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376. ON THE FOSSIL BEECH LEAVES FROM THE NINGYO-TOGE AREA, IN CHUGOKU DISTRICT, JAPAN*

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中国地方人形峠産のブナ化石葉について：　岡山・鳥取県境の人形峠附近には、かなり有望なウラン鉱床が発見されて多くの注目を浴びている。この附近に発達する第三系からは保存の極めてよい植物化石が多産するが、ことにブナの化石葉は産出した全個体数の約50%をしめ、この化石植物群の組成は現在の本邦におけるブナ林の植生に近似している。これらのブナ化石葉の大部分（340個）は、奥津春生が仙台附近の中新統上部から記載した *Fagus palaeocrenata* に同定される。筆者はこれらの多数のブナ化石葉の中で、比較的保存のよい125個について葉形指数・側脈数などを測定し、現生のブナの葉についての同様なる計測値などと比較・検討して、この *F. palaeocrenata* と各種の現生ブナとの類縁性について論じた。　棚井敏雅

Tertiary sediments distributed in the Ningyô-tôgé area on the border between Tottori and Okayama Prefectures, are now recognized to contain one of the promising minable uranium-bearing ores in Japan. These sediments cover the pre-Tertiary sediments and granitic rocks with an unconformity, of which latter the so-called "Chûgoku peneplain" is made up. Tertiary sediments seem to be of terrestrial origin; they are divided into four formations—namely, the Mitoku, Onbara, Ningyô-tôgé and Takashimizu formations in ascending order. Except for the last, these formations contained a good quantity of plant fossils. In this fossil flora, named the "Hôki flora", fossil beech leaves are abundantly contained; they occupy about 50 per cent of the total 689 specimens of the flora. Nearly all of these beech leaves are fairly identical to *Fagus palaeocrenata* OKUTSU, which was recently described from Late Miocene flora near Sendai, Japan. In this paper the writer reports his investigation of the variation of some leaf characters in these fossil materials, and also presents a consideration of the morphological resemblance between this fossil species and its related living species.

The Hôki flora consists of three florules; the Mitoku, Onbara and Ningyô-tôgé florules. The relative abundance of *Fagus palaeocrenata* in these florules, as estimated from respective total determinable specimens, is shown as follows:

Table 1. Relative abundance of *Fagus palaeocrenata* in the Hôki flora.

Florule	Specimens of *F. palaeocrenata*	Percentage for the total specimens	Total specimens of each florule
Mitoku	51	25.0%	204
Onbara	117	46.4	252
Ningyô-tôgé	172	71.0	242
Total	340		698

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* Received Feb. 4, 1959; read Feb. 14, 1959.

The floral composition and physical condition of these florules are discussed in detail in another paper (TANAI and ONOE, 1960. in press). Concerning the geologic ages of them, the Mitoku florule is Late Miocene, the Onbara is Mio-Pliocene, and the Ningyô-tôgé is Early Pliocene in age respectively. It will be noted that the beech leaves in those florules gradually increased with the passage of the geologic ages. These three florules seem to have been similar in composition to the beech forest, and especially the floristic association of the Ningyô-tôgé florule was very close to that of the present pure stand of the beech forest in northern Japan.

Fagus palaeocrenata is very close to the living *F. crenata* BLUME in shape, size and secondary nerve number, but it is different from the latter in having usually slender teeth on the leaf margin. Among the living beeches in the world, the principal species having serrate margined leaves are as follows: *Fagus americana* SWEET in North America, *F. Hayatae* PALIB. in Formosa, *F. longipetiolata* SEEMEN in China and *F. sylvatica* LINNE in Europe. The two living species of Japanese beech, *F. crenata* BL. and

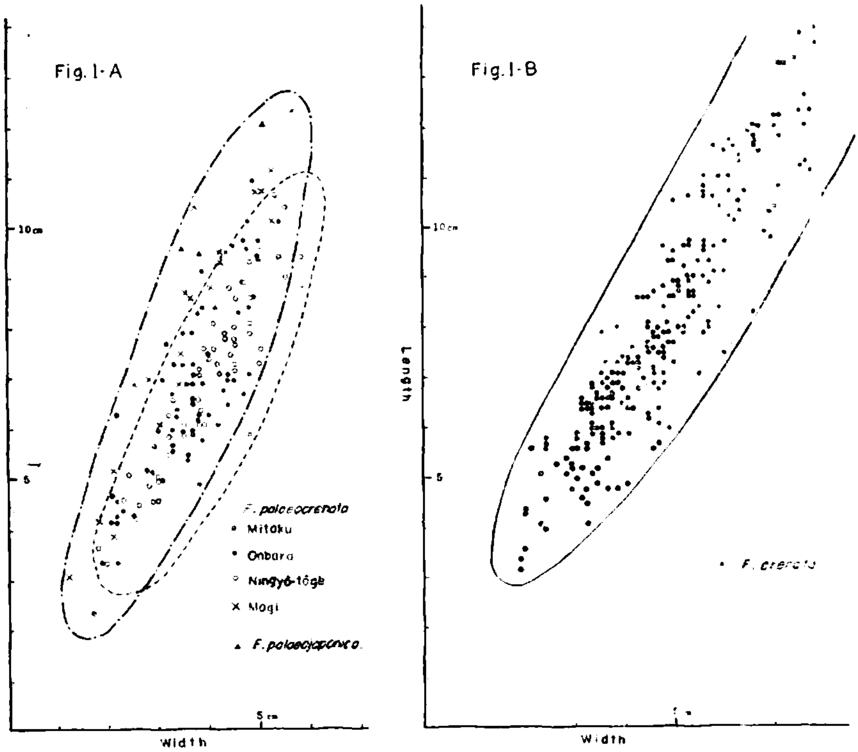

Fig. 1. Showing the variation-extension of foliar dimensions in the leaves of fossil and living beeches.

1-A. Beech leaves in the Hôki and Mogi floras.
1-B. Living beech-leaves of *Fagus crenata* collected from the various areas of Japan.

F. japonica Maxim., mostly have undulate margined leaves on the young shoots.

A large number of the fossil beech leaves of the Hôki flora are very variable in size and shape. Among 340 specimens of that flora the foliar dimensions of 125 comparatively well-preserved leaves are shown in Fig. 1-A. Between the beech of the Mitoku and Onbara, the variation-extensions of foliar dimensions are scarcely different, but that of Ningyô-tôgé is more or less different from the above two. Namely, the average leaf index* of the Ningyô-tôgé beeches is slightly smaller than the indices of the two older florules.

The leaves of the living *Fagus crenata* are also widely variable in size and shape; the foliar dimensions of recent leaves collected from various areas of Japan,** are shown in Fig. 1-B. The variation-extension of the foliar dimensions of the living specimens includes that of the Ningyô-tôgé specimens, but in general the average leaf index of the former is slightly smaller than that of the latter. Accordingly, the leaf index of the beech may be said to show a tendency to become gradually smaller with the passage of the ages. However, the variation of the foliar dimensions among these fossil and recent leaves is too gradual to enable one to distinguish them distinctly from each other.

On the other hand, the secondary nerves of the living beech leaves are variable in number, but the variation of secondary numbers shows some constant extension respectively in each

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* leaf index = length/width ×100.

** In the measurement of the foliar dimensions, use was made mainly of the leaves stored in the Herbarium of Faculty of Agriculture, Hokkaidô University; also leaves collected by the writer were partly used. These living leaves were collected from about 20 localities in southwestern Hokkaidô and Honshû.

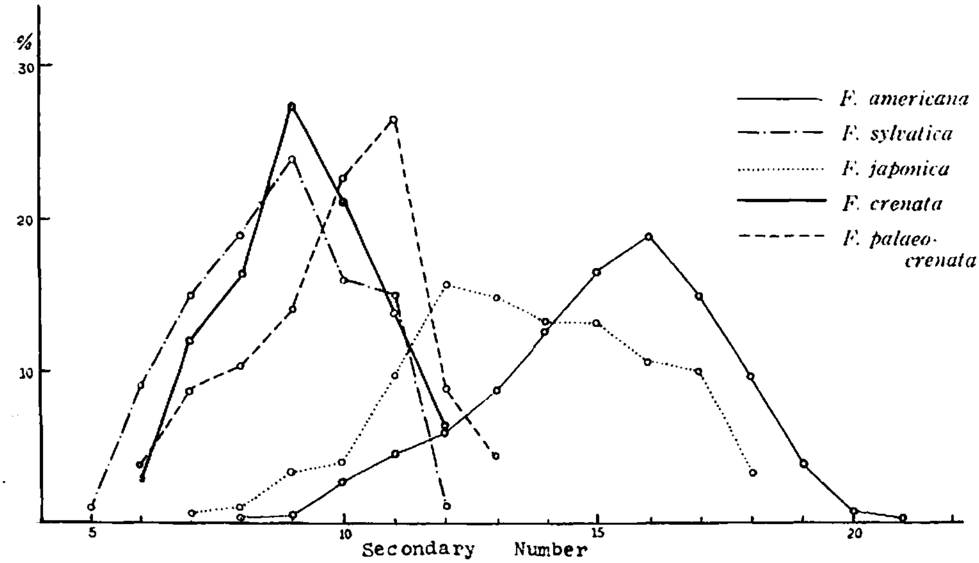

Fig. 2. Showing the frequency of the specimens having same number of secondary nerves in several fossil and living beech species.

living species of the world. The respective variations of secondary numbers in several living species of the world are shown in Table 2. The writer enumerates the numbers of specimens having the same secondary number in the living Japanese species and the Hôki species of beech. The frequency of the leaves having each secondary number respectively in several living and fossil specimens* is shown in Fig. 2. All peaks of respective species in the frequency lines do not coincide with each other. Most specimens of *F. palaeocrenata* which occurred from the Ningyô-tôge area, bear 9 to 12 pairs of secondary nerves, while most leaves of the living *F. crenata* bear 6 to 12 pairs of secondaries.

Table 2. Variations in number of secondary nerves in leaves of several living beech of the world.

Living species	Numbers of secondary nerves
F. crenata	6—12
F. japonica	7—18
F. americana	8—21
F. sylvatica	5—21
F. longipetiolata	7—15
F. Engleriana	8—17
F. Hayatae	6--10

From the view point of number of secondary nerves, *F. palaeocrenata* is a transitional form between the two Japanese living species, *F. crenata* and *F. japonica*. Most of the fossil leaves which have been hitherto described as *F. ferruginea* AITON in the Japanese Tertiary flora, should be included into this species on account of their general characters, especially on account of having marginal serration of leaves. *F. ferruginea* is now considered synonymous to *F. americana*. *F. palaeocrenata* and *F. americana* are actually very different in variation-extensions of secondary numbers, and so the fossil leaves called *F. ferruginea* in North America are quite different from those of *F. palaeocrenata* in spite of having marginal serration. The living leaves of *F. longipetiolata* now growing in Central China are serrate in margin, and most of them are 9 to 12 pairs in number of secondary nerves. Accordingly, from the view points of secondary number and marginal character, *F. palaeocrenata* is considered to be most close to *F. longipetiolata* SEEMEN among the living beeches of the world, though the former is shorter than the latter in respect to length of petiole. Thus, the fossil beech leaves being now discussed are not rather close to the living *F. crenata* in morphological features, and so the specific name "*palaeocrenata*" seems to be not so fitting for them.

Beside the above-noted materials, there are found a few beech-leaves which cannot be identified to *F. palaeocrenata*. They are more in number of secondary nerves than *F. palaeocrenata*, and usually undulate in margin. Furthermore, they are narrower in width than the latter. Thus, they should be treated as another species of beech (TANAI et ONOE, 1960). As shown in Fig. 1-A, the leaf index of this species is usually larger than that of *F. palaeocrenata*.

The writer wishes to acknowledge his indebtedness to Mr. T. ONOE of the Geological Survey of Japan for his assistance in this study. Acknowledgement

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* The frequency percentages of *F. japonica*, *F. americana* and *F. sylvatica*, are enumerated by the writer from 500 specimens which were studied by S. ENDO (in OKUTSU, 1955).

is also due to Miss A. Yamada for her kind assistance in the preparation of figures. The Herbarium of Faculty of Agriculture of Hokkaidô University, is also remembered with grateful appreciation.

Description of Species

Fagus palaeocrenata Okutsu

Plate 23. figures 2-7, 9-11

1883. *Fagus ferruginea*, Nathorst, *Kgl. Svensk. Vet. Akad. Handl., Bd. 20, no. 2*, p. 43, pl. 4, figs. 11-17; pl. 5, figs. 3, 9, 11; pl. 6, fig. 1.
1920. *Fagus ferruginea*, Florin, *Kgl. Svensk. Vet. Akad. Handl., Bd. 61*, p. 18, 36, pl. 1, figs. 3, 4, 12.
1931. *Fagus ferruginea*, Kon'no, *Geology of Central Shinano* (edit. by Honma), pl. 10, fig. 3.
1941. *Fagus ferruginea*, Miki, *Japan. Jour. Bot., vol. 11*, p. 257, fig. 7-a,-b.
1954. cfr. *Fagus crenata*, Huzioka et Suzuki, *Trans. Proc. Palaeont. Soc. Japan, N.S., no. 14*, p. 137, pl. 16, figs. 1 4.
1954. *Fagus ferruginea*, Takahashi, *Mem. Fac. Sci., Kyûshû Univ., Ser. D, vol. 5, no. 1*, p. 56. pl. 5, fig. 1.
1954. *Fagus crenata*, Takahashi, *Do.*, p. 56, Pl. 3, figs. 7-12; Pl. 4, figs. 1-8.
1955. *Fagus palaeocrenata*, Okutsu, *Sci. Rep., Tohoku Univ., 2nd. ser., vol. 26*, p. 92, pl. 6, figs. 4-9
1957. *Fagus palaeocrenata*, Murai, *Rep. Tech., Iwate Univ., no. 10*, p. 44, pl. 1, fig. 4; pl. 2, figs. 1-6.
1960. *Fagus palaeocrenata*, Tanai et Onoe, *Rep. Geol. Surv. Japan* (in press), pl. 6, figs. 3-5; pl. 8, figs. 1-7; pl. 9, figs. 1-6.

Description:—Leaves variable in size and shape, elliptical or ovate in outline, 3.3 to 10.8 cm. long and 1.9 to 5.8 cm. wide; base slightly asymmetrical, rounded or broadly obtuse or frequently cuneate; apex bluntly pointed, acute, or sometimes slightly acuminate; midrib prominent and stout near the base, then slender distantly, somewhat zigzag at the upper portion of blade; secondary nerves 6 to 12 pairs in number, opposite to subalternate, diverging from the midrib at the angles of 35 to 40 degrees in middle portion, almost straight and subparallel, slightly curving up near the margin, entering into the marginal teeth, craspedodrome; tertiaries thin, percurrent; nervilles thin, indistinct, forming polygonal meshes; margin simply serrate with slender and short teeth; petiole short, 5 to 10 mm. in length; texture firm, membraneous.

Cupula 4 lobed, villous: lobes with obtuse apex, 1.2 cm. in length and 0.6 cm. in width; peduncle stout, 1.5 cm. long and 1.0 mm. thick. Bud-scales small in size, boat-like in shape, 0.6 to 1.0 mm. long and 0.3 to 0.4 cm. wide; base truncate, and apex acutely pointed: nerves fine, nearly straight, parallel to the margin.

Remarks:—The present materials are quite identical in their general leaf characters to this species established by H. Okutsu (1955), especially in number of secondary nerves and marginal serration. Most of the fossil leaves which have been previously described as *F. ferruginea* Aiton in Japanese Tertiary flora, are included into this species in their general characters. The average leaf index of the present materials is smaller than that of Okutsu's original materials. The fossil leaves figured *F. ferruginea* from the Mogi plant beds by Nathorst (1883) are probably included into this species, and the leaf index of them is slightly larger than the present materials. The leaf index of original figures is almost similar to those of Mogi (Nathorst, 1883), Gosho (Murai, 1957) and Inzyo (Miki, 1941) materials, though their figured materials are less in number of specimens than the writer's materials.

Recently from the Miocene flora of Korea HUZIOKA (1951) described following three species of fossil beech being similar to this species; *F. Uotanii*, *F. koraica* and *F. protolongipetiolata*. Among them the present species is most close to *F. koraica* in the general characters. Other two species are also close to this species in their general features, but they are different from the latter in the length of petiole. The writer's materials are 5 to 10 mm. long in the petiole, and most of them are 7 mm. The petiole of *F. protolongipetiolata* is 11 mm., and that of *F. Uotanii* 2 to 3 mm. in length. However, in their general features those three Korean species of beech described by HUZIOKA, are better to be included into the present species.

The present species, *F. palaeocrenata*, is one of the most common fossils in the Late Miocene and Pliocene sediments of Japan. In Late Miocene flora of Japan, this species occurs in association with many cool-temperate elements, such as *Pinus palaeopentaphylla* TANAI et ONOE, *Thuja nipponica* TANAI et ONOE, *Populus aizuana* HUZIOKA et SUZUKI, *Alnus protohirsuta* ENDO, *Betula protoermanii* ENDO, *Carpinus nipponica* ENDO, *Quercus protodentata* TANAI et ONOE, *Celtis Nordenskioldii* NATHORST, *Ulmus protojaponica* TANAI et ONOE, *U. protolaciniata* TANAI et ONOE, *Acer palaeodiabolicum* ENDO, *A. subpictum* SAPORTA, *Styrax protoobassia* TANAI et ONOE, etc.

The related living species, *Fagus crenata* BL., which is one of the most sensitive trees for the vertical distribution, is now distributed from southwestern Hokkaidô to Kyûshû in Japan. It grows now most luxuriantly at the altitude of 1000 to 1700 meters above sea level in the mountains of central Japan, while it grows at the ground level in southern Hokkaidô, and often there forms pure forests on the uplands or mountain slopes.

Occurrence:—Ningyô-tôgé, Onbara and Mitoku formations.

Fagus palaeojaponica TANAI et ONOE

Plate 23, figures 1, 8

1883. *Fagus sieboldi*, NATHORST, *op. cit.*, p. 84, pl. 15, fig. 6.
1888. *Fagus japonica*, NATHORST, *Palaeont. Abhandl., vol. 4*, p. 227, pl. 9, figs. 3-8.
1939. *Fagus japonica*, ENDO, *Jubl. Publ., Commem. Prof. Yabe, vol. 1*, p. 344, pl. 23, fig. 8.
1958. *Fagus japonica*, MURAI, *Rep. Tech., Iwate Univ., no. 11*, p. 20, pl. 2, figs. 1-3.
1960. *Fagus palaeojaponica*, TANAI et ONOE, *Rep. Geol. Surv. Japan* (in press), pl. 7, figs. 3-5.

Description:—Leaves rather large in size, somewhat asymmetrical and elliptical or oblong-ovate in shape, 9 to 11 cm. long (estimated) and 3.3 to 4.5 cm. wide; base asymmetrically obtuse or rounded, and rarely cuneate; apex acute or somewhat acuminately pointed; midrib prominent, stout near the base, then slender distantly, somewhat zigzag at the upper portion of blade; secondary nerves stout, 13 to 16 pairs, alternate to subopposite, diverging from the midrib at the angles of 40 to 45 degrees, almost straight and subparallel, curving upwards near the margin, camptodrome; tertiaries thin, percurrent; nervilles thin forming polygonal meshes; margin almost entire at the lower half and undulate at the upper half; petiole missing or broken, over 7 mm. long; texture, membraneous.

Remarks:—Though the present materials are somewhat fragmental, they are distinctly different from the above-described species, *Fagus palaeocrenata*, in the secondary nervation and marginal character. Namely, the latter species is usually less in number of secondaries than the former and has a serrate margin. *F. palaeocrenata* is rarely undulate in margin, but it is not usually over 13 in number of secondaries. Comparing to the abundant occurrence of *F. palaeocrenata* in the Hôki flora, the present materials are very rare, and so they may be only varieties or some malformed leaves of the former species. However, the present materials are generally narrower in width than the leaves of *F. palaeocrenata*, namely the leaf-index of the former is usually larger than that of the latter. Thus, the foliar characters between the both materials are so distinctly different that the present materials are now treated as a new species.

The related living species to this fossil species is *Fagus japonica* MAXIM., which grows only in the mountains of Honshû, Kyûshû and Shikoku, Japan. The luxuriant growth of the living species is found rather in a lower altitude than *F. crenata* BLUME.

Occurrence:—Ningyô-tôgé, and Onbara formations.

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Explanation of Plate 23

(All natural size unless otherwise stated)

Fig. 1. *Fagus palaeojaponica* TANAI et ONOE, Onbara formation.
Figs. 2-4. *Fagus palaeocrenata* OKUTSU, Ningyô-tôgé formation.
Figs. 5-7. *Fagus palaeocrenata* OKUTSU, Onbara formation.
Fig. 8. *Fagus palaeojaponica* TANAI et ONOE, Ningyô-tôgé formation.
Fig. 9. *Fagus palaeocrenata* OKUTSU, Mitoku formation.
Fig. 10. Cupula of *F. palaeocrenata* OKUTSU, Onbara formation.
Fig. 11. Budscale of *F. paleocrenata* OKUTSU, ×1.5, Ningyô-tôgé formation.

These specimens are stored in the Geological Survey of Japan.


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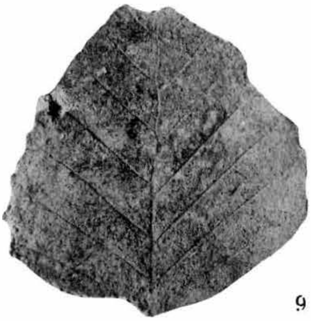
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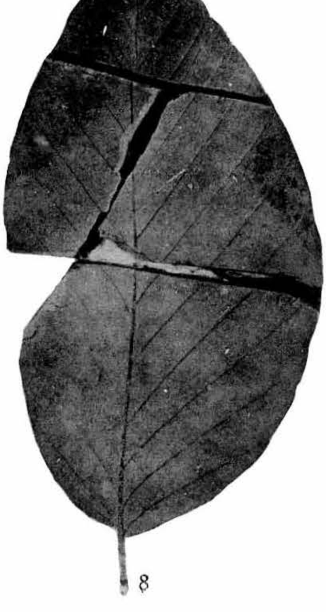
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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 37, pp. 201-208. pl. 24, April 1, 1960

377. A NEW LOCALITY OF THE *VICARYA* FAUNA FROM AOMORI PREFECTURE*

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青森県から *Vicarya* fauna の新発見：青森県西津軽郡鰺ヶ沢町南方滝淵発電所ダム附近の田野沢層より *Vicarya* を発見した。玆にその新産地を紹介すると共に，*Vicarya* 及びこれと共産する軟体動物群を記載し，簡単にこれらが持つ地質学的意義にふれた。

岩 井 武 彦

Introduction and Acknowledgements

The molluscan fossils upon which this paper is based from the collection of Professor Gunjiro SAKAI and the students of the Department of Geology, Faculty of Education, Hirosaki University, from the Tanosawa formation developed in the area bordering Mt. Iwaki, northwest of Hirosaki City, during field work in August 1957.

Although a report on the geology of the said area has been presented by Professor SAKAI and the writer on the occasion of the meeting of the Tohoku Branch of the Geological Society of Japan held in Akita City in 1957, no mention has yet been made of the molluscan fauna occurring therefrom because specific discrimination had not been completed then. Therefore, taking this opportunity the writer treats the molluscan fossils from the Tanosawa formation of the mentioned area because they have an important bearing on the geological age and correlation of it with other areas in Japan.

Here the writer thanks Professor Gunjiro SAKAI of the Hirosaki University and Professor Kotora HATAI of the Tohoku University, for their encouragement and kind advice throughout the course of the present work. Thanks are also due to Mr. Koichiro MASUDA of the Tohoku University for his support in many ways.

Remarks on the Stratigraphy

Although the stratigraphy and paleontology of the Tertiary strata developed in Nishi-Tsugaru-gun, Aomori Prefecture, have been studied by several authors, there is no work concerning the area from which the present *Vicarya* fauna was found. With regard to the present area only the works of SAKAI (1957) and IMANISHI (1948) should be mentioned.

The stratigraphy of the area bordering Mt. Iwaki was summarized by SAKAI (1957), in descending order, as follows:

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* Received Feb. 17, 1959; read Feb. 14, 1959.

Narusawa formation: gray siltstone, tuffaceous fine- to coarse-grained sandstone interbedding pumiceous sandstone layers and lenticular pumiceous tuff and agglomerate. Molluscs, foraminifers, diatoms and sponge-spicules.

conformity

Maido formation: dark gray massive siltstone, diatomaceous sandy mudstone, interbedding pumiceous tuff and marl concretions. Diatoms and *Makiyama*.

conformity

Akaishi formation: alternation of black siltstone and shale intercalating pumiceous tuff. *Makiyama* and some molluscs.

conformity

Odoji formation: black to gray hard shale and black siliceous shale with glauconite sandstone.

conformity and unconformity

Tanosawa formation: green tuff, green tuff breccia, gray tuffaceous sandstone, sandstone and conglomerate. Molluscs, foraminifers, etc.

unconformity

Basement: Pre-Tertiary rocks (including Paleozoic sedimentaries).

The Tanosawa formation from where the *Vicarya* fauna was collected is varied in lithology and its geological structure is complex in the vicinity of the fossil locality. For this reason the exact stratigraphic position of the *Vicarya* fauna within the Tanosawa could not be determined. Since stratigraphical studies are being continued, it is thought that its horizon will be clarified.

Locality and Mode of Occurrence of the Molluscs

The molluscan fossils were collected from the bed of the left side of the Nakamura River at about 300 meters north of the Takibuchi dam, Ajigasawa-machi, Nishi-Tsugaru-gun, Aomori Prefecture. They were found embedded in a greenish gray tuffaceous sandstone associated with minor amounts of carbonaceous matter. The molluscan fossils occur as a scattered, sporadic fossil-coenose. However, in places they occur as a crowded assemblage comprising many individuals but few species in the form of patches. None of the specimens preserve their entire outer shells and occur as casts and molds, which still retain their sculpture.

The species discriminated from the collection are given in Table 1 together with their frequency and distribution.

Remarks on the Molluscan Fauna

The present record of the *Vicarya-Anadara* fauna is the northernmost locality known in the Japanese Islands and it is thought that the distribution may be extended by future studies. The assemblage is evidence for considering that the ecological conditions prevailing in the area where the fossils were entombed may have been similar to other localities from where the fauna has hitherto been reported. From this evidence it is inferred that the geological age and stratigraphic position of the Tanosawa formation corresponds to those of other areas

Table 1. List of determined species and their distribution in the Neogene deposits of Japan

Genus and species / Locality	I	II	III	IV	V	VI	VII	VIII	IX	X
Anadara kakehataensis H. & N.	VA						+	+		+
Anadara kurosedaniensis H. & N.	R						+	+		
Anadara abdita MAKIYAMA		+	+	+	+				+	
Anadara daitokudoensis MAKIYAMA		+	+	+	+	+				
Anadara amicula (YOKOYAMA)									+	
Anadara ninohensis (OTUKA)									+	
Anadara aff. *trilineata* (CONRAD)									+	
Anadara sp.	F									
Pitar itoi (MAKIYAMA)	C		+	+						
Pitar yabei OTUKA	F								+	
Pitar sp. A	C									
Pitar sp. B	F									
Vicarya cf. *callosa japonica* YABE & HATAI	A	+	+	+	+	+	+	+	+	+

VA: very abundant (10+). A: abundant (5+). C: common (3+). F: few (2). R: rare (1).

I: Tanosawa formation. Nishi-Tsugaru-gun. Aomori Prefecture (T. IWAI, 1959).

II: Heiroku formation, Meisen-gun, North Korea (J. MAKIYAMA, 1926).

III: Kanchindo formation, ibid.

IV: Mankodo formation, ibid.

V: Kukinaga formation, Tana-gaura, Ryukyu Islands (S. HANZAWA, 1935).

VI: Uetsuki formation, Katsuda-gun, Okayama Prefecture (J. MAKIYAMA, 1932).

VII: Susahara formation, Kakehata, Toyama Prefecture (K. HATAI & S. NISIYAMA, 1949).

VIII: Higashi-Innai formation, Machino-machi, Noto Peninsula (K. MASUDA, 1955).

IX: Shiratori formation, Ninohe-gun, Iwate Prefecture (K. HATAI, MS).

X: Orito formation, Sado Island (K. MASUDA, MS)

yielding the *Vicarya-Anadara* fauna.

It is generally recognized that the *Vicarya-Anadara* fauna represents shallow water and frequently the former genus is found in brackish water deposits. The thermal conditions under which *Vicarya* flourished, so far as can be determined from its associated fossils and from that it is a typical Indo-Pacific genus, was one of tropical to subtropical nature. Therefore, the occurrence of the genus in areas as far north as about 40 degrees north latitude, which is remote from the geographical distribution of Recent Indo-Pacific elements, indicates that the tropical to subtropical oceanic currents must have flowed farther north than at present or that the then existing thermal conditions were more uniform throughout the western Northern Pacific.

Upholding the warm water view of the *Vicarya-Anadara* fauna is the occurrence of the *Miogypsina-Operculina* foraminiferan fauna of extensive distribution in the Japanese Islands and also recorded from the Tanosawa formation. Further, the varied pectinid fauna and abundant warm water pelecypod fauna from the Tanosawa formation are all in agreement with the warm water conditions indicated by the *Vicarya-Anadara* fauna just mentioned. Although the aforementioned kinds of fossils occur from the Tanosawa formation, the exact stratigraphic positions of them within the formation is not certain owing to the complicate structure as already stated.

All of the species discriminated from the present collection comprise those which have rather extensive geographical distribution yet more or less short geological range. All have been recorded from early Miocene deposits of the Japanese Islands where they extend from the southern to northern parts. None have been recorded from deposits considered to be of late Miocene, thus it is inferred that all may have become extinct before the close of the early Miocene in the Japanese Islands. From such relations it may be understood that age determination and correlation of the geographically isolated formations based on those fossils becomes trustworthy.

All of the species treated in this article are now preserved in the collection of the Department of Geology, Faculty of Education, Hirosaki University, Aomori Prefecture. Since all of the treated species are from the same locality already mentioned in earlier pages, they will not be repeated under each species.

Systematic Descriptions

Family Arcidae

Genus *Anadara* GRAY, 1847

Anadara (*Anadara*) *kakehataensis* HATAI and NISIYAMA, 1949

Plate 24, Figures 3a, 3b, 4.

1949. *Anadara* (*Anadara*) *kakehataensis* HATAI and NISIYAMA, *Jour. Paleont., vol. 23, no. 1*, pp. 88-89, pl. 23, figs. 8-10.
1955. *Anadara* (*Anadara*) *kakehataensis*, MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N.S., no. 20*, p. 123, figs. 2a-b.

Shell heavy, moderate in size, trigonal-quadrate in outline, posterior side straight, ventral margin abruptly rounded at extremities, umbonal region swollen, beak rather strongly incurved anteriorly, area broad, arcuately trigonal in profile, numerous small chevron teeth. Sculpture of 20-25 narrowly weakly granular, nearly equal ribs with interspaces of similar width.

Valve	Length	Height	Depth (intact)
Right	44.1mm	30.6mm	18.2mm
Right	41.5	31.7	19.6
Left	36.5	34.0	16.8
Left	33.5	28.4	18.5

Although abundant specimens of this species are in the collection, none retain their original shell-material and occur as casts and molds. However, the specific characters are preserved.

Anadara (*Anadara*) *kurosedaniensis* HATAI and NISIYAMA, 1949

Plate 24, Figures 5a, 5b.

1949. *Anadara* (*Anadara*) *kurosedaniensis* HATAI and NISIYAMA, *Jour. Paleont., vol. 23, No. 1*, p. 89, pl. 23, figs. 11, 12.
1955. *Anadara* (*Anadara*) *kurosedaniensis*, MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N.S., no. 20*, p. 123, fig. 3.

Shell small, quadrate in outline, posterior side straighter than anterior, ventral margin broadly rounded. Umbonal region flatly swollen, beaks rather sharply incurved and directed anteriorly, area rather narrow. Radial and granular sculpture on anterior half, posterior part rather swollen and ribs smooth. Length 22.6 mm, height 21.9 mm, and depth 6.2 mm.

This species is represented by a single specimen of a right valve. Although its preservation is not good, it seems to be identical with the named species.

Anadara (*Anadara*) sp. indet.

Plate 24, Figures 6a, 6b.

Shell moderate in size, oblique trigonal in outline, posterior side straight, beak rather high but not swollen, incurved anteriorly, area broad, arcuately trigonal in profile, surface with radial riblets and crossed with concentric growth lines, ribs about 20 in number and nearly equal to interspaces in breadth. Length 41.2 mm, height 39.4 mm, and depth 14.6 mm.

The single left valve in the collection resembles *Anadara kakehataensis* HATAI and NISIYAMA in general features, but is more elongated and the posterior margin is longer. There are no known species with which the present one can be identified.

In Table 1 are enumerated such *Anadara* species as, *abdita* MAKIYAMA, *daitokudoensis* MAKIYAMA, *amicula* (YOKOYAMA), *ninohensis* (OTUKA) and aff. *trilineata* (CONRAD). These arcids have been reported to occur in association with *Vicarya*, and therefore the name of *Anadara-Vicarya* fauna is proposed. These species are all extinct in the present seas of Japan and have extensive distribution in the early Miocene deposits of Japan.

Each of the arcids mentioned in Table 1 show a gradual decrease in the number of their radial ribs with the increase in latitude, should southern or southwestern Japan be taken as the starting point. Should abundant specimens of them accumulate from various localities distributed within southwestern to northern Japan, it is thought that the relation existing between latitude and specific variation be known and from it more details as to the relation between migration and migratory-forms be established. However, the time is still premature for stating further on the problem, even though it is thought that the mentioned relationships are important in interpreting the early Miocene molluscan fauna of Japan.

Family Veneridae

Genus *Pitar* RÖMER, 1857

Pitar itoi (MAKIYAMA), 1926

Plate 24, Figure 7.

1926. *Pitaria itoi* MAKIYAMA, *Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, vol. 2, no. 3, art. 6*, p. 159, pl. 13, fig. 7.
1936. *Pitar itoi* MAKIYAMA, *ibid., vol. 11, no. 4, art. 8*, p. 214, pl. 5, figs. 11, 12.
1937. *Pitar itoi* NOMURA and HATAI, *Saito Ho-on Kai Mus., Res. Bull., no. 13*, p. 135, pl. 18, fig. 4.

Shell moderate in size, elongate ovate in outline, well convex. Beak high, pointed, turned inwards and forwards, umbonal part swollen. Anterior and posterior sides rounded, postero-dorsal margin about twice as long as anterior, gradually declining. Sculpture of close, fairly sharp incremental growth lines. Lunule ovate-cordate, not deeply impressed. Hinge rather short, arcuate behind beak, teeth ill-defined. Height 30.5 mm, length 38.5 mm, depth 13.2mm.

The single left valve refered to this well known early Miocene species agrees with the original figures given by MAKIYAMA on specimens from the Miocene of North Korea. This species is extensively distributed in the early Miocene formations of Japan.

Pitar yabei OTUKA, 1934

Plate 24, Figure 8.

1934. *Pitar yabei* OTUKA, *Bull. Earthq. Res. Inst., Tokyo Imp. Univ., vol. 12, pt. 3,* p. 617, pl. 48, figs. 49, 50.

The single left valve in the collection agrees with the figures and description of this species, the original of which is:

"Shell moderate in size, solid, thick, trigonally ventricose, slightly polished, marked by minute concentric growth lines; beak large, subcentral or slightly posterior; anterior end prominent, rounded, posterior narrowly rounded; ventral margin smooth" (OTUKA).

Although the present specimen is slightly deformed, its outline when restored, the form of beak and the type of sculpture are quite similar to that of the type specimen figured by OTUKA from the early Miocene deposits of the Ninohe District, Iwate Prefecture, Northeast Honshu. The present specimen measures 35.5 mm in length, 35.9 mm in height and 10.5 mm in depth of a left valve.

Pitar sp. indet.

Plate 24, Figures 9, 10.

There are two types refered to *Pitar* sp. indet. One of the types is close to *Pitar yabei* OTUKA, except for being more elongate and higher, but this may be due to subsequent pressure. The specimens refered to this type measure 26.4 and 32.0 mm in height, 31.7 and 27.6mm in length, and 10.2 and 10.2mm in depth of two right valves, respectively.

The other type comprises several ill-preserved specimens with their anterior parts being longer than the posterior. The shells are not swollen, and the small beaks are turned inwards and forwards. Although these may belong to the named genus, their specific positions remain unknown.

Family Potamididae

Genus *Vicarya* D'ARCHIAC and HAIME, 1854

Vicarya cf. *callosa japonica* YABE and HATAI, 1938

Plate 24, Figures 1a, 1b, 2.

1938. *Vicarya callosa japonica* YABE and HATAI, *Sci. Rep., Tohoku Imp. Univ., Ser. 2, vol. 19, no. 2,* p. 149, pl. 21, figs. 12, 13, 21, 22.

1955. *Vicarya callosa japonica* MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N. S., no. 20,* p. 125.

1956. *Vicarya callosa japonica* MASUDA, *ibid., no. 21,* pl. 26, figs. 1a, 1b.

Shell moderately large in size, turreted, with many whorls of which the lower 12 are preserved. Spinous tubercles on infra-sutural band nearly horizontally extending outwards from axis, upper part nearly flat, lower inclines. Spiral striae numbering two or three on lower whorls. Sinuous growth lines well exhibited and rather deep on body whorl. Height 50+mm, longer diameter 29.5 mm, shorter diameter 25.5 mm.

Several ill-preserved specimens are in the collection, all consist of casts and molds, but still preserve the surface sculpture and well defined sinuous growth lines on the body whorl. Although the majority of the specimens are more or less deformed they still retain the characteristic spinous tubercles, sinuous growth lines, widened aperture, long and narrow turreted shell, and fortunately a small portion of the external shell was still preserved in one specimen.

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Explanation of Plate 24

(All figures in natural size)

Figs. 1a, 1b, 2. *Vicarya* cf. *callosa japonica* YABE and HATAI. Fig. 1a, ruber cast of the mold shown in Fig. 1b. Fig. 2, broken apertural part showing the strong sinuous growth lines. The flat spines and strong spiral ribs are well displayed.

Figs. 3a, 3b, 4. *Anadara* (*Anadara*) *kakehataensis* HATAI and NISIYAMA. Showing the strong radial ribs, inflatness and characteristic shape (Fig. 3a). The external shell is not preserved.

Figs. 5a, 5b. *Anadara* (*Anadara*) *kurosedaniensis* HATAI and NISIYAMA. Ill-preserved specimen, yet exhibiting the characteristic granular sculpture on part of the shell and the inflated nature. The shape of the beak differs from that of *A. kakehataensis* (Fig. 3b) and in width of the area.

Figs. 6a, 6b. *Anadara* (*Anadara*) sp. indet. This elongated *Anadara* with high shell, swollen beak and wide area agrees with no known species from Japan.

Fig. 7. Left valve of *Pitar itoi* (MAKIYAMA), showing the characteristic shape and development of concentric growth lines.

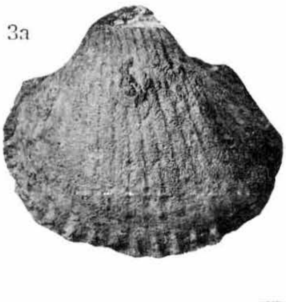
Fig. 8. Right valve of *Pitar yabei* OTUKA. Although not well preserved it is referred to the named species.

Figs. 9, 10. *Pitar* sp. indet. Fig. 9 is a deformed specimen while Fig. 10 is more or less normal. These may present different species but their preservation does not permit specific determination.

All of the specimens figured are preserved in the collection of the Department of Geology, Faculty of Education, Hirosaki University. All are from the same locality of the left side of the Nakamura River, 300 meters north of the Takibuchi dam, Ajigasawa-machi, Nishi-Tsugaru-gun, Aomori Prefecture.


1a


1b


3a


3b


4

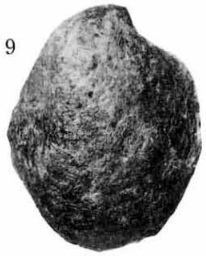

2


5a


5b


6b


6a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Trans. Proc. Palaeont. Soc. Japan, N. S. No. 37, pp. 209-222, pl. 25, April 1, 1960

378. CARDIIDS FROM THE MIYAZAKI GROUP*

(Palaeontological Study of the Miyazaki Group—VII)

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宮崎層群産 Cardiidae 科化石： Cardiidae 科は示準化石として，あるいは示相化石として重要な属や種を含んでいる。宮崎層群より6属7種の化石を得たので，宮崎層群の古生物学的研究の一部として，その記載のみをここで行なった。 首藤次男

Introduction

The family Cardiidae is one of the groups which have been subjected to the extensive study. Numerous genera and species are counted as the important leading fossils or as the indicators of the environmental conditions. Since the study of the family started so early and went far into details, too many forms of generic or subgeneric level have been distinguished and named, some of which seem to be difficult to separate from the allied forms on account of the gradual change of the characters. Recently Dr. A. M. Keen proposed a revised classification of the family. Though her classification seems to leave still some vagueness on the definition, which can be traced, for example, by the rather gradational change of the characters among the species belonging to *Vepricardium* (Cardiinae), *Regozara* and *Vasticardium* (Trachycardiinae), it is no doubt an excellent one and I describe the species generally according to it.

This paper is the seventh part of the serial report, entitled as palaeontological study of the Miyazaki group, and chiefly concerned with the description of the species and some questions about and reference to only the particular cases based on the materials from that group is offered.

I wish to express my cordial thanks to Dr. Tadashige Habe of Kyushu University and Dr. Katsura Oyama of the Geological Survey of Japan for their valuable advices on the classification of the forms. I wish also to express my appreciation to Professor Ryuzo Toriyama for his kind help in the course of the study and reading over the typescript. I am indebted to Professor Tatsuro Matsumoto for his guidance on the general work in the field and at the laboratory.

Systematic Description

Family Cardiidae Broderip 1840

Subfamily Cardiinae Stoliczka 1870

Genus *Vepricardium* Iredale 1929

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* Received March 2, 1959; read Nov. 30, 1957.

Type-species: *Vepricardium pulchricostatum* IREDALE by original designation

Vepricardium kyushuense, new species

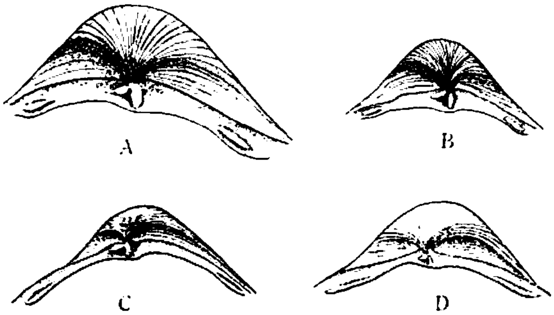
Plate 25, Figures 7, 8, 18, 21 and 22;
Text-figures 1A and 2A.

Material:—Holotype: GK-L 4770, paratypes: GK-L 4767, 4769, 4771, 4891 and 4905. Numerous specimens came from the various localities, which belong to the different horizons. The matrix is the muddy sandstone and more or less calcareous.

Measurements:—The measurements of the selected specimens are shown below.

Specimen reg. no.	Loc. (MI-)	Length (mm)	Height (mm)	Depth (mm)	H/L (%)	D/L (%)	Umbonal angle (degrees)	Number of the ribs	Valve
GK-L 4745	820	20.0	18.5	6.6	92.5	33.0	111	33	right
4769	5070	12.5	12.3	4.6	98.4	36.8	111	29	left
4770	4853	35.0	34.8	12.0	99.4	34.3	104	32	right
4771	4853	28.5	27.0	11.0	94.7	38.6	112	30	right
4791	2610	20.0	19.0	6.8	95.0	34.0	—	35	right
4891	822	11.1	9.8	3.8	88.3	34.2	114	32	left
4897	839	14.1	—	4.4	—	31.2	119	33	left
4905	839	14.1	13.1	4.2	92.9	29.8	116	31	right
4906	839	6.2	5.4	—	87.1	—	116	28	right
4907	839	9.1	8.3	—	91.2	—	116	29	left

Diagnosis:—The shell is moderate to small in size, fairly inflated, almost equilateral and equivalve. It is ovate in outline and slightly longer than high in the young stage and becomes higher in the adult. The test is moderately thick and solid. The umbones are prominent, elevated, incurved, touching and almost orthogyrate. The anterior margin is regularly rounded and smoothly continuous both to the somewhat concave antero-dorsal and the broadly curved ventral margin. The posterior margin is roundly and obliquely subtruncated and continues to the short dorsal margin and the ventral one with narrow curvature. The antero-dorsal margin is somewhat concave just below the umbo and the postero-dorsal one is straight. Both margins are almost equal in length, making the umbonal angle of about 110 degrees. The surface is sculptured by the numerous radial ribs and the periodic lines of growth. The ribs are moderately elevated with the steep sides and the rounded tops and one and a half times broader than the rounded interstices on the central main part of the shell. On the anterior and especially on the posterior part of the shell, they are rather sharply ridged and narrowed along the crest and ornamented by the distinct prickles on their crest and by the weak granulations on the sides. They are less broader there in proportion to the width of the interspace than on the main part. Near the umbo they are rather smooth and as wide as the interstices. The number of the ribs is counted about 30 to 35 and about 31 on an average. The cardinals consist of an almost horizontal and moderate-sized anterior cardinal and the large vertical posterior one on the right valve. The anterior lateral tooth is larger than the posterior one and far



Text-figure 1. The hinge of the selected species of the Cardiids from the Miyazaki group.
A—left hinge of *Vepricardium kyushuense* n. sp.
B—left hinge of *Vasticardium ogurai* (OTUKA)
C—right hinge of *Clinocardium subdecussatum* n. sp.
D—right hinge of *Laevicardium pigmae* n. sp.
Figures were drawn with camera-lucida, but slightly idealized.

apart from the cardinals. The interior ventral margin is distinctly crenulated.

Comparison:—According to the original author *Vepricardium* is featured by what "the ribs are rounded and bear scalloped prickles, the hollows facing the apex, closely set, missing on earliest portion of shell - -". Though the mature specimens of the present species really have the prickly ribs anteriorly and posteriorly, their scaly ornamentation is less developed than that in the type species. Thus concerning with this point of the character the present species shows, at least superficially, some affinity to *Vasticardium* IREDALE and *Regozara* IREDALE. However in the latter two genera the shell is very high and the ribs are generally much more smooth in *Vasticardium* and carinated in *Regozara*. While there seeems to be no fundamental difference among the hinges of these three forms. Concludingly the present species is better to be classified into *Vepricardium* than into other genera on the basis of its shell-outline and the ribbing, and it may be accepted that the divergency in the ribbing from that of the type species lies within the range of the variation of the genus.

Vepricardium sinense (SOWERBY) (REEVE, 1843, sp. 3) is an ally to the present species. The former resembles the latter especially in its size, shell-outline and the number and the prickly ornamentation of the ribs, but the former has much less prominent umbo than the latter and its ribs are very much elevated and peculiarly narrowed along the summit even in the main area of the shell-surface.

V. asiaticum (BRUGUIÈRE) (REEVE, 1843, sp. 90) also resembles the present species in its ribbing, but the former is two to three times larger than the latter.

Horizon:—The Kawabaru, Tano, Tsuma and Tonogôri member (upper Middle Miocene).

Localities:—Kakoi1) (MI-4074) and Azukino2) (MI-4853), Sanzai mura; Yamaji3) (MI-5070), Mino mura; Tonogôri4) (MI-4717), Saito City, Koyu gun; Nakabyu5) (MI-4020), Yatsushiro mura; Uchinohaye6) (MI-839), Takaoka machi, Higashi-Morogata gun; Horiguchi7) (MI-820 and

822), Tano machi: Kagamisu pass8) (MI-2610), Kiyotake machi, Miyazaki gun, Miyazaki Prefecture.

Subfamily Trachycardiinae
Stewart 1930

Genus *Vasticardium* Iredale 1927

Type-species: *Cochlea nebulosa* Martyn by original designation

Vasticardium hyuganum, new species

Plate 25, Figure 17.

Material:—Holotype: GK-L 4747. A single left valve obtained from the coarse sand bearing grey silty sandstone at the hill side west of Aya Town with the association of *Siratoria siratoriensis* (Otuka), *Paphia exilis takaokaensis* Shuto, *Veletuceta reevei* (Mayer) and *Ctena* sp.

Measurements:—length 23 mm, height 24 mm, depth 5.7 mm, umbonal angle 113 degrees, number of the ribs 39.

Diagnosis:—The shell is medium in size, ovato-trigonal in outline, slightly higher than long, somewhat inequilateral and rather compressed. The umbo is moderately high, prominent, curved inward and prosogyrate. The anterior margin is regularly rounded and smoothly continuous to the broadly curved ventral margin. The posterior margin is roundly subtruncated and continues to the ventral and dorsal margins with the blunt angle. The antero- and postero-dorsal margins are nearly straight and make the umbonal angle of about 110 degrees. The former is shorter than the latter. A blunt angulation is discernible from the umbo to the postero-ventral corner and the area just behind the angulation is somewhat concave. The surface is sculptured with about 39 radial ribs, which are rather low, round and smooth on the top, subequal in size throughout the entire surface except for the narrower posterior ones. Their profile is rather flat-topped at the central main part of the shell-surface and rounded at and near the ventral margin. The interstices are shallow, flat on the bottom and three-fifths narrower than the ribs themselves. The inner ventral margin is finely crenulated corresponding to the outer ribs. The hinge is unknown.

Comparison:—Though the hinge teeth have not been verified, the specimen belongs with no doubt to the genus *Vasticardium* on the morphological basis of its slightly oblique and transversely elongated shell ornamented by the close and numerous ribs which are smooth on the top and separated by the narrow interstices.

Vasticardium burchardi (Dunker) (1882, pl. 15, f. 4-6) is very closely allied to the present species in the features of the rather shallow valves which are transversly elongated with its posterior angulation and the flat-topped rather low ribs separated by the narrow interstices. Founding uppon these characters the two species together with *V. radiatum* (Reeve) and *V. pallidum* (Reeve) etc. make up a particular group among the numberless forms of *Vasticardium*. In spite of this basic resemblance between the two species above mentioned, *V. burchardi* is clearly distinguished from the new species by its much larger and higher shell with smaller umbonal angle than the latter.

Cardium (*Trachycardium*) *commutatum* Rovereto (Cossmann, 1921, p. 72, pl. 4,

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1) 宮崎県児湯郡三財村囲. 2) 同村小豆野. 3) 同郡三納村山路. 4) 西都市都於郡. 5) 同県東諸県郡八代村中別府. 6) 同郡高岡町内八重. 7) 同県宮崎郡田野町堀口. 8) 同郡清武町鏡洲峠

f. 25-29), which has the ornamentation and the hinge of *Vasticardium*, is better to be classified into that group and closely resembles the new species in general feature, but the former has the much closer ribs than the latter.

Cardium ("*Eucardium*") *njalindungense* MARTIN (1917, p. 485, pl. 61, f. 106) also resembles the present new species in general, but the shell of the former is more inflated, especially in the main part, and more produced at the anterior part than that of the latter; that is to say, the former shows more oval and orthoclinal outline. The hinge of the two can not be compared.

Horizon:—The Tano member (upper Middle Miocene).

Locarity:—Waritsuke[1] (MI-671), Aya machi, Higashi-Morogata gun, Miyazaki Prefecture.

Vasticardium ogurai (OTUKA)

Plate 25, Figures 13 and 16;
Text-figure 1B.

1938. *Cardium* (*Bucardium*) *ogurai* OTUKA, *Jour. Fac. Sci., Imp. Univ. Tokyo, sec. 2, vol. 5, pt. 2*, pp. 28-29, pl. 1, figs. 1, 2 and 8.

Material:—Hypotype: GK-L 4789 (right valve) and 4790 (right valve). The specimens were collected from the fine sandy matrix by H. KURODA.

Measurements:—

Specimen reg. no.	Length (mm)	Height (mm)	Depth (mm)	H/L (%)	D/L (%)	Umbonal angle (degrees)
GK-L 4789	ca. 25	23.5	9.7	94.0	38.8	107
4790	ca. 28	28.0	10.2	100.0	36.4	—

Remarks:—The present species was described originally as *Bucardium* on the basis of a few specimens from the Shôbara Miocene formation by the late Professor OTUKA in 1938. Its original description is as follows;

"Shell subtrigonal, rounded, inflated, almost equilateral; umbones small, but prominent; curved inward, about middle of shell length; antero-dorsal side concave; postero-dorsal side more or less convex; anterior and posterior side rounded; central side broadly rounded and crenulated; surface sculptured with about 40 to 36 radial ribs; radial ribs smooth near apical part, almost equal in size; interstices equal in width to the ribs; inner surface, excepting the umbonal part, regularly sculptured with weak ribs reflecting the surface radial ribs."

Bucardium was established by GRAY in 1853 but its type designation was made subsequently by Von VEST in 1875 (KEEN, 1937, pp. 4-5). The comparison of the type species, *Cardium ringens* LAMARCK, with "*Bucardium*" *ogurai*, however, leads to the conclusion that the latter should not belong to that genus. That is to say, *Cardium ringens* has the markedly concave antero- and postero-dorsal margins; in other words, its antero- and postero-dorsal parts expand outward to make a large apical angle like as in *Cardium* s.s.. Furthermore its outer radial ribs with foliaceous rims on sides are not so numerous and separated by the very deep interstices especially on the posterior part. These characteristics are not recogniz-

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[1] 宮崎縣東諸県郡綾町割付

able on the present species, and accordingly it should not be included in the genus *Bucardium*. While OTUKA compared his "*Bucardium*" *ogurai* with *Cardium asiaticum* BRUGUIÈRE and mentioned the close alliness between the two, the latter is now classified into *Vepricardium* IREDALE 1929, which is characterized by the prickly ribs and the narrow and deep interstices between them. "*Bucardium*" *ogurai* seemingly devoids of these features too. It is more reasonably classified into *Vasticardium* on the foundation of its shell-outline and ribbing.

The specimens in hand are slightly larger than the syntypes of the original author. The shells are subeqilateral and ovato-trigonal in outline with rather large, swollen, high, recurved and touching umbones. The surface sculpture consists of about 35 radiating ribs which are weakly reflected on the inner surface except for the apical and the postero-dorsal part beyond the posterior angulation. The ribs are flat on the top and narrower than the round and shallow interstices. On the left valve the cardinal teeth are composed of the vertical and rather prominent posterior tooth and the almost horizontal and less prominent anterior one. The anterior- and posterior-lateral teeth are thin and long and equally distant from the cardinals (Text-fig. 1)

Vasticardium tochigiense HIRAYAMA (1954, p. 64, pl. 3, f. 13-15) remarkably resembles the present specimens in the general form and the ribbing, but the shells of the former are less inflated than the latter and their umbones are not touching.

Horizon:—The Boroishi member (upper Middle Miocene).

Locality:—Kiyama[1] (MI-8578), Nichinan City, Miyazaki Prefecture.

Subfamily Protocardiinae KEEN 1951

Genus *Nemocardium* MEEK 1876

Type-species: *Cardium semiasperum* DESHAYES by monotypy

Subgenus *Keenaea* HABE 1951

Type-species: *Cardium samarangae* MAKIYAMA by original designation

Nemocardium (*Keenaea*) *samarangae* (MAKIYAMA)

Plate 25, Figures 1, 2, 3, 4, 5, 6, 19, 23 and 24

1850. *Cardium modestum* A. ADAMS and REEVE, *Zoology of the Voyage of HMS Samarang, Mollusca*, pl. 22, fig. 6.
1920. *Cardium modestum*, YOKOYAMA, *Jour. Coll. Sci., Imp. Univ. Tokyo, vol. 39, art. 6*, p. 128, pl. 9, fig. 12-13.
1934. *Cardium* (*Nemocardium*) *samarangae* MAKIYAMA, *Mem. Coll. Sci., Kyoto Imp. Univ., ser. B, vol. 10, no. 2, art. 6*, p. 143.
1936. *Cardium* (*Nemocardium*) *modestum*, NOMURA and HATAI, *Saito Ho-on Kai Mus., Res. Bull., no. 10*, p. 125, pl. 16, fig. 10.
1937. *Cardium* (*Nemocardium*) *samarangae*, NOMURA and JIMBO, *ibid. no. 13*, p. 162, pl. 22, fig. 6.
1951. *Nemocardium* (*Keenaea*) *samarangae* HABE, *Genera of Japanese Shells, Pelecypoda, no. 2*, p. 152, fig. 326.
1954. *Nemocardium samarangae*, HIRAYAMA, *Sci. Rep., Tokyo Kyoiku Daigaku, sec. C, no. 18*, p. 66, pl. 3, figs. 16-17.

Material:—Hypotypes: GK-L 4727 and 4731. Abundant specimens were obtained from various localities with the association of the large molluscan assemblages.

Measurements:—Shown in table 1.

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1) 宮崎県日南市木山

Table 1. The measurements of the selected specimens of *Nemocardium* (*Keenaea*) *samarangae* (MAKIYAMA) from various localities and horizons.

Specimen reg. no.		Loc. (MI-)	Length (mm)	Height (mm)	Depth (mm)	H/L (%)	D/L (%)	Umbonal angle (degrees)	Posterior ribs	Valve
GK-L	4721	5739	28.9	27.9	10.4	96.5	36.0	110	29	right*
	4722	5739	27.4	26.4	10.2	96.3	37.2	110	30	right
	4723	5739	19.9	18.4	7.3	92.4	36.7	111	31	left
	4724	5739	26.0	24.3	9.9	93.3	38.3	112	30	right
	4225	5739	23.2	21.5	8.2	92.4	35.3	114	30	left
	4726	5739	24.5	23.3	8.2	95.0	33.8	115	30	right
	4727	5739	26.1	24.8	9.2	94.8	35.2	113	28	right
	4728	5739	28.0	26.2	10.1	93.5	36.1	114	29	left
	4731	5739	21.9	20.3	7.9	92.6	34.7	113	29	right*
	4732	4074	20.9	20.0	7.3	95.5	34.9	112	32	left*
	4733	4074	19.8	18.2	7.6	91.8	38.3	113	31	right
	4735	4074	13.4	12.4	4.7	92.4	35.1	113	30	left
	4750	5061	16.5	15.3	5.8	92.6	35.2	110	31	right
	4752	5061	14.5	13.4	4.6	92.2	31.7	115	28	right
	4756	4853	19.0	18.2	7.1	95.4	37.3	109	28	right
	4757	4853	22.1	20.4	8.1	92.7	36.8	111	29	right
	4772	5595	27.0	25.1	9.7	93.2	35.9	114	29	right
	4774	5674	35.0	33.7	12.3	96.4	35.2	115	29	right*
	4787	4074	18.3	16.4	5.7	89.5	31.1	109	29	left
	4794	4717	15.9	15.3	5.8	96.1	36.4	113	29	right*
	4795	4717	20.8	19.9	7.5	95.6	36.1	109	30	right
	4798	5061	23.9	22.9	8.5	95.8	35.7	103	33	left*
	4799	5061	14.7	13.7	4.8	93.2	32.6	112	30	right
GK-m	1	Moeshima**	29.6	27.1	10.3	91.5	34.8	118	31	left
	2	——	26.4	24.2	8.7	91.7	32.9	118	27	right
	3	——	23.3	20.9	7.2	89.6	30.9	117	28	left
	4	——	27.6	25.9	9.3	93.5	33.7	111	33	right
	5	——	28.6	26.5	9.8	92.6	34.2	112	31	left
	6	——	27.2	24.9	8.9	91.4	32.7	114	33	right
	7	——	24.7	22.0	7.5	89.0	30.3	117	29	right
	8	——	24.6	22.5	8.7	91.4	35.3	118	30	left
	9	——	29.2	27.4	9.7	93.4	33.2	111	30	left
	10	——	25.1	23.0	8.3	91.6	33.1	116	31	left
	11	——	24.8	22.6	8.2	91.3	33.1	113	32	left
	12	——	23.7	21.5	7.6	90.6	32.1	115	31	left
	13	——	24.9	23.1	8.5	93.1	34.2	112	30	left
	14	——	24.2	22.1	7.9	91.4	32.7	118	31	left

* conjoined specimen
** Pleistocene bed

upper horizon—loc. MI-5595, 5674 & 5739
middle horizon—loc. MI-4717
lower horizon—loc. MI-4074. 4853 & 5061

Remarks:—The present species has been found in three horizons of the Miyazaki group. The upper horizon, the uppermost part of the Takanabe member (Lower Pliocene), includes three localities, where the lithology is tuffaceous muddy sandstone altogether and the preservation of the fossils is perfect. The middle horizon, the Tonogôri member (Uppermost Miocene), contains only a single locality, where the specimens occur in a lenticular shell bed of sandy matrix intercalated in the silty rock and the preservation is not always perfect. In the lower horizon three localities have been known and the lithology at these localities is calcareous fine sandstone and the preservation is moderately suitable. Though the minor difference in morphologic characters among the specimens of three horizons or of the separated localities of the same horizon really exists, it concerns with only the characters of subordinate significance, that is to say, they differ remarkably only in the size of the shell. Comparing with the living and the Pleistocene specimens, the common features or unity of the present material as one population may be easily recognized. The specimens from the Miyazaki group as a whole have the higher and deeper shells with smaller umbonal angle than the Recent or Pleistocene ones as indicated in table 1. As to the above mentioned aspect some sort of boundary may be really defined between the two groups of the specimens. However the other important features are quite identical between the two. Furthermore certain Miocene specimens reported by several authors illustrate the laterally elongated outline and necessarily the large umbonal angle. That is to say, these Miocene fossils more closely resemble the Recent and Pleistocene specimens concerning with these features than with those of Mio-Pliocene Miyazaki group. Of course it must be careful to consider whether these differences in the morphologic features mean the interspecific divergence or mere ecological variation within a single species. In the present case, however, it is more acceptable to consider that such morphological aspects as above mentioned are the intraspecific phenomena.

Horizon:—The Kawabaru, Tsuma, Tonogôri and Takanabe members (upper Middle Miocene to Lower Pliocene).

Localities:—Kizukume[1] (MI-5739) and Iwawaki[2] (MI-5674), Tonda mura; Tôriyama[3] (MI-5595), Kawaminami mura; Tonogôri[4] (MI-4717), Saito City; Kakoi[5] (MI-4074) and Azukino[6] (MI-4853), Sanzai mura; Yamaji[7] (MI-5060 and 5061), Mino mura, Koyu gun, Miyazaki Prefecture.

Subfamily Laevicardiinae KEEN 1936

Genus *Clinocardium* KEEN 1936

Type-species: *Cardium nuttalli* CONRAD by original designation

Clinocardium subdecussatum new species

Plate 25, Figures. 9, 10, 12 and 20;
Text-figure 1C

Material:—Whole specimens came from the calcareous nodules, rich in fossils, in the fine sandstone. The detouched specimens are more or less imperfect on account of the difficulty in cleaning in spite of the original state of suitable

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1) 宮崎県兒湯郡富田村鬼付女. 2) 同村岩脇. 3) 同郡川南村通山. 4) 西都市都於郡. 5) 同県兒湯郡三財村囲. 6) 同村小豆野. 7) 同郡三納村山路

preservation. Holotype: GK-L 4777, paratypes: GK-L 4776, 4781, 4782 and 4784. Other numerous specimens are more or less imperfect or fragmental.

Measurements:—The measurements of the selected specimens are given below.

Specimen reg. no.	Loc. (MI-)	Length (mm)	Height (mm)	Depth (mm)	H/L (%)	D/L (%)	Umbonal angle (degrees)	Number of the ribs	Valve
GK-L 4776	5061	21.0	20.6	6.5	98.1	30.9	110	49	right
4777	5061	19.6	18.0	6.0	91.8	30.6	111	50	right
4780	5060	19.0	18.0	—	95.7	—	109	45	right
4781	5060	11.4	11.3	3.7	99.1	32.4	119	46	left
4782	5060	19.5	18.2	5.7	93.3	29.2	110	50	right
4783	5061	15.0	14.0	4.6	93.3	30.6	111	47+	right
4784	5060	15.0	14.5	4.4	96.6	29.3	117	51	right

Diagnosis:—The shell is rather small in size, ovate in outline, remarkably inequilateral, and oblique. The test is rather thin and fragile. The umbones are moderately prominent, somewhat swollen, incurved, quite touching, prosogyrate, and situated at the two-fifths of the shell length from the anterior extremity. The antero-dorsal margin is somewhat concave below the umbo and about three-fourths shorter than the nearly straight postero-dorsal margin. The anterior margin is narrowly curved above, and broadly and regularly curved below to continue to the broadly curved ventral margin without any angulation or discontinuity. The posterior margin is narrowly rounded. A blunt angulation runs from the umbo toward the postero-ventral corner. The posterior surface beyond the angulation is concave and somewhat flattened and expanded posteriorly. The surface sculpture consists of the numerous radial ribs and the less distinct concentric lines. On one hand the ribs are stronger on the anterior, posterior and ventral parts than on the central and the umbonal area. On the other hand the concentric lirae are not observed near the ventral part of the full grown shell and distinct on the early portion, where the decussate sculpture is illustrated. The radial ribs are flat on the top and separated by the very fine grooves at the young stage. As the shell grows they become more distinct, more elevated and rather round and the interstices become wider and deeper with the definite steep sides. The number of the ribs ranges from 45 to 50. The hinge plate is narrow and long. On the right valve the anterior cardinal is horizontal and fused at the base with the posterior one which is vertical and somewhat larger than the former. The laterals are far apart from the cardinals (text-fig. 1C). The interior margin is finely crenulated.

Comparison:—One of the most characteristic features of this species is the weak decussate aspect of the surface sculpture. The type species of the genus has not such sculpture as this, and likewise the greater part of the representatives of the genus is devoid of it. Accordingly the decussate forms, if this feature is seriously estimated, may be regarded as a particular subgroup of the genus, but not as a different genus, for concerning with the other characteristics any significant difference from the type species is not realized.

Clinocardium fastosum (YOKOYAMA) (1927, p. 178, pl. 48, f. 5) posesses such a sculpture as this, but it is four and a half times larger than the present new species and furthermore the postero-dorsal and posterior margin of the former are much more regularly curved than in the latter.

If the decussate feature is not estimated, a few of the known species resemble the present one. *Clinocardium pristinum* KEEN reported from the Upper Miocene Cierbo-Neroly formations (KEEN, 1954, p. 16, pl. 1, f. 9 and 15) is one of the resembling species, but has more produced postero-ventral corner than the present species.

C. coosense (DALL) (1909, p. 118, pl. 13, f. 3) has somewhat higher shell than the present new species.

C. chikagawaense KOTAKA (1950, p. 46, pl. 5, f. 1-6) is about three times larger than the present species. Furthermore the former is more oblique and has less numerous ribs.

Horizon:—The lowest part of the Tsuma member (Upper Miocene).

Locality:—500m northwest of Yamaji[1)] (Ml-5061), Mino mura, Koyu gun, Miyazaki Prefecture.

Genus *Fulvia* GRAY 1853

Type-species: *Cardium apertum* BRUGUIÈRE by monotypy

Fulvia mutica (REEVE)

Text-figure 2B.

1844. *Cardium muticum* REEVE, *Conch. Icon.*, *vol. 2*, *Cardium* sp. 32.

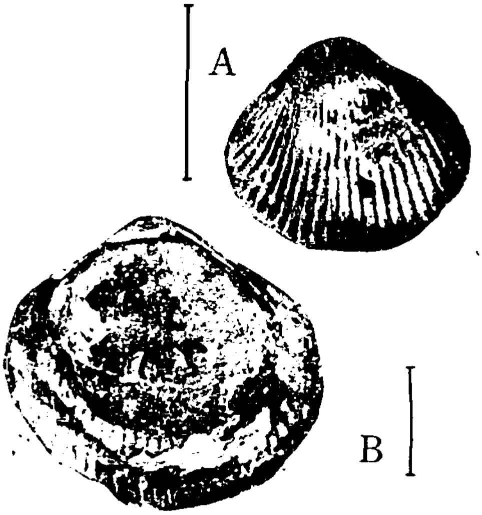
1920. *Cardium muticum*, YOKOYAMA, *Jour. Coll. Sci.*, *Imp. Univ. Tokyo*, *vol. 39*, *art. 6*, p. 128, pl. 9, fig. 11.

1922. *Cardium muticum*, YOKOYAMA, *ibid.* *vol. 44*, *art. 1*, p. 154, pl. 12, fig 7.

1951. *Cardium muticum*, HIRASE (rev. by TAKI), *Illust. Handb. Shells*, pl. 30, fig. 2.

1951. *Fulvia mutica*, HABE, *Genera of Japanese Shells*, *Pelecypoda*, *no. 2*, p. 150, figs. 329-330.

Material:—Hypotype: GK-L 4767. Rather common with the large assemblages of molluscan fossils in the tuffaceous fine sandstone at Tôriyama.



Text-figure 2.

A—*Vepricardium kyushuense* n. sp. paratype, GK-L 4905, loc. Uchinohaye, Takaoka machi, Higashi-Morogata gun, Miyazaki Prefecture.

B—*Fulvia mutica* (REEVE), GK-L 4765, loc. Tôriyama, Kawaminami mura, Koyu gun, Miyazaki Prefecture.

Two unit bars indicate one cm respectively.

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1) 宮崎県児湯郡三納村山路北西 500 m

Measurements:—

Specimen reg. no.	Length (mm)	Height (mm)	Depth (mm)	H/L (%)	D/L (%)	Valve
GK-L 4748	31.0	30.3	20.2	97.7	32.6	conjoined
4765	31.3	28.0	—	89.4	—	left
4766	20.0	19.2	7.3	93.6	35.6	right
4767	18.0	17.1	6.5	95.0	36.1	right

Remarks:—The specimens in hand are featured by the fragile shell of transversely elongated ovate form which are gaping anteriorly and especially posteriorly and ornamented with the weak radial striae on the surface. Founded upon these diagnosis and other subordinate characteristics it is reasonable, I believe, to identify them to *Fulvia mutica* (REEVE), though the present fossil shells are somewhat smaller than the adult shells of the living forms which are commonly found among the euneritic to subneritic faunas of the Japanese waters.

Horizon:—The upper part of the Takanabe member (Lower Pliocene).

Locality:—Tôriyama[1] (MI-5595), Kawaminami mura, Koyu gun, Miyazaki Prefecture.

Genus *Laevicardium* SWAINSON 1840

Type-species: *Cardium oblongum* GMELIN by subsequent designation, STOLICZKA 1871

Laevicardium pigmae, new species

Plate 25, Figures 11, 14 and 15;
Text-figure 1D.

Material:—Holotype: GK-L 4880; paratypes: GK-L 4793, 4803, 4876, 4877 and 4879. The matrix is well sorted pale grey fine sandstone. The associated faunule is small and simple.

Measurements:—

Specimen reg. no.	Loc. (MI-)	Length (mm)	Height (mm)	Depth (mm)	H/L (%)	D/L (%)	Umbonal angle (degrees)	Posterior ribs
GK-L 4793	2610	8.7	7.7	3.5	88.6	40.2	107	4
4803	2610	7.5	7.1	3.1	94.6	41.3	105	4
4876	923	10.5	9.4	3.4	89.5	32.4	97	5
4877	923	5.6	5.5	1.7	98.2	30.4	95	4
4879	923	6.1	5.4	1.8	88.5	29.5	92	4
4880	923	6.7	6.3	2.3	94.0	34.3	99	4

Diagnosis:—The shell is very small, ovate in outline, somewhat longer than high, slightly oblique and inequilateral. The umbones are prominent, high, swollen, incurved, almost touching and situated nearly at the half from the anterior margin. The anterior margin is narrowly rounded and smoothly continuous to the gently curved ventral margin. The posterior margin is obliquely subtruncated. The antero- and postero-dorsal margins are somewhat

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1) 宮崎県児湯郡川南村通山

concave and rather short, making an umbonal angle of about 100 degrees. They are almost equal in length. A blunt angle is discernible from the umbo toward the postero-ventral corner. The surface beyond the angulation which is not but the escutcheon, is sharply defined by the concave part along the angulation and the smooth area along the margin. The surface is almost smooth at the central part and sculptured by numerous fine radial riblets ventrally, anteriorly and posteriorly. The riblets are about 32 to 35 in number, of which four to five ones on the posterior part of the main surface along the angulation are rather strong, but are not so elevated, showing the wavy profile. The cardinals are tiny and the laterals are long and platy. The anterior lateral tooth is more apart from the cardinal than the posterior one. (text-fig. 1D). The interior margin is finely but distinctly crenulated.

Comparison:— The present species comes to maturity which is obviously shown by the ventral ribbing, though its size is very small, and that is one of the characteristic features of the species. *Laevicardium* generally includes many small forms, but really such small one as this are few among the known species.

Laevicardium undatopictum (PILSBRY) (1904, p. 554), living in our country and one of the index species of somewhat interlocked embayment fauna, closely resembles the present species, but the former has more numerous surface riblets and shallower area than the latter.

Horizon:— The Tano member (upper Middle Miocene).

Localities:—Uyeharu1) (MI-923), Tano machi; and Kagamisu pass (MI-2610), Kiyotake machi, Miyazaki gun, Miyazaki Prefecture.

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Explanation of Plate 25

Vepricardium kyushuense n. sp. .... p. 210

Fig. 7. (×1.5), paratype, GK-L 4769, left valve; immature specimen; loc. Yamaji, Mino mura, Koyu gun, Miyazaki Prefecture.

Fig. 8. (×1.5), GK-L 4764, immature, showing the apical part; loc. Nakabyu, Yatsushiro mura, Higashi-Morogata gun, Miyazaki Prefecture.

Fig. 18. (×1.5), GK-L 4801, right valve; loc. Azukino, Sanzai mura, Koyu gun, Miyazaki Prefecture.

Fig. 21. (×1), GK-L 4746, left valve; loc. Uchinohaye, Takaoka machi, Higashi-Morogata gun, Miyazaki Prefecture.

Fig. 22. (×1.5), holotype, GK-L 4770, right valve; loc. Azukino.

Vasticardium hyuganum n. sp. .... p. 212

Fig. 17. (×1.5), holotype, GK-L 4747, left valve; loc. Waritsuke, Aya machi, Higashi-Morogata gun, Miyazaki Prefecture.

Vasticardium ogurai (OTUKA) .... p. 213

Fig. 13. (×1.5), holotype, GK-L 4790, right valve; loc. Kiyama, Nichinan City, Miyazaki Prefecture.

Fig. 16. (×1.2), hypotype, GK-L 4789, right valve; loc. same as the preceding one.

Nemocardium (Keenaea) samarangae (MAKIYAMA) .... p. 214

Fig. 1. (×1.5), hypotype, GK-L 4727, right valve; loc. Kizukume, Tonda mura, Koyu gun, Miyazaki Prefecture.

Fig. 2. (×1.5), GK-L 4798, left valve of the conjoined specimen; loc. Yamaji, Mino mura, Koyu gun, Miyazaki Prefecture.

Fig. 3. (×1.5), interior view of the same specimen as Fig. 1.

Fig. 4. (×1.5), GK-L 4726, right valve; loc. Kizukume.

Fig. 5. (×1.5), GK-L 4732, left valve of the conjoined specimen; loc. Kakoi, Sanzai mura, Koyu gun, Miyazaki Prefecture.

Fig. 6. (×1.5), GK-L 4725, left valve; loc. Kizukume.

Fig. 19. (×1.25), GK-L 4774, right valve; loc. Iwawaki, Tonda mura, Koyu gun, Miyazaki Prefecture.

Fig. 23. (×1.5), posterior view of the same specimen as Fig. 5.

Fig. 24. (×1.5), hypotype, GK-L 4731, posterior view; loc. Kizukume.

Clinocardium subdecussatum n. sp. .... p. 216

Fig. 9. (×2), paratype, GK-L 4776, right valve; loc. Yamaji, Mino mura, Koyu gun, Miyazaki Prefecture.

Fig. 10. (×2), paratype, GK-L 4781, left valve; loc. same as the preceding one.

Fig. 12. (×2), holotype, GK-L 4777, right valve; loc. same as the preceding one.

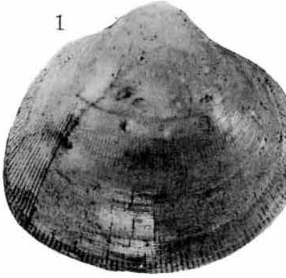
Fig. 20. (×2), showing the sculpture on the marginal part.

Laevicardium pigmae n. sp. .... p. 219

Fig. 11. (×2.5), paratype, GK-L 4793, right valve; loc. Kagamisu pass, Kiyotake machi, Miyazaki gun, Miyazaki Prefecture.

Fig. 14. (×2.5), paratype, GK-L 4803, right valve; loc. same as the proceding one.

Fig. 15. (×3), holotype, GK-L 4880, left valve; loc. Kariyabaru, Tano machi, Miyazaki gun, Miyazaki Prefecture.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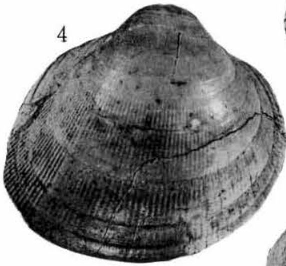
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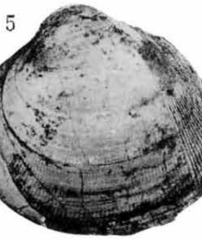
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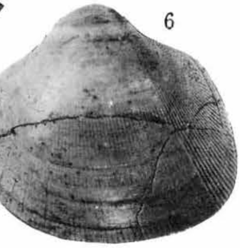
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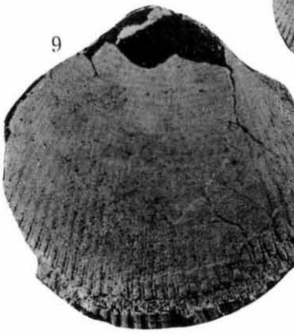
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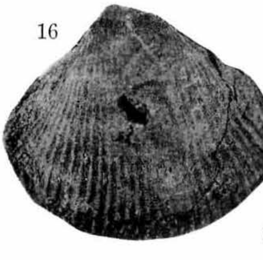
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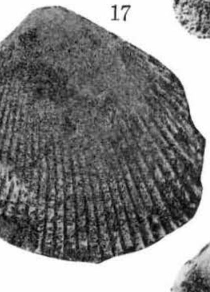
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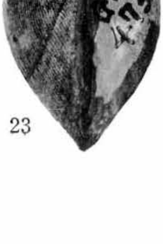
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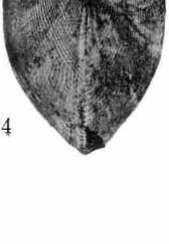
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Trans. Proc. Palaeont. Soc. Japan. N. S., No. 37, pp. 223-229, pl. 26, April 1, 1960

379. UPPER JURASSIC PTERIACEA FROM THE SOMA GROUP, FUKUSHIMA PREFECTURE, JAPAN*

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福島県相馬の上部ジュラ系産 Pteriacea： 福島県相馬の上部ジュラ系・中の沢層産の Pteriidae (8 種, うち 4 新種), Halobiidiae (1 種) 及び Bakevelliidae (1 新種) を記載した。 Pteriidae は中の沢層上部の小池石灰岩中の泥灰質部及び下位の砂岩との漸移部に多く、 相馬上部ジュラ系産二枚貝化石の重要な部分を構成している。 Halobiidae の 1 種は *Aulacomyella* ? sp. で *Aulacomyella* は IMLAY によれば中期キンメリッヂ世に限定されて産するとのことであるが、 *Aulacomyella* ? sp. の中の沢層からの産出は注目すべきである。

田村 実

This is to describe the Pteriacea from the Jurassic Soma Group. The occurrence of Pteriidae, Halobiidae and Bakevelliidae are restricted in the 7th and 8th zones of Trigoniae in the Nakanosawa formation. It is noteworthy that these zones belong to the calcareous facies. More precisely, calcareous sandstone (7th) merges upwards to the Koike limestone or marly shales (8th) with limestone intercalations.

Somapteria gen. nov. is instituted on *Somapteria koikensis* TAMURA, new species. The species described here and their occurrences are shown in the next table.

Specific name	7th zone	8th zone
Pteria masatanii TAMURA, new species	+	−
"*Pteria*" sp.	−	+
Somapteria koikensis TAMURA, new species	−	+
Pteroperna lingulata TAMURA, new species	+	−
Pteroperna pauciradiata TAMURA, new species	+	−
Pteroperna sp.	+	−
Pteroperna ? sp.	+	−
Aulacomyella ? sp.	+	−
Gervillia tatenosawensis TAMURA, new species	+	−

Two valves of these species are generally detached but test is preserved. Although some species are represented by imperfect specimens, the Pteriacea represent certainly an important component of the Soma pelecypod fauna.

The writer wishes to express his sincere thanks to Prof. T. KOBAYASHI of the University of Tokyo, for his kind

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* On the summary of the geology, the localities and zones of pelecypods, the readers are referred to the previous paper (1959b). Received Jan. 24, 1959; read Feb. 14, 1959.

guidance, facilities and supervision of the manuscript. The specimens now described were partly collected by the writer but others by KOBAYASHI, OTUKA, MASATANI and several others, to whom the writer's thanks are due.

Description of Species

The shell-obliquity is defined by an angle between a hinge-line and a median line of a shell body.

Family Pteriidae

Genus *Pteria* SCOPOLI, 1777

Pteria masatanii TAMURA, new species

Plate 26, Figures 19, 20.

Description:—Shell large (about 100mm high; about 80 mm long), strongly inequilateral, slightly compressed, pteriform, much higher than long. Left valve thin; umbo located near anterior extremity; hinge margin long; anterior auricle short; posterior one much longer; anterior margin sinuated below auricle but rounded, extended backward and passing into round ventral margin; posterior margin concave; greatest tumidity found near center; posterior adductor long, crescentic, located at a little posterior and above mid-height; hinge area trigonal; ligament pit moderately wide, oblique, triangular, descending backward from umbo and meeting hinge margin in anterior half; hinge thickened anteriorly, provided with several parallel crenulations near umbo; a small number of ridges in basal part of posterior wing parallel to hinge margin; surface probably smooth; nacreous layer thick.

Observation:—A large left valve shows its interior. Its posterior auricle is broken. The thick hinge below umbo bears about 5 taxodont-like crenules which are parallel to one another and vertical to the margin. The hinge area is characteristic of the genus and nearly equal to those of the recent *Pteria*. The shell form of this is fairly similar to *Magnavicula*. *P.* (*M.*) *penguin* (RÖDING) resembles this species at first sight, but they differ in shell form and adductor scars.

Occurrence:—7th zone at Loc. 15.

"*Pteria*" sp.

Plate 26, Figure 21.

Shell small (34mm long, 24mm high), inequilateral, depressed, somewhat quadrate and longer than high; umbo at about anterior 1/3 of hinge margin, scarcely projected above; anterior auricle fairly large and not acute; posterior auricle short and ill-defined; shell body wide; shell-obliquity about 50°; anterior and posterior margins a little concave below auricles but nearly straight downwards; ventral margin rounded; growth-lines seen on surface; adductor scar crescentic, large, nearly central; hinge unknown.

Represented only by an internal mould of a right valve with thin test in the upper half. It is close to *Pinctada* in outline and subcentral crescentic large adductor scar, though a large anterior wing and its not scaly surface disagree with *Pinctada*.

Occurrence:—8th zone at Loc. 14.

Genus *Somapteria* TAMURA, new genus

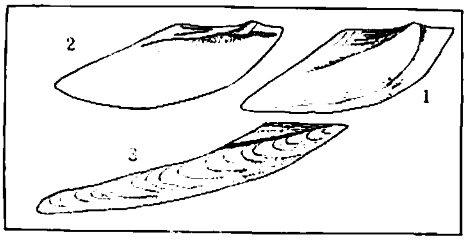
Type-species:—*Somapteria koikensis* TAMURA, new species.

Diagnosis:—Shell small for family, equivalve, inequilateral, moderately convex, trigonal and elongated; umbo anterior; auricles not demarcated from shell body, surface smooth except for fine threads; hinge "*Pteria*" type; ligament pit narrow and oblique below umbo; several taxodont-like teeth on thickened hinge margin anterior to ligament pit; two long lateral teeth on each valve.

Remarks:—The hinge structure warrants its belonging to the Pteriidae. Auricles are not so clearly demarcated as usual in the Pteriidae. The anterior extremity of hinge forms an obtuse-angle. The weak shell-obliquity is a generic characteristic. The outline of this genus is similar to *Gervillella* rather than *Pteria*. Its resemblance to *Gervillella* is only superficial and no multivincular ligament pit can be seen.

Pteria tutcheri ARKELL from the Great Oolite of England (ARKELL, 1931) is intimately related to the type-species and probably intermediate between common-type of *Pteria* and the genus in outline.

Distribution:—Upper Jurassic of Japan.



Somapteria koikensis TAMURA, new species
1: exterior of right valve.
2: interior of left valve.
Gervillia tatenosawensis TAMURA, n. sp.
3: left internal mould.

Somapteria koikensis TAMURA, new species

Plate 26, Figures 3-8; Text-figures 1, 2

Description:—Shell small, equivalve, strongly inequilateral, elongated trigonal in outline and much longer than high; umbo a little projected beyond hinge-margin and at about anterior 1/3 of hinge margin; auricles though depressed, not demarcated from shell body; anterior extremity forming about 80° angle but not angulated; posterior one about 140°; antero-ventral margin slightly rounded; posterior nearly straight or even a little concave; hinge subequal to or a little shorter than posterior margin in length; shell body rounded and prolonged posteriorly; surface ornamented with fine radial ribs and others subparallel to posterior margin; hinge area long and narrow, with a trigonal ligament pit sloping backwards from umbo; hinge plate thickened below umbo and finely crenulated; two internal ridges in posterior below hinge margin long, not parallel to each other.

Measurement		L	H
Left valve	(MM 3238)	24mm	14mm
Left	(MM 3239)	31	14
Left	(MM 3240)	34	14
Left	(MM 3241)	28	14
Right	(MM 3242)	30	13

Observation:—Numerous specimens at hand show morphic variance. Their preservation is excellent for Jurassic specimens of Japan. The auricles are ill-defined and non-alate. The shell is strongly produced back. Internally, it is typical of *Pteroperna*. The surface ornaments are delicate or invisible in most specimens but distinct in one (MM 3243).

Comparison:—Its shell form is most conspicuous and auricles are ill-defined. It resembles *Gervillella* [*Gervillella avi-*

culoides (Sowerby) (Arkell, 1931), *Gervillella acuta* (J. de C. Sowerby) and *Gervillella monotis* (J. A. Eudes-Deslongchamps) (Morris and Lycett, 1853; Cox and Arkell, 1948)] in outline but different in hinge.

Occurrence:—8th zone at Loc. 14.

Genus *Pteroperna* Morris and Lycett, 1853

Pteroperna pauciradiata Tamura, new species

Plate 26, Figures 1, 2.

Description:—Shell medium, strongly inequilateral, pteri-form and longer than high; left valve moderately convex; hinge margin long and straight; umbo anterior; anterior auricle triangular and fairly large but much smaller than posterior; anterior margin nearly straight, exclusive of sinus; sinus below posterior auricle deep; shell body fairly inflated and its apical angle about 40°; shell-obliquity 40°-45°; surface with 6 radial ribs and fairly coarse concentric lines of growth; 2-3 ridges on posterior auricle parallel but turn upwards at their extremities.

Observation and *Comparison:*—Two broken left valves at hand lack lower and posterior parts. The shell-obliquity is a little different between them, but both agree in posteriorly produced outline.

Pteroperna costatula Eudes-Deslongchamps (Morris and Lycett, 1853; Newton, 1895), especially its young form, resembles this species but its adult form lacks radial ribs and the shell-obliquity attains about 65°. Its young form with 6-8 radials is smaller than this species. *Pteroperna modiolaris* (Münster) (Cox, 1938) from the Jurassic of Southern Arabia has 7 radials but in the shell-obliquity and general form it is different from this. *Pteroperna blakei* Cox (1940) from Cutch is very close to this in outline but lacks radial ornaments.

Occurrence:—7th zone at Loc. 15.

Pteroperna lingulata Tamura, new species

Plate 26, Figures 16-18.

Description:—Shell small, pteriform and trigonal, a little longer than high, nearly equivalve but different in convexity, right valve less convex than left; umbo at about anterior 1/3 of hinge or a little anterior, not projected; hinge-line long and straight; auricles depressed and separated from shell body but not much produced distally; posterior margin a little concave below posterior auricle but its lower part rounded and passing into round ventral margin; anterior margin sinuate below umbo and extended into ventral; shell-obliquity 45°-50°; shell body linguiform, wide and expanded backward; apical angle 60°-65°; several wrinkles distinct in umbonal part; growth-lines fine.

Measurement		L	H
Right valve	(MM 3248)	15 mm	12 mm
Left	(MM 3249)	10	8
Left	(MM 3250)	16	14

Observation and *Comparison:*—The convexity is fairly different between two valves. The hinge is usually long and the posterior auricle ill-defined. It resembles *Pteroperna polyodon* (Buvignier) from the Corallian of England (Arkell, 1931) but its umbo lies more posteriorly. The umbonal wrinkles are absent in that species. This is closely allied to *Pteroperna* sp. from the Sakamoto Jurassic (TAMURA, 1959a), although the latter is different from the former in low and elongate form.

Occurrence:—7th zone at Loc. 15.

Pteroperna sp.

Plate 26, Figure 15.

Shell large (80 mm in length), very inequilateral, probably longer than high; right valve depressed; test fairly thick; umbo situated anteriorly; hinge-line long and straight; anterior auricle long, straight and a little sulcated below; posterior auricle unknown; 3 ridges parallel to hinge margin on posterior auricle; surface smooth.

Represented by an incomplete right valve. The parallel ridges on surface show its belonging to *Pteroperna*. Its characteristic lies in the anteriorly elongated large wing.

Occurrence:—7th zone at Loc. 3.

Pteroperna ? sp.

Plate 26, Figure 22.

Shell large (about 80 mm long, 58 mm high), very inequilateral, pteriform and longer than high; left valve fairly inflated; umbo located much posteriorly, a little acuminate; dorsal margin nearly straight; anterior auricle large and elongated; posterior probably short; anterior and ventral margins rounded exclusive of a small sulcus; posterior margin rounded, deeply sulcated below hinge and running into round ventral margin; tumidity highest near antero-ventral margin; shell-obliquity about 45°; hinge unknown; surface probably smooth.

Represented by a left valve without auricles. Its characteristics are the large and elongate shell body and tumid left valve.

Occurrence:—7th zone at Loc. 8.

Family Halobiidae

Genus *Aulacomyella* FURLANI, 1910

Aulacomyella ? sp.

Plate 26, Figure 23.

Shell small (height, 9 mm), subequilateral, nearly flat, suborbicular, with length subequal to height; auricles and hinge unknown; several wrinkles present in umbonal region; fine ridged radial ribs distinct except for umbonal part.

An incomplete right valve at hand lacks an auricle and hinge. The general shape and concentric wrinkles show its reference to *Aulacomyella*. Its radial ribs are much less in number than in *A. farquharsoni* COX (1935) from the Somaliland Jurassic, IMLAY's *Aulacomyella* sp. (1945) from the Louisiana Jurassic and *A. neogene* IMLAY (1940) from the Mexican Jurassic. They occur gregareously, while this is shown by a solitary specimen.

It is noteworthy that the above three species in addition to *A. problematica* FURLANI (1910) from Dalmatia are all middle Kimmeridgian (IMLAY, 1940).

Occurrence:—7th zone at Loc. 15.

Family Bakevelliidae

Genus *Gervillia* DEFRANCE, 1820

Gervillia tatenosawensis TAMURA, new species

Plate 26, Figures 9-14; Text-figure 3.

Description:—Shell small, strongly

convex, equivalve, ensiform, about five times as long as high; test fairly thick; umbo terminal; anterior auricle rudimental; posterior auricle narrow, distinctly defined by a deep furrow; shell body obliquely extending back, broadened, thick and widest at about anterior 1/3; dorsal margin a little concave; ventral slightly convex; growth-lines concentric, numerous; hinge area narrow and straight; 3 ligament pits elongate, rectangular; a few ridges and furrows found below ligament area.

Observation and *Comparison*:—This species is abundant in marly facies of Tatenosawa (Loc. 15) but none is complete. Three ligament pits are visible in a specimen (Text-figure 3). Long ridge-like teeth (probably 2 ridges and 1 furrow in left and 1 ridge and two furrows in right valve) are also ascertained in several other specimens. The test is generally thick. Gaping on the anterior ventral margin is unknown. The ear forms about 150° at the posterior end. It bears fine striae nearly parallel to the posterior margin.

This is distinct from *G. solenoides* (HOLZAPFEL, 1888, p. 223, pl. 24, figs. 11 and 12) in flattened antero-ventral margin and narrow posterior auricle. It resembles *G. forbesiana* D'ORBIGNY

Explanation of Plate 26

Pteroperna pauciradiata TAMURA, new species
Figs. 1, 2. Left valves (Fig. 1: holotype); ×1. Loc. 15. (MM 3246, 3247).

Somapteria koikensis TAMURA, new species
Fig. 3. Hinge structure of a right valve: ×1.5. Loc. 14. (MM 3244).
Figs. 4-6. Internal moulds of left valves (with shell fragments): ×1. Loc. 14. (MM 3239, 3238, 3241).
Fig. 7. Right valve (holotype); ×1. Loc. 14. (MM 3242).
Fig. 8. Interior of a left valve: ×1 Loc. 14. (MM 3240).

Gervillia tatenosawensis TAMURA, new species
Figs. 9-14. Broken left valves (Fig. 9: holotype); ×1.5. Loc. 15. (MM 3255, 3256, 3257, 3258, 3259, 3260).

Pteroperna sp.
Fig. 15. Broken right valve; ×1. Loc. 3. (MM 3251).

Pteroperna lingulata TAMURA, new species
Fig. 16. Right valve (holotype): ×1.5. Loc. 15. (MM 3248).
Figs. 17, 18. Left valves; ×1.5. Loc. 15. (MM 3250, 3249).

Pteria masatanii TAMURA, new species
Figs. 19, 20. Interior of the holotype left valve and its internal mould: ×1. Loc. 15. (MM 3236).

"*Pteria*" sp.
Fig. 21. Internal mould of a right valve (with shell fragments): ×1. Loc. 14. (MM 3237).

Pteroperna ? sp.
Fig. 22. Internal mould of a left valve; ×1. Loc. 15. (MM 3252).

Aulacomyella ? sp.
Fig. 23. Right valve; ×1. Loc. 15. (MM 3253).

All specimens here illustrated are kept in the Geological Institute, University of Tokyo.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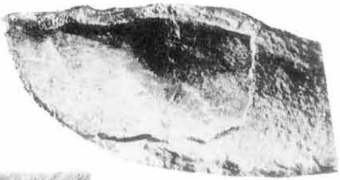
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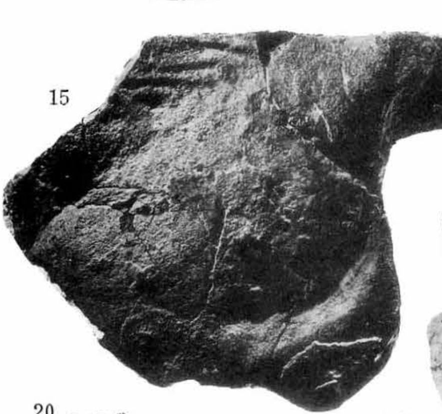
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from the Gault of Folkstone and the Lower Greensand of Atherfield (WOODS, 1905), but its ligament pits are different from those in shape and number. Compared to it the shell body is broader and more inflated in ventral margin below auricle in *G. forbesiana* from the Sanchu-Graben (YABE, NAGAO and SHIMIZU, 1926). *Gervillella*? sp. from the Sakamoto Jurassic (TAMURA, 1959a) is allied to it in general shape but *G.*? sp. has a depressed anterior auricle and wide shell.

Occurrence:—7th zone at Loc. 15.

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Trans. Proc. Palaeont. Soc. Japan, N. S., No. 37, pp. 230-237, April 1, 1960

PRESIDENTIAL ADDRESS

STUDIES ON TRILOBITES IN LAST THREE DECADES*

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Among fossils ancient extinct organisms bear particular importance for palaeontologists because such fossils are monopolistic objects of their study. Trilobites are typical of this category. Shiraki's find of Ordovician trilobites near Mt. Taipaik (大白山) in Korea drove me in 1926 to this mountainous region for fossil hunting. In those days the Trilobita belonged to the Crustacea and comprised 20 families or so, but now there are about 150 families which constitute an independent class of the Arthropoda. It is indeed a great advancement. Because I was fortunately able to participate in this progress, I wish to outline the results of this epoch in morphology, taxonomy and descriptive work.

It was in summer, 1932, that Dr. Størmer and I were invited by Prof. Raymond to his home. It was a memorable evening for me, because it was about the *Wendepunkt* in Trilobitology. Needless to say, the late Prof. Raymond was the well known successor of Prof. Beecher in this science, who had thoroughly proven the crustacean nature of trilobites in 1920 and developed Beecher's tripartation of the Trilobita. Therefore I visited him at Harvard to discuss the trilobite classification.

At that time Dr. Størmer was engaged in trilobite morphology. In a preliminary report (1933) he pointed out the analogy and homology of the trilobitan appendages with those of the crustaceans and arachnoids respectively, emphasizing that the trilobite has only one segment of the propodite and the characteristic gill-blades on the expodite which are quite different from crustacean setae. It took much more time to reconstruct the appendages of Trentonian *Ceraurus pleurexanthemus* out of serial sections of its rolled specimens. His *Studies on Trilobite Morphology, Parts 1 to 3* were successively published in 1939, 42, and 51 through which it was determined that trilobites have the appendages of same pattern as those of the Trilobitoidea and they are closely related to the Chelicerata. As a result the taxonomic position of the Trilobita was promoted as below.

Phylum Arthropoda
  Subphylum Trilobitomorpha Størmer, 1944
    Class Trilobitoidea Størmer, 1959
    Class Trilobita Walch
  Subphylum Chelicerata
  Subphylum Pycnogonida

It is interesting to note that the crest of *Palaeontologia Sinica* is a tail of a trilobite called *Drepanura* which has long been known among the Chinese by the name of bat-stone (Chang, 1921). About 250 years ago Lywyd (1698) described Trinuclei. The first Linnean

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species was *Entomolithus paradoxus*, 1745, but it was a composite species, γ form of which was *Agnostus pisiformis* (Linné), 1757. The term. *Trilobites*, was proposed by Walch in 1771 and 5 genera were distinguished by Brongniart in 1822. Subsequently trilobites had been classified by Dalman, Emmrich, Milne-Edwards, Burmeister, Hawle and Corda, Barrande, Salter and others in various manners before Beecher proposed his *Natural Classification of Trilobita* in 1897. The last one was different from the preceding ones in that it was founded on recapitulation theory.

From ontogenetical point of view Beecher laid special stress on eyes and facial sutures. His classification received wide acceptance, although its validity was questioned by Pompeckj immediately, a year after the proposal. Reed also noted that part of blindness is the result of aphotic adaptation, although he agreed that many blind trilobites are primitive. Later the Hypoparia were ignored by Swinnerton (1915). While Poulsen reported the proparian suture in the early larval stage of *Peltura scaraboeoides* (1923), Richter (1932) considered the Proparia to be more primitive than the Opisthoparia.

In 1935 I pointed out the ***polyphyletism of the Proparia*** as well as the Hypoparia by the fact that Cambrian proparians or hypoparians reveal little relationship not only among themselves, but also to later proparians or hypoparians. Therefore I had to conclude that Beecher's three orders are not natural groups.

Although the facial suture is one of the most important criteria, the natural classification must be founded on *combination of evolutional characters*. Each biocharacter developed in one or more trends, two of which happened to be even opposed. A trilobite group developed along the trend of a character slowly, but the development was quicker in another group. Thus the evolution of trilobites is complicated. For the natural classification not only morphological and ontogenetical evidences, but also specio-temporal distribution must be brought into consideration because the ***parallelism of the trilobite evolution*** among palaeogeographic provinces cannot be overlooked.

Furthermore it was concluded that at least four groups of trilobites had already appeared in the early Cambrian period. Therefore their Pre-Cambrian divergence is pre-palaeontological. The ***four palaeontological stocks*** were the Agnostida, Redlichida (or Mesonacida), Corynexochida and Ptychoparida which formed the four primary orders in my classification in 1935. The secondary orders are later groups which appeared so sporadically that their origin is obscure.

Subsequently in 1936 the invalidity of the Proparia was vindicated by the discovery of a proparian off-shoot of the Olenidae in the Lower Ordovician of Argentina. In the same year Stubblefield discussed cephalic sutures in great detail and concluded that the proparian condition might be regarded as arrested development. Whitehouse (1936, 39) on the other hand recongnized 7 Cambrian stocks of trilobites. In applying Jaekel's terms (1909), he combined his Agnostida and Eodiscida into the Miomera and the remaining five into the Polymera. Then, Resser (1938) segregated his Agnostida out of the Trilobita inclusive of eodiscids. On the contrary, I monographed the agnostids (1939) and eodiscids (1944) with the result it was concluded that the two constitute my Agnostida which represent the most specialized distinctive order of the Trilobita.

After the rejection of the tripartation, Størmer (1948) applied Beecher's orders to his classification, beside Protoparia which was a homonym of Swinnerton's (1915). He took the olenellid anaprotaspid for the incipient form, but recently Whittington (1957) pointed out that the smallest olenellid larvae so far known are meraspid cephala, instead of protaspids. Beecher's orders were accepted still later in some text-books (Moore, Lalicker and Fischer, 1952; Shrock and Twenhofel, 1953). Naturally closer studies were made on cephalic sutures by many students. Rasetti (1952) distinguished 7 types of sutures among early Cambrian trilobites to which two later Cambrian types were added. More types are known at present, but at the same time it has been ascertained that the same suture type occurs in the three polymeric orders.

About 30 years ago the classification of Cambrian trilobites was so ambiguous that even specialists arranged them in the alphabetical order by generic names. Especially, little was known of intergeneric relationship among those of Asia or the Pacific province. This was the reason why I made a special study on Cambrian genera and families. Though very tentative, in 1935 I classified the Cambrian trilobites into 34 families which were grouped into the above 4 primary orders in addition to the Dikelocephalida.

Lately the interfamily relationship was examined by Henningsmoen (1951) with special reference to the outline of the glabella and its furrows, although the relation of the glabella to the major cephalic configuration, I think, would be no less an important criterion. He obtained 12 superfamilies, two-thirds of which were derivatives from the Conocoryphacea. Then, Hupé (1953, 55) combined the Eodiscoidae and Agnostoidea into the Miomera and the other 24 superfamilies into the Polymera. In the latest classification elaborated by Harrington et al. (1959) the comprehensive Polymera or Conocoryphacean derivatives are divided into several orders and suborders. In seeing this scheme in *Treatise on Invertebrate Paleontology* I was rather astonished to find that the result agrees with mine so well in the fundamental frame as seen below.

Treatise, 1959.	Author, 1935.
Agnostida Kobayashi	Agnostida
Redlichida Richter	Mesonacida (or Redlichida)
Corynexochida Kobayashi	Corynexochida
Ptychopariida Swinnerton	Ptychoparida
Ptychopariina Richter	(Ptychoparida)
Asaphina Salter	Dikelocephalida (from Ptychoparida, 1936)
Illaenina Jaanusson	Proetacea (from Ptychoparida)
Harpina Whittington	Harpacea (ditto.)
Trinucleina Swinnerton	Trinuclacea (ditto.)
Phacopida Salter	(Phacopacea)
Phacopina Struve	Phacopacea (unknown origin)
Cheirurina Harrington and Leanza	Cheiruridae (ditto.) Encrinuridae (ditto.)

Calymenina Swinnerton	Calymenacea (from Ptychoparida)
Lichida Moore	Lichadea (from Mesonacida or Zacanthoidae ?)
Odontopleurida Whittington	Odontopleuridae (ditto.)

It is obvious that palaeontology depends on palaeontography which depends in turn on fossils. Silicified material is a favourite of palaeontologists as it can yield by observations a great deal of unexpected data especially on the ventral morphology and ontogeny. During my stay at the U.S. National Museum I saw some beautiful brachiopods extracted by Dr. Cooper. In 1935 he sent me a photograph of silicified trinucleid which he had found in Virginia. Next year free trilobites from the Upper Ordovician of Percé, Quebec were illustrated in a paper by Cooper and Kindle. This line of investigation was greatly improved in the United States. One cannot but admire a free carapace with a hypostoma, especially of a larval form.

Although I do not intend to go into details of descriptive works at this time, they were developed in various trends in these 30 years. Namely, many ancient type specimens in Norway, Bohemia and other countries were precisely restudied; the Olenidae, Odontopleuridae and other selected families thoroughly revised; large faunas in Britain, Sweden, Esthonia, Rheinland, South France and other classical areas monographed; and innumerable new trilobites described from Palaeozoic areas which had previously been littel or not well investigated.

Much we owe to Poulsen and Troedsson for the knowledge of the rich Arctic faunas. Some 30 species of trilobites had been known from the Andine province before 1935 when I described the *Kainella* faunule of Prairie Catamarca, but according to Harrington and Leanza (1957) the Ordovician of Argentina comprises at present more than 130 species. Likewise, only about 35 species were known from the Cambrian of Siberia before the *Atlas of the leading forms of fossil faunas in USSR*, Vol. 1, Cambrian (1940) in which Lermontova took part. Since 1950, however, new genera proposed for Cambrian trilobites from Siberia and Central Asia have numbered some 70 in total. It is predicted that described trilobites from Australasia are only a small part of those which really existed (Öpik et al. 1957).

A monumental work was published by Walcott as early as in 1913 for the *Cambrian faunas of China*. Trilobites of Eastern Asia were further amplified by Mansuy, Reed, Yabe, Sun, Saito, Sheng, Wang, Endo, Resser and others and recently by Hsü, Lu, Chang, Chien, Chu, Hsiang, Yi and others. In Japan trilobites are uncommon but *Coronocephalus* and a few others were described by Hamada, Igo, Okubo and others. It is a remarkable fact that the Asio-Pacific faunas contain quite distinct genera and families, the Eoasidaspidae by Poletayeva for example.

Here the trilobitology is reviewed in connection with geology. Benson's discovery of Cambrian trilobites in New Zealand (1956) is crucially important for the reason that Ordovician has been the oldest dated rock among the Pacific islands. Similarly, Buravas' find of trilobites at Tarutau, Southwest Thailand is invaluable in that the isle is the southernmost Cambrian locality of

Eurasia and at the same time these are the oldest fossils in the Burmese-Malayan geosyncline (1957).

A copious Lower Cambrian fauna was described from the Anti-Atlas by HUPÉ (1952). It is interesting to see in the type section of Amouslek that *Neoredlichia* occurs in the midst of the olenelloid zones. In Australia on the contray *Redlichia* is said to be earliest Middle Cambrian except in South Australia where it occurs in the Lower Cambrian (ÖPIK et al. 1957). Prior to this, SAITO (1933) suggested that the *Redlichia* stage in North Korea is lowest Middle Cambrian since it is underlain by the *Protolenus* bed with disconformity. SAITO's species was, however, later eliminated from *Protolenus*, s. str. In South China on the other hand it was clarified that various protolenoids evolved parallel to redlichids.

It is certain that the redlichids migrated from Eastern Asia to North Africa in the Olenellian epoch through the Himalayan trough. Probably Atlantic *Bailiella* took the same path, because it is reported from South France, Kashmir, Tonkin-Yunnan border, Korea, North China and Central Siberia. It is more certain that the Dorypygidae entered into Northern Europe from Eastern Asia through Central Asia (IVSHIN, 1953), because the family is well represented in Kazakstan and West Siberia. It is understandable that *Centropleura* could migrate from the Atlantic province to New Siberia and Central Siberia, but how *Centropleura* reached Australia from Asia remains a puzzle.

As discussed elsewhere (1949), it is remarkable that the occurrence of *Glyptagnostus reticulatus* in four continents indicates the oldest world instant in the geological age. Because *Olenus*, *Hedinaspis* and *Glyptagnostus* occur in Korea all in dark carbonaceous limestones along the axis of the Yokusen geosyncline, I suggested that their wide Eurasiatic dispersal was made possible with the aid of oceanic currents comparable to the Sargass sea of today (1943-44). It was emphasized further that the axial zone of the Appalachian geosyncline was the route of migration from the Atlantic to the Cordilleran or the Andean province (1957). WILSON (1957) noted also the cosmopolitan Olenidae in dark argillaceous geosynclinal sediments and jointly with LOCKMAN, he (1958) elucidated the evolution and distribution of the Cambrian trilobites in North America, in classifying their habitats into the cratonic, intermediate and extracratonic realms.

Incidentally, it is noteworthy that *Asaphopsis*, *Taihungshania*, *Synhomalonotus* *Coronocephalus*, *Crotalocephalus*, *Thysanopeltella*, *Dechenella* and some other genera provide undeniable evidence for sea connection from Eastern Asia to Europe or Australasia in the Ordovician, Gotlandian or Devonian period.

Now I recollect RAYMOND's address on *Pre-Cambrian Life* (1935) in which he spoke of the diversity of naked pelagic animals in the late Pre-Cambrian period and their armouring at the transition to the Cambrian due to their benthonic adaptation on shallow bottom and the superiority in struggle for existence which took place by over-population. This interpretation applies to trilobites as well as other animals. Fossil records in the transitional epoch are still meager, but medusae and annelids were lately discovered in South Australia far below the archaeocyathid limestone (GLASSNER, 1959). In my opinion the

Proterozoic glaciations causing changes of hydrosphere not only in areal extension but also in variation of environments, most probably favoured this important step in the development of aquatic life. It is also remembered that the Neo-Cryptozoic eon is comparable with the whole Phanerozoic eon in time length (1944-45).

At all events four primary stocks of trilobites appeared in the early Cambrian epoch among which the shortest survivors were the Redlichida, probably followed by the Corynexochida and then by the Agnostida. It is, however, an important problem, whether the Corynexochida really disappeared before the Ordovician period, because the order flourished most in the insufficiently explored Asio-Pacific province and because the phylogenetic position of the Dameselliidae, Leiostegiidae and Komaspiidae remains unsolved. The origin of cheirurids, phacopids, odontopleurids and lichids is still unknown. In view of the resemblance of the Eoacidaspidae to the Corynexochida, however, I think future researches in the Asio-Pacific province may throw light on the derivation of certain secondary stocks from the primary.

The rise and fall of trilobite families took place on the largest scale during the late Cambrian and early Ordovician epochs. All of the Cambrian families died out by the end of the Ordovician period, while some forerunners of the post-Cambrian families appeared already in the latter part of the Cambrian period. The evolution of trilobites is so highly complicated that it can hardly be unified by any theory. However, the rule of effacement, that is, that effacement advances from the distal to the proximal part of a shield (1939), applies not only to the Miomera, but also to the Polymera. Rules on hypertrophy of the axial lobe and caudalization of post-cephalic segments also meet with few exception. In the future, combination of such rules will make it possible to decipher the tangled history of evolution.

I shall close my speech with a few words of reference to some new compilations. GRABAU and SHIMER'S *Index Fossils of North America* was completely revised and reillustrated by SHIMER and SHROCK (1944). Publications of this kind were compiled for the Cambrian of U. S. S. R. by VOLOGDIN (1940), for the Palaeozoic of Western Siberia by KHALFIN (1955) and for Fossil Invertebrates of China by Academia Sinica (1957). These two Soviet publications contain many new genera and species by LERMONTOVA and others. STØRMER (1949) and HUPÉ (1953) presented a chapter on Trilobita respectively in GRASSÉ'S *Traité de Zoologie* Tom. 6 (1949) and PIVETEAU'S *Traité de Paléontologie* Tom. 3 (1953). HUPÉ'S *Classification des Trilobites* (1953, 55) and HARRINGTON and others' Trilobita in MOORE'S *Treatise* (1959) give the most comprehensive information on the class but for Asiatic genera it is hoped more supplementary information will be gathered to complete our knowledge.

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PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

「日本古生物学会昭和34年度年会」は1960年1月16日および17日東北大学理学部地質学古生物学教室において開催した。(参会者49名) 年会における報告・議事・講演者並びに講演題目は次の通りである。

年　会

会計・事業報告及議事

会長講演

Studies on Trilobites in last three decades ....T. Kobayashi

特別講演会

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Cuspidaria from the Miyazaki Group (代読) ....T. Shuto

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On the Genus *Populus* ....S. ENDO

1957年10月1日より1960年1月16日までの会員移動は次の通りである。

入会者　千地万造　Durham, J. W.　藤田郁男
堀口万吉　石田志朗　石井　醇
石崎国熙　岩井武彦　角田　保
加藤又二郎　甲藤次郎　粉河昭平
Lemone, D. D.　光木将喜　永井浩三
中村耕二　岡田博有　沖村雄二
Sadlick, W.　斎藤常正　佐三公好
白井健祐　高橋治之　田中啓策
寺岡易司　Wiedman, J. P.

退会者　秋山輝行　木下亀城　Kirk, E. (死亡)　Nagappa, Y.　長島俊美　Reeside, J. B. jr. (死亡)　鈴木倉次(死亡)　高梨文治　Teves, J. S. (死亡)

	開催地	開催日	講演申込締切日
第75回例会	埼玉大学	1960年5月21日	1960年4月30日
第76回例会	島根大学	1960年9月24日	1960年9月5日

会員消息

会員勘米良亀齢君は英国 Glasgow 大学に留学中であつたが1月帰国した。
会員小西健二君は米国 Colorado 鉱山学校に留学中であつたが2月帰国した。
会員新野弘君は Ecuador の Galapagos 島探検を終え3月帰国した。
会員鳥山隆三君の「秋吉の地質学的研究」に対し西日本新聞社より西日本文化賞が授与された。

NEWS

The Tenth Pacific Science Congress of the Pacific Science Association は Honolulu の University of Hawaii において同大学の協力のもとで National Academy of Sciences, Washington, D.C. と Bernice P. Bishop Museum との共催で 1961年8月21日から9月6日まで開かれることになった。そのうち，8月21日から9月2日までが会期で，引き続いて見学旅行がある。因みにこれまでに開かれた太平洋学術会議の開催地とその年次は次の如くである。

I. 1920. Honolulu, Hawaii
II. 1923. Melbourne and Sydney, Australia
III. 1926. Tokyo, Japan
IV. 1929. Batavia and Bandoeng, Java
V. 1933. Victoria and Vancouver, Canada
VI. 1939. Berkeley, Stanford and San Francisce, U.S.A.
VII. 1949. Auckland and Christchurch, New Zealand
VIII. 1953. Quezon City, Philippines
IX. 1957. Bangkok, Thailand

購読御希望の方は本会宛御申込下さい

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日本古生物学会会則

(1958年12月6日総会にて改正)

第1条　本会は日本古生物学会という。

第2条　本会は古生物学およびこれに関係ある諸学科の進歩および普及を計るのを目的とする。

第3条　本会は第2条の目的を達するため次の事業を行う。

1. 会誌そのほかの出版物の発行。
2. 学術講演会の開催。
3. 普及のための採集会・講演会そのほかの開催。

第4条　本会の目的を達するため総会の議を経て本会に各種の研究委員会を置くことができる。

第5条　本会は古生物学およびこれに関係ある諸学科に興味を持つ会員で組織する。

第6条　会員を分けて普通会員・特別会員・賛助会員および名誉会員とする。

第7条　普通会員は所定の入会申込書を提出した者につき評議員会の議によって定める。

第8条　特別会員は本会に10年以上会員であり古生物学について業績のあるもので，特別会員5名の推薦のあったものにつき評議員会の議によって定める。

第9条　賛助会員は第2条の目的を賛助する法人で評議員会の推薦による。

第10条　名誉会員は古生物学について顕著な功績のある者につき評議員会が推薦し，総会の決議によって定める。

第11条　会員は第12条に定められた会費を納めなければならない。会員は会誌の配布を受け第3条に規定した事業に参加することができる。

第12条　会費の金額は総会に計って定める。会費は普通会員年600円，特別会員年1,000円，賛助会員年10,000円以上とする。名誉会員は会費納入の義務がない。在外の会員は年3弗とし会誌および特別出版物の配布を受ける。

第13条　本会の経費は会費・寄付金・補助金などによる。

第14条　会費を1ヶ年以上滞納した者および本会の名誉を汚す行為のあった者は，評議員会の議を経て除名することができる。

第15条　本会の役員は会長1名，評議員15名とし，うち若干名を常務委員とする。任期は総て2年とし再選を妨げない。

会長の委嘱により本会に幹事および書記若干名を置くことができる。

常務委員は評議員会において互選される。評議員は特別会員の中から会員の通信選挙によって選出される。

第16条　会長は特別会員の中から評議員会において選出され，本会を代表し会務を管理する。

会長に事故ある場合は会長が臨時に代理を委嘱する。

第17条　本会には名誉会長を置くことができる。名誉会長は評議員会が推薦し総会の決議によつて定める。名誉会長は評議委員会に参加することができる。

第18条　本会は毎年一回定例総会を開く。その議長には会長が当り本会運営の基本方針を決定する。

総会の議案は評議員会が決定する。

会長は必要があると認める時は臨時総会を召集する。総会は会員の十分の一以上の出席をもって成立する。

会長は会員の三の分一以上の者が会議の目的たる事項および召集の理由を記載した書面をもって総会召集の請求を受けた場合は臨時総会を召集する。

第19条　総会に出席しない会員は他の出席会員にその議決権の行使を委任することができる。但し，欠席会員の議決権の代行は1人1名に限る。

第20条　総会の議決は多数決により，可否同数の時は議長がこれを決める。

第21条　会長および評議員は評議員会を組織し，総会の決議による基本方針に従い運営要項を審議決定する。

第22条　常務委員は常務委員会を組織し評議員会の決議に基づいて会務を執行する。

第23条　本会の会計年度は毎年1月1日に始まり12月31日に終る。

第24条　本会会則を変更するには総会に付議し，その出席会員の三分の二以上の同意を得なければならない。

付　則　1）評議員会の議決は総て無記名投票による。