists also of weathered, brownish, loose, clayey, fine sandstone of 10 cm thick. Aggregate occurrence of shell fragments, broken gastropods and disarticulated valves, and the small size of the shell characterize the upper layer. Among *Corbula* sp., *Gari?* sp., *Circe intermedia*, *Oliva* cf. *funeralis*, *Apollon* sp., *Vepricardium multispinosum*, *Bursa margaritula*, *Callista erycina*, *Conus generalis* and others, which are found in the upper layer, *Corbula* sp. is the most abundant. Non-fossiliferous massive sandy mudstone of about 1 m in thickness estranges the two fossil layers.

The lower layer consists of dark brownish, hard, calcareous fine sandstone. Calcareous material has been leached from molluscan shells. Shell remains and their fragments are large in size compared with those of the

upper layer. Species contained are *Vicarya callosa*, *Strombus tjilonganensis*, *S. cf. isabella*, *Conus minimus*, *Anadara multiformis*, *Joannisiella cumingi*, *Paphia exarata*, *Clementia papyracea*, *Lutraria arcuata*, *Vasticardium* sp., *Tellinella virgata* and others. Fossils of the upper and the lower layers are in general ill preserved. In some specimens shell materials have been leached away entirely, thus only their external casts or internal molds are available for study. Shell carbonate, originally aragonite, has been altered into calcite. Thus quite often, the original shell structure is not preserved.

Except for a few examples, bivalved shell and gastropod with well preserved aperture are found scarcely in the upper and the lower layers. In exceptional case, 10 of 14 individuals of *Joannisiella cumingi*, and four out of 9 individuals of *Paphia exarata* are found in intact bivalve. No appreciable amount of worn out can be detectable either on their shell surfaces or on external impressions. Aperture or apex of most gastropods are not preserved, except for *Strombus tjilonganensis*, whose surface sculpture, apex or base are often preserved completely.

Species composition of both layers are different slightly from each other. The upper layer is characterized by clustered occurrence of *Corbula* sp., whereas the lower layer is characterized by the *Vicarya-Anadara* association. *Corbula* sp., *Sunetta concinna*, *Callista erycina*, *Vasticardium* sp. and *Nassarius crenulatus* are common in both layers. Most individuals of both the upper and the lower layers seem to be transported from a distance. However, *Joannisiella cumingi*, *Paphia exarata* and probably *Strombus tjilonganensis* of the lower layer are considered to be autochthonous

or if transported the distance short from the habitat. Thus, the assemblage found in the lower layer is probably a mixture of two different associations. *V. callosa*, *A. multiformis* and *Corbula* sp. are transported to some distance from their habitat and are deposited on the muddy sand bottom of sublittoral zone where the substratum has been settled by *J. cumingi*, *P. exarata* and *S. tjilonganensis*.

Paleogeographically, the site of Loc. 11-3 is estimated to be an interior of a shallow embayment, which opens south-eastward, and is surrounded by a swampy area. Alternation of sandstone and mudstone with thin coal seams indicates oscillation between brackish and marine environments.

Comparison between the Pitogo fauna and the Kadonosawa-type fauna

Stratigraphical significance of *Vicarya*-bearing molluscan fauna of the Philippines ("the Batan fauna" of SMITH (1913) and "the Vigo fauna" of DICKERSON (1921)) was discussed fully by MARTIN (1901), SMITH (1913) and DICKERSON (1921). In general, the lower part of the Philippine Miocene such as the Batan formation is characterized by the *Vicarya*-bearing molluscan fauna and at the same time by the occurrence of coal seams just below or near to the molluscan fossil horizons. Distribution of *Vicarya*-bearing fauna covers a wide area including the northern part of Luzon Island; Batan Island of Albay; the Batangas district; Bondoc Peninsula; Cebu Island and the Zamboanga district of Mindanao Island.

Species associated with *Vicarya callosa* in the northern Luzon listed by MARTIN (1901) are *Terebra jenkinsi* MARTIN, *T.*

bandongensis MARTIN, *Fusus verbeeki* MARTIN, *Murex grooti* JENKINS, *Bursa gyrina* (LINNÉ), *Cardita decipiens* MARTIN and *Rostellaria javana* MARTIN. The other species association given by DICKERSON (1922) from Cebu Island is *Cerithium jenkinsi* MARTIN, *C. herklotsi* MARTIN, *Voluta innexa* REEVE, *Natica* sp., *Conus* sp., *Chione lacerata* HANLEY and *Pecten leopardus* REEVE. The former assemblage includes *Terebra* and *Cardita* species, whereas the latter has several cerithid and pectinid species besides *V. callosa*. Although both assemblages are somewhat different in species composition, overall characters seem to be similar to each other paleoecologically. The *Vicarya-Anadara* association of the Pitogo fauna does not share much similarity with these assemblages mentioned above. Coexistence of *Vicarya* sp., comparable to *callosa*, and *Anadara multiformis* is reported by HAYASAKA (1943) from the northern part of Luzon. The distributions of *Vicarya-Anadara* and *Paphia-Joannisiella* associations or their ecologically similar assemblages are not restricted to the Philippines but are traceable as far north as in

the Japanese Miocene, and as far south as in Java.

In the paleoecological study of the Japanese Neogene molluscan fauna, CHINZEI & IWASAKI (1967) recognized four different species assemblages in the lower Miocene Kadonosawa fauna, i.e. the *Batillaria*, *Ostrea*, *Dosinia-Anadara* and *Macoma-Lucinoma* assemblages. They distribute zonally in having a certain relation to depth and the distribution of bottom sediments. A molluscan fauna closely allied to that found in the Kadonosawa basin in species composition is encountered also in several lower Miocene formations in Japan, i.e. the Kurosedani formation of the Yatsuo group of Honshu, the Sakai formation of Kakinaga group of Tanegashima Island, and etc. The fauna of the Kurosedani formation is characterized by *Telescopium telescopium* LINNÉ, *Geloina luchuana* (PILSBRY), *Vicarya callosa*, *Vicaryella ishiiana* (YOKOYAMA) and "*Anadara kakehataensis* HATAI & NISIYAMA". The fauna of the Sakai formation is characterized by *T. telescopium*, *V. callosa*, "*A. kakehataensis*", *Cyclina japonica* KAMADA and *Joanni-*

Table 1. Idealized species association of near-shore 4 assemblages of the Japanese Kadonosawa-type fauna. (Modified after CHINZEI & IWASAKI, 1967)

Near shore		Off-shore	
<i>Telescopium-Geloina</i> assemblage	<i>Batillaria</i> assemblage	<i>Ostrea</i> assemblage	<i>Dosinia-Anadara</i> assemblage
<i>Telescopium telescopium</i> <i>Geloina luchuana</i>	<i>Vicarya callosa</i> <i>Vicaryella ishiiana</i> <i>Batillaria yamanarii</i> <i>Nassarius</i> sp. <i>Ringicula ninohensis</i> " <i>Anadara kakehataensis</i> " <i>Soletellina minoensis</i> <i>Macoma</i> sp.	<i>Ostrea gravitesta</i> <i>Clementia</i> sp. <i>Panopea japonica</i>	<i>Anadara ninohensis</i> <i>Glycymeris cisshuensis</i> <i>Joannisiella cumingi</i> " <i>Clinocardium</i> " <i>shinjiense</i> <i>Tapes siratoriensis</i> <i>Dosinia nomurai</i> <i>Clementia papyracea</i> <i>Polinices meisensis</i> <i>Conus tokunagai</i>

siella cumingi. The lower Miocene fauna which is characterized by those species is often called the Kadonosawa-type or Yatsuo-Kadonosawa fauna and has been used as a good indicator of the tropical shallow sea of the past.

Associate occurrence of *Vicarya callosa*, *Vicaryella ishiiana* and "*A. kakehataensis*" in the field indicate that they all belong to the same, the *Batillaria* assemblage of the Kadonosawa-type fauna. *J. cumingi* is found commonly with the species of the *Dosinia-Anadara* assemblage. *T. telescopium* and *G. luchuana* constitute yet another assemblage which characterizes the inner-most area of an embayment, perhaps the peculiar environment like mangrove swamp. However, since mangrove swamp is not always found along the tropical coast, the *Telescopium-Geloina* assemblage is naturally not always associate with the Kadonosawa-type faunal assemblages. The five, *Telescopium-Geloina*, *Batillaria*, *Ostrea*, *Dosinia-Anadara* and *Macoma-Lucinoma* assemblages are arranged more or less zonally from the shore to the central area of embayment in the lower Miocene Kadonosawa stage.

KASENO, Y. (1964) divided "the Kurosedani fauna" into two, namely A and B assemblages. The A assemblage which characterizes the brackish environment of interior embayment is composed of "*A. kakehataensis*", *Ostrea gravitesta* YOKOYAMA, *Vicarya yokoyamai* TAKEYAMA, "*Telescopium nipponicum* OYAMA", *Cerithidea kanpokuensis* MAKIYAMA etc. On the other hand, the B assemblage is composed of elements of shallow bottom of open sea environment, such as "*Anadara ogawai* (MAKIYAMA)", *Glycymeris cisshuensis* MAKIYAMA, *Pitar itoi* (MAKIYAMA), *Polinices meisensis* MAKIYAMA, *Conus toyamaensis* TSUDA and

others. KASENO's classification is rather rough and the A assemblage seems to be a mixture of the *Telescopium-Geloina*, *Batillaria* and *Ostrea* assemblages and the B assemblage includes the *Dosinia-Anadara* and *Macoma-Lucinoma* assemblages of CHINZEI & IWASAKI.

The important species of the Kadonosawa-type fauna are listed in the Table 1. Though some differences in species composition appear between northern limit and the southernmost records, these can be regarded as slight geographical variation influenced by ecological condition within the same biogeographical province. Combinations of such particular species as "*A. kakehataensis*" and *V. callosa* of the *Batillaria* assemblage, and *Dosinia nomurai* OTUKA and "*Clinocardium*" *shinjiense* (YOKOYAMA) of the *Dosinia-Anadara* assemblage are useful indices of the Kadonosawa-type fauna.

The *Amussiopecten-Clementia-Paphia-Joannisiella* "assemblage" or the *Amussiopecten-Paphia* "assemblage" of SHUTO (1957b, 1961) found in the upper Miocene Miyazaki group of south Kyushu represents a muddy bottom fraction of the *Dosinia-Anadara* assemblage. Its species composition is often quite dissimilar to the average composition of the *Dosinia-Anadara* assemblage because the *Dosinia-Anadara* assemblage is composed mainly of the sandy bottom dwellers. However, such common species as *Dosinia nomurai*, *Joannisiella cumingi* and *Glycymeris* species connect the *Amussiopecten-Paphia* "assemblage" with the rest of the *Dosinia-Anadara* assemblage of *sensu lato* without any significant gap.

UOZUMI, S. & FUJIE, T. (1966) reported the *Vicarya*-bearing fauna from Okushiri Island, southwestern Hokkaido. This is the northern extremity of the distribution of the *Vicarya*-bearing mol-

luscan fauna in the Japanese lower Miocene, where *Vicarya yokoyamai*, *Vicaryella notoensis* MASUDA, "*A. kakehataensis*", *Ostrea gravitesta*, *Diplodonta ferruginata* MAKIYAMA, *Dosinia nomurai* etc. occur from the Tsurikake formation. The southernmost record of the Kadono-

sawa-type fauna in Japan is now known from the Sakai formation of Tanegashima Island (stratigraphy by KOREEDA, K. 1963). The fauna is composed of *T. telescopium*, *Vicarya callosa*, *Vicaryella ishiiiana*, "*A. kakehataensis*", *O. gravitesta*, *Batillaria yamanarii* MAKIYAMA, *J. cumingi*, *Cyclina japonica*, *Clementia papyracea*, *Polinices meisensis* etc.

The two islands, Okushiri and Tanegashima are separated about 1,500 km in distance and 11.5° in latitudinal distance. Thus the considerable amount of geographical variations in species composition are recognizable between the two local faunas. *D. ferruginata* in Okushiri Island is replaced by *J. cumingi* in Tanegashima Island. However, the differences of the species composition in *Vicarya* and *Vicaryella* are likely to be not the replacement by unrelated species but merely a variation within a species or a species group.

The Pitogo fauna is similar to the Kadonosawa-type fauna in species composition as well as in ecological characteristics including habitat inferred from sedimentological investigation in spite of a great distance, 1,800 km, that separates Pitogo from Tanegashima, the southernmost locality of the Kadonosawa-type fauna. Latitudinal difference is more than 17°. The same or closely related species occur in both the Kadonosawa-type and the Pitogo faunas. Comparative study of species composition in both faunas will permit to infer that most of constituent species of the Pitogo fauna are derived from the assemblages comparable to the *Batillaria* assemblage and *Dosinia-Anadara* assemblage of the Kadonosawa-type fauna. *V. callosa*, *Corbula* sp. and *A. multiformis* seem to constitute the southern variety of the *Batillaria* assemblage, and *J. cumingi*, *P. exarata*, *Conus minimus* and

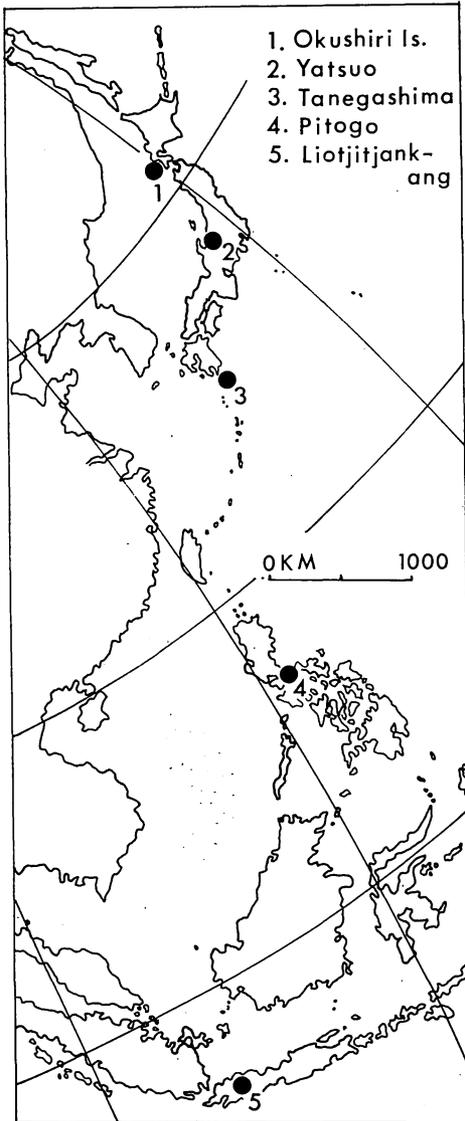


Fig. 6. Map showing selected places where the *Vicarya-Anadara* association occurs.

Clementia papyracea constitute that of the *Dosinia-Anadara* assemblage. Absence of *Ostrea* sp. in the Pitogo fauna suggests the conclusion that the oyster bank or *Ostrea* assemblage usually found in most examples of the Kadonosawa-type fauna might not develop in this particular area.

The marked combination of species, *V. callosa* and "*A. kakehataensis*" of the Kadonosawa-type fauna, is replaced by that of *V. callosa* and *A. multiformis* in the Pitogo fauna. The combination of *Dosinia nomurai* and "*Clinocardium*" *shinjiense* of the Kadonosawa-type fauna is disappeared and is replaced by association of such species as *Dosinia* sp. or *Paphia exarata* and *Vasticardium* sp. in the Pitogo fauna. However, *Dosinia* sp. and *Vasticardium* sp. hold no longer the place of the main constituents in the Pitogo fauna. In the Miyazaki group, the *Dosinia-Anadara* assemblage of the Kadonosawa-type fauna may be represented by the *Clementia-Paphia-Joannisiella* "assemblage". The conclusion is that the brakish sediment which is characterized by the *V. callosa-A. multiformis* combination of the *Batillaria* assemblage becomes more muddy offshore, and it might be lived by the dwellers such as *P. exarata* and *J. cumingi* or in some places by *Dosinia* sp. and *Vasticardium* sp.

Among 36 species of the Pitogo fauna, *V. callosa*, *Clementia papyracea* and *J. cumingi* are found also in the Japanese Kadonosawa-type fauna. *A. multiformis* and *Conus minimus* have closely allied species in the Kadonosawa-type fauna. Such venerid species as *Callista erycina*, *Paphia exarata* and *Katelsia hiantina*, and sanguinolariid species as *Gari?* sp., *Cultellus* sp. and *Azorinus scheepmakeri* are likely to fill the places of venerid species, *Dosinia nomurai* and *Nippono-*

marcia nakamurai IKEBE, and sanguinolariid species, *Soletellina minoensis* YOKOYAMA and *Cultellus izumoensis* YOKOYAMA of the Kadonosawa-type fauna respectively. Thus, assemblage analysis available for the Japanese Miocene fauna seems to be applicable also to the fauna of the Philippine Miocene.

It is quite natural that the Pitogo fauna has larger number of species comparable to those found in the Kadonosawa-type fauna from Tanegashima than those from Okushiri Island. Such species as *Maçtra antiquata*, *Strombus tjilonganensis*, *S. cf. isabella*, *Oliva cf. funebris* and *Voluta?* sp. have not been known from the Japanese area. Since the recent representatives of these species or closely related species are inhabitants of tropical shallow sandy substratum, their distributions are likely to be restricted to the south of the Japanese Islands in the early Miocene age. In general, the Pitogo fauna can be regarded as a southern extension, or more exactly, a tropical representative, of the Japanese Kadonosawa-type fauna.

No molluscan fauna which includes the *Vicarya* sp.-*Anadara* sp. combination has hitherto been reported from the extensive area between the Philippines and Kyushu. It can hardly be speculated whether the fauna of this area is similar to the Pitogo fauna in its species association or intermediate one between the Pitogo and the Tanegashima faunas. The lower Miocene sediments found in Formosa and Iriomote Island of the Yaeyama Islets consist exclusively of thick coal bearing formations and the shallow sea sediments including the lower Miocene molluscan fossils can scarcely be expected to be found in this area.

The Pitogo fauna is also comparable to the Miocene molluscan fauna from

Java, Indonesia. In the MARTIN's report (1879), molluscs with the *V. callosa*-*A. multiformis* combination were listed from several localities. The lower Miocene bituminous sediments at one locality near Liotjitjankang, western Java yield *V. callosa*, *Strombus tjilonganensis*, *Telescopium telescopium*, *Corbula* spp., *Dosinia* spp., *Paphia rimosa*, *Ostrea* spp. and *A. multiformis* etc. The Liotjitjankang fauna is very close to the Pitogo fauna in its species composition and essentially the same in ecological characteristics. Liotjitjankang is located slightly to the south of equator, and thus the Pitogo fauna which is the southern extension of the Kadonosawa-type fauna extends further south into the southern hemisphere. However, a certain kinds of species in the Liotjitjankang fauna are found rarely in the Kadonosawa-type including the Pitogo fauna. These are *Cypraea* spp., *Murex* spp., *Chama* spp. and *Tridacna* spp. which are found usually in coral reef facies. Thus, these species in the Liotjitjankang fauna are likely to be derived from another Miocene shallow sea assemblage of particular environment like coral reef facies.

The assemblage attaching to coral or bryozoan reef facies is not known in the Kadonosawa-type fauna of the Japanese area, although the fauna is likely to have been survived in considerably warm environment. The *Eulepidina* limestone of the lower Gumaca formation, and certain elements of the Liotjitjankang fauna suggest that in the early Miocene, near shore reef facies dominates in the area to the south of the Japanese area.

The other molluscan fossils correlative to the Pitogo and the Kadonosawa-type faunas are found from the Miocene Gáj group distributed in the provinces of Sind, Pakistan and Cutch, western India.

Fauna of the upper argillaceous part of the Gáj group is characterized by the occurrence of such species as *Ostrea multicostrata* DESHAYES, *Anadara sub-multiformis* (VREDENBURG), *Omphalocladrum granosa* (SOWERBY), *Dosinia pseudoargus* (D'ARCHIAC & HAIME), *Paphia virgata* (SOWERBY), *Vicarya verneuili* (D'ARCHIAC) and *Turritella angulata* SOWERBY (BLANFORD, W. T., 1880; VREDENBURG, 1928). Though the species are different to some extent from those of Indonesia and the Philippines, ecological characters of both faunas seem to resemble very closely to each other. Although the precise chronological correlation of the faunas remains to be studied, the *Vicarya*-bearing tropical fauna did exist almost contemporaneously in the lower Miocene time along the coasts of the western Pacific and of the Indian Ocean. Area of its distribution is one of the largest among the Neogene molluscan faunas of the shallow embayment. The Pitogo fauna is comprehensible as one of the southern representatives of this widely distributed fauna of the Indo-Pacific province.

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References cited

- BLANFORD, W. T. (1880): The geology of western Sind. *Mem. Geol. Surv. India, Vol. 17, Art. 1*, pp. 1-210, 1 map.
- CHINZEI, K. & IWASAKI, Y. (1967): Paleocology of shallow sea molluscan faunas in the Neogene deposits of northeast Honshu, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S., No. 67*, pp. 93-113.
- CORBY, G. W. & others (1951): Geology and oil possibilities of the Philippines. *Repub. Philip., Dept. Agric. Nat. Resources, Technic. Bull. No. 21*, 363 pp., 57 pls.
- DICKERSON, R. E. (1921): A fauna of the Vigo group: Its bearing on the evolution of marine molluscan faunas. *Philip. Jour. Sci., Vol. 18, No. 1*, pp. 1-21, pls. 1, 2.
- (1922): Review of Philippine paleontology. *Ibid., Vol. 20, No. 2*, pp. 195-229, pls. 1-16.
- (1924): Tertiary paleogeography of the Philippines. *Ibid., Vol. 25, No. 1*, pp. 11-50, pls. 1-4.
- HAYASAKA, I. (1943): *Arca multiformis* MARTIN from Luzon. *Trans. Nat. Hist. Soc. Taiwan, Vol. 33, No. 241*, pp. 334-340, pl. 11.
- (1944): A new species of Miocene *Arca* from the Philippines. *Ibid., Vol. 34, Nos. 246, 247*, pp. 123-126.
- JENKINS, H. M. (1863): On some Tertiary Mollusca from Mount Séla, in the Island of Java. *Quart. Jour. Geol. Soc. London, Vol. 20, Pt. 1*, pp. 45-73, pls. 6, 7.
- KAMADA, Y. (1960): On the associated occurrence of *Vicarya* and *Vicaryella* in the Japanese Tertiary, with the first description of a Paleogene species of *Vicarya* from Japan. *Sci. Repts., Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol. No. 4*, pp. 281-295, pls. 30, 31.
- KASENO, Y. (1964): Biostratigraphic problems of the Neogene strata in Hokuriku region, central Japan. *Fossils, No. 7*, pp. 27-35.
- KIMURA, T., TOKUYAMA, A., GONZALES, B. A. & ANDAL, D. R. (1968): Geologic structures in the Tayabas Isthmus district, Philippines. Contributions to geology and palaeontology of southeast Asia, 49. in *Geology and Palaeontology of Southeast Asia*, KOBAYASHI, T. & TORIYAMA, R. edit., No. 4, pp. 156-178, Univ. Tokyo Press.
- KOREEDA, K. (1965): Geological study of southern part of Tanegashima Island, Kagoshima Prefecture. (MS in Japanese) *Graduation thesis, Geol. Inst., Yokohama Nat'l. Univ., No. 44*.
- MARTIN, K. (1879-1880): Die Tertiärschichten auf Java. 236 pp., 28 Taf., 1 Karte, Leiden.
- (1883): Nachträge zu den "Tertiärschichten auf Java". 1ter Nachtrag: Mollusken. *Sammlung. Geol. Reichs-Mus. Leiden, 1te Ser., Beiträge Geol. Ost-Asiens und Australiens, Bd. 1*, pp. 194-265, Taf. 9-13.
- (1895-1906): Die Fossilien von Java. *Sammlung. Geol. Reichs-Mus. Leiden, Neue Folge, Bd. 1, Gastropoda*, pp. 1-332, Taf. 1-45.
- (1801): Concerning Tertiary Fossils in the Philippines. in Report on the geology of the Philippine Islands by BECKER, G. F., *U. S. Geol. Surv., 21st Annual Rept.*, pp. 487-625.
- (1909, 1910): Die Fossilien von Java. *Sammlung. Geol. Reichs-Mus. Leiden, Neue Folge, Bd. 1, 2te Abt., Ht. 1, 2*, pp. 334-386, Taf. 46-54.
- MASUDA, K. (1966): Molluscan fauna of the Higashi-Innai formation of Noto peninsula, Japan-II; Remarks on molluscan assemblage and description of species. *Trans. Proc. Palaeont. Soc. Japan, N. S., No. 64*, pp. 517-337, pls. 35, 36.
- NOETLING, F. (1895): On some marine fossils from the Miocene of upper Burma. *Mem. Geol. Surv. India, Vol. 27, Pt. 1*, pp. 1-45+5, pls. 1-10.
- (1901): Fauna of the Miocene beds of Burma. *Palaeont. Indica, New Ser., Vol. 1, Mem. Geol. Surv. India No. 3*, 378 pp. 25 pls.
- SHUTO, T. (1957a): Fossil *Paphia* from the

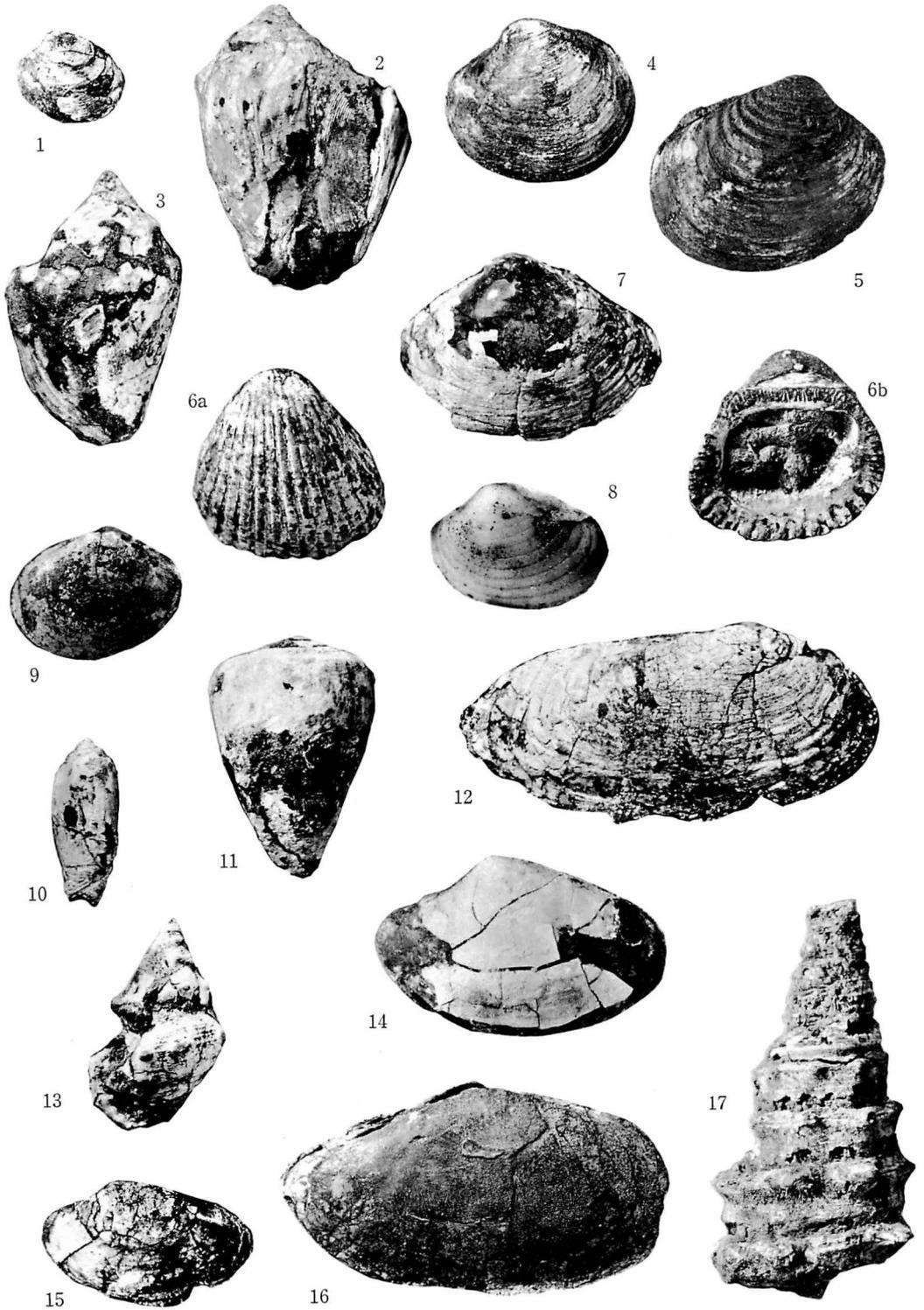
- Miyazaki group. *Japan. Jour. Geol. Geogr.*, Vol. 28, Nos. 1-3, pp. 138-160, pl. 12.
- (1957b): Polymorphism in mollusks and facies differentiation. (Palaeontological basis for the consideration of speciation-1). *Jour. Geol. Soc. Japan*, Vol. 63, No. 745, pp. 565-585.
- (1957c): Palaeontological aspects of speciation. (Ditto-II). *Ibid.*, Vol. 63, No. 746, pp. 636-647.
- (1961): Palaeontological study of the Miyazaki group.—A general account of the faunas. *Mem. Fac. Sci., Kyushu Univ.*, Ser. D. Geol., Vol. 10, No. 2, pp. 73-206, pls. 11-13.
- SMITH, W. D. (1913): Contributions to the stratigraphy and fossil invertebrate fauna of the Philippine Islands. *Philip. Jour. Sci.*, Vol. 8, No. 4, Sec. A, pp. 235-300, pls. 1-20.
- (1924): Geology and mineral resources of the Philippine Islands. *Bureau Sci. Manila, Publ. No. 19*, 539 pp., 39 pls.
- TAKEYAMA, T. (1933): Notes on the genus *Vicarya*, with description of two Japanese forms. *Japan. Jour. Geol. Geogr.*, Vol. 10, Nos. 3, 4, pp. 129-144, pl. 13.
- UOZUMI, S. & FUJIE, T. (1966): Neogene molluscan fauna in Hokkaido, Part II. Description of the Okushiri fauna associated with *Vicarya*, from Okushiri Island, southwest Hokkaido. *Jour. Fac. Sci., Hokkaido Univ.*, Ser. 4, Geol. Mineral., Vol. 13, No. 2, pp. 139-163, pls. 11-13.
- VREDENBURG, E. (1921): Results of a revision of some portions of Dr. NOETLING'S second monograph on the Tertiary fauna of Burma. *Rec. Geol. Surv. India*, Vol. 51, Pt. 3, pp. 224-302.
- (1928): Descriptions of Mollusca from the post-Eocene Tertiary formation of north-western India. *Mem. Geol. Surv. India*, Vol. 50, Pts. 1, 2, 506+21 pp., 33 pls.
- YABE, H. & HATAI, K. M. (1938): On the Japanese species of *Vicarya*. *Sci. Repts., Tohoku Imp. Univ.*, 2nd Ser. (Geol.), Vol. 19, No. 2, pp. 149-172, pl. 21.

Higashi-Innai	東 印 内	Kurosedani	黒 瀬 谷	Tanegashima	種 子 ヶ 島
Iriomoto	西 表	Miyazaki	宮 崎	Tsurikake	釣 懸
Kadonosawa	門 ノ 沢	Okushiri	奥 尻	Yaeyama	八 重 山
Kukinaga	荃 永	Sakai	坂 井	Yatsuo	八 尾

Explanation of Plate 23

(All figures are natural size unless otherwise stated)

- Fig. 1. *Callista (Costacallista) erycina* (LINNÉ); specimen B.
- Figs. 2, 3. *Strombus (Laevistrombus?) tjilonganensis* MARTIN; fig. 2, specimen A; fig. 3, specimen B.
- Fig. 4. *Joannisiella cumingi* (HANLEY); specimen A.
- Fig. 5. *Clementia papyracea* (GRAY); Hondagua specimen.
- Fig. 6a, b. *Anadara multiformis* (MARTIN); a; shell surface; b, inner surface; specimen A.
- Fig. 7. *Mactra antiquata* SPENGLER; specimen A.
- Fig. 8. *Callista (Costacallista) erycina* (LINNÉ); Silicon-rubber cast of specimen, not measured, $\times 2$.
- Fig. 9. *Sunetta concinna* DUNKER; specimen A.
- Fig. 10. *Oliva cf. funebris* LAMARCK; specimen A.
- Fig. 11. *Conus (Cleobula) minimus* LINNÉ; specimen A.
- Fig. 12. *Lutraria arcuata* REEVE.
- Fig. 13. *Bursa (Gyrineum) margaritula* (DESHAYES); specimen A.
- Figs. 14, 15. *Paphia exarata* (PHILIPPI); fig. 14, specimen A; fig. 15, specimen D.
- Fig. 16. *Tellinella virgata* (LINNÉ); inner mold.
- Fig. 17. *Vicarya callosa* JENKINS; specimen A.



562. A NEW SPECIES OF *SAGENOPTERIS* FROM NARIWA,
SOUTHWEST HONSHU, JAPAN*

KAZUO HUZIOKA

Institute of Mining Geology, Mining College, Akita University

成羽産 *Sagenopteris* の一新種: *Sagenopteris nariwaensis* と命名した成羽産の新種は成羽小学校の大塚尚男氏らによって東枝の新産地より採集されたもので、小葉が6枚あることが特徴である。この属では小葉の最も多い種である。 藤岡一男

In 1905, YOKOYAMA first described some fossil plants from the Nariwa district in Okayama Prefecture and considered this plant-bearing bed to be Upper Triassic in age. The fossil plants, called by the name of the Nariwa flora, was studied in detail by

OISHI (1930, 1931, 1932, 1938, 1940) and OISHI and HUZIOKA (1935, 1936, 1938), who described about one hundred species of plants. These plants are stated to be closely related to the Rhaetic floras of Europe and Greenland. The Nariwa Formation which bears the

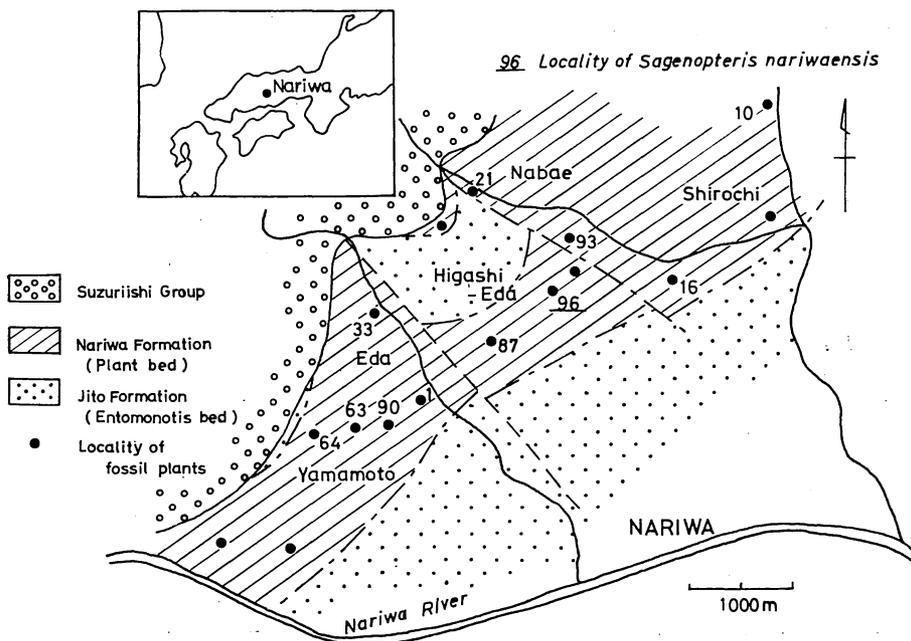


Fig. 1. Localities of Fossil Plants in the Eda area.

* Received June 7, 1969; read June 15, 1969.

Nariwa flora overlies the Jito Formation which yielded *Entomonotis ochotica* of the Norian stage with conformity, and both of the formations are regarded by Japanese geologists as representing the Norian stage of the Upper Triassic. KOBATAKE (1954) and KON'NO (1962) added two new species of Equisetales to the Nariwa flora. The Nariwa flora as now known consists of 104 valid plants which are distributed in the Pteridophyta and the Gymnospermae, including the present new species of *Sagenopteris*. The following is a complete list of the fossil plants hitherto known from 96 localities of the Nariwa district:

Table 1. List of the fossil plants from Nariwa.

PTERIDOPHYTA

Marattiaceae

1. *Marattiopsis muensteri* (GOEPPERT) SCHIMPER

Osmundaceae

2. *Todites goeppertianus* (MÜNSTER) KRASSER
3. *T. princeps* (PRESL) GOTHAN
4. *T. williamsoni* (BRONGNIART) SEWARD

Dipteridaceae

5. *Clathropteris elegans* OISHI
6. *C. meniscoides* BRONGNIART
7. *C. obovata* OISHI
8. *Dictyophyllum muensteri* (GOEPPERT) NATHORST
9. *D. nilssoni* (BRONGNIART) GOEPPERT
10. *D. spectabile* NATHORST
11. *Goeppertella varida* OISHI et HUZIOKA
12. *Hausmannia (Protorhipis) crenata* (NATHORST) MOELLER
13. *H. (P.) nariwaensis* OISHI
14. *H. (P.) dentata* OISHI
15. *Thaumatopteris elongata* OISHI
16. *T. kochibei* (YOKOYAMA) OISHI et YAMASITA
17. *T. nipponica* OISHI
18. *T. pusilla* (NATHORST) OISHI et YAMASITA

Filicales incertae sedis

19. *Sphenopteris gracilis* OISHI
20. *S. sp.*
21. *Cladophlebidium ? okayamaensis* OISHI et HUZIOKA
22. *Cladophlebis bitchuensis* OISHI
23. *C. denticulata* (BRONGNIART)
24. *C. gigantea* OISHI
25. *C. haiburnensis* (LINDLEY et HUTTON) BRONGNIART
26. *C. nariwaensis* OISHI et HUZIOKA
27. *C. nebbensis* (BRONGNIART)
28. *C. pseudodelicatula* OISHI
29. *C. raciborskii* ZEILLER
30. *C. raciborskii* forma *integra* OISHI et TAKAHASI
31. *C. (Osmundopsis ?) subplectrophora* OISHI et HUZIOKA
32. *C. tenue* OISHI et HUZIOKA
33. *C. sp.*
34. *Spiropteris sp.*

Equisetales

35. *Annulariopsis inopinata* ZEILLER ?
36. *Pseudolobatannularia densiflora* KOBATAKE
37. *Equisetites multidentatus* OISHI
38. *E. nariwaensis* KON'NO
39. *E. sp.*
40. *Neocalamites carrerei* (ZEILLER) HALLE
41. *N. hoerensis* (SCHIMPER) HALLE
42. *Phyllothecca sp.*

GYMNOSPERMAE

Cycadophyta

Cycadales

43. *Ctenis japonica* OISHI
44. *C. takamiana* OISHI et HUZIOKA
45. *C. yabei* OISHI
46. *Nilssonia acuminata* (PRESL) GOEPPERT
47. *N. brevis* BRONGNIART
48. *N. muensteri* (PRESL) SCHIMPER
49. *N. orientalis* HEER
50. *N. simplex* OISHI
51. Cfr. *N. tenuicaulis* (PHILLIPS) FOX-STRANGWAYS

Bennettitales

52. *Otozamites huzisawae* OISHI et HUZIOKA
53. *O. lancifolius* OISHI

54. *O. molinianus* ZIGNO
 55. *Pterophyllum aequale* (BRONGNIART) NATHORST
 56. *P. angustum* (BRAUN) GOTHAN
 57. *P. ctenoides* OISHI
 58. *P. cfr. distans* MORRIS
 59. *P. jaegeri* BRONGNIART
 60. *P. schenki* ZEILLER
 61. *P. serratum* OISHI et HUZIOKA
 62. *P. sp. a*
 63. *P. sp. b*
 64. *P. sp. c*
- Caytoniales
 65. *Sagenopteris nariwaensis* HUZIOKA
 66. *S. nilssoniana* (BRONGNIART) SEWARD
- Cycadophyta incertae sedis
 67. *Ptilozamites nilssoni* NATHORST ?
 68. *P. tenuis* OISHI
 69. *Taeniopteris lanceolata* OISHI
 70. *T. leclerei* ZEILLER
 71. *T. minensis* OISHI
 72. *T. nabaensis* OISHI
 73. *T. richthofeni* (SCHENK)
 74. *T. stenophylla* KRYSHTOFOVICH
 75. *T. ? sp. nov.* OISHI
 76. *T. ? sp.*
- Ginkgophyta
 77. *Baiera elegans* OISHI
 78. *B. filiformis* OISHI
 79. *B. furcata* HEER
 80. *B. guilhaumati* ZEILLER
 81. *B. minuta* NATHORST
 82. *B. paucipartita* NATHORST
 83. *B. taeniata* BRAUN
 84. *B. sp.*
 85. *Ginkgoites sibirica* (HEER) SEWARD
 86. *G. digitata* (BRONGNIART) SEWARD var. *huttoni* SEWARD
 87. *Phoenicopsis* sp.
- Coniferales
 88. *Elatocladus plana* (FEISTMANTEL) SEWARD
 89. *E. tennerima* (FEISTMANTEL) SAHNI
 90. *E. sp.*
 91. *Pityophyllum longifolium* (NATHORST) MOELLER
 92. *Nageiopsis rhaetica* OISHI
 93. *Podozamites concinnus* OISHI et HUZIOKA
 94. *P. lanceolatus* (LINDLEY et HUTTON)
95. *P. schenki* HEER
 96. Cfr. *Storgaardia spectabilis* HARRIS
 97. *Stenorachis bitchuensis* OISHI
 98. *S. elegans* OISHI
 99. *S. (Ixostrobus ?) konianus* OISHI et HUZIOKA
 100. *Swedenborgia cryptomerioides* NATHORST
 101. *S. major* HARRIS
- Gymnospermae ? incertae sedis
 102. *Campyrophyllum hoermanni* GOTHAN ?
 103. *Czekanowskia rigida* HEER
 104. *Yabeiella* sp.

Very lately, Mr. H. OTSUKA, a teacher of the Nariwa primary school, collected an interesting undescribed fossil plant (Pl. 24, fig. 1) from a new locality (Loc. 96) at Higashi-Eda (Fig. 1), and forwarded it to the writer for study. This interesting plant bears six leaflets which are palmately disposed from a point. Its leaflets is linear lanceolate in outline, with a distinct midrib and entire margin, but its lateral veins are hardly observable. At Eda and Yamamoto, where there are known more than a dozen localities of fossil plants (Fig. 1). Mr. OTSUKA repeatedly collected fossil plants in cooperation with Messrs. T. OGAWA and H. HIRAMATSU, and was successful in collecting additional specimens of the new plant. The writer studied these specimens and he placed them in the genus *Sagenopteris* from the characters of the petiole and anastomosing lateral veins in the leaflet, as described below :

Description of species

Caytoniales

Genus *Sagenopteris* PRESL

The genus *Sagenopteris* belongs to the Caytoniales and is regarded as an independent phylum of seed plants of the Gymnospermae. The Caytoniales com-

prise three genera such as *Sagenopteris* (leaf), *Caytonia* (megasporophyll) and *Caytonanthus* (microsporophyll). *Sagenopteris* was applied by PRESL to small fronds composed of some palmately disposed leaflets with a more or less distinct midrib and anastomosing secondary veins. The genus *Sagenopteris* which ranges from the Upper Triassic to the Lower Cretaceous of the world is known by about thirty species.

Sagenopteris nariwaensis, sp. nov.

Pl. 24, figs. 1-6, 6a, 7, 7a

Description: Leaf consists of a petiole and six leaflets. Petiole stout and long, somewhat thickened at the top. Six leaflets palmately disposed from the top of the petiole, symmetrically arranged, the median pair being the largest. Leaflet narrowly lanceolate in outline, excepting the edge pair which is short and variable in shape, gradually tapered to both ends of the acute apex and the acuminate base, without stalks, entire at the margin. Midvein thick and rigid, becoming obscure distadly. Lateral veins derived from the midvein at acute angles, densely arranged, frequently anastomosed forming elongate meshes. Epidermal cells of leaflets not preserved. Productive organs likely in connection with this leaf have never been found.

The leaf figured in Pl. 24, fig. 1 is a well preserved specimen though its petiole is missing. The median leaflets are 6 cm in length and 1 cm in breadth. Pl. 24, figs. 2-6, show petiolated leaves with a stout petiole, which is 1 mm broad and more than 2 cm long, with six leaflets at its top, somewhat thickened. The median leaflet in Fig. 2 is more than 6 cm long and 1.6 cm wide. The lateral veins are generally obscure

in preservation, but their anastomosing habits are well shown in Pl. 24, figs. 6, 6a, 7, 7a.

Comparison and remarks: The present leaf is referable to the genus *Sagenopteris* in all preserved features, and its most important character is the possession of six leaflets. It has been generally believed that *Sagenopteris* essentially bears four leaflets on a petiole, though most species of *Sagenopteris* have been named on detached leaflets. *Sagenopteris nariwaensis*, sp. nov. is the first occurrence of a six-leaflets bearing *Sagenopteris*. In having six leaflets, this species is distinguished from all known species of *Sagenopteris*. *S. elliptica* FONTAINE (1889, p. 149, Pl. XXVII, figs. 9-17) from the Lower Cretaceous of North America is a species closely related to the one from Nariwa; it was originally described as having five-leaflets, but it may have had six leaflets as in the case of *S. nariwaensis*. So far as single detached leaflet is concerned, the Nariwa species is quite similar to *S. nilssoniana* (BRONGNIART) WARD and *S. phillipsi* (BRONGNIART) PRESL, both of which have wide geographic distribution. The former is the representative species of the genus in the Upper Triassic and the Lias, and the latter is characteristic in the Upper and the Middle Jurassic. Compared with those two species, the present one has narrower lanceolate leaflets.

Five valid and two undeterminable species of *Sagenopteris* have been known from the Japanese Mesozoic formations, as shown in Table 2.

Occurrence: Loc. 96, Higashi-Eda, Nariwa, Nariwa Town, Kawakami-gun, Okayama Prefecture; Nariwa Formation (Norian, Triassic).

Plants associated with *S. nariwaensis* at Loc. 96: *Clathropteris meniscoides* BRONGNIART, *Cladophlebis denticulata*

Table 2. Species of *Sagenopteris* in Japan.

Species	Occurrences
<i>S. nariwaensis</i> HUZIOKA	Nariwa Formation, Okayama Pref.; Norian, Upper Triassic.
<i>S. nilssoniana</i> (BRONGNIART) WARD (syn. <i>S. rhoifolia</i> PRESL, <i>S. sp.</i> YOKOYAMA, 1905; <i>S. sp.</i> OISHI and HUZIOKA, 1938)	Yamanoi Formation of the Mine Group, Yamaguchi Pref. (OISHI and TAKAHASI, 1936, OISHI, 1940); Carnian, Upper Triassic. Nariwa Formation, Okayama Pref.; Norian, Upper Triassic. Kuruma Formation of Toyama and Nagano Prefs. (OISHI, 1940); Lias, Lower Jurassic.
<i>S. petiolata</i> OISHI (1940)	Kiyosue Formation of the Toyonishi Group, Yamaguchi Pref.; Upper Jurassic. Utano Formation, Yamaguchi Pref. (TAKAHASI, 1957); Middle Jurassic.
<i>S. phillipsi</i> (BRONGNIART) PRESL (syn. <i>S. paucifolia</i> PRESL (OISHI, 1940)	Kuzuryu subgroup of the Tetori Group, Fukui Pref. (OISHI, 1940, KIMURA, 1958); Upper Jurassic.
<i>S. ? inequilateralis</i> OISHI (1940)	Yuasa Formation of the Ryoseki Series, Wakayama Pref.; Lower Cretaceous.
<i>S. sp.</i> YOKOYAMA (1889)	Tetori Group, Ishikawa Pref.; Upper Jurassic.
<i>S. sp.</i> KIMURA (1958-a)	Kizaki Plant Bed, Nagano Pref.; Upper Jurassic.

(BRONGNIART), *C. nebbensis* (BRONGNIART), *Taeniopteris minensis* OISHI, *Podozamites lanceolatus* (LINDLEY et HUTTON), and etc.

Collectors: Messrs. Hisao OTSUKA, Takeo OGAWA and Hideshi HIRAMATSU.

Depository: The Nariwa Museum, Nariwa Town, Okayama Pref.

References

- FONTAINE, W.M. (1889): The Potomac or younger Mesozoic Flora. *U.S. G.S. Mon.* 15, pp. 1-377.
- HARRIS, T.M. (1932): The Fossil Flora of Scoresby Sound East Greenland. Part 3. Caytoniales and Bennettitales. *Med. om Greenland, Bd. 85, No. 5*, pp. 1-133.
- (1940-a): *Caytonia*. *Ann. Bot., N.S. Vol. IV, No. 16*, pp. 713-734.
- (1940-b): On some Jurassic Specimens of *Sagenopteris*. *Ann. Mag. Nat. Hist., Ser. II, Vol. VI*, pp. 249-265.
- (1941): *Caytonanthus*, the Microphyll of *Caytonia*. *Ann. Bot., N.S. Vol. V, No. 17*, pp. 47-58.
- KIMURA, T. (1958-a): Mesozoic Plants from the Kizaki District, Nagano Prefecture, Japan. *Jubilee Publ. Commem. Prof. H. FUJIMOTO*, pp. 135-138.
- (1958-b): On the Tetori Flora (Part 3). Mesozoic Plants from the Kuzuryu Sub-Group, Tetori Group, Japan. *Bull. Sen. High School attached to Tokyo Univ. Educ., No. II-2*, pp. 1-47.
- KOBATAKE, N. (1954): On the Mesozoic Verticulate Leaves from Japan and Korea with some Views of *Lobatannularia* and its Affinities. *Sci. Rep. No. 3, South Coll. and North Coll., Osaka Univ.*, pp. 71-80.
- KON'NO, E. (1962): Some Species of *Neocalamites* and *Equisetites* in Japan and Korea. *Sci. Rept. Tohoku Univ., 2nd ser. (Geology), Special Volume, No. 5 (KON'NO Memorial Volume)*, pp. 1-47.
- OISHI, S. (1930): Notes on some Fossil Plants from the Upper Triassic Beds of Nariwa. *Jap. Jour. Geol. Geogr., Vol.*

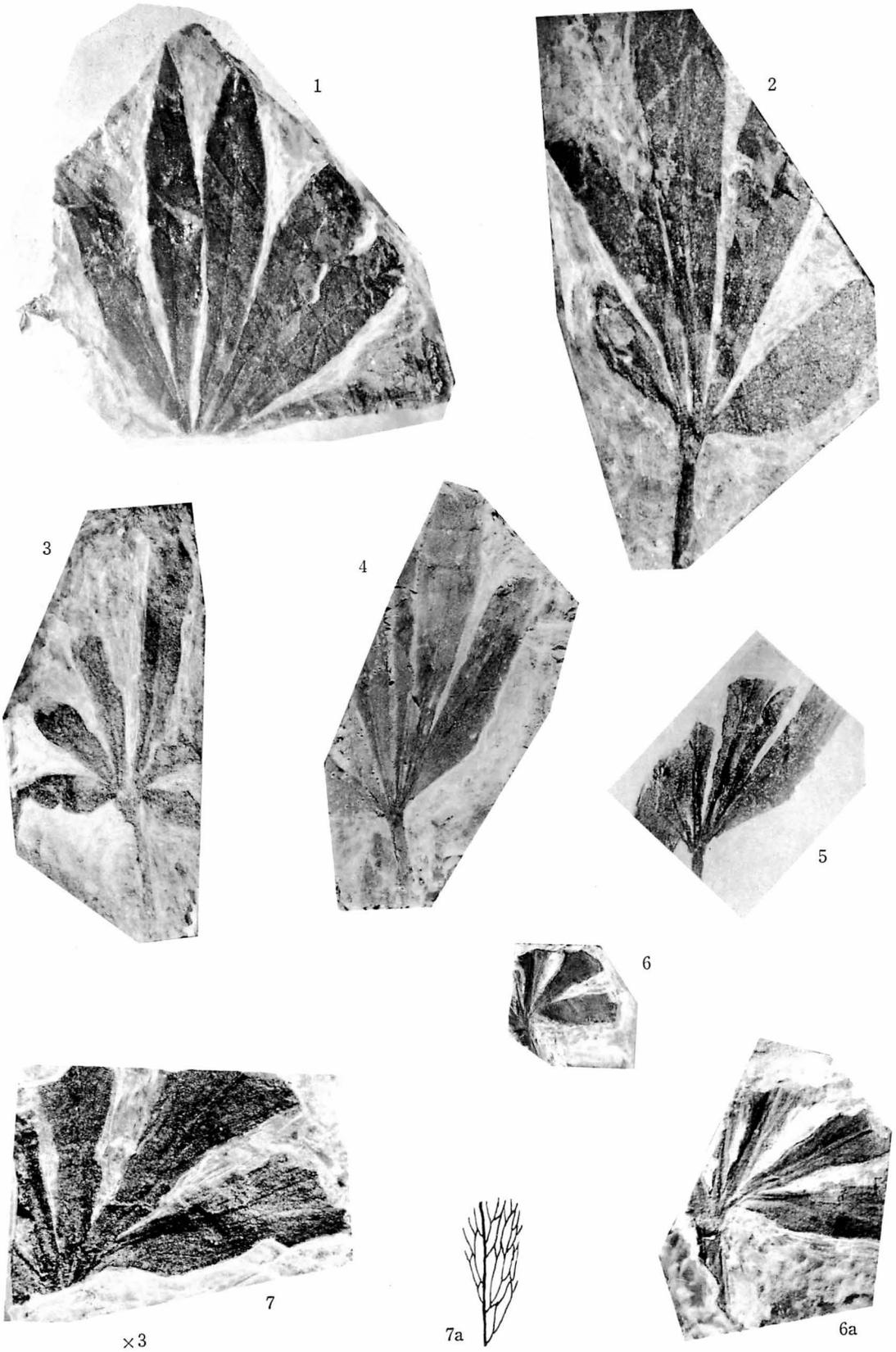
- VII, No. 2, pp. 49-58.
- (1931): *Yabeiella* sp. from the Japanese Triassic. *Ibid.*, Vol. VIII, No. 4, pp. 357-359.
- (1932): The Rhaetic Plants from the Nariwa District, Okayama Prefecture, Japan. *Jour. Fac. Sci., Hokkaido Imp. Univ.*, Ser. IV, Vol. II, Nos. 3-4, pp. 257-379.
- (1938): The Japanese Equivalent of the *Lepidopteris* and *Thaumatopteris* Zones of East Greenland. *Proc. Imp. Acad. Tokyo*, Vol. 14, pp. 77-80.
- (1940): The Mesozoic Floras of Japan. *Jour. Fac. Sci., Hokkaido Imp. Univ.*, Ser. IV, Vol. V, Nos. 2-4, pp. 123-480.
- OISHI, S. and K. HUZIOKA (formerly YAMASITA) (1935): On the Genus *Swedenborgia* NATHORST and its Occurrence in the Nariwa Bed, Okayama Pref., Japan. *Proc. Imp. Acad. Tokyo*, Vol. 11, pp. 438-440.
- and — (1936): On the Fossil Dipteridaceae. *Jour. Fac. Sci., Hokkaido Imp. Univ.*, Ser. IV, Vol. III, No. 2, pp. 135-184.
- and — (1938): Fossil Plants from Nariwa. A Supplement. *Ibid.*, Vol. IV, Nos. 1-2, pp. 69-101.
- OISHI, S. and E. TAKAHASI (1936): The Rhaetic Plants from Province Nagato. A Supplement. *Ibid.*, Vol. III, No. 2, pp. 1-13.
- SEWARD, A.C. (1910): Fossil Plants. Vol. II.
- TAKAHASI, E. (1957): Fossil Flora of the Toyora and the Toyonishi Groups, Yamaguchi Prefecture (in Japanese). *Yamaguchi Jour. Sci.*, Vol. 8, pp. 79-82.
- YOKOYAMA, M. (1889): Jurassic Plants from Kaga, Hida and Echizen. *Jour. Coll. Sci., Imp. Univ. Tokyo*, Vol. IV, Art. 1, pp. 1-89.
- (1905): Mesozoic Plants from Nagato and Bitchu. *Ibid.*, Vol. XX, Art. 5, pp. 1-13.

Higashi-Eda 東 枝
Eda 枝
Yamamoto 山 本

Nariwa Town 成羽町
Kawakami-gun 川上郡

Explanation of Plate 24

Figs. 1, 2, 3, 4, 5, 6, 6a, 7, 7a. *Sagenopteris nariwaensis*, sp. nov. Loc. 96, Higashi-Eda, Nariwa, Nariwa-town, Kawakami-gun, Okayama Prefecture.



563. FRESHWATER MOLLUSCS FROM THE COAL-BEARING OWADA FORMATION, SOUTHEAST RUMOI, HOKKAIDO, JAPAN*

HIROSHI NODA

Institute of Geology and Paleontology, Faculty of Science,
Tohoku University, Sendai, Japan

北海道 留萌市 南東部 大和田夾炭層産 淡水棲貝 化石について：北海道 留萌市 南東部に分布する 大和田夾炭層より産した 淡水棲貝化石を 検討した 結果次の 一新種を含む五種 *Unio uryuensis* SUZUKI, *Lanceolaria pisciformis* (YOKOYAMA), *Margaritifera perdahurica* YOKOYAMA, *Margaritifera owadaensis* NODA, n. sp., *Viviparus* cf. *uryuensis* YOKOYAMA を識別した。従来、大和田夾炭層を中新世とするもの、古第三紀とするものがあつたが、上記貝化石によって、大和田夾炭層は雨竜層群あるいは石狩層群に対比されるもので、古第三紀層であるといえる。この結果大和田夾炭層に関する若干の地史的考察を行なつた。

野田 浩 司

Introduction

During the stratigraphic work in the Owada coal-field (SUGAI, 1968), the writer collected some fresh-water molluscan fossils from the coal bearing Owada Formation exposed around the Owada Colliery, southeast of Rumoi City, Hokkaido (Fig. 1).

The stratigraphy, geology and paleontology of the Rumoi and Uryu coal-fields situated near the present area have been studied by many workers, yet there still remain some problems concerning the stratigraphy, geological age and correlation based upon the lithological, structural and paleontological evidences of the Owada Formation, which is covered by the fossiliferous Miocene Yudoro and Togeshita formations with unconformity.

* Received July 26, 1969; read June 14, 1969 at Yakohama.

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Historical Review

YAMANE (1912a, b), IIZUKA and UEMURA (1920a, b) reported on the geology around the Owada coal-field (SUGAI, 1968). ENDO (1931) in his study of the plants from the Japanese Paleogene proposed the

name of the Owada coal-bearing Formation but without definition; the stratigraphic name was adopted by NAGAO (1933).

HASHIMOTO (1950) studied the stratigraphy around the Owada coal-field and defined the Owada coal-bearing Formation. He (HASHIMOTO, 1950) recognized a stratigraphic break between the Owada Formation and the Yudoro Formation and this was accepted by TSUSHIMA and YAMAGUCHI (1952), who considered the formation to be Miocene in age based upon the geology and good quality of the coal. HASHIMOTO (1950) collected a freshwater molluscan fossil, *Corbicula atrata tokudai* (YOKOYAMA), at Baba-Tanzan-no-sawa where the Owada Formation is distributed.

In 1956, TANAI stated that the Owada Formation is characterized by Paleogene plants as *Onoclea*, *Osmunda*, *Equisetum*, *Ulmus*, *Planera*, *Mallotus*, *Pueraria*, *Platanus*, *Maelea*, etc., and he correlated the formation with the upper part of the Ishikari Group. From the heavy mineral association, TANAI (1956), IJIMA and TANAI (1955) and IJIMA (1957) recognized similarity between the Owada Formation and the Ishikari Group. Recently, HITOSUGI and SASAKI (1959) supported their opinion.

The age of the fresh-water mollusc *Corbicula atrata tokudai* (YOKOYAMA) collected by HASHIMOTO (1950) from a rolled block in the area of distribution of the formation was questioned at that time as to whether it indicated the Paleogene or the Neogene. Subsequently, TSUSHIMA and YAMAGUCHI (1953) reported *Viviparus* sp., *Lanceolaria* sp. and *Margaritifera* sp. from the formation and based upon them they considered the formation to be Miocene in age and this was later accepted by TAKEDA (1954), contrary to the Paleogene

age suggested by TANAI (1956).

Remarks on the Fresh-water Molluscs from the Coal-bearing Owada Formation

The coal-bearing Owada Formation covers with unconformity the unknown Paleozoic Kumaneshiri Formation which is mainly composed of schalstein and slate and is covered by the Yudoro and Togeshita formations with unconformity. The formation distributed around the Owada Colliery is composed of pebble conglomerate and medium grained sandstone which yielded the fresh-water molluscs described in the present article. Fresh-water molluscan fossils collected and discriminated from a pale brownish gray tuffaceous medium grained sandstone exposed along the national road side near Owada and on the opposite side of the Rumoi River (see locality map) are *Unio uryuensis* SUZUKI, *Lanceolaria pisciformis* (YOKOYAMA), *Margaritifera perdahurica* YOKOYAMA, *Margaritifera owadaensis* NODA, n. sp., and *Viviparus* cf. *uryuensis* SUZUKI. These fossils are restricted in geological and geographical distributions. For example, *Unio uryuensis* SUZUKI had been recorded from only the Upper Tachibetsu Formation* (YOKOYAMA, 1932; SUZUKI, 1941a, 1942), *Margaritifera pisciformis* (YOKOYAMA) is known from the Lower and Upper Tachibetsu Formation (YOKOYAMA, 1932), the coal-bearing Yubari Formation (SUZUKI, 1941a), Lower *Corbicula* bearing Formation (SUZUKI, 1942, 1944), Middle Uryu Group (SUZUKI, 1942), *Margaritifera perdahurica* YOKOYAMA occurs from the coal-bearing Yubari

* =Stratigraphic names quoted; stratigraphic nomenclature not undertaken.

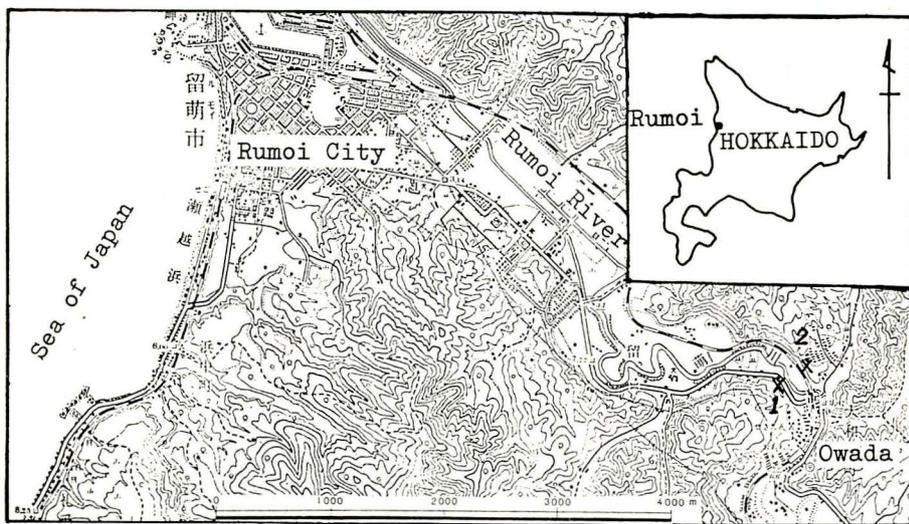


Fig. 1. Map showing the positions of the fossil localities.

Formation (SUZUKI, 1942, 1944), Yubetsu Formation (SUZUKI, 1942), Lower *Corbicula* bearing Formation (SUZUKI, 1942, 1944), Tachibetsu Formation (YOKOYAMA, 1932; SUZUKI, 1941b), Wakkanappe Formation (SUZUKI, 1942) and *Viviparus uryuensis* SUZUKI is known from the Upper Tachibetsu and Lower Tachibetsu Formation (YOKOYAMA, 1932; SUZUKI, 1941b), and Middle Uryu Group (SUZUKI, 1941b) all in Hokkaido.

From the above cited data, the coal-bearing Owada Formation is considered to correspond with the Upper Shiroki to Tachibetsu Formation of the Uryu Group. Because the lower and upper parts of the Owada Formation are missing in the present area, exact correlation with other areas is difficult. However, in broad sense, the formation may be said to be a correlative of the Uryu or Ishikari Group. The geological age of the Uryu Group was considered to be Eocene by TANAI (1950), ASANO (1962), OHARA (1966), OHARA and KAN'NO (1969) and SUGAI (1968).

The fossil fresh-water molluscan as-

semblage cited above is known only from the central part of western Hokkaido in Japan. This fauna comprises warm water dwellers different from the freshwater molluscan assemblage from the Sasebo Group in North Kyushu (UEJI, 1934), the coal-bearing Jinbu Formation in Mie Prefecture (SUZUKI, and OYAMA, 1946), the Koura Formation in Shimane Prefecture (SUZUKI, 1949) and from other sporadic occurrences in Nagano Prefecture (OMORI and IBARAGI, 1966; SUZUKI, 1949).

The Tappu and Shimokine formations are not developed in the Owada area where the Owada Formation is overlapped by the Miocene Yudoro and Togeshita formations. This distribution of the different strata seems to indicate that the Owada area may have been a marginal area favourable to the dwelling of freshwater molluscan assemblages and adjacent to the Kabato Massif which is mainly composed of Paleozoic rocks.

It is thought that the Miocene Yudoro and Togeshita formations were deposited after a long period of erosion sub-

sequent to the deposition of the coal-bearing Owada Formation. This view is also upheld by the unconformity between the formations lying unconformably on the Unknown Paleozoic Kumane-shiri Formation. It is considered that those elevated land areas were distributed in the Owada area during the Miocene Yudoro stage. From such assumptions, the present writer is inclined to the view that the coal-bearing Owada Formation was deposited during the Paleogene, and the age may be Eocene based upon the freshwater molluscan fossils mentioned above contrary to the Miocene age stated by TSUSHIMA and YAMAGUCHI (1953) and TAKEDA (1954).

Description of Species

Family Unionidae FLEMING, 1828

Subfamily Unioninae FLEMING, 1828

Genus *Unio* PHILIPSON, 1788

Subgenus *Unio* s. s.

Unio (Unio) uryuensis SUZUKI, 1941

Pl. 25, figs. 1, 2, 4, 5, 7, 13

1941b. *Unio uryuensis* SUZUKI, *Jour. Fac. Sci., Imp. Univ., Tokyo, Sec. 2*, vol. 6, pt. 2, p. 25-26, pl. 1, figs. 11a-c.

1942. *Unio uryuensis* SUZUKI, SUZUKI, *Japanese Jour. Geol. Geogr.*, vol. 18, no. 4, p. 151-152, pl. 17, figs. 3, 6.

The present species was originally described based upon the specimen from the Upper Tachibetsu Formation, Uryu coal field by SUZUKI in 1941b.

The species is characterized by the transversely elliptical form, with both anterior and posterior dorsal parts rather shouldered. The beak is situated anteriorly and there are long lateral

teeth along the posterior dorsal side. The posterior ridge is rather blunt. The shell is sculptured with blunt elevated concentric growth lines.

The species is distinguishable from the Recent species *Unio biwae* KOBELT, 1879 or *Unio douglasiae* GRIFFITH and PIDGEON, 1834 (*vide* KURODA, 1931) in having rather shouldered dorsal margin and more inflated shell. Among the fossil species, *Margaritifera perdahurica* YOKOYAMA (1932) resembles the present species in shell form but the latter differs from the former in having a posterior elevated ridge.

The shell collected from the coal-bearing Owada Formation is rather of medium size and measures about 5 cm in length and 3 cm in height.

The specimens of intact and isolated valves were collected from a tuffaceous, medium grained sandstone (Loc. no. 1) where they are rather common.

Locality and formation: Locality nos. 1, 2, Owada Formation.

Depository: IGPS* coll. cat. no. 86890.

Genus *Lanceolaria* CONRAD, 1853

Lanceolaria pisciformis (YOKOYAMA, 1932)

Pl. 25, fig. 10

1932. *Nodularia pisciformis* YOKOYAMA, *Jour. Fac. Sci. Imp. Univ., Tokyo, Sec. 2*, vol. 3, pt. 6, p. 243, pl. 3, figs. 1-2.

1941a. *Lanceolaria pisciformis* (YOKOYAMA), SUZUKI, *Ibid.*, vol. 6, pt. 1, p. 8-9, pl. 1, figs. 10a-c.

1941b. *Lanceolaria pisciformis* (YOKOYAMA), SUZUKI, *Ibid.*, vol. 6, pt. 2, p. 26-28, pl. 1, figs. 12-13.

1942. *Lanceolaria pisciformis* (YOKOYAMA), SUZUKI, *Japanese Jour. Geol. Geogr.*,

* = Abbreviation for Institute of Geology and Paleontology, Faculty of Science, Tohoku University, Sendai.

vol. 18, no. 4, p. 152-153, pl. 18, figs. 1-5, pl. 19, figs. 1-2.

1944. *Lanceolaria pisciformis* (YOKOYAMA), SUZUKI, *Trans. Proc. Palaeont. Soc. Japan*, no. 181, p. 7.

The present species was originally described on the specimen derived from the Upper Tachibetsu Formation by YOKOYAMA (1932) under the name of *Nodularia pisciformis*. Subsequently, SUZUKI (1941b) re-examined the holotype and referred it to the genus *Lanceolaria* based upon the hinge teeth and shell form. The present species as already mentioned by SUZUKI (1941), is characterized by the elongated shell form, rounded anterior and narrowly curved posterior end, elevated posterior ridge along the posterior side extending from near the beak to the posterior end of the shell, and by the shell sculpture of blunt irregular elevated growth lines.

The Recent species in Japan, *Lanceolaria cuspidata* KIRA (1959), differs from the present one in having lower and longer shell, and more acute posterior end. There are no fossil species reported from Japan that are comparable with the present one.

The species at hand measures 6.5 cm in length and 2.5 cm in height. It was collected from a tuffaceous, medium grained sandstone; rather few.

Locality and formation: Locality no. 1, Owada Formation.

Depository: IGPS coll. cat. no. 86891.

Family Margaritiferidae HAAS, 1941

Genus *Margaritifera* SCHMACHER, 1816

Margaritifera perdahurica

YOKOYAMA, 1932

Pl. 25, figs. 8a-b, 9, 11, 12

1890. *Anodonta* sp., JIMBO, p. 42, pl. 1, fig.

6. (*vide* SUZUKI, 1941c).

1932. *Nodularia biwae* YOKOYAMA (not KOBELT, 1879), *Jour. Fac. Sci., Imp. Univ., Tokyo, Sec. 2*, vol. 3, pt. 6, p. 243-244, pl. 4, fig. 4.
1932. *Margaritifera perdahurica* YOKOYAMA, *Ibid.*, p. 244, pl. 4, fig. 2.
- 1941b. *Margaritifera perdahurica* YOKOYAMA, SUZUKI, *Ibid.*, vol. 6, pt. 2, p. 24-25, pl. 1, fig. 9.
- 1941c. *Margaritifera perdahurica* YOKOYAMA, SUZUKI, *Trans. Proc. Palaeont. Soc. Japan*, no. 138, p. 102-104, text-figs. 6a-c on p. 103. (reproduction of JIMBO'S, 1890 *Anodonta* sp.).
1942. *Margaritifera perdahurica* YOKOYAMA, SUZUKI, *Japanese Jour. Geol. Geogr.*, vol. 18, no. 4, p. 147-148, pl. 19, figs. 3-7.
1944. *Margaritifera perdahurica* YOKOYAMA, SUZUKI, *Trans. Proc. Palaeont. Soc. Japan*, no. 181, p. 6, pl. 6, figs. 1-2.

The present species was originally described on the specimens from the Upper Tachibetsu Formation of the Uryu Group by YOKOYAMA in 1932. Much earlier, JIMBO (1890) illustrated *Anodonta* sp. from the Ishikari Series and this was identified as *Margaritifera perdahurica* by SUZUKI in 1941c.

The species is characterized by the elongately ovate form with anterior side rounded and the posterior side slightly narrow to somewhat acute at the posterior end because of a posterior ridge extending from near the beak. The ventral margin is rather elongated. The shell is sculptured with concentric but irregular growth lines.

The Recent species *Margaritifera margaritifera* (LINNAEUS) resembles the present species but differs from the latter in having more rounded shell form and the beak is situated nearer to the central part of the shell length. The specimens are rather common in the tuffaceous medium grained sandstone (Loc. no. 1)

where they occur as intact or molds or casts of the isolated valve.

Locality and formation: Locality nos. 1, 2, Owada Formation.

Depository: IGPS coll. cat. no. 86892.

Margaritifera owadaensis NODA, n. sp.

Pl. 25, figs. 3a-c

Shell medium in size, transversely elliptical in form. Anterior border rounded and the posterior slightly narrowly rounded compared with the anterior. Ventral margin broadly arcuated. Dorsal margins not so convex. Shell surface sculptured with irregular growth lines, some slightly elevated and others of very fine striations. Beak situated at anterior one third of shell length, small and compressed. Inner features not available, but anterior muscle scar strongly impressed and situated near beak.

Shell 3.7 cm in length and 1.5 cm in height (holotype).

Comparison and affinities: The present new species is slightly deformed. It resembles *Margaritifera perdahurica* in shell form but differs from the latter in the degree of roundness at both sides of the shell.

Locality and formation: Locality no. 1, Owada Formation.

Depository: IGPS coll. cat. no. 86893 (Holotype).

Family Viviparidae GRAY, 1848

Genus *Viviparus* MONTFORT, 1810

Viviparus cf. *uryuensis* YOKOYAMA, 1932

Pl. 25, fig. 6

Compared with:

1932. *Viviparus uryuensis* YOKOYAMA, *Jour. Fac. Sci., Imp. Univ., Tokyo, Sec. 2,*

vol. 3, pt. 6, p. 236-237, pl. 1, figs. 8-9-1941b. *Viviparus uryuensis* YOKOYAMA, SUZUKI, *Ibid.*, vol. 6, pt. 2, p. 20-21, pl. 1, figs. 1-4.

The present species was originally described from the Tachibetsu Formation by YOKOYAMA in 1932. The species at hand is characterized by the rounded body whorl, swollen base, distinct suture but the upper whorls are not preserved. The specimen at hand somewhat resembles *Viviparus jimboi* SUZUKI from the Ishikari Series (SUZUKI, 1941c) but the latter has more swollen body whorl. *Viviparus kosasanus* UEJI described from the Sasebo Group in North Kyushu by UEJI in 1934 differs from the specimen at hand by being more shouldered at the sutural part and by the swollen periphery, though SUZUKI and OYAMA (1948) considered the species of UEJI (1934) to be a subspecies of *uryuensis*.

The species is rather rare in occurrence from the Formation.

Locality and formation: Locality no. 1, Owada Formation.

Depository: IGPS coll. cat. no. 86889.

References Cited

- ASANO, K. 1962, Japanese Paleogene from the view point of Foraminifera with descriptions of new species. (*in Japanese with English abstract*) *Contr. Inst. Geol. Palaeont., Tohoku Univ.*, no. 57, p. 1-32, pl. 1, figs. 1-2, tabs. 1-2.
- ENDO, S. 1931, Cenozoic plant fossils, in Iwanami Koza. 44 pp., Iwanami Shoten. (*in Japanese*).
- GRIFFITH, E. and PIDGEON, E., 1834, The Mollusca and Radiata, Cuvier's Animal Kingdom, vol. 12, p. 1-601, pls. 1-15. (*fide* KURODA, 1931).
- HASHIMOTO, W., 1950, Geology of the environs of the Kabato Massif, Part 1, On the base of the Upper Mizuho Tō in the

- Rumoi oil and coal fields (*in Japanese*). *Bull. Geol. Commit. Hokkaido*, no. 13, p. 1-8, 1 map, 1 table.
- HITOSUGI, T. and SASAKI, M., 1959, Geological map of the coal-fields of Japan III. Explanatory text of the Owada district, Rumoi coal field (*in Japanese with English abstract*). *Geol. Surv. Japan*, 28 pp.
- IJIMA, A., 1957, Preliminary note on the heavy mineral association of the Ishikari Series (Eocene-Oligocene) in the Ishikari, Kabato and Rumoi coal fields in Hokkaido, Japan. *Jour. Geol. Soc. Japan*, vol. 63, no. 737, p. 67-81, pl. 3, figs. 1-4, tabs. 1-3.
- IJIMA, A. and TANAI, T., 1955, On the heavy mineral association of the Ishikari Group, Part 1. Especially on the geologic age of the Kabato and Owada coal-bearing Formation (*Japanese abstract only*). *Jour. Geol. Soc. Japan*, vol. 61, no. 718, p. 332.
- IZUKA, Y. and UEMURA, M., 1919, Report of the geology of Rumoi and Tomamae oil and coal fields (*in Japanese*). *Min. Surv. Rep., Geol. Surv. Japan*, no. 76, p. 74-90, pl. 1.
- and — 1920, Report of the geology of the Rumoi coal and oil fields, Teshio Province (*in Japanese*). *Ibid.*, no. 30, p. 1-68, pls. 1-2, figs. 1-2, tabs. 1-10.
- JIMBO, K., 1890, Hokkaido Chishitsu Ryakuron (*in Japanese*). Hokkaido Prefecture, p. 1-94, pls. 1-7, figs. 1-24, tabs. 1-22 (*vide* SUZUKI, 1941c).
- KIRA, T. 1959. Coloured illustrations of the shells of Japan (*in Japanese*). Hoikusha, 23 pp., 71 pls.
- KOBELT, W., 1879, Fauna molluscorum extramarinorum Japoniae, nach den von Prof. Rein gemachten Sammlungen bearbeitet von. *Abhand. Senckenberg. Naturf. Gesel.*, vol. 11, p. 1-171, pls. 1-23. (*vide* KURODA, 1931).
- KURODA, T., 1931, An illustrated catalogue of the Japanese shells (*in Japanese*). *Venus*, vol. 2, no. 6, append. p. 27-76, figs. 43-93.
- NAGAO, T., 1933, Paleogene (*in Japanese*), Iwanami Koza, Iwanami Shoten, 120 pp.
- OHARA, S., 1966, Stratigraphy and geological structures of the Tertiary deposits in the Uryu coal-field, Hokkaido, Japan (*in Japanese with English abstract*). *Jour. Coll. Arts. Sci., Chiba Univ.*, vol. 4, p. 617-630, figs. 1-6, tabs. 1-2.
- and KAN'NO, S., 1969, Mid-Tertiary molluscan fauna of the Uryu coal field (*in Japanese*). *Fossils*, no. 17, p. 41-49, figs. 1-2.
- OMORI, M. and IBARAGI, N., 1966, On the fresh-water molluscan fauna collected from the Komoro Group, Nagano Prefecture (*in Japanese*). *Jour. Soc. Earthsci. Amat. Japan*, no. 17, p. 41-43, pls. 1-2, figs. 1-4.
- SASA, Y., 1938, On the stratigraphic position of the coal deposits in the Uryu coal fields in Hokkaido (*in Japanese*). *Trans. Hokkaido Coal-mining Soc.*, no. 291, p. 1-16, pl. 1.
- SUGAI, K., 1968, Geological maps of the coal fields of Japan VIII. Study on the stratigraphy and geological structure of Uryu-Rumoi coal fields, Hokkaido, Japan (*in Japanese with English abstract*). *Geol. Surv. Japan*, 61 pp.
- SUZUKI, K., 1941a, Some non-marine shells from the Oligocene Ishikari Series in the Ishikari coal-field, Hokkaido. *Jour. Fac. Sci., Imp. Univ., Tokyo, Sec. 2*, vol. 6, pt. 1, p. 1-11, pls. 1-2, figs. 1-2.
- 1941b, Notes on the Tertiary non-marine Mollusca from the coal-field of Uryu,

Baba-Tanzan-no-sawa	馬場炭山の沢
Ishikari	石狩
Jimbu	神武
Kumaneshiri	隈根知
Koura	古浦
Owada	大和田
Rumoi	留萌
Shimokine	下紀念

Shiroki	白木
Tappu	達布
Tachibetsu	太刀別
Togeshita	峠下
Yudoro	ユドロ
Yubari	ユバリ
Yubetsu	雄別
Wakkanappe	若鍋

- Hokkaido. *Ibid.*, vol. 6, pt. 2, p. 13-37, pls. 1-2, figs. 1a-b.
- 1941c, On the three Tertiary non-marine shells illustrated in K. JIMBO's "Hokkaido Tisitu Ryakuron (Geological sketch of Hokkaido), 1890". *Trans. Proc. Palaeont. Soc. Japan*, art. 138, p. 520-525, figs. 1-6.
- 1942, The Tertiary naids of Hokkaido in the collection of the Department of Geology and Mineralogy, Hokkaido Imperial University. *Japanese Jour. Geol. Geogr.*, vol. 18, no. 4, p. 141-156, pls. 18-19.
- 1944, Notes on some Tertiary non-marine Mollusca from North Nippon (*in Japanese with English abstract*). *Trans. Proc. Palaeont. Soc. Japan*, art. 181, p. 100-109, pls. 50-51.
- 1949, Development of the fossil non-marine molluscan faunas in Eastern Asia. *Japanese Jour. Geol. Geogr.*, vol. 21, nos. 1-4, p. 91-133, tabs. 1-23.
- and OYAMA, K., 1948, Fresh-water shells from the coal bearing Tertiary formations in Mie-ken, Japan (*in Japanese with English abstract*). *Venus*, vol. 15, nos. 1-4, p. 36-44, figs. 1-5.
- TAKAI, F., 1950, *Amynodon watanabei* from the Latest Eocene of Japan with a brief summary of the Latest Eocene Mammalian faunule in Eastern Asia. *Rep. Geol. Surv. Japan*, no. 131, p. 1-14, pl. 1, tabs. 1-2.
- TAKEDA, H., 1954, Geological interpretation of the Rumoi oil field (*in Japanese with English abstract*). *Jour. Japan. Assoc. Petrol. Tech.*, vol. 19, no. 5, p. 155-163, figs. 1-9.
- TANAI, T., 1956, On the geologic age of the Owada and Kabato coal-bearing formations in Hokkaido, Japan (*in Japanese with English abstract*). *Bull. Geol. Surv. Japan*, vol. 7, no. 1, p. 11-20, figs. 1-3, table 1.
- TSUSHIMA, K. and YAMAGUCHI, S., 1954, Explanatory text of the geological map of Japan, Scale 1:50,000, Rumoi (*in Japanese with English abstract*). *Geol. Surv. Japan*, 16 pp.
- UEJI, T., 1934, Fresh-water fossil molluscs from Kitamatsuura coal-field, Northern Kyushu, Japan (*in Japanese with English abstract*). *Venus*, vol. 4, no. 6, p. 341-350, pls. 5-7.
- YAMANE, S., 1912a, Report of the geology of Rumoi and Tomamae areas, Teshio Province (*in Japanese*). *Min. Surv. Rep., Geol. Surv. Japan*, no. 10, p. 1-84, pls. 1-2, figs. 1-2, tabs. 1-5.
- 1912b, Report on the geology of Rumoi and Tomamae areas, Teshio Province (*in Japanese*). *Ibid.*, no. 10, p. 85-122, pls. 1-3, figs. 1-2.
- YOKOYAMA, M., 1932, Tertiary Mollusca from the coal-field of Uryu, Ishikari. *Jour. Fac. Sci., Imp. Univ., Tokyo, Sec. 2*, vol. 3, pt. 6, p. 221-247, pls. 1-4.

Explanation of Plate 25

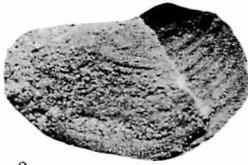
(All figures in natural size)

- Figs. 1, 2, 4, 5, 7, 13. *Unio uryuensis* SUZUKI, p. 238, Loc. no. 1, Owada Formation, IGPS coll. cat. no. 86890.
- Figs. 3a-c. *Margaritifera owadaensis* NODA, n. sp., p. 240, Loc. no. 1, Holotype, 3a: right valve, 3b: left valve, 3c: umbilical view, Owada Formation, IGPS coll. cat. no. 86893.
- Fig. 6. *Viviparus* cf. *uryuensis* YOKOYAMA, p. 240, Loc. no. 1, Owada Formation, IGPS coll. cat. no. 86889.
- Figs. 8a-b, 9, 11, 12. *Margaritifera perdahurica* YOKOYAMA, p. 239-240, Loc. no. 1, Owada Formation, IGPS coll. cat. no. 86892.
- Fig. 10. *Lanceolaria pisciformis* (YOKOYAMA), p. 238-239, Loc. no. 1, Owada Formation, IGPS coll. cat. no. 86891.

(All specimens are preserved in the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, Sendai, Japan)



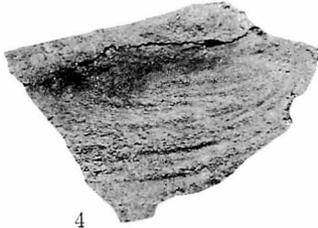
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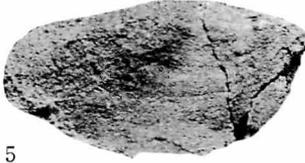
2



3a



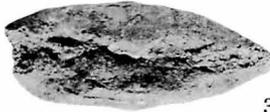
4



5



3b



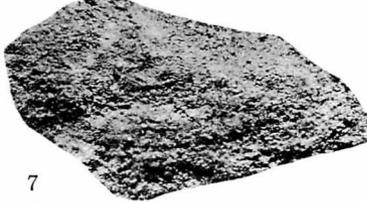
3c



8a



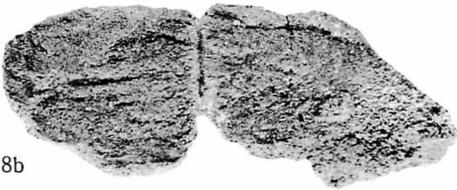
6



7



9



8b



10



11



12



13

564. *HALOBIA STYRIACA*, UPPER TRIASSIC PELECYPOD,
DISCOVERED IN OKINAWA-JIMA, THE RYUKYU ISLANDS*

TEIICHI KOBAYASHI

University of Tokyo

and

TAKASHI ISHIBASHI

Department of Geology, Kyushu University

琉球沖縄に於ける三畳紀斧足類 *Halobia styriaca* の発見：石橋が沖縄島本部半島で発見した化石のうちに *Halobia styriaca* があった。*Styriaca* group のハロビアはカーニック階特産であり、*Halobia styriaca* は同階下部に特徴的な種であるので、琉球の *styriaca* 層準も同時代と考えられる。この種はアルプス地方からインドネシアの間に分布していた事が判っていたが、この発見でこのテチス種が沖縄まで拡っていた事が判った。

小林貞一・石橋 毅

It was some years ago that new fossil localities were discovered in the Nakijin Formation by the junior author (1969) at Nakijin and Kamimotobu villages, Motobu peninsula, Okinawa-jima and a small lot of fossils was submitted the senior author through Dr. KONISHI for identification. As the preliminary observation has already been reported in the 94th meeting of the Palaeontological Society of Japan at Akita, 1966, it included *Halobia styriaca* and a few other pelecypods.

The *styriaca* horizon is definitely Carnic and most probably lower Carnic in age, because the known occurrences of the *Halobia styriaca* group are exclusively in the Carnic stage and *Halobia styriaca* as a species is typical of the lower Carnic fauna. The discovery of such an

Upper Triassic fossil beds in Okinawa is indeed an important addition to the stratigraphic column of the Ryukyu islands.

Setting aside obscure occurrences in a few places of the Pacific province, the distribution of the *styriaca* group has so far been restricted to the region from the Alps to Indonesia. Therefore the Okinawa *styriaca* indicates the eastern limit of the distribution of this Tethys species.

Since that time the junior author found additional new localities and greatly amplified the collection of pelecypods, ammonoids and other fossils by repeated explorations so much that it requires more time to be worked out. Therefore only *Halobia styriaca* is described here as an advanced report.

Here the authors record their best thanks to Professor Kenji KONISHI of

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the Kanazawa University for his courtesy and assistance which they received in connection with this study.

Family Halobiidae KITTL

Genus *Halobia* BRONN

The *Halobia styriaca* Group

KITTL (1912) classified *Halobia* species into 11 groups. The *styriaca* group is one of them having the round or oval outline of the shell, scarcely prosogyral umbo, simple flat anterior ear, indistinct or flattened posterior triangular field and radial ribs broad, simple generally and sometimes once bifurcated, but twice bifurcation is rare. He referred the following 10 species to the *styriaca* group:

Halobia areata KITTL: North Alps, Carnic.

Halobia arthaberi KITTL: North Alps, upper (?) Carnic.

Halobia beyrichi (MOJS.): North Alps, Carnic.

Halobia bosniaca KITTL: Dinarid, Carnic.

Halobia landlensis KITTL: North Alps, Carnic.

Halobia (?) *lenticularis* (GEMM.): Italy (Basilicata and Sicily), North Alps (?), lower Carnic.

Halobia (?) *lepsiusi* (GEMM.): North Alps, Carnic.

Halobia marmorea KITTL: North Alps, lower Carnic.

Halobia (?) *richthofeni* (MOJS.): South Alps, lower Carnic (St. Cassian).

Halobia styriaca (MOJS.): North Alps, Hungary, Roumania (Dobrudscha), Dinarid (Bosnia, Dalmatia), Greece, Sicily, Indonesia (Timor, North Sumatra), lower Carnic.

The distribution of the above species

is written here with reference to not only KITTL's (1912), but also later publications. (See DIENER, 1923, KUTASSY, 1930, KOBAYASHI and MASATANI, 1968). All of them were described from the Carnic stage of the Alps and the Mediterranean region or Southeast Europe except for the isolated occurrences of *H. styriaca* in Indonesia (VOLZ, 1899, KRUMBECK, 1921, 24, WANNER, 1931).

Halobia cf. *styriaca* and *H. aff. styriaca* are known to occur respectively at Basilica, Italy and the Himalaya (DIENER, 1908). Of *H. cf. styriaca* from the Malayan frontier of Thailand (KOBAYASHI and TOKUYAMA, 1959), CHEN (1964) identified it with *Halobia substyriaca* nov. from the Carnic of Western Szechuan.

Halobia styriaca has once been reported by PIROUTET (1908) from the isle of Sonde, New Caledonia in association with *Halobia kwaluana* in the basal part of the Upper Triassic formation, but no palaeontological work has since been published of the species. ARTHABER suggested the possible occurrence of the same species in Mexico, but this suggestion has presumably been derived from the confusion of the species with *H. austriaca* (FRECH, 1907, KITTL, 1912).

KITTL (1912, p. 94) quoted that "Die Art (*H. styriaca*) ist geradezu ein Leitfossil für die unterkarnischen Schichten." In North America *Halobia arthaberi* and *H. aff. lepsiusi* were reported to occur in western Canada in the lower Noric stage (TOZER, 1961, McLEARN, 1960), but a further information is needed to confirm their specific identification.

Halobia styriaca (MOJSISOVICS)

Pl. 26, figs. 1-10, text-figs. a, b.

1874. *Daonella styriaca* MOJS. *Abhandl. k. k. geol. R.-Anst., Bd. 7, p. 10, pl. 1, figs.*

- 4-5.
1899. *Daonella styriaca* VOLZ, *Zeitschr. deutsch. geol. Gesell.*, Bd. 51, p. 27, pl. 1, fig. 1.
1906. *Daonella styriaca* RENZ, *Neues Jahrb. f. Min. etc.*, 1906, I, p. 30, pl. 3, figs. 1-2, non 3.
1907. *Daonella styriaca* WANNER, *Neues Jahrb. f. Min. etc.*, Beil. Bd. 24, p. 194, pl. 9, fig. 3.
1912. *Halobia styriaca* KITTL, *Result. wiss. Erforsch. Balaton-Sees*, 1 Bd., 1 Th. Pal. Bd. 2, p. 9, pl. 6, figs. 3-7.
1924. *Halobia styriaca* KRUMBECK, *Palaeont. von Timor, Lief. 13*, p. 132, pl. 9, fig. 8, pl. 10, figs. 1-6.
1925. *Halobia styriaca* DIENER, *Leitfossilien*, 4 Lief. p. 27, text-fig. 5.
1930. *Halobia styriaca* KUTASSY, *Foeldtani Koezleony*, Bd. 60, p. 205, pl. 3, fig. 2.

None of the specimens before hand shows a complete outline of the shell, but evidently it is fairly tall and nearly equilateral. The umbo is located sub-medially, but a little anteriorly, moderately convex, slightly projected above the hinge margin and apparently shorter than the shell-length. The proportional height to the length is not exactly determinable, because all specimens are deformed.

The anterior ear is very flat and smooth, but it is not clearly separated from the inflated main part of the shell. Therefore it appears very indistinct, when the shell is flattened. The posterior triangular area is narrower than the ear and ill-defined. There radial sculptures are obscure or absent.

Some concentric grooves or folds are well marked in the umbonal one-third or one-fourth of the shell which is more inflated than the remaining part. They are generally stronger on the posterior lateral side. Additional concentric folds or geniculations are occasionally met with in grown stages. Radial ribs are

obscure in the umbonal part where the concentric sculptures are strong. Some 15 to 20 ribs are countable in the median part of the shell in the middle stage of growth. They are very broad, flat, straight and separated from one another by narrow grooves. Some posterior ribs are, however, slightly arcuate with backward convexity. These ribs are partly bifurcated and very rarely even twice bifurcated by insertion of similar narrow grooves.

Figure 2 and 1 are respectively an external mould of a left valve and its rubber cast respectively. It measures 19 mm in height and its outline is thought less deformed than other specimens. The shell is nearly as long as high; umbo almost median and only a little projected above the hinge margin which is straight and horizontal in front of the umbo, but the margin is gradually descending behind the umbo and more distinctly slant than in other specimens. The other margins are well rounded. The shell is gently inflated and the convexity is strengthened in the umbonal region where some 10 concentric folds are regularly disposed. The anterior ear is simple, depressed and flat, but somewhat thickened at the hinge margin. The preumbonal angle of the ear is about 20 degrees.

The *Posidonia* or *Bositra* stage transmits into the *Halobia* stage at the height of about 7 mm. Radial ribs are broad, flattopped and separated from one another by narrow grooves, some of which are bifurcated by insertion of a groove. Anterior ribs are straight, while posterior ones are gently arcuate with backward convexity. About 20 ribs are countable near the ventral margin, but on the lateral sides of the shell the ribbing becomes obsolete.

The left valve in fig. 3 which is 50

mm long is nearly full mature. The height of this shell appears somewhat reduced secondarily. Some 23 ribs are countable along the ventral margin in the main middle part which forms an umbonal angle of 130 degrees.

In the specimen in fig. 4 two valves are disposed almost rectangularly and strongly deformed in a diagonal direction. The upper and lower shell in the figure are respectively narrowed or shortened secondarily. The radial and concentric sculptures which are rectangular to the direction of compression are strongly emphasized whereas those parallel to the direction are obscured.

The left valve in fig. 6 is compressed diagonally as can be judged from its outline as well as distinct concentric striae in the posterior portion which are otherwise generally imperceptible.

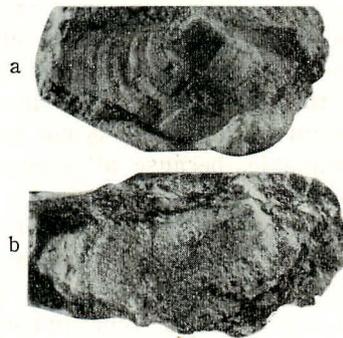
The shells in figs. 5 and 7 are laterally compressed with the result it is seen that the length of the shell is quite reduced and the radial ribs and grooves are strengthened. Due to secondary emphasis of inserted grooves the ribs appear denser in these shells than in those in figs. 1 and 2. In fact they are countable about 30 in the specimen in fig. 7.

The above specimens were all collected at the ruin of the Nakijin castle. The specimen in fig. 8 which was obtained at Motobu high school is similarly compressed laterally, so that the shell looks tall and the ribs are densely populated. The figures 9 and 10 show the umbonal region of two specimens from the second locality which are not much deformed. They agree well in outline and sculpture with the shell from the first locality in figs. 1 and 2 which is also almost undeformed.

In the authors' opinion two small specimens from Motobu high school illus-

trated here are immature shells of this species. Radial ribs are absent in the right valve, 12 mm long (text-figure a). It is fairly convex and the anterior ear clearly defined by a shallow groove. Its concentric sculpture consists of broad folds separated by narrow grooves and finer grooves on the folds. These concentric sculptures are stronger on the posterior than the anterior side where only the growth striae are visible. On the anterior side they are abruptly bent backward near the hinge margin. The right valve in fig. 9 represents the next stage of growth in which radial ribs appear in the middle and anterior portions. A few radials are already bifurcated.

Another small right valve in text-fig. b is exceptionally attached with the counter valve. The surface sculpture is, however, ill-preserved in this specimen.



Text-fig. a. Rubber cast of a small right valve; HMO. $\times 3$

Text-fig. b. Rubber cast of a small right valve attached with the counter valve; HMO. $\times 2\frac{1}{2}$.

In the outline of the shell, position of the umbo and particularly in the aspects of concentric and radial sculptures this Okinawa form fits nicely with the group of *Halobia styriaca* by KITTL and especially with *Halobia styriaca*. It is closer

to *H. styriaca* than *H. areata* KITTL which the latter was synonymized with the former by KRUMBECK (1924). Because the ear of this species is not always distinctive, it has originally been placed by MOJSISOVICS in *Daonella*. It has been accepted by some others until KITTL transferred it to *Halobia*.

Daonella cassiana MOJSISOVICS is a common associate with *Halobia styriaca* with which it was confused by RENZ (1906) and others. Like *Daonella styriaca* MOJSISOVICS, *D. cassiana* was transferred later into the genus *Halobia* by KRUMBECK (1924). *Halobia cassiana* redefined by KRUMBECK differs from *H. styriaca* in having a more anterior umbo, longer shell expanded postero-ventrally and radial ribs much more numerous in comparison with *H. styriaca*. He included *Halobia arthaberi* KITTL in his *H. cassiana*. Incidentally, KRUMBECK erected *Daonella kittli* to include *Daonella cassiana* by BITTNER (1895) and KITTL (1912).

Halobia cassiana (MOJS.) var. *yunnanensis* REED (1927) from the Upper Triassic of Yunnan is represented by a few deformed specimens which look more likely a member of the *H. austriaca* group rather than the *H. styriaca* group. *H. yunnanensis* may be a close ally to *Halobia kwaluana* VOLZ of the former group.

Finally, *Halobia tobensis* KOBAYASHI and MASATANI (1968) from the Carnic of Sumatra has the outline of the shell and some other aspects resembling this species, but it fits better with the *H. austriaca* group in the mode of ribbing.

Occurrence:—Dark grey siltstones of the Nakijin formation at localities, HMO and HNa-P.

HMO: Motobu high school, Motobucho, Okinawa.

HNa-P: 200 m west of the ruin of the

Nakijin castle, Nakijin-son, Okinawa.

This is the eastern most occurrences of *Halobia styriaca* because its known distribution has been in the lower Carnic beds from the Alps to Indonesia.

References

- BITTNER, A. (1895): Lamellibranchiaten der Alpine Trias. *Abh. k. k. geol. Reichsanst.*, 10 (1).
- CHEN, Chu-chen (1964): On the Occurrence of *Halobia* Fauna from the Ganzi Region, West-Sichuan (Szechuan) and its Significance. *Acta Pal. Sinica*, vol. 12, no. 1.
- DIENER, C. (1908): Ladinic, Carnic and Noric Fauna of Spiti. *Palaeontol. Indica, Ser. 15*, Vol. 5, Mem. No. 2.
- (1923): Lamellibranchiata triadica. *Fossilium Catalogus 1, Animalia*, Pars 19.
- (1925): Leitfossilien der Trias. *Wirbellose Tier und Kalkalgen*. G. GÜRICH'S *Leitfossilien*, 4te Lief.
- FRECH, F. (1907): Ueber Aviculiden von Palaeozoikum Habitus aus der Trias von Zacatecas. *Compte Rendu de la Xeme Session Confrères géologique intern. Mexico, 1906. Ier Fasc.*
- ISHIBASHI, T. (1969): Stratigraphy of the Triassic Formation in Okinawa-jima, Ryukyu. *Mem. Fac. Sci. Kyushu Univ., Ser. D, Geology*, Vol. 19, No. 3.
- KITTL, E. (1912): Materialien zu einer Monographie der Halobiidae und Monotidae der Trias. *Result. wiss. Erf. Balatonsees*, 1 Bd. Th. Pal. Bd. 2.
- KOBAYASHI, T. and MASATANI, K. (1968): Upper Triassic *Halobia* (Pelecypoda) from North Sumatra with a Note on the *Halobia* Facies in Indonesia. *Japan. Jour. Geol. Geogr.*, Vol. 39, Nos. 2-4.
- and TOKUYAMA, A. (1959): The *Halobiae* from Thailand. *Jour. Fac. Sci., Univ. Tokyo, Sec. 2*, Vol. 12, Pt. 1.
- KRUMBECK, L. (1924): Die Brachiopoden, Lamellibranchiaten und Gastropoden der Trias von Timor, 2. *Palaeontol. von Timor*, Lief. 13.
- KUTASSY, A. (1928): Die Ausbildung der

- Trias im Moma Gebirge (Ungaren-Siebenbürgen). *Centralbl. f. Min. etc. Jahrg. 1928*, Abt. B, No. 5.
- (1930): Triadische Fossilien von Portugiesischen Timor. *Foetzldtani Koezloeny*, Bd. 60.
- (1931): Lamellibranchiata triadica, 2. *Fossilium Catalogus, 1, Animalia*, Pars 51.
- MCLEARN, F.H. (1960): Ammonoid Faunas of the Upper Triassic Pardonat Formation, Peace River Foothills, British Columbia. *Geol. Surv. Canada*, Mem. 31.
- MOJSISOVICS, E.V. (1874): Ueber die Pelecypodengattungen *Daonella* und *Halobia*. *Abhandl. geol. Reichsanst.* 7 (2).
- PIROUTET, M. (1908): Note sommaire sur le Trias de la Nouvelle Calédonie. *Bull. Soc. géol. France, 4 Sér.*, t. 8.
- REED, F.R.C. (1927): Palaeozoic and Mesozoic Fossils from Yunnan. *Pal. Indica, N.S.*, Vol. 10, No. 1.
- RENZ, C. (1906): Ueber Halobien und Daonellen aus Griechenland nebst asiatischen Vergleichstücken. *Neues Jahrb. f. Min. etc. Jahrg., 1906*, Bd. 1.
- TOZER, E.T. (1961): The Sequence of Marine Triassic Fauna in Western Canada. *Geol. Surv. Canada*, Paper 61-6.
- VOLZ, W. (1899): Beiträge zur geologischen Kenntniss von Nord-Sumatra. *Zeitschr. deutsch. geol. Gesell.*, Bd. 51.
- WANNER, J. (1907): Triaspetrefakten der Mollukken und des Timorarchipels. *Neues Jahrb. f. Min.* Bd. 24.
- (1931): Mesozoikum. *Leidsch geologische Medd.*, Deel 5.

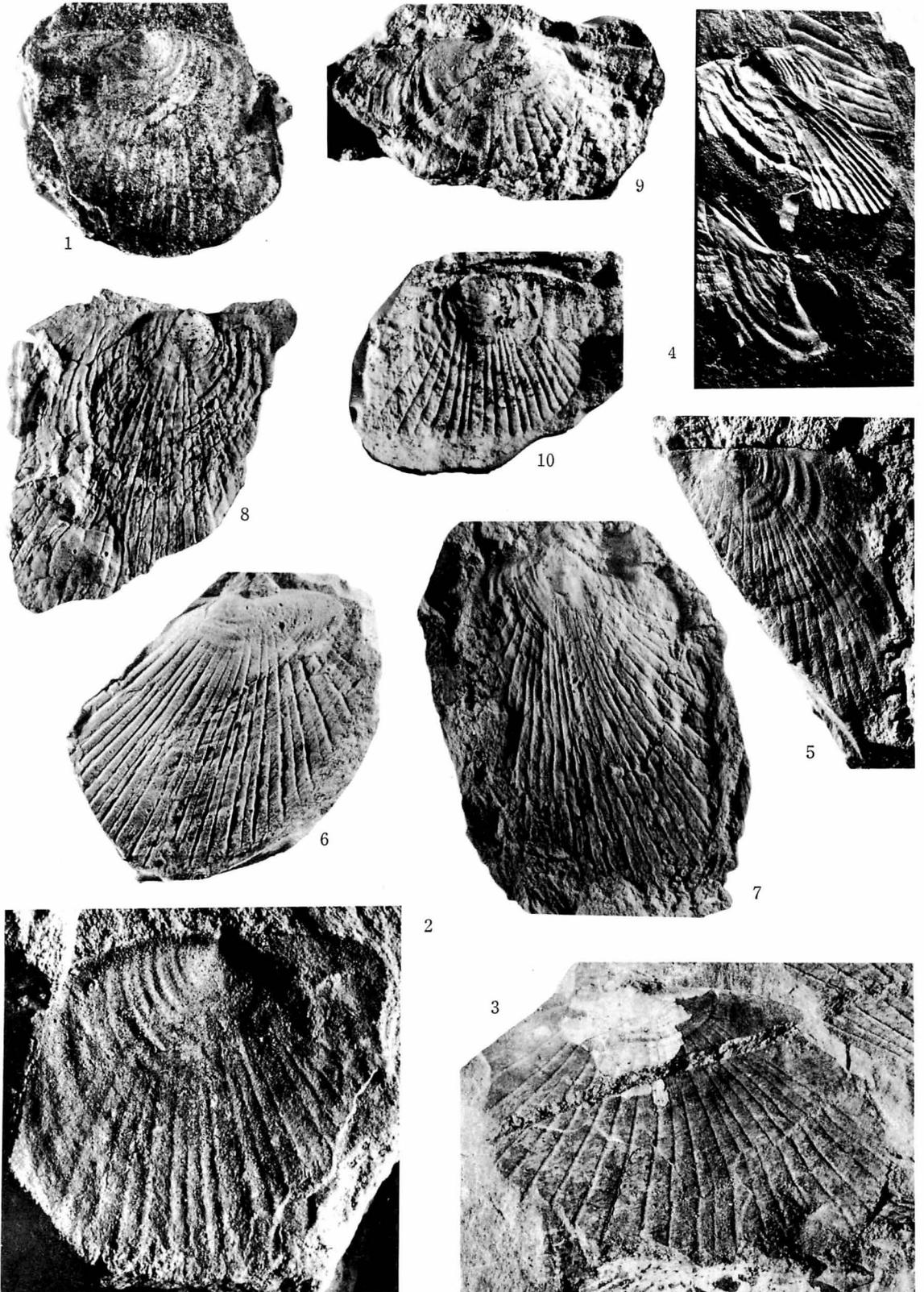
Explanation of Plate 26

Halobia styriaca (MOJSISOVICS) from Okinawa, Ryukyu Islands

Loc. HNa-P: 200 m west of ruin of Nakijin castle, Nakijin-son, Okinawa.

Loc. HMO: Motobu high school, Motobu-cho, Okinawa.

- Fig. 1. Rubber cast of a left valve from HNa-P. $\times 2$
- Fig. 2. External mould of the same valve as the preceding. $\times 3$
- Fig. 3. A left valve cut by a vein; HNa-P. $\times 1\frac{1}{2}$
- Fig. 4. Two deformed valves disposed almost rectangularly; HNa-P. $\times 1\frac{1}{2}$
- Fig. 5. Internal mould of a left valve laterally compressed; HNa-P. $\times 1\frac{1}{2}$
- Fig. 6. Rubber cast of a left valve diagonally compressed; HNa-P. $\times 1\frac{1}{2}$
- Fig. 7. Rubber cast of a left (?) valve laterally compressed; HNa-P. $\times 1\frac{1}{2}$
- Fig. 8. Rubber cast of a right valve laterally compressed; HMO. $\times 2$
- Fig. 9. Rubber cast of a right valve; HMO. $\times 1\frac{1}{2}$
- Fig. 10. Rubber cast of a left (?) valve; HMO. $\times 2$.



PROCEEDINGS OF THE PALAEOONTOLOGICAL SOCIETY
OF JAPAN

日本古生物学会第 103 回例会及びシンポジウムは、1969 年 11 月 29 日(土)~12 月 1 日(月)の 3 日にわたって 鹿児島大学 理学部地学教室を会場として開催された(参加者 70 名)。

個人講演

- On the distribution of *Dictyozamites* and its palaeobotanical significance KIMURA, T.
底生有孔虫群集の種間関係の解析法 — 特にすみわけ・ともずみ現象の解析について .. 小沢智生
Ahermatypic corals from the Pleistocene Ninomiya Formation in Kanagawa Prefecture, central Japan HAMADA, T.
Discovery of *Calceola* from the Fukuji Series, Gifu Prefecture, Japan HAMADA, T.
サルボウ類の放射肋本数 岩崎泰穎
Fossil Mollusca from Teshima, Shodo-gun, Kagawa Prefecture, Southwest Japan (代読) SAITO, M., BANDO, Y. & NODA, M.
掛川貝化石群の変遷(その 2) — *Suchium suchiense*, *S. s. subsuchiense* への変化 — 土 隆一
Molluscan fauna of the Kukinaga Group in Tane-ga-shima, South Kyushu, Japan HAYASAKA, S.
日本産上部白亜系グリケミスについて 田代正之
A review of some Cretaceous corbiculids in North America OTA, Y.
The hinge structure of *Trigonoides*, with description of *Trigonoides mifunensis* sp. nov., from upper Cretaceous Mifune Group, Kumamoto Prefecture, Japan TAMURA, M.
中生代の“浮游性”二枚貝について ... 速水 格
アロメトリーの見地からみた 2 変数形質の変異 松隈明彦・速水 格
Halobia styriaca (MOJSISOVICS), upper Triassic pelecypods, discovered in Okinawa-

- jima, the Ryukyu Islands KOBAYASHI, T. & ISHIBASHI, T.
Upper Triassic ammonites from Okinawajima, Ryukyus ISHIBASHI, T.
上部白亜紀アンモナイト Barroisiceratinae の分類系統 松本達郎
鹿児島県文化センターに寄贈された小川勇吉氏収集のアンモナイト 松本達郎・大塚裕之
Permian brachiopods from Khao Phrik, Thailand (代読) YANAGIDA, J.
南西北海道産中新世苔虫類 速水 俱子
Addition to the Permian Bryozoa from Komuk, Peninsular Thailand SAKAGAMI, S.
北海道 渡島半島上磯石灰岩のコンドントの地質時代の考察 坂上澄夫・南川純夫
Elaphurus shikamai OTSUKA の第二の標本について 大塚裕之

シンポジウム「九州の第四系」は日本地質学会西日本支部と共催により、11 月 30 日(日)に行われた。(世話人・早坂祥三・首藤次男)

- 北部・東部九州の第四系 亀山徳彦
北九州の第四紀火山層序 松本従夫
有明海周辺第四系の層序と花粉群集 ... 高橋 清
有明海海底および周辺におけるコアの珪藻層序学的研究 — とくに縄文海進の問題 — .. 林 行敏
宮崎の第四系 遠藤 尚
鹿児島市北部第四系貝化石層の層序関係 大木公彦・早坂祥三
南九州のシラスについて .. 種子田定勝・宮地六美
九州の第四紀脊椎動物群 大塚裕之
南西諸島第四系の放射年代学 大村明雄・小西健二
対馬海峡の底質と有孔虫 氏家 宏
九州西方海域の海成堆積物中の生物遺骸群集 .. 鎌田泰彦
総括

12 月 1 日(月)には、地質巡検「鹿児島湾北部周辺の第四系」が舉行された。(案内者 露木利貞・早坂祥三・大塚裕之・大木公彦)

日本古生物学会 1970 年総会・及び年会は、1970 年 1 月 19 日(月)・20 日(火)の両日、新装成った仙台市青葉山の東北大学理学部地質学・古生物学教室で行われた(参加者 55 名)。

海外学会出席報告

North American Paleontological Convention,
1969.....鹿間時夫・棚井敏雅

解説講演

個体変異解析の問題点と方法.....速水 格

個人講演

- Evolution and classification of Sphenophylales in upper Paleozoic Cathaysia Flora.....ASAMA, K.
- Some palynomorphs from the upper Cretaceous sediments of Hokkaido.....TAKAHASHI, K.
- Evolutionary trend of *Acer* in East Asia and North America.....TANAI, T.
- Miocene coccolithophorids from Noto, Japan.....NISHIDA, S.
- Nannofossils from the Nobori and Ananai formations, Shikoku, Japan ..NISHIDA, S.
- 太平洋赤道地域の深海 コアの珪藻層序と古地磁気層序との関係について(予報)....金谷太郎
- Miocene Foraminifera from the Sandakan formation, North Borneo.....UJIIÉ, H.
- Cluster analysis of living planktonic assemblages in the Southeast Indian Ocean ..NAGASE, K. & UJIIÉ, H.
- On some species of Thecosphaera from the Neogene formations, Japan.....NAKASEKO, K.

- On the *Spongoplegma antarcticum* HAECKEL.....NAKASEKO, K.
- 新潟県北部の新第三系放射虫化石について.....中世古幸次郎・家田享一
- Radiolarian fossils from the Oidawara formation in Gifu Prefecture, Japan.....IEDA, K.
- An interesting species of *Colania* from the Rat Buri Limestone, central Thailand.....OZAWA, T., KANMERA, K. & TORIYAMA, R.
- Recent and fossil *Rapana* from the Pacific coast of North America.....KANNO, S.
- Note on the molluscan assemblage in Usuki Bay, Kyushu.....SHUTO, T.
- Lower Triassic ammonoids from the Kitakami Massif.....BANDO, Y.
- Uncommon keeled ammonites from the upper Cretaceous of Hokkaido and Saghalien.....MATSUMOTO, T.
- Early Devonian brachiopods from the Lesser Khingan district of Northeast China....HAMADA, T.
- Occurrence of marine reptile bones from the upper Cretaceous Futaba Group.....OBATA, I. & HASEGAWA, Y.
- A new elasmosaur from the upper Cretaceous Futaba Group.....HASEGAWA, Y. & OBATA, I.
- フィッシュン・トラック法による現生シャコ貝中のウランの偏在について.....大村明雄・中西 孝
- 現生・化石軟体動物における $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ の異種間および同種間の変動について.....中道 修・小西健二・酒井 均

研究集会「化石中の同位体」は 1 月 20 日午後 2 時 30 分より開催された。(世話人 高柳洋吉・浜田隆士)

学会記事

- ◎ 1970 年度よりの入会者(1970 年 1 月 18 日の評議員会で承認) 普通会員 13 名, 在外会員 12 名(敬称略) 猪郷久治, 今井豊二, 加藤道雄, 丸山文男, 増田富士雄, 三木 孝, 村松憲一, 寺地雅美, 山崎良雄, 柳沢 学, 岡藤五郎, Lloyd H. BURCKLE, Ferreira SOARES, 白石成美, 酒井豊三郎
- ◎ 1969 年度中に逝去された会員 3 名(敬称略) 名誉会長 矢部長克, 特別会員 遠藤隆次, 会員 植松健児
- ◎ 1969 年度中の退会者 9 名(敬称略) 小川勇二郎, 小島伸夫, 松村 稔, 畠田昌幸, 久住久吉, 岩本寿一, 盛園尚孝, 小野山邦子, 島 糺

- ◎ 1970年1月18日の評議員会に於いて、次の7名の諸君が特別会員に推薦された(順不同敬称略)。
岩井武彦, 小林巖雄, 水野篤行, 中野光雄, 岡本和夫, 大森昌衛, 魚住 悟
- ◎ 1970年1月18日の評議員会に於いて遠藤誠道君が名誉会員に推薦された。
- ◎ 学会誌論文賞が, 1970年度総会の席上, 青木直昭君の“Benthonic Foraminiferal Zonation of the Kazusa Group, Boso Peninsula”に対して贈られた。
- ◎ 1970年度の学術奨励金は高橋清君(花粉・孢子化石の研究)および加藤 誠君(古生代サンゴ化石の研究)に対して贈られた。
- ◎ 1970年度より会費が下記のように変更され, それに伴って会則の当該部分が改訂された(1970年度総会で決定)

	旧 会 費	新 会 費
一 般 会 員	年 1,000 円	年 1,500 円
在 外 会 員	年 4 米ドル	年 7 米ドル
特 別 会 員	年 1,500 円	年 2,200 円

- ◎ 報告紀事出版規定の一部が下記のように改訂された(1970年度総会で決定)。
投稿規定 5.
挿図は 10 個 合計 60 坪 (1 坪は 1 平方寸)→挿図は 10 個 合計 600 cm²
同 上 7.
挿図は 2 個 合計 18 坪→挿図は 2 個 合計 200 cm²
なお, 規定を超過する分については, 従来通り実費を著者負担とするが, 本年度のおよその費用は, 本文 1 頁につき 2000 円, 1 図版につき 8000 円, 凸版は 1 個最低 300 円 (50 cm²), それ以上 1 cm² につき約 8 円である。
- ◎ 先に公募した特別号 No. 15 の原稿は, 1970年1月18日の評議員会で審議の結果, 申込みのあった浜田隆士君の“Early Devonian Brachiopods from the Lesser Khingan District of North-east China”を採択と決定, 文部省の刊行助成金を申請中で, 本年中に出版の予定である。

日本古生物学会特別号の原稿募集

PALAEONTOLOGICAL SOCIETY OF JAPAN, SPECIAL PAPERS NUMBER 16 を 1971 年度に刊行したく、その原稿を公募します。適当な原稿をお持ちの方は、次の事項に合わせて申込書を作成し、福岡市箱崎町九州大学理学部地質学教室気付、日本古生物学会特別号編集委員会（代表者 松本達郎）宛に申し込んで下さい。

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- (4) 申込締切 1970 年 11 月 15 日（消印有効）。採否は 1971 年 1 月の評議員会で審議決定の上申込者に回答の予定です。ただしその前または後に、申込者との細部の交渉を、編集委員から求めることがあるかもしれません。
- (5) 印刷予定論文が完全な場合には、決定後できるだけ早く印刷にとりかかる予定です。文部省の刊行助成金（「研究成果刊行費補助金」）を申請希望の場合には、学会から申請（例年は 1 月中旬中に申請締切）し、その採否・金額など決定後印刷にとりかかります。その場合は文部省との約束により、その年の秋（前例では 11 月 20 日）までに初校が全部出なければ、補助金の交付が中止されることになっています。
- (6) 特別号の投稿規定はとくにありません。会誌に準じ、前例を参考とし、不明の点は編集委員会に問い合わせして下さい。経費がかかるので、特別な場合を除き、別刷は作成せず、本刷 25 部を著者に無料進呈します。それ以上は購入（但し著者には割引）ということになります。いくつかの論文を集めて 1 冊にするときには、世話人の方から指示して、体裁上の不統一のないようにして下さい。印刷上の指示事項が記入できるよう、原稿の左右両側・上下に十分空白をとって、タイプを浄書して下さい。

例 会 通 知

	開 催 地	開 催 日	講 演 申 込 締 切 日
104 回 例 会	茨 城 大 学	1970 年 6 月 27 日	1970 年 5 月 10 日
105 回 例 会	国立科学博物館	1970 年 9 月 下旬	1970 年 8 月 10 日
106 回 例 会	広 島 大 学	1970 年 11 月	
1971年 総会・年会	東 京 大 学	1971 年 1 月	
107 回 例 会	関 西 地 区	1971 年 6 月	

NEWS

- ◎ 本号の付録として、Index of Transactions of the Palaeontological Society of Japan, Article No. 1 to No. 515 を発行し、会員に配布することとなった。
- ◎ 特別号 No. 14, The Litho- and Bio-facies of Carbonate Sedimentary Rocks, A Symposium が 1969 年 11 月 25 日に発行された。定価 2000 円、会員は 1 年の間 1700 円。
- ◎ 化石 18 号が、1969 年 10 月に発行された。内容は、「新生代貝類化石群の時空分布」特集その他である。
- ◎ 第 24 回万国地質学会議は、1972 年 8 月 21~30 日 Canada, Montreal で開催される。連絡先は、Secretary-General, 24th International Geological Congress, 601 Booth Street, Ottawa 4, Ontario, Canada.
- ◎ 三菱財団より昭和 45 年度自然科学研究助成募集について照会があった。1 件 3 千万円以内、約 15 件を採択。期間は原則として 1 年。応募希望者は、東京都千代田区丸ノ内 2-6-2。丸ノ内八重洲ビル 309 号室、財団法人 三菱財団あて、応募要項および用紙を請求されたい。応募締切は、昭和 45 年 5 月 31 日。
- ◎ 底棲生物研究推進のために、ベントス研究会が発足した。会費は当分の間 800 円。連絡先は熊本県天草郡苓北町富岡、九大臨海実験所内ベントス研究会。

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