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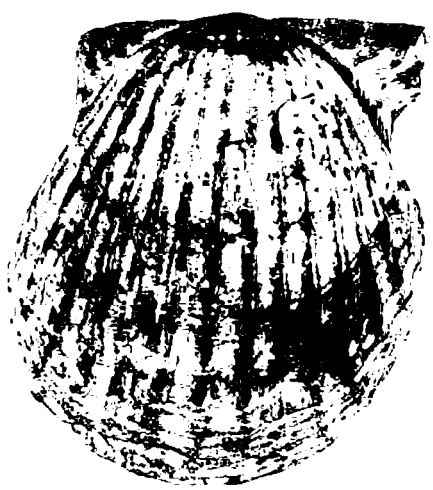

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TRANSACTIONS

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490. CARBONIFEROUS CONODONTS FROM YOBARA, AKIYOSHI LIMESTONE, JAPAN (STUDIES OF ASIATIC CONODONTS, PART II)*

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秋吉石灰岩江原産のコノドント：柳田寿一の研究した腕足類に富む秋吉石灰岩江原の採石場のコノドントを調べ，その時代を考察した。全般的には筆者らが先に報告した青海石灰岩産のものと類似するが，よりペンシルバニヤ系の要素が薄く，Chesterian との類縁性が濃くなつている。江原産コノドント群集は青海のそれとほぼ同層位か，またはやや古くペンシルバニヤ系最下部に対比されよう。いくら古く見積つても Chesterian 上部の Kinkaid より古くはなるまい。なお筆者らがコノドントを沢山摘出した層準は正しくは腕足類の密集部よりやや上位である。

猪郷久義・小池敏夫

Introduction and Acknowledgements

The Akiyoshi Limestone is the classical field of the Upper Paleozoic stratigraphy and paleontology in Japan and has been repeatedly studied by many workers. Recently YANAGIDA (1962) has reported an interesting brachiopod fauna from the Uzura quarry, Yobara. The stratigraphic position of this quarry is thought to be lower part of the Akiyoshi Limestone Group and to be equivalent to the *Millerella* sp. α Zone (TORIYAMA, 1958). Also YAMAGIWA and OTA (1963) have described several corals from the same locality. We have succeeded to separate well-preserved rich conodonts from the limestone collected from the mentioned fossil locality. This paper is dealt with these conodonts and discussion of their geologic age.

Acknowledgements are due to Mr. Masamichi OTA of the Akiyoshidai Science Museum for his valuable suggestion in the field. We also thank Mr. Tadahiko OGAWA for his help to our laboratory work. A part of the expenses of the field survey was defrayed from the Scientific Research Fund, Ministry of Education, Japanese Government.

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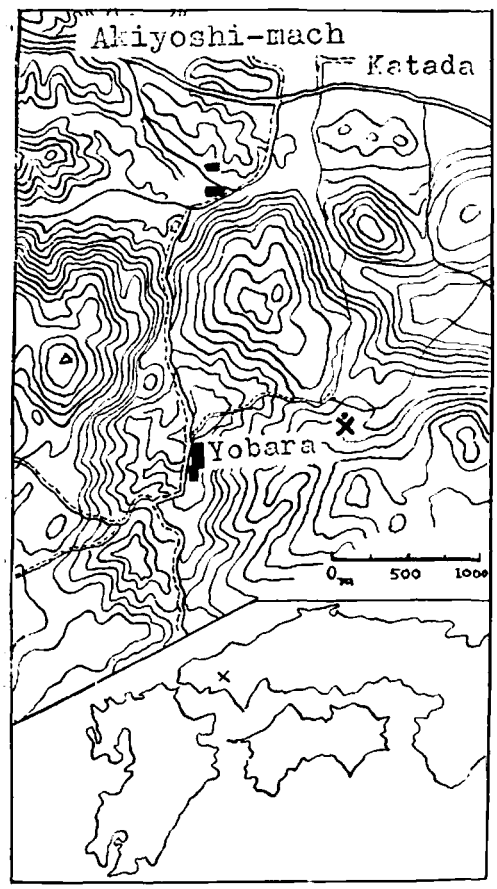
Conodont Fauna and its Geologic Age

The material was collected from the abandoned quarry named Uzura at Yobara, Ofuku, Yamaguchi Prefecture, southwestern Japan (Text-fig. 1). Limestone cropped out in this quarry is highly fossiliferous, pale gray and massive to bedded. It abundantly yields brachiopods, corals, smaller foraminifera and many other fossils. We have found the following conodonts, namely:—*Hindeodella sakagamii* IGO and KOIKE, *Synprioniodina* sp., *Ligonodina hanaii* IGO and KOIKE, *Lonchodus* sp., *Lonchodina akiyoshiensis* IGO and KOIKE, n. sp., *Lon-*



Text-fig. 1. Maps showing the locality.

chodina ? sp. A, *Lonchodina* sp., *Hindeodus imperfectus* (REXROAD), *Ozarkodina orientale* IGO and KOIKE, *Spathognathodus minutus* (ELLISON), *Gnathodus opimus* IGO and KOIKE, *Gnathodus commutatus* (BRANSON and MEHL) *nagatoensis* IGO and KOIKE, n. subsp., and other fragmentary indeterminable genera.

This conodont fauna is very similar to the Omi conodont fauna which was described by IGO and KOIKE (1964) but as will be discussed below there can be recognized some differences between both faunas. *Hindeodella sakagamii*, *Lonchodina hanaii* and *Ozarkodina orientale* are common species in both faunas. *Gnathodus opimus* and *Gnathodus commutatus nagatoensis* are very abundant and characteristic species in the Akiyoshi fauna, but they are rare in the Omi. *Lonchodus* sp., *Lonchodina* ? sp. A, *Lonchodina* sp., *Lonchodina akiyoshiensis* and *Spathognathodus minutus* are not so common in this fauna, but they have never been found in the Omi fauna. The genera *Streptognathodus* and *Idiognathodus* are characteristic in the Omi fauna, particularly the former, but both genera have never been obtained from the Akiyoshi fauna. The species of *Hindeodella* and *Synprioniodina* are rather common in the Omi fauna, but they are rare in Akiyoshi.

The geologic age of the representing fauna is an important problem. YANAGIDA (op. cit.) described many brachiopods from the same locality, although the brachiopod-bearing horizon is slightly below the conodont rich horizon. According to his extensive paleontological work, these brachiopods are similar to those of European and Asian upper Lower Carboniferous (Viséan), such as, *Phricodothyris insolita* GEROGE, *Brachythyris akiyoshiensis* YANAGIDA, *Spirifer* aff. *liangehowensis* CHAO, *Spirifer* sp., *Cleiothyridina expansa* (PHILLIPS), *Cleiothyridina royssii* (L'EVEILÉ), *Actinoconchus planosulcata* (PHILLIPS), *Composita* aff. *argentea* (SHEPARD), *Dielasma* cfr. *kingi* DE KONINCK, *Dielasma* sp., *Yanishewskiella japonica* YANAGIDA, *Pugnax* aff. *sulcatus* (SOWERBY) and *Schizophoria* aff. *resupinata* (MARTIN).

YAMAGIWA and OTA (1964) described the following corals, namely:—*Stylidophyllum ozawae* YAMAGIWA and OTA, *Clisiophyllum awa* (MINATO), *Clisiophyllum* sp., *Lonsdaleoides toriyamai* MINATO and *Lophophyllidium uzurensis* YAMAGIWA and OTA. Although they did not

discuss the geologic age of the coral fauna, it has close similarities to those from the lower part of the Middle Carboniferous (the *Millerella* to *Profusulinella* Zones) in southwestern Japan.

As already discussed by the writers, the Omi conodont fauna was thought to be Early Pennsylvanian or Late Namurian in age, and not younger than Middle Pennsylvanian. The Omi conodont fauna are lacking the typical Mississippian genera and species. The Akiyoshi fauna is also avoided the characteristic Mississippian conodont genera, but some of the species are related to the highest Mississippian (Chesterian) species of North America. *Hindeodus imperfectus* is not so many in this fauna but it has been repeatedly described from the Chesterian of the upper Mississippi Valley region. According to COLLINSON, SCOTT and REXROAD (1962) this species ranges up to the top of the Kinkaid Limestone. *Spathognathodus minutus* is a long ranging species in the Pennsylvanian (ELLISON, 1941, STURGEN and YOUNGQUIST, 1949 etc.). *Ozarkodina orientale* is similar to the Chesterian species of *O. compressa* REXROAD. *Lonchodina akiyoshiensis* resembles *L. furnishi* REXROAD which was described from the Glen Dean Formation of the type Chesterian in the upper Mississippi Valley region. *Gnathodus opimus* is related to *G. roundyi* which has been known from the various localities of the Desmoinesian in North America. It also has some similarities to *Gnathodus girtyi* which was described from the Mississippian Barnet Formation in Texas (HASS, 1953). The Mississippian species of *Gnathodus texanus* ROUNDY and the cosmopolitan species of *G. mosquensis* PANDER are also allied species to our specimens. *Gnathodus commutatus nagatoensis* resembles the several subspecies of *G. commutatus* described from the Mississippian and Namurian in North America and Europe.

As mentioned above the present fauna is consisting of both Upper Mississippian (Chesterian) and Pennsylvanian species or allied ones. On the other hand, entire lacking of *Streptognathodus* and *Idiognathodus* is never overlooked to consider the geologic age of this fauna. The mentioned genera are very characteristic and prominent in the Omi Limestone. From these faunal characters we became to conclude that the Akiyoshi conodont fauna is slightly older than the Omi fauna and considered to be the earliest Pennsylvanian or latest Mississippian in age. There is, however, stronger possibility of the earliest Pennsylvanian age of this fauna rather than of the Mississippian.

Description of Species

Genus *Hindeodella* BASSLER, 1925

Hindeodella sakagamii IGO and KOIKE

Pl. 8, figs. 1, 2

Hindeodella sakagamii IGO and KOIKE, 1964, *Pal. Soc. Japan, Trans. Proc., n.s.*, no. 53, p. 184, pl. 27, figs. 1, 2.

Comparison:—All specimens at hand are quite identical to the Omi specimens and we could not find any remarkable difference. Further description seems to be unnecessary.

Reg. nos. 23090, 23091.

Genus *Synprioniodina* ULRICH and BASSLER, 1926

Synprioniodina sp.

Pl. 8, fig. 9

Two bars meet forming an angle of about 40 degrees in common plane. Posterior bar thin, laterally compressed, rather high and having sharply edged aboral side. Denticles subequal in size throughout, sharply pointed, almost erect or slightly angled anteriorly, fused at base and deeply penetrated into bar. Anticusp short, having coalesced and anteriorly inclined denticles. Main cusp thin, sharply pointed, directed anteriorly. Aboral side of bar distinctly grooved. Pulp cavity beneath main cusp deep, conical and with moderately elevated flare.

Comparison:—This indeterminable species resembles *Synprioniodina microdenta* ELLISON, but the former has higher posterior bar and subequal posterior denticles. *Synprioniodina collinsoni* IGO and KOIKE is also allied species, but the denticles of the posterior bar and anticusp are dissimilar in shape. The American Chesterian species of *Synprioniodina denticamura* REXROAD and LIEBE is very similar to our *S.* sp., but owing to the incomplete Akiyoshi material detailed comparison is difficult.

Reg. no. 23092.

Genus *Ligonodina* BASSLER, 1925

Ligonodina hanaii IGO and KOIKE

Pl. 8, fig. 13

Ligonodina hanaii IGO and KOIKE, 1964, *Pal. Soc. Japan, Trans. Proc., n. s.*, no. 53, p. 186, pl. 28, figs. 21, 22.

Comparison:—The Akiyoshi specimens are quite identical to the Omi specimens and no further description is necessary. As already pointed out by IGO and KOIKE this species resembles *Ligonodina typa* (GUNNELL). It also resembles *Ligonodina abbreviata* YOUNGQUIST and HEEZEN described from the Early Pennsylvanian shale, Knoxville, Iowa.

Reg. no. 23093.

Genus *Lonchodus* PANDER, 1856

Lonchodus sp.

Pl. 8, fig. 11

Imperfect bar straight, laterally compressed, slightly curved inward and having very thin posterior end. Aboral side distinctly grooved. Denticles long, discrete, laterally compressed, almost erect or slightly directed posteriorly, having sharp edges antero-posteriorly and sharply pointed tip.

Comparison:—Many similar fragmentary bars have been described and illustrated from the various Lower Pennsylvanian and Upper Mississippian rocks. *Lonchodus* ? sp. came from Knoxville, Iowa (YOUNGQUIST and HEEZEN, 1948) and ELLISON's (1941) indeterminable specimen (Pl. 20, fig. 28) are similar to our specimens.

Reg. no. 23094.

Genus *Lonchodina* BASSLER, 1925

Lonchodina ? sp. A

Pl. 8, fig. 15

Unit consisting of two bars forming about right angle. Anterior bar rather long, thin, and with five denticles. Anterior denticles discrete, sharply pointed, rounded in cross section, almost erect or curved posteriorly and inward. Main cusp not so large, circular in transverse section. Posterior denticles large, slightly curved posteriorly, flattened and with sharp edges antero-posteriorly. Number of posterior denticles may be one or two. Pulp cavity large, located beneath main

cusp, conical and rather sharrow, surrounded by slightly expanded flare. Aboral side of bar distinctly grooved.

Comparison:—*Lonchodina* ? sp. A is similar to *Lonchodina* ? *nipponica* IGO and KOIKE described from the Omi Limestone, but the present indeterminable species has different main cusp and posterior denticles. It also closely resembles *Lonchodina* ? *panderosa* ELLISON, but our specimens have different shape of the denticles. This species seems to be new to science but denomination is reserved until more numerous materials are accumulated.

Reg. no. 23095.

Lonchodina akiyoshiensis IGO and KOIKE, n. sp.

Pl. 8, figs. 8, 10, 12, 14

Bar thin, blade-like, consisting of anterior and posterior bars meeting at an angle of 120 degrees. Anterior bar long and rather high and with sharp anterior end. Anterior denticles six to seven in number, laterally compressed, somewhat curved posteriorly and most of them equal in size, with sharp edges fore and aft and coalesced at base. Main cusp parallel to anterior denticles and having elevated median ridge continuing to expanded triangular flare. Posterior bar shorter than anterior bar. Posterior denticles variable in size and shape, three or four in number, thin, sharply pointed and almost erect to base of bar. Pulp bavity large and sharrow. Aboral side of bars with deep groove extended from pulp cavity.

Comparison:—*Lonchodina akiyoshiensis* resembles *Lonchodina furnishi* REXROAD described from the Glen Dean Formation (Chesterian) of Illinois and others, but the American species has larger main cusp than our form.

Reg. nos. 23096 (holotype), 23097-23099.

Genus *Hindeodus* REXROAD and FURNISH, 1964

Hindeodus imperfectus (REXROAD)

Pl. 8, figs. 3-5, 7

Trichonodella imperfecta REXROAD, 1957, *Illinois Geol. Surv. Rep. Inv.*, 199, p. 41, pl. 4, figs. 4, 5; REXROAD, 1958, *Ibid.*, 209, p. 26, pl. 4, fig. 6.

Elsonella ? *imperfecta* REXROAD and COLLINSON, 1961, *Illinois Geol. Surv., Circ.*, 319, p. 6; REXROAD and BURTON, 1961, *Jour. Pal.*, vol. 35, p. 1152, pl. 141, fig. 1.

Hindeodus imperfectus REXROAD and FURNISH, 1964, *Ibid.*, vol. 38, p. 672, pl. 111, figs. 13, 14.

Lateral bars in one plane or very slightly twisted, thin and blade-like, meet at approximately 120 degrees beneath main cusp. Aboral side of bars slightly concave downward, sharply edged and not grooved. Denticles in both bars eight to nine in number and more or less variable in size and number, and generally smaller adjacent to main cusp and distal end, circular in cross section and sharply pointed, whose anterior surface flat and posterior surface convex posteriorly. Pulp cavity small, conical and shallow with faint elevation of flare on posterior side of main cusp but depressed on opposite side.

Comparison:—The Akiyoshi specimens are quite similar to the American Chesterian specimens and no remarkable difference can be recognized.

Reg. nos. 23100-23103.

Genus *Ozarkodina* BRANSON and MEHL, 1933

Ozarkodina orientale IGO and KOIKE

Pl. 9, figs. 14, 15

Ozarkodina orientale IGO and KOIKE, 1964, *Pal. Soc. Japan, Trans. Proc., n. s.*, no. 53, p. 187, pl. 27, figs. 21-23.

Comparison:—The Akiyoshi material is similar to the Omi specimens which were illustrated in Text-fig. 3 on plate 2 (IGO and KOIKE, 1964), but it differs from the latter in weaker elevation of flaring lip and larger main cusp. The mentioned biocharacter is closely related to *Ozarkodina compressa* REXROAD described from the Kinkaid Limestone, uppermost Chesterian in Illinois.

Reg. nos. 23105, 23106.

Genus *Spathognathodus* BRANSON and MEHL, 1941

Spathognathodus minutus (ELLISON)

Pl. 9, figs. 16-18

Spathodus minutus ELLISON, 1941, *Jour. Pal.*, vol. 15, p. 120, pl. 20, figs. 50-52.

Spathognathodus minutus ELLISON and GRAVES, 1941, *Missouri Univ. Sch. Mines, Metall., Bull., Tech. Ser.*, vol. 14, no. 3, p. 3-4, pl. 2, figs. 1, 3, 5; YOUNGQUIST and DOWNS, 1949, *Jour. Pal.*, vol. 23, p. 169-170, pl. 30, fig. 4; STURGEON and YOUNGQUIST, 1949, *Ibid.*, vol. 23, p. 385, pl. 74, figs. 9-11; pl. 75, fig. 19.

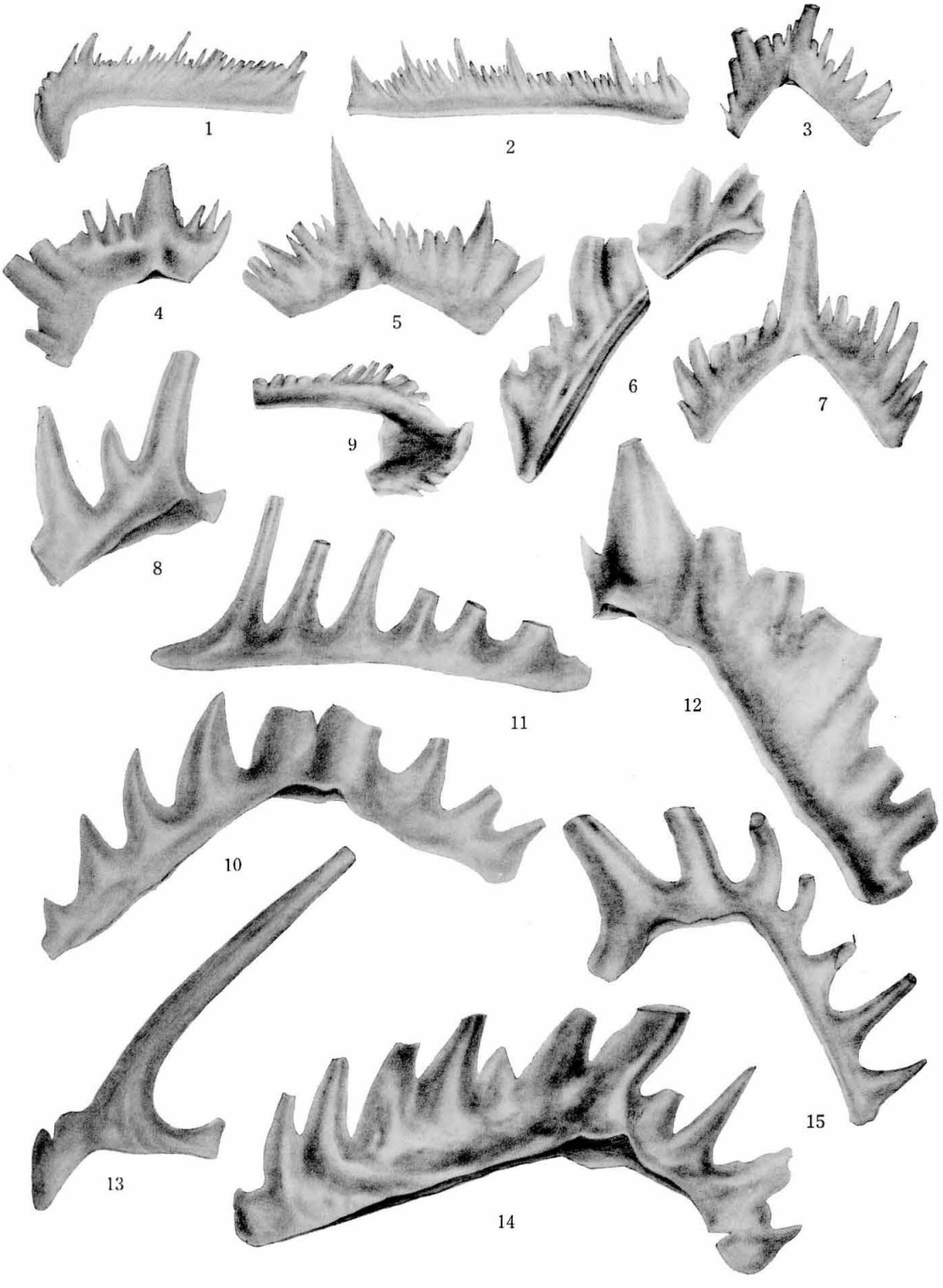
Blade short, thin, laterally straight and with arched aboral side and sharply edged anterior and posterior ends. Denticles coalesced, laterally compressed, with sharply pointed tips, variable in size and shape, and become smaller toward both anterior and posterior ends. Posterior denticles chevron-like, nine to ten in number. Anterior denticles three in number, small in size. Main cusp large, erect to slightly directed anteriorly. Pulp cavity near posterior end of blade, large, expanded with the deepest point at slightly posterior of main cusp. Aboral side of anterior part of blade grooved.

Comparison:—Our specimens are iden-

Explanation of Plate 8

(All figures ×75 except for fig. 6)

Figs. 1, 2. *Hindeodella sakagamii* IGO and KOIKE
1, inner lateral view; 2, outer lateral view.
Figs. 3-5, 7. *Hindeodus imperfectus* (REXROAD)
3, 4, outer lateral views; 5, inner lateral view; 7, outer lateral view.
Fig. 6. *Lonchodina* sp.
6, inner lateral view, ×37.
Figs. 8, 10, 12, 14. *Lonchodina akiyoshiensis* IGO and KOIKE, n. sp.
8, 10, outer lateral views; 12, inner lateral view; 14, inner lateral view of the holotype.
Fig. 9. *Synprioniodina* sp.
inner lateral view.
Fig. 11. *Lonchodus* sp.
outer lateral view.
Fig. 13. *Ligonodina hanaii* IGO and KOIKE
inner lateral view.
Fig. 15. *Lonchodina* ? sp. A
outer lateral view.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tical to the ELLISON's specimens and also to other American specimens. Compared with the ELLISON's holotype, the Japanese specimens have slightly fewer number of the posterior denticles.

Reg. nos. 23107-23109.

Genus *Gnathodus* PANDER, 1856

Gnathodus opimus IGO and KOIKE

Pl. 9, figs. 1-8

Gnathodus opimus IGO and KOIKE, 1964, *Pal. Soc. Japan, Trans. Proc., n.s.*, no. 53, p. 189, pl. 28, figs. 15-18.

Comparison:—The Akiyoshi specimens slightly differ from the holotype of Omi. Species of *Gnathodus* are very variable in the ornamentation and shape of cup. Some of the Akiyoshi specimens have three parallel node-like ridges including carina continued from blade. The development of these ridges along carina are very variable as illustrated in the plate. Therefore we treated these biocharacters as an intraspecific variability. *Gnathodus girtyi* HASS has three parallel ridges but our species is lacking transversely developed nodes. *Gnathodus roundyi* GUNNELL is also similar to our species.

Reg. nos. 23110-23117.

Gnathodus commutatus (BRANSON and MEHL) *nagatoensis* IGO and KOIKE, n. subsp.

Pl. 9, figs. 9-13

Axis straight to slightly curved inward. Denticles of carina fused, node-like with obtuse tip or subtriangular shape in lateral view. Cup widest in almost middle, asymmetrical its and outerside slightly wider than inner side. Height of cup gradually decrease posteriorly. Oral surface of cup smooth in some specimens or ornamented by two low nodes adjacent to carina anteriorly in other specimens. Blade thin, laterally compressed, slightly longer than carina. Denticles of blade fused, increase in size to near anterior end. Each denticles has sharp-edged tip. Aboral side of blade sharply edged with fine groove merged into expanded pulp cavity. Apex of pulp cavity located at same point of widest part of cup.

Comparison:—This new subspecies of *Gnathodus commutatus* differs from other subspecies of *commutatus* in the lateral view of the cup. Summit line of *Gnathodus commutatus* (s. l.) in lateral view is usually straight or substraight, but our subspecies has arched summit line and shows narrow node-like carina on cup.

Reg. nos. 23120 (holotype) 23118, 23119.

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Explanation of Plate 9

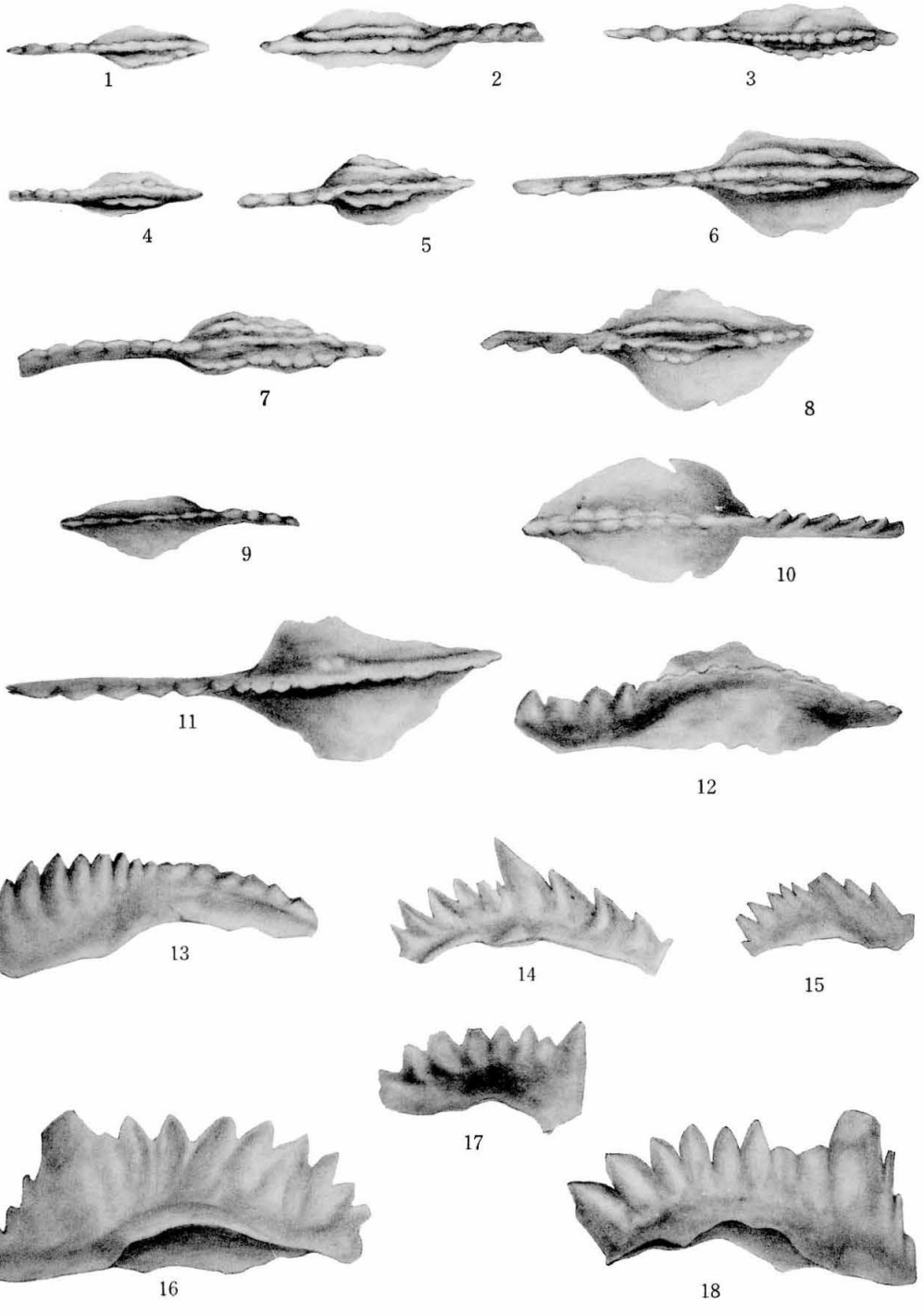
(All figures ×75)

Figs. 1-8. *Gnathodus opimus* IGO and KOIKE
1-8, oral views.

Figs. 9-13. *Gnathodus commutatus* (BRANSON and MEHL) *nagatoensis* IGO and KOIKE, n. subsp.

Figs. 14, 15. *Ozarkodina orientale* IGO and KOIKE
14, outer lateral view ; 15, inner lateral view.

Figs. 16-18. *Spathognathodus minutus* (ELLISON)
16-18, outer lateral views.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Yobara 江　原　　Ofuku 於　福

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 59, pp. 92-109, pls. 10, 11, Sept. 30, 1965

491. SOME FOSSIL *ANADARA* FROM SOUTHWEST JAPAN*

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西南日本の化石種 *Anadara* について：*Anadara takaoensis*, *Anadara tricenicosta*, *Anadara suzukii* を含めて *Anadara suzukii* group としそれぞれの層準及び分類上の検討をし此の group に伴う 7 種を記載した。7 種のうち新亜属 1, 新種 3 を含む。 野 田 浩 司

Introduction

The younger Neogene deposits of Japan are characterized by two marine faunas; the Oyashio type or Onma-Manganzi Fauna of OTUKA (1936) and the Kuroshio-type or Kakegawa Fauna of MAKIYAMA (1927). These two types of fauna are also well shown in the species of the Genus *Anadara*. The *Anadara* (*Scapharca*) *suzukii* group is restricted to and is characteristic of the latter type of fauna whereas the *Anadara* (*Anadara*) *amicula* and *Anadara* (*Anadara*) *tatunokutiensis* group are significant to the former type of fauna. The present article treats the *Anadara* (*Scapharca*) *suzukii* group.

In 1926, YOKOYAMA (1926a, p. 368) described *Arca suzukii* from the Tonohama Formation in Kochi Prefecture and in 1928 YOKOYAMA (1928, p. 103) recorded and illustrated *Arca philippiana* from the upper part of the Byoritsu Formation in Formosa.

Recently, those two species of YOKOYAMA were included into the synonymy of *Anadara* (*Scapharca*) *tricenicosta* by MAKIYAMA (1958, pl. 54) without comments on their characters. However, since some problems concerning them seem to exist, the writer made an attempt to interpret the stratigraphic ranges of those species and to correlate the *Anadara* (*Scapharca*) *suzukii* group with other related species which are associated with above group of Arcids from Formosa, Okinawa and Japan. Based upon the abundant specimens of the group now stored in the Institute of Geology and Paleontology, Tohoku University, Sendai from the various localities distributed in Formosa, Okinawa Island and Japan, the present study was undertaken. This article is the outgrowth of part of the study on the Japanese Arcidae, fossil and Recent. The other group or groups of *Anadara* will be reserved for another opportunity.

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Remarks on the *Anadara* (*Scapharca*) *suzukii* group

The *Anadara* (*Scapharca*) *suzukii* group in this article includes *Anadara* (*Scapharca*) *tricenicosta* (=*Scapharca philippiana*) and *Anadara* (*Scapharca*) *suzukii* both of which were reported by YOKOYAMA (1926a, 1928) from the Tonohama Formation in Kochi Prefecture and *Anadara* (*Scapharca*) *takaoensis* of YABE and HATAI (1942) from the Nakoshi Sandstone of Okinawa Island, a stratigraphic unit defined by MACNEIL (1960). These three species resemble one another very closely morphologically and are thus considered to be related with each other. *Anadara* (*Scapharca*) *tricenicosta* occurred abundantly from the Tokazan Formation in Formosa and Naganuma Formation in Kanagawa Prefecture. As living, this species is distributed in the southwestern Sea of Japan, around the Ryukyu Islands, Formosa, the Chinese Sea and in the Indo-Pacific Ocean.

Anadara (*Scapharca*) *suzukii* is known to occur from the Takanabe Formation in Miyazaki Prefecture, Ananai Formation in Kochi Prefecture, Dainichi Formation in Shizuoka Prefecture and from the Nakoshi Sandstone in Okinawa Island. *Anadara* (*Scapharca*) *takaoensis* is originally from the Kaizan Bed in Formosa and is also recorded from the Nakoshi Sandstone in Okinawa Island.

The Tokazan Formation in the northern part of Formosa is underlain with the Takuran Formation which yielded *Pecten* (*Notovola*) *javanus* MARTIN, *Pecten* (*Notovola*) *naganumanus* YOKOYAMA, *Conchocele nipponica* (YABE and NOMURA) and consists mainly of sandstone and conglomerate. It is distinguished into the Kozan and Kaenzan facies according to the prevalence of sandstone or conglomerate. The Kozan facies is chiefly of loose silty sandstone with intercalated clayey shale, conglomerate, pyrite nodules, carbonized drift woods, reef limestones and has yielded mammals, mollusks, echinoids and foraminifers. Most of the species of the molluscan fossils from the Kozan facies have been described by YOKOYAMA (1928) and NOMURA (1933) as representing the Byoritsu Bed. Among them, some interesting Arcids such as *Anadara* (*Scapharca*) *tricenicosta*, *Anadara* (*Tosarca*) *sedanensis*, *Tricidos kiyonoi*, *Hawaiarca uwaensis* and *Striarca interplicata* (=*Striarca yokoyamai*) are known from this facies. Recently, SHUTO (1961) from the results of his palaeontological studies of the Miyazaki Group in

Kyushu, southwestern Japan, correlated the Byoritsu Bed (=Kozan facies of CHANG, 1958) to his *Amussiopecten praesignis-Granulifusus dualis* Zonule (=his 4th to 6th horizon of the Miyazaki Group) based upon the characteristic molluscan fossils.

Furthermore, SHUTO (1961) extended his study on the molluscan fossils to correlate the formations of Pliocene age distributed along the Pacific borderland of southwestern Japan listing the species in common from the isolated area as Indonesia, Formosa, Okinawa, Miyazaki, Kochi, Kakegawa and the Kwanto regions.

In 1961, TSUCHI from his studies on the fossil molluscs independently arrived to the same conclusion as SHUTO. The results of their works have been accepted in general by many paleontologist in Japan.

Considering the mammal fossils, *Stegodon sinensis*, *Stegodon orientalis*, *Parelephas trogontherii*, *Elephas* sp., *Rhinoceros* sp., *Cervus* (*Sika*) *taiouanus*, *Cervus* (*Deperetia*) *kazusensis* and *Bibos geron* have been reported by RIN (1935) and CHANG (1958) from the facies transitional to the Kaenzan from the Kozan. The same facies has yielded abundant marine fossils as above mentioned, and the mammal yielding horizon is associated with *Anadara* (*Tegillarca*) *granosa* (LINNAEUS). Those mammal fossils are according to TAKAI (1963), commonly known from the Pleistocene sediments in Japan.

To make a comprehensive study on the fossil molluscs, another problem arises as to whether Tokazan Formation is Pliocene or Pleistocene. Many of the molluscan fossils, particularly the important ones from the so-called Byoritsu Bed are characteristic Pliocene forms as already pointed out by YOKOYAMA (1928), NOMURA (1933), NOMURA (1937), SHUTO (1961) and TSUCHI (1961), but on the other hand most of the fossil mammals indicate the Pleistocene age, and it is interesting that they are from the upper part of the Tokazan Formation. In 1958, CHANG summarized the stratigraphy of Formosa and he stated that the Tokazan Formation can be divided into two facies of the Kozan and Kaenzan based on the characteristic lithology and he pointed out that the former facies occupies a position somewhat lower than of the latter stratigraphically. He also stated that the former is superposed with discontinuity or merges into the facies of the upper part of the Kaenzan. Moreover, CHANG considered that the lower Tokazan Formation may be Pliocene whereas the upper is Pleistocene based upon the paleontological evidence. This view was previously held by OTUKA in 1935 even though he did not express a strong opinion at that time. This problem on the boundary between the Pliocene and Pleistocene is reserved for another opportunity. Without solving this problem, one cannot expect to undertake correlation of strata on a widespread scale as along the southwestern borderland of the Pacific Ocean.

The Nakoshi Sandstone which yielded *Anadara* (*Scapharca*) *takaoensis*, *Anadara* (*Scapharca*) *suzukii* and *Anadara* (*Tosarca*) *sedanensis* in the northwestern part of the Okinawa Island was well described by MACNEIL (1960). This stratigraphic unit overlies the Shimajiri group with unconformity and is covered with Naha Limestone, a unit that was once considered to be equivalent with the Ryukyu Limestone by HANZAWA (1935). This sandstone yielded abundant marine molluscan fossils as already reported by NOMURA and ZINBO (1936), YABE and HATAI (1942) whom believed it to be the

Shimajiri Bed of HANZAWA (1935) and of MACNEIL (1960). *Anadara* (*Scapharca*) *takaoensis* from the Nakoshi Sandstone is associated with *Anadara* (*Scapharca*) *suzukii*. These two species closely resembles *Anadara* (*Scapharca*) *tricenicosta* in surface sculpture except for the number of radial ribs and size, as will be discussed later.

The younger Neogene formations distributed along the Pacific borderland of southwest Japan are developed in the Miyazaki Basin of eastern Kyushu, the southwestern part of Kochi Prefecture and from the Kakegawa district in Shizuoka Prefecture northwards to the Kwanto region. These Neogene deposits are represented by the Takanabe, Ananai and Dainichi Formations respectively, and have yielded some extinct *Anadara* species which are only restricted to this area. These younger strata (Pliocene) are aligned parallel to the Median Line already mentioned by OTUKA (1931).

The molluscan fossils from the Takanabe Formation were studied by YOKOYAMA (1928a), OTUKA (1930), ITOIGAWA (1953) and SHUTO (1952-1964). In addition to the molluscan fossils, OTUKA (1932) reported *Stegodon* from the Takanabe Formation; This mammal is generally accepted as an index fossil of the Pliocene age and its name is *Stegodon bombifrons* according to TAKAI (1963). OTUKA (1931) and SHUTO (1958) expressed the view that this elephant horizon is of Pliocene age. SHUTO (1961) summarized the biostratigraphy of the Miyazaki Basin and established faunal zonules, and among them his 4th to 6th were stated to be Pliocene in age. Lithologically, the thick medium grained sandstone of the lower part of the Takanabe Formation grades downwards into a tuff bed which is superposed on a homogenous massive mudstone which is correlated with the Miocene Tsuma Formation. OTUKA (1930) considered the relation between his Takanabe Formation and Tsuma Formation to be an unconformity that is indicated by the lithofacies and general geostructure which had been influenced by an epeirogenetic movement, probably concerned with the movement of the Median Line. Such stratigraphic relationship is also observed in Kochi Prefecture where the Ananai Formation lies upon the Nobori or Nahari Formations with clinounconformity, and where the Kakegawa Group overlies on the Sagara Group with unconformity. Generally, the Japanese Miocene can be distinguished from the early Pliocene by several important features as already pointed by HATAI (1960). "Almost everywhere as known at present, there exsists a stratigraphical break between the two (Miocene and Pliocene) or evidence for diastrophism when the relation is conformable. Frequently, volcanic activity accompanies the sediments superposed upon the unconformity or associated with eustatic movement, whether the sediments are terrestrial, brackish or marine, while immediately below it or the uppermost limit of the late Miocene evidences for regression can be often recognized but without intense volcanism". The same relation from faunal consideration was attained by SHUTO (1961) and TSUCHI (1961). Further significant works on the problem are the Umbonidae by SUZUKI (1934), SUGIYAMA (1935, 1935a) and MAKIYAMA (1924), on the phylogeny and evolution of the *Turritella* by KOTAKA (1969), on the Pectinidae by MASUDA (1962), *Siphonalia* by MAKIYAMA (1941) and on the Veneridae by SHUTO (1957). The results of studies on those fossils clarified their geological ranges and relationship with the different strata in which they occur. The examined *Anadara* species show chronological ranges

TABLE 1. TABLE SHOWING CORRELATION OF MOLLUSCA ZONES AND STRATIGRAPHIC UNITS

MAKIYAMA (1924)	UMBONIUM ZONE	UMBONIUM SUBSUCHIENSE ZONE	MYSTICUM ZONE
SHUTO (1961)	SIPHONALIA DECLIVIS ZONE		
SHUTO (1961)	VENERICARDIA PANDA ZONE		
SHUTO (1961) MASUDA(1962)	AMUSSIOPECTEN PRAESIONIS ZONE		
KOTAKA (1959)	TURRITELLA PERTEREBRA ZONE		
NODA (1965)	ANADARA SUZUKII ZONE		
FORMOSA (CHANG, 1958)	KOZAN FACIES OF THE TOKAZAN FORMATION	TAKURAN FORMATION OF THE MIAOLI GROUP	
OKINAWA (MACNEIL, 1960)	NAKOSHI SANDSTONE		
MIYAZAKI (OTUKA, 1930-31. SHUTO, 1958, 61)	TAKANABE FORMATION		
SHIKOKU (KATTO et al. 1953. KATTO & OZAKI, '55)	ANANAI FORMATION		
KAKEGAWA (MAKIYAMA & SAKAMOTO, 1958)	NANGO SAND MUD ALTERNATION	HOSOYA SILTST.	TENNO SANDST. DAINICHI SANDST.

given in the Table 1 in comparison with other groups.

An examination was made on the Arcid specimens of the *Anadara* group collected from the Tokazan, Nakoshi, Takanabe, Ananai and Dainichi Formations. Measurements were made on those specimens as shown in Figure 1.

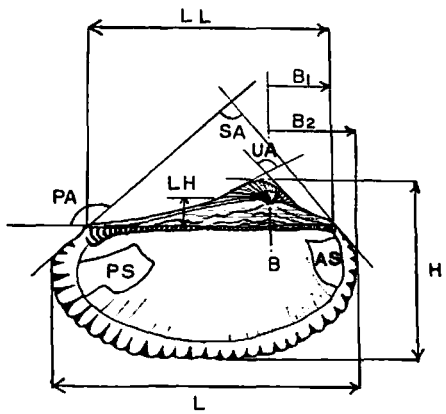

Fig. 1. Key to symbols used in descriptions of *Anadara* species based on *Anadara* (*Scapharca*) *tricenicosta* (NYST). Recent.

AS: Anterior muscle scar
B: Beak
B_1: Position of beak from anterior end of ligament, defined as beak/ligament length
B_2: Position of beak from anterior end of shell, defined as beak/shell length
H: Shell height
L: Shell length
LH: Height of ligament
LL: Length of ligament
PA: Angle between hinge line and posterior end of shell
PS: Posterior muscle scar
SA: Angle between anterior and posterior ends of shell
UA: Umbonal angle

Measurements were made on 18 individuals of *Anadara* (*Scapharca*) *suzukii* from the Ananai Formation and four from the Dainichi Fossil Zone. Seventy

individuals of *Anadara (Scapharca) tricenicosta* from the Tokazan Formation and eight Recent specimens from Wakanoura Bay, Wakayama Prefecture and from the coast of Tateyama, Chiba Prefecture were examined in detail. The details of 11 individuals of *Anadara (Scapharca) takaoensis* from the Nakoshi Sandstone, Okinawa Island were also studied. The statistical treatments of the specimens above mentioned are shown in Figs. 2-4.

Judging from Fig. 2 and 3, some differences is recognized between the specimens of *Anadara (Scapharca) tricenicosta* mainly from Formosa and of *Anadara (Scapharca) suzukii* from the Japanese Islands. Recently, MAKIYAMA (1958) placed *Arca suzukii* of YOKOYAMA in the synonymy of *Anadara (Scapharca) tricenicosta*. The name of *Anadara philippiana suzukii* was first used by MAKIYAMA and SAKAMOTO (1955) for the specimens derived from the Nango sandstone and mudstone alternation beds, Kakegawa district. TSUCHI (1961) used

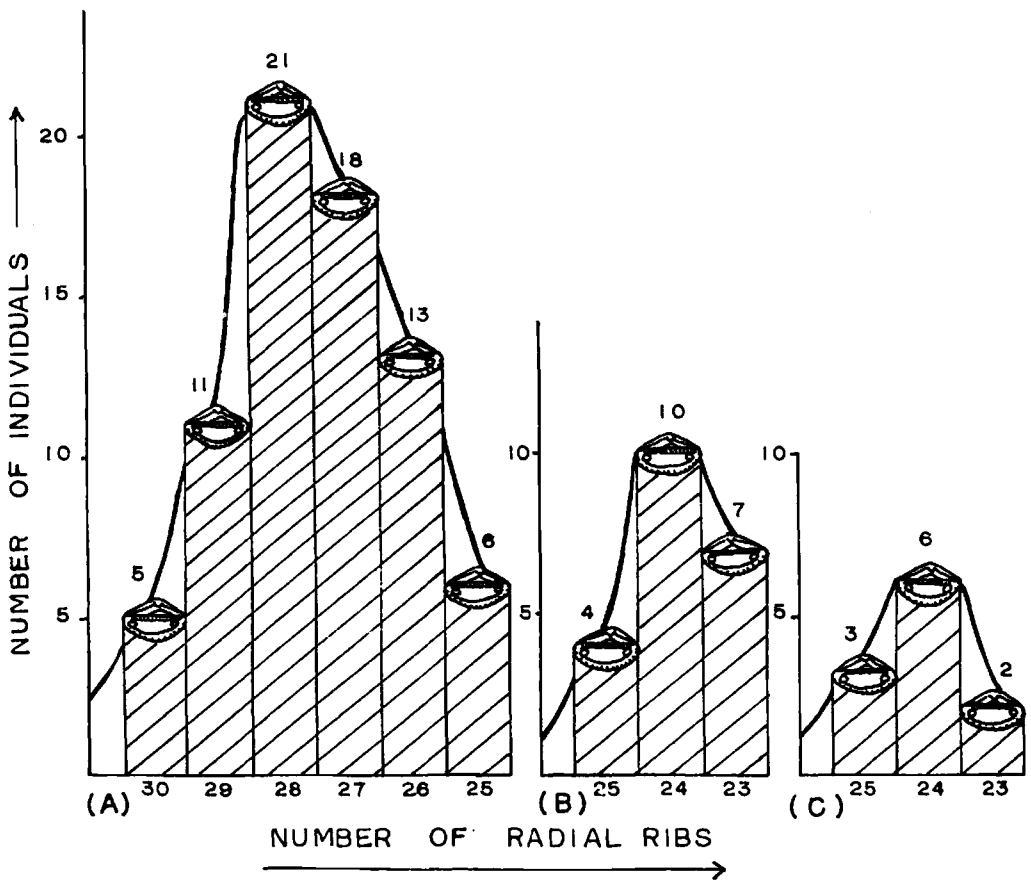

Fig. 2. The relation between the number of radial ribs in the different species: (A). *Anadara (Scapharca) tricenicosta* (NYST), (B). *Anadara (Scapharca) suzukii* (YOKOYAMA), (C). *Anadara (Scapharca) takaoensis* (NOMURA).

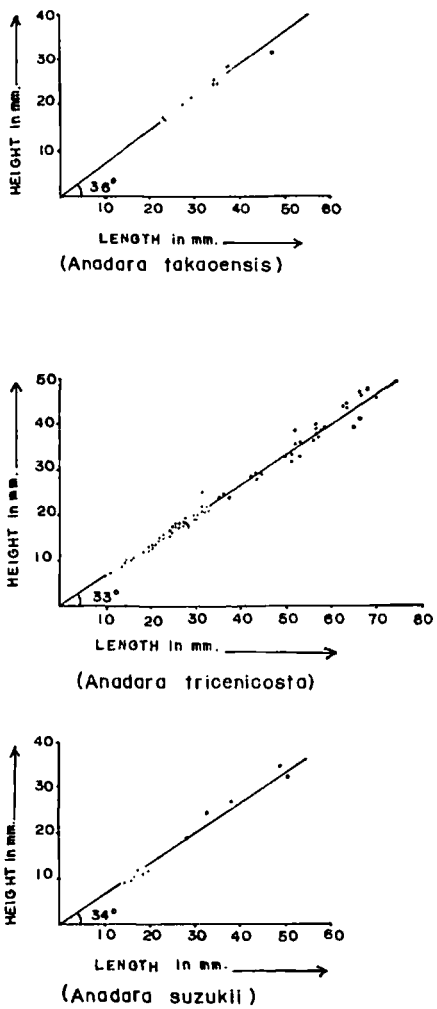

Fig. 3. The size variation in each species and the angle between the height and length of the shells.

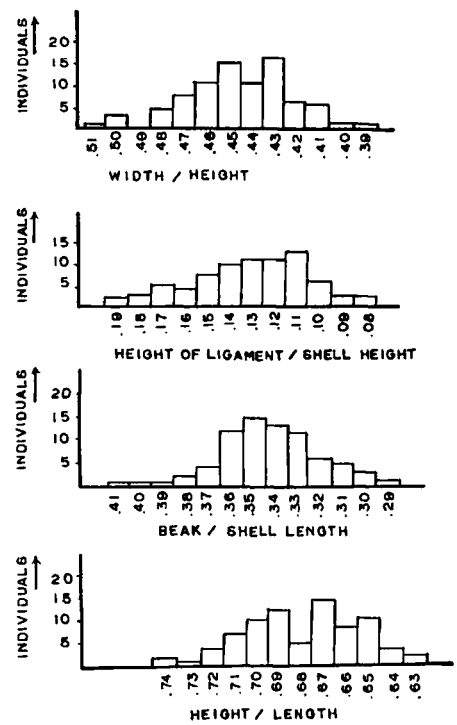

Fig. 4. Figures showing the different statistical relations observed in *Anadara* (*Scapharca*) *tricenicosta* (NYST).

the name of *Anadara tricenicosta suzukii* for the specimens yielded from the Takanabe Formation and his Kechienjian stage. Both names may be safely considered as homonyms. Difference between them is size; *Anadara* (*Scapharca*) *tricenicosta* from the Tokazan Formation has a maximum length of 70 mm. and height of 48 mm., while *Anadara* (*Scapharca*) *suzukii* from Japan shows a maximum length of 49 mm. and height 35 mm. This seems to be an example of size increase with the lapse of time. SCHENCK and REINHART (1938) mentioned that the increase in size of the adult specimens is doubtless too indefinite to have exact time value, but a trend from small to large is nevertheless an hypothesis worth testing. Besides the difference in size of the shells, as noticed from Fig. 2, the number of radial ribs are different. This is a very important specific character and generally employed in the distinction of the species of the genus *Anadara*. Most common number of radial ribs of *Anadara* (*Scapharca*) *tricenicosta* from the Tokazan Formation is 28, whereas

in the Japanese species of *Anadara* (*Scapharca*) *suzukii* the number is 24. This difference is very important one. Some Recent specimens from Wakanoura Bay and the coast of Tateyama have 27-28 radial ribs and in this respect they are allied to the Formosan specimens. It may be added that they are also related therewith in size variation.

Accordingly, the Tokazan species is closely allied to the Recent one from Japan, though there are some differences compared with *Anadara* (*Scapharca*) *suzukii*. As SCHENCK and REINHART (1938) pointed out the number of radial ribs is the same from the immature to the adult or gerontic form in the Recent *Anadara bisenensis* (1938, p. 45, table 10) studied by them. The similar feature is observed on *Anadara* (*Scapharca*) *subcrenata* from the Ariake Sea, Fukuoka Prefecture as shown in Table 2. This is shown by the series of growth stages of the specimens cultured by the Ariake Fishery Laboratory, Yanagawa City, Fukuoka Prefecture.

age \ Number of radial ribs	29	30	31	32	33	34
6 months	3	4	3			
9 months				2	2	
1 year			1	2	2	
Fossils from various localities		3	8	12	4	1
Total	3	7	12	16	8	1
Percentage	6.4	14.9	25.6	34.1	17.1	2.1

Table 2.

As above mentioned, the number of radial ribs is nearly constant from the juvenile stage to the adult.

Anadara (*Scapharca*) *takaoensis*, another species of this group, resembles the above mentioned two species, and was originally described by NOMURA (1933) from the Kaizan Bed of Formosa. The type species of NOMURA is unfortunately not well preserved, but YABE and HATAI (1942) illustrated a well preserved specimens of that species from the Shimajiri bed (=Nakoshi Sandstone of MACNEIL, 1960) in Okinawa Island in association with *Anadara* (*Scapharca*) *suzukii* and *Anadara* (*Tosarca*) *sedanensis*. The Kaizan species is said to be upper Miocene in age by NOMURA (1933). Statistic measurements were made only on a few specimens, therefore Figs. 2, 3 are shown for comparison with the other species of this group. The angle of height against length show some difference between *Anadara* (*Scapharca*) *takaoensis* and *Anadara* (*Scapharca*) *tricenicosta*. This shows the development from the aclinal form to the prosoclinal one, and the arrangement corresponds with ontogeny. So far as known, *Anadara* (*Scapharca*) *takaoensis* has its lower limit in the Kaizan bed of Formosa and its upper limit in the Nakoshi Sandstone. *Anadara* (*Scapharca*) *suzukii* is restricted to the Nakoshi-Takanabe-Ananai-Dainichi Formation and *Anadara* (*Scapharca*) *tricenicosta* ranges from the Tokazan Formation up to the Recent. From the lower horizon to the upper horizon, the radial ribs increase from 24 to 27-28 in number.

Systematic Description

Family Arcidae

Subfamily Anadarinae REINHART, 1935

Genus *Anadara* GRAY, 1847

Subgenus *Scapharca* GRAY, 1847

Anadaaa (Scapharca) suzukii (YOKOYAMA), 1926

Pl. 10, Figs. 3-7, 10-13; Pl. 11, Figs. 9-10

1926. *Arca suzukii* YOKOYAMA, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, Vol. 1*, p. 368, pl. 42, figs. 6-7.

The present species was originally described by YOKOYAMA in 1926a on the specimens from the Tonohama Formation in Kochi Prefecture. The original description is "Shell rather small, thick, convex, transversely oblong, inequilateral, the posterior side being somewhat less than twice the anterior, rounded both in front and behind, with ventral border broadly arched and passing gradually into the anterior as well as to the posterior without forming any marked angle; antero-dorsal and postero-dorsal borders straight and forming with the anterior border as well as with the posterior an angle which is greater than a right angle. Surface radiately ribbed; ribs twenty-four in number, elevated, flat-topped with interstices varying in breadth, sometimes broader, sometimes narrower than the ribs themselves, crossed by prominent lines of growth which in the interstices are elevated like lamellae while on the ribs they are more like transverse striae or crenulations. Beaks more or less swollen with ends pointed and incurved, rather approaching each other. Area narrow, with unequal striations parallel to the hinge line. Teeth small, nearly forty in number. A right and a left valve. The former is 20.3 millim. long, 13.7 millim. high and 6 millim. deep, while the latter is 25.5 millim. long, 18.7 millim. high and 8 millim. deep."

Remarks: *Arca suzukii* of YOKOYAMA (1926a) as already discussed in earlier pages was included into the synonymy of the Recent *Anadara (Scaphaaca) tricenicosta* (NYST) by MAKIYAMA in 1958. Three years later SHUTO (1961) recorded *Anadara (Scapharca) suzukii* (YOKOYAMA) from the Takanabe Formation in Miyazaki Prefecture under the name of *Anadara tricenicosta* (NYST) whereas TSUCHI (1961) listed *Anadara (Scapharca) tricenicosta suzukii* (YOKOYAMA) from the Takanabe Formation and his Kechienjian stage. *Anadara (Scapharca) suzukii* (YOKOYAMA) resembles *Anadara (Scaphara) tricenicosta* (NYST) in surface sculpture, however, as already mentioned, YOKOYAMA stated this species to have 24 radial ribs which are elevated and flat-topped, their interspaces are sculptured with elevated like lamellae and on the ribs there appear like transverse striae or crenulations. These characters are also observed in *Anadara (Scapharca) tricenicosta* (NYST), but the number of radial ribs are most commonly 27-28. These features are shown in Figs. 2-3.

Anadara (Scapharca) takaoensis (NOMURA) also resembles the present species but the latter differs from the former in having stronger radial ribs and slightly depressed posterior side. *Anadara (Scapharca) suzukii* (YOKOYAMA) has a more swollen shell, and the central ventral margin is more convex than in *Anadara (Scaphara) takaoensis* (NOMURA). *Anadara (Scapharca ?)* sp. in this article is allied to *Anadara (Scapharca) suzukii* (YOKOYAMA) in number of radial ribs but the former has a more elongated form and the depressed area extends from the beak to posterior side.

Locality and Formation: IGPS coll. cat. no. 54606, Tonohama, Yasuda-mura, Aki-gun, IGPS coll. cat. no. 54605, Iogi, Iogi-mura, Aki-gun, IGPS coll. cat. no. 54607, Oono, Tano-mura, Aki-gun, all in Kochi Prefecture, Ananai Formation,

Pliocene; IGPS coll. cat. no. 29244, Tombe, Kitaogasa-mura, Ogasa-gun, Shizuoka Prefecture, Dainichi Formation, Pliocene; Nakoshi Sandstone, Okinawa Island, Pliocene; Takanabe Formation, Miyazaki Prefecture, Pliocene; Nango sandstone and mudstone alternation, Shizuoka Prefecture, Pliocene.

Anadara (*Scapharca*) *takaoensis* (NOMURA), 1933

Pl. 10, Fig. 14; Pl. 11, Figs. 3-6

1933. *Arca* (*Arca*) *takaoensis* NOMURA, *Sci. Rep., Tohoku Imp. Univ., 2nd Ser., Vol. 16, No. 1*, p. 39, pl. 4, figs. 2-5.

1942. *Anadara* (*Scapharca*) *takaoensis*, YABE and HATAI, *Japan. Jour. Geol. Geogr., Vol. 18, Nos. 1-2*, p. 73-74, pl. 7, figs. 2, 3, 6.

The present species was originally described by NOMURA in 1933 based upon the specimens from the Kaizan Beds in Formosa. He gave the following description: "Shell small, longly-ovate, moderately inflated with rather low beak at the anterior third of shell-length; anterior end rounded, the posterior subtruncated and somewhat produced; valve with about twenty five distinct radial ribs which are separated by much narrow interspaces; anterior ribs narrower than the posterior, finely granulated. Hinge line rather short; cardinal area narrow. Teeth and other internal characters not exposed. Five isolated left valves were examined. A specimen chosen as the type is 23.5 mm. long, 16.0 mm. high and about 7 mm. deep."

Remarks: The present species was originally described based on the specimens from the Kaizan Beds above mentioned and subsequently YABE and HATAI (1942) well illustrated this species from the Nakoshi Sandstone in Okinawa Island. This species is characterized by its radial ribs which are largely elevated, rather wide and granulated on their back. NOMURA (1933) stated that there are no species of fossil as well as Recent *Arca* in Japan that are closely related to this species but *Anadara* (*Scapharca*) *suzukii* (YOKOYAMA) is closely allied to *Anadara* (*Scapharca*) *takaoensis* (NOMURA) in its shell surface sculptures.

Locality and Formation:—IGPS coll. cat. no. 37428, 37444, type locality, NNW of Shinsui Police Box, Shinsui, Enshusho, Takao-shu, Formosa, Kaizan Beds, Miocene; IGPS coll. cat. no. 61387, Yard of the Nakoshi Primary School, Hanejimura, Kunigami-gun, Okinawa Island, Nakoshi Sandstone, Pliocene; IGPS coll. cat. no. 51306, Gabesoga, Kunigami-gun, Okinawa Island, Nakoshi Sandstone, Pliocene.

Anadara (*Scapharca*?) sp.

Pl. 10, Figs. 8-9

Shell moderate in size, inflated, test rather thick, stout, roundly quadrate. Inequilateral, longer than high, posterior end produced subtrapezoidal with posterior ridge. Anterior dorsal margin shorter than posterior one, and both nearly straight. Posterior end truncated, forming about 122-120° with hinge line. Anterior end smoothly rounded. Ventral margin widely arcuated. Umbo somewhat swollen, beak small, low, turned anteriorly, situated at about one third of shell-length from anterior. Ligamental area with 1 to 1 1/2 imperfect v-shaped chevrons; narrow hinge line straight, with numerous perpendicular teeth but details unknown. Inner surface rather smooth but with crenulations on ventral margin corresponding to outer surface with radial ribs. Shell surface with 20-

21 radial ribs. Radial ribs rather subquadrate in cross section, flat-topped, somewhat wider than interspaces. Interspaces sculptured with faint concentric growth lines. Posterior depressed area runs from beak to posterior ventral end, sculptured there with 5-6 radial ribs.

Remarks: The present species is not well preserved and therefore its precise details could not be studied. However, it may represent a new species. It is characteristic in its few number and shape of radial ribs with a depressed area along the posterior border. This unnamed species resembles *Anadara (Tegillarca) granosa* (LINNAEUS) in having 16-20 characteristic radial ribs but differs therefrom in the depressed area and surface sculptures.

Locality and Formation: IGPS coll. cat. no. 90033, Tonohama, Yasuda-mura, Aki-gun, Kochi Prefecture, Ananai Formation, Pliocene.

Anadara (Scapharca) tricenicosta (NYST), 1848

Pl. 10, Figs. 1-2, 16-17

1844. *Arca radiata* REEVE (non SOWERBY), *Conch. Icon., Vol. 2, Arca*, pl. 6, fig. 40.
1848. *Arca tricenicosta* NYST, *Mem. Acad. Roy. Belg., Vol. 22*, p. 74.
1882. *Scapharca philippiana* DUNKER, *Ind. Moll. Mar. Japon.*, p. 235.
1891. *Arca (Scapharca) philippiana*, KOBELT in MARTIN und CHEMNITZ, *Conch. Cab., Vol. 8*, p. 90-91, pl. 25, figs. 1-2.
1928. *Arca (Scapharca) philippiana*, YOKOYAMA, *Imp. Geol. Surv. Japan, Rep. No. 101*, p. 103, pl. 17, figs. 4-5.
1932. *Anadara (Scapharca) tricenicosta*, PRASHAD, *Lamellibranchia of the Siboga Expedition, Part 2*, p. 39-40.
1933. *Arca (Arca) philippiana*, NOMURA, *Sci. Rep., Tohoku Imp. Univ., 2nd Ser., Vol. 16, No. 1*, p. 36-37.
1951. *Anadara (Diluvarca) tricenicosta*, KIRA, *Illust. Shells Japan, Hoikusha*, p. 87, pl. 43, fig. 11.

Remarks: PRASHAD (1932) pointed out that in view of the name *Arca radiata* having been used by SOWERBY in 1840 for a fossil species, NYST changed the name of REEVE's species to *Arca tricenicosta* in 1848. DUNKER proposed the name of *Scapharca philippiana* for the same species. KOBELT (1891) described this species in detail and published a figure of one of DUNKER's original *Scapharca philippiana*. In 1844, REEVE described *Arca radiata* as follows; "Shell ovately oblong, equivalve, side rounded, whitish, stained with light brown about the umbones, sparingly covered with epiderms, radiating ribbed, ribs about thirty in number, very narrow, obsoletely rounded, interspaces between the ribs latticed, area of ligament middling."

KOBELT (1891) gave a supplementary description to REEVE's one. According to KOBELT (1891), this species is characterized by the shell being inequilateral, inequivalve with 30 radial ribs; radial ribs rather narrower than interspaces and fine lamellae form growth lines. Ligamental area elongated, rhomboidal and measures 72 in length, 50 in height and 43 in width in mm. As pointed out by KOBELT (1891), REEVE's description was based only upon the shell surface. While KOBELT's description included the surface and inner shell. It is important that KOBELT mentioned that the shell of this species is inequivalve and that there is discrepance in surface sculpture between the right and left valves. REEVE on the other hand said this species is equivalve and he did not mention discrepancy between the valves. Concerning the form of the muscle scars, this species as well as *Anadara (Scapharca) takaoensis* (NO-

MURA) and *Anadara* (*Scapharca*) *suzukii* have L-formed posterior muscle scar though the anterior one is rounded (Fig. 1, Pl. 10, fig. 2). The ligamental area is depressed trigonal in form, turned anteriorly, being shorter in the anterior half and, longer and narrower in the posterior half, with the irregular chevrons rather few in number. Although NOMURA (1933), NOMURA and ZINBO (1936) and MAKIYAMA (1958) considered *Anadara* (*Scapharca*) *suzukii* (YOKOYAMA) to be a synonym of *Anadara* (*Scapharca*) *tricenicosta* (NYST), this species differs from *Anadara* (*Scapharca*) *suzukii* (YOKOYAMA) statistically, but coincides with *Scapharca philippiana* DUNKER.

Geologic Occurrence: Tokazan Formation in Formosa, Pliocene; Naganuma Formation, Kanagawa Prefecture, Pleistocene (in part) and Recent.

Anadara (*Scapharca* ?) *shizuokaensis* NODA, n. sp.

Pl. 11, Figs. 7-8

Shell large, much swollen, thick, stout, rounded ovate except for beak, longer than high, inequilateral, anterior side short and posterior produced, ventral margin broadly convex. Dorsal margin straight, anterior dorsal margin shorter than posterior one. Shell surface sculptured with strong rather narrow, flat-topped radial ribs which are strong, sharply squarish in cross section and narrower than their interspaces. Interspaces sculptured with concentric lines of growth, some lamellae cross backs of radial ribs. Umbo swollen, beak small, incurved strongly directed and situated anteriorly. Ligamental area trigonal in profile, flat, rather wide, with low angled, chevron grooved. Ligamental are a bounded by narrow and deep furrows along dorsal margins. Hinge line straight. Teeth rather large and decrease in size near boundary of anterior and posterior sides, and ventrally convergent at both extremities. Anterior muscle scar ovately rounded under the dorsal end, posterior one larger and roundly quadrate. Pallial line smooth hardly incurved at posterior muscle scar, rather deep ventral margin of inner shell strongly crenulated. Dimension (in mm.) of holotype; Length 80.2, height 62.1, width 31.2, height of ligament 8.6, length of ligament 55.8, length of teeth 53.1, radial ribs 37 in number.

Holotype: IGPS coll. cat. no. 78919, Collector T. SATO.

Type Locality: Hosoya, Kitaogasa-mura, Ogasa-gun, Shizuoka Prefecture, Nango Sandstone and Mudstone Alternation, Pliocene.

Remarks: The Pliocene form of *Anadara* from the Kakegawa district, Shizuoka Prefecture had been known under the name of *Anadara castellata* (YOKOYAMA) and *Anadara suzukii* (YOKOYAMA). The former one was described by YOKOYAMA as a subspecies of *satowi*. YOKOYAMA stated that this species is characterized by the shell being very inequilateral, the anterior side rounded, the posterior more or less truncated, the surface with a blunt edge running from the beak to the posterior ventral corner. There are 36 radial ribs or there-about and they are broad, usually flattened, separated by narrower interspaces and the area is very narrow.

Accordingly the present new species differs from *Anadara castellata* (YOKOYAMA) in having no edge along the posterior border and by the narrow, sharply squarish radial ribs and by the ligamental area being rather broad. *Anadara* (*Scapharca*) *taiwanica* NODA (MS) from Formosa is another allied species but it

differs from the present new species in its more swollen shell and rather wide, low, flatly topped radial ribs. *Anadara ommaensis* OTUKA is characterized by its narrower umbonal area and flat shell compared with the present new species.

Anadara (*Scapharca* ?) *iwashibaraensis* NODA, n. sp.

Pl. 10, Fig. 15

Shell medium in size, rather thick, swollen, inequilateral in form, very prosoclinal, anterior side narrowly rounded and posterior side broad, somewhat truncated, although somewhat poorly preserved. Dorsal margin slightly arcutated, ventral margin runs obliquely from narrower anterior to broader posterior end. Surface sculptured with strong radial ribs which are rather wide, low, smooth, flat-topped with their interspaces rather smooth but having concentric growth lines transversing the radial ribs. Radial ribs 31 in number, and with no depressed area along posterior margin. Umbo swollen, flat, lower. Beak small, pointed, situated at one third shell length from anterior side. Ligamental area narrow, bounded with rather strong furrows of small teeth perpendicular to hinge line. Pallial line rather deep and smooth. Anterior muscle scar smaller than posterior one, subrounded. Inner ventral margin crenulated shallowly.

Holotype: IGPS coll. cat. no. 29050, Collector S. NOMURA.

Type Locality: Iwashibara, Kamitareki-mura, Ogasa-gun, Shizuoka Prefecture, Dainichi Formation, Pliocene.

Remarks: The present new species resembles the Recent *Anadara* (*Scapharca*) *broughtnii* (SCHRENCK) but the former has fewer radial ribs. *Anadara* (*Scapharca*) *subcrenata* (LISCHKE) in having a depressed area along the posterior margin differs from the present new species though number of radial ribs is similar.

Subgenus *Tosarca* NODA, n. subgen.

Type species: *Anadara* (*Tosarca*) *tosaensis* NODA, n. sp., Ananai Formation, Kochi Prefecture, Pliocene.

Diagnosis:—Shell very inequilateral, trapezoidal in form, anterior very narrow, posterior produced and obliquely truncated behind. Surface sculptured with strong, numerous, dichotomous or partly dichotomous radial ribs, some twice dichotomous at both extremities with wide depressed area extending from beak to posterior margin. Umbo swollen. Ligamental area rather narrow, more or less depressed from beak to hinge line. Inner margin crenulated at ventral margin. Teeth a continuous series.

Remarks: This new subgenus is proposed for the species of *Anadara* commonly known as *Anadara sedanensis* (MARTIN), *Arca vellicata* REEVE and *Anadara tosaensis* NODA, n. sp., the latter of which is selected as the type species of the new subgenus. *Anadara* s. s. and *Scapharca* are distinguishable from the present new subgenus by their unique inequilateral shell with trapezoidal form, more swollen, slightly medially impressed umbonal area, and narrow ligamental area which is depressed in profile. Although these features are found in *Anadara* or *Scapharca*, *Tosarca* is characterized in having the above mentioned shell form and shape of dichotomous radial ribs. These characters are easily grouped up from other *Anadara* species. Moreover this new subgenus is characteristic of the Indo-Pacific Province.

Anadara (*Tosarca*) *tosaensis*
NODA, n. sp.

Pl. 11, Figs. 11-13

Shell medium in size, test very thick, stout, subtrapezoidal, inequilateral, longer than high, slightly concave with wide posterior depressed area. Dorsal margin slightly arcuated, passing into angulated posterior and anterior sides. Anterior ventral margin smoothly rounded, posterior ventral margin nearly straight. Posterior side truncated. Beak small, low, situated anteriorly, umbonal area flat, slightly depressed medially. Ligamental area very narrow, depressed from beak to hinge line and with two chevron grooves, covered with longitudinal striations. Hinge line straight with perpendicular small teeth, ventrally convergent at both extremities. Surface sculptured with rather strong wide, low, flat-topped radial ribs, 43 in number. Interspaces of radial ribs very narrow. Anterior 10-11 ribs dichotomous, backs of radial ribs and posterior 14-15 radial ribs sculptured with two or three very fine longitudinal furrows on their backs, middle part of shell without furrows on their backs of radial ribs. Dimension (in mm.) of holotype; Length 52.4, height 52.0, length of ligament 37.8, angle of umbo 106°, angle of hinge line and posterior end 103°, and radial ribs 43 in number.

Holotype: IGPS coll. cat. no. 54609, Collector S. NOMURA.

Type Locality: Oono, Yasuda-mura, Aki-gun, Kochi Prefecture, Ananai Formation, Pliocene.

Remarks: The present new species resembles *Anadara iwatonoensis* NODA (MS) from Yamanashi Prefecture in type of furrows on backs of the radial ribs but differs in their form. *Anadara* (*Tosarca*) *sedanensis* (MARTIN) is allied to this new species in form but the former is sculptured with only dichotomous radial ribs while the latter does not carry them in the middle part of the shell surface though their shell form and shape of the radial ribs are similar with one another.

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Explanation of Plate 10

(All figures in natural size)

Figs. 1-2. *Anadara* (*Scapharca*) *tricenicosta* (NYST), p. 102-103
1. Left valve, 2. Inner surface of right valve. IGPS coll. cat. no. 37591, Locality; 300 m. East of Hakushaton, Chikunan-gun, Shinchiku-shu, Formosa, Tokazan Formation, Pliocene.

Figs. 3-7. *Anadara* (*Scapharca*) *suzukii* (YOKOYAMA), p. 100-101
3. Right valve, 4. Inner surface of right valve, 5. Showing the ligamental area, 6. Inner surface of fig. 7, 7. Left valve. IGPS coll. cat. no. 54606, Locality; Tonohama, Yasuda-mura, Aki-gun, Kochi Prefecture, Ananai Formation, Pliocene.

Figs. 8-9. *Anadara* (*Scapharca* ?) sp., p. 101-102
IGPS coll. cat. no. 90033, Locality; Tonohama, Yasuda-mura, Aki-gun, Kochi Prefecture, Ananai Formation, Pliocene.

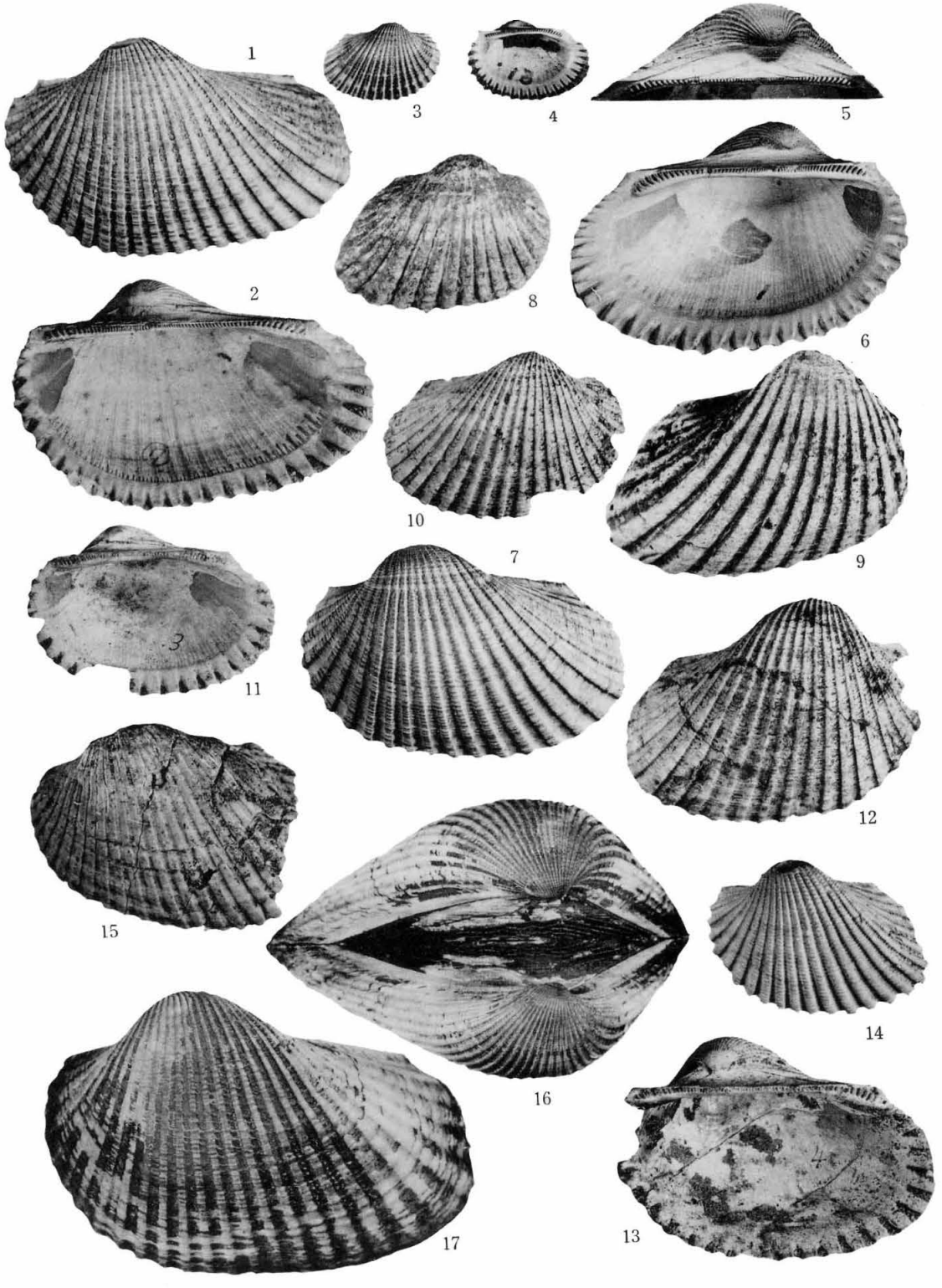
Figs. 10-13. *Anadara* (*Scapharca*) *suzukii* (YOKOYAMA), p. 100-101
10. Right valve, 11. Inner surface of fig. 10, 12. Right valve, 13. Inner surface of fig. 12. IGPS coll. cat. no. 29244, Locality; Tombe, Kamitareki-mura, Ogasa-gun, Shizuoka Prefecture, Dainichi Formation, Pliocene.

Fig. 14. *Anadara* (*Scapharca*) *takaoensis* (NOMURA), p. 101
Left valve, IGPS coll. cat. no. 51306, Locality; Gabesoga, Kunigami-gun, Okinawa Island, Nakoshi Sandstone, Pliocene.

Fig. 15. *Anadara* (*Scapharca* ?) *iwashibaraensis* NODA, n. sp., p. 104
Holotype, IGPS coll. cat. no. 29050, Locality; Iwashibara, Kamiogasa-mura, Ogasa-gun, Shizuoka Prefecture, Dainichi Formation, Pliocene.

Figs. 16-17. *Anadara* (*Scapharca*) *tricenicosta* (NYST), p. 102-103
16. Umbonal view showing the ligamental area, 17. Left valve. IGPS coll. cat. no. 11724, Kii Peninsula, Wakayama Prefecture, Recent.

Abbreviation: IGPS=Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.



KUMAGAI Photo.

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Explanation of Plate 11

(All figures in natural size)

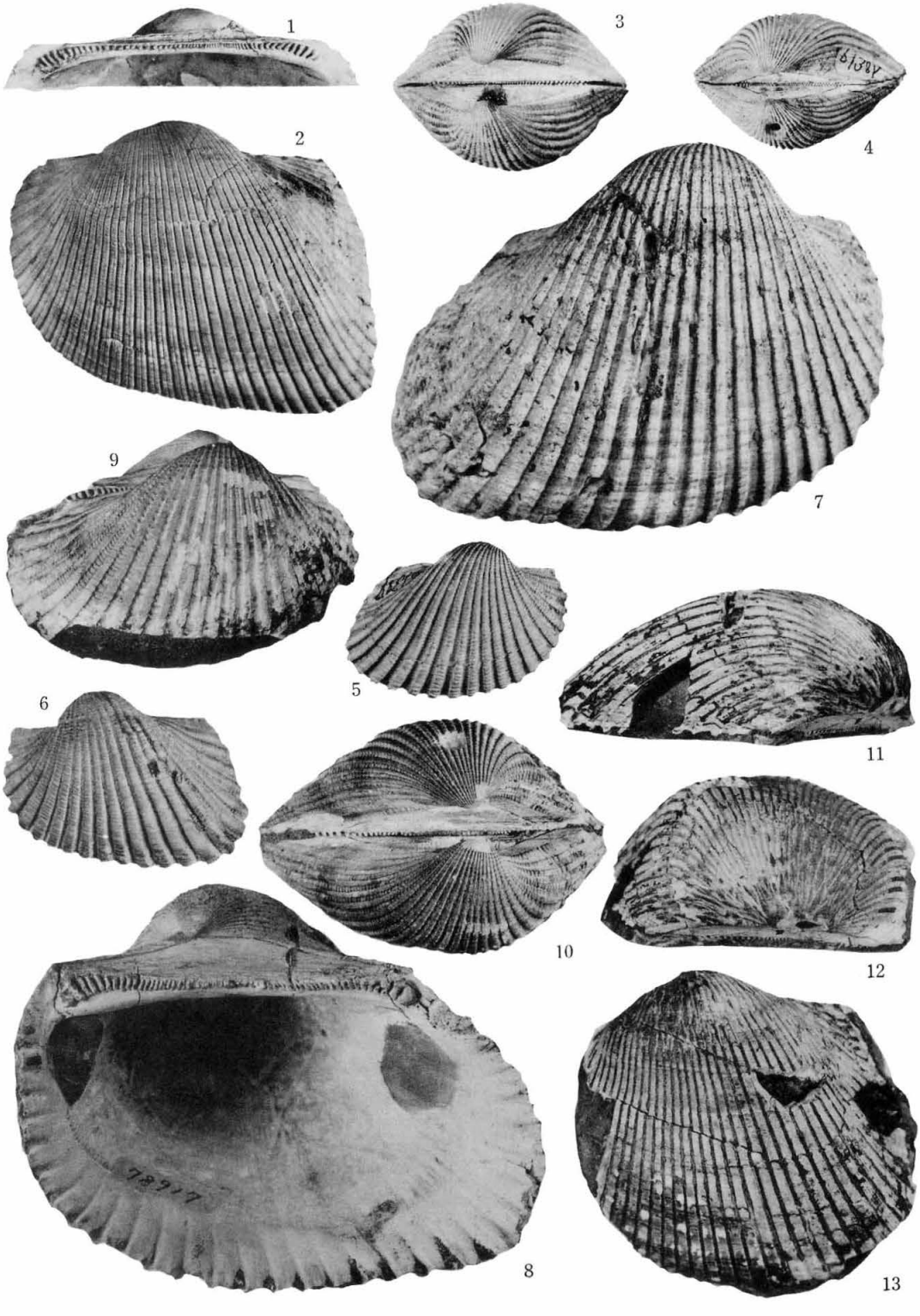
Figs. 1-2. *Anadara* (*Tosarca*) *sedanensis* (MARTIN).
1. Showing the teeth and the narrow ligamental area, 2. Left valve. IGPS coll. cat. no. 61388, Locality : Yard of Nakoshi Primary School, Nakoshi, Haneji-mura, Kunigami-gun, Okinawa Island, Nakoshi Sandstone, Pliocene.

Figs. 3-6. *Anadara* (*Scapharca*) *takaoensis* (NOMURA), p. 101
3-4. Umbonal view, 5. Right valve, 6. Left valve. IGPS coll. cat. no. 51306, Locality : Gabesoga, Kunigami-gun, Okinawa Island, Nakoshi Sandstone, Pliocene.

Figs. 7-8. *Anadara* (*Scapharca* ?) *shizuokaensis* NODA, n. sp., p. 103-104
7. Right valve, 8. Inner surface of fig. 7. Holotype, IGPS coll. cat. no. 29180, Locality ; Hosoya, Kitaogasa-mura, Ogasa-gun, Shizuoka Prefecture, Nango Formation, Pliocene.

Figs. 9-10. *Anadara* (*Scapharca*) *suzukii* (YOKOYAMA), p. 100-101
9. Right valve, 10. Umbonal view. IGPS coll. cat. no. 61387, Locality ; Yard of Nakoshi Primary School, Nakoshi, Haneji-mura, Okinawa Island, Nakoshi Sandstone, Pliocene.

Figs. 11-13. *Anadara* (*Tosarca*) *tosaensis* NODA, n. sp., p. 105
11. Showing the depressed area along the posterior side with fine furrows on radial ribs, 12. Umbonal view and showing the depressed narrow ligamental area, 13. Left valve. Holotype, IGPS coll. cat. no. 54609, Locality : Oono, Yasuda-mura, Aki-gun, Kochi Prefecture, Ananai Formation, Pliocene.



KUMAGAI Photo.

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Enshusho	燕巣庄	Nakoshi	仲尾次
Haneji-mura	羽地村	Oono	大野
Hosoya	細谷	Shinsui	深水
Iwashibara	鰯原	Takao-shu	高雄州
Kaenzan	火炎山	Tokazan	頭料山
Kozan	香山	Tombe	富部
Kunigami-gun	国頭郡	Tonohama	唐野浜
Miaoli	苗栗		

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 59, pp. 110-113, pl. 12, Sept. 20, 1965

492. A GIGANTIC SCALLOP FROM THE SEA BOTTOM OFF THE DANJO ISLANDS, NAGASAKI PREFECTURE, JAPAN*

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長崎県男女群島沖海底から採集した巨大なホタテ貝：長崎県五島列島に近い男女群島沖の海底から数年前珊瑚採集の網にかかつて引上げられた大型の *Mizuhopecten* (右殻) 化石について，ここに報告する。これは異常に大型の貝で大きさではホタテ貝の仲間では恐らく世界的にも珍らしいものと思う。殻が厚くない事や肋上の浅い細溝の分岐の状態から，形の大きい点は異常発育の結果ではなくて種的特徴と判断した。一見東北地方に棲息するホタテガイに似たところがあるが，詳細にその特徴を調べると別種である。形態上の特徴からみると，*M. tryblium* group や，*M. kimurai—M. tokyoensis* に関係のある種と考えられるが，既知の *Mizuhopecten* の種の中でこれに一致するものはないので，新種として報告する。時代は鮮新世と推定した。

永沢譲次

Introduction and Acknowledgements

The specimen described in this article was dredged by a coral net from the sea bottom off the Danjo Islands near the Goto Islands, Nagasaki Prefecture, few years ago.

In the spring of 1964, the writer at the suggestion of Professor N. SAKAZUME of the Doshisha University in Kyoto, visited Fukue Islet, one of the Goto Islands, and was fortunate in being able to study a fossil specimen which is now preserved in the collections of Mr. I. KAMAGA, a resident of Fukue Islet. This fossil *Mizuhopecten* is interesting because it is the largest one hitherto known from Japan. The comparatively thin test and the morphological characters of this specimen indicate that its unusually large size is a specific character, rather than the result of abnormal growth of the shell.

The external surface of this shell is bluish gray and partly covered with calcareous organic remains. The shell is more or less water worn and damaged slightly, but the specific characteristics of the specimen are clear and show it to be an undescribed form.

The writer is greatly indebted to Professor Nakao SAKAZUME for his kind help and encouragement during the course of this study.

The writer wishes to express his deep gratitude to Mr. Itaro KAMAGA of Fukue Islet, for kind permission to study the specimen, to Professor Kotora HATAI of the Tohoku University for his kindness in reading this manuscript and for his advice, to Dr. Koichiro MASUDA of the same university for the permission to study his collection, and to Dr. Shozo HAYASAKA of the same university for his kind help.

* Received Jan. 29, 1965; read Jan. 24, 1965 at Tokyo.

Description

Family Pectinidae

Subfamily Pectininae

Genus *Mizuhopecten* MASUDA, 1963

Mizuhopecten kamagai
NAGASAWA, n. sp.

Pl. 12, figs. 1-7

Holotype:—A right valve in the possession of Mr. Itaro KAMAGA, a resident of Tomie-machi, Fukue Islet in the Goto Islands, Nagasaki Prefecture, Japan.

Description:—Shell very large measuring 28 cm in length, 27 cm in height, being slightly broader than high, suborbicular, equilateral, rather thin and moderately inflated, about 4.5 cm in depth of right valve, apical angle about 110 degrees.

Right valve with 35 distinct, but comparatively low, round topped radial ribs, which are considerably broader than their interspaces and in the upper parts of disc often divided into two parts by fine, shallow and narrow longitudinal striae or furrows, but on the central or lower parts of the shell by two rather distinct shallow longitudinal furrows dividing ribs into three parts in general as seen in *Mizuhopecten yamasakii* (YOKOYAMA); base of furrows and interspaces and sides of radial ribs concave.

Among the 35 radial ribs on the surface, no furrows were recognized on nine of the radial ribs because of being covered with foreign matter and to the wear, but one furrow was observed on each of 13 radial ribs and two on another 13 radial ribs.

At about the upper half of the disc or at the younger part a series of alternating elevated radial ribs and a few low ones were observed, that is, 4~6 radial ribs which form a group are more elevated than the rather low 1~2 radial ribs which are situated between the groups of elevated radial ribs. Altogether five such groups, counted from the right margin of shell could be recognized, but this feature is obscure at the left submargin of the shell as seen often near the beak of *Mizuhopecten tokyoensis* (TOKUNAGA) and also tend to become obscure towards the lower part of the disc.

Auricle large; hinge-length/height= 0.55, height of auricle/height=0.18, length of anterior auricle much larger than that of the posterior, anterior auricle ornamented with concentric striations and provided with shallow byssal notch, radial threads obscure; posterior one sculptured with seven radial riblets and concentric striations; hinge with rather faint cardinal crura and a large triangular shaped resilial pit provided with lateral ridges.

Comparison and affinity:—*Mizuhopecten yessoensis yokoyamae* (MASUDA) [*M. poculum* subsp. α, (AKIYAMA)] from Chikagawa and *M. kurosawensis* (YOKOYAMA) from Onma, which are included into the *M. poculum* group can be distinguished from the present one by their elevated, more or less squarish, round-topped radial ribs which are nearly equal to or narrower than their interspaces in breadth and the *M. yessoensis* (JAY) group, by generally undivided flattish radial ribs, left auricle truncated behind in general, and the resilial pit being rather small in height compared with the present one.

Among the numerous species of scallops having the interspaces narrower than the radial ribs on the right valve in *Mizuhopecten*, there are two distinct groups as follows: The one group possesses broader and less numerous radial ribs which are furnished with radial

threads, or divided into riblets, and the other group has more numerous radial ribs which are not so broad, but equal or sometimes subequal in their breadth and often furnished with one or two radial furrows, or in parts of the disc, divided into two parts.

Mizuhopecten kimurai (YOKOYAMA) and *M. tokyoensis* and their allies belong to the former group, and the latter group includes *M. nakatombetuensis* (AKIYAMA), *M. yamasakii* (YOKOYAMA), *M. tryblium* (YOKOYAMA) and their allies.

The characteristics mentioned above of the radial ribs of the two groups are recognized in the present single specimen, namely, the characteristics of the former group, especially near the beak, and that of the latter group on the lower half of the shell, as already described.

Therefore, the arrangement of the radial ribs on the upper half of the disc in this specimen is similar to the radial ribs of *M. kimurai* whereas the features of *M. tokyoensis* may be seen on the disc as a whole.

This characteristic seems to be important from the phylogenetic point of view.

But, as the extraordinary arrangement of the radial ribs on the upper half of this specimen is considered to be only an indication or the remnant of the character which the *M. kimurai* group and its ancestor possessed, the present one may be incorporated into the latter group mentioned above or treated as a new form.

Though the mode of biufrcations of the radial ribs of the present new species is the same in *M. yamasakii* and its allies, this one is distinguishable from them by its larger auricles and by the left auricle being not truncated behind and in the shell shape having the length exceeding the height.

Especially, *M. yamasakii* is distinguished from this species by its conspicuous stout lateral ridges on both margins of the resilial pit.

The present species resembles those of the *tryblium* group, but it can be distinguished from *M. tryblium tryblium* (YOKOYAMA), *M. t. shinshuensis* (AKIYAMA) and *M. t. ibaragiensis* (MASUDA) by having larger number of trifurcate radial ribs and its large right auricle, and also from *M. t. kintaichiensis* (MASUDA) by the large number of radial ribs and by the

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Explanation of Plate 12

Figs. 1-7. *Mizuhopecten kamagai*, n. sp.

1. Right valve, Holotype, ×1/3.6, from the bottom off the Danjo Islands, Nagasaki Prefecture, now kept by Mr. I. KAMAGA.
2. Interior view of Fig. 1, ca. ×1/3.5.
3. Posterior profile of Fig. 1, ca. ×1/3.5.
4. Left auricle stripped of covering substances, and the 4 groups of elevated radial ribs showing the special arrangement; a part of the plaster model of Fig. 1.
5. Right auricle stripped, partially, of covering substances, its concentric striations and the 6 groups of elevated radial ribs; a part of the plaster model of Fig. 1.
6. The half part of the hinge area of Fig. 2 showing a cardinal crura; a part of the plaster model of Fig. 2.
7. Surface sculptures of several radial ribs which are trifurcate or bifurcate at the middle part of the left ventral margin; a part of the plaster model of Fig. 1.

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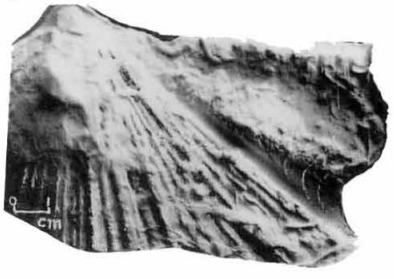

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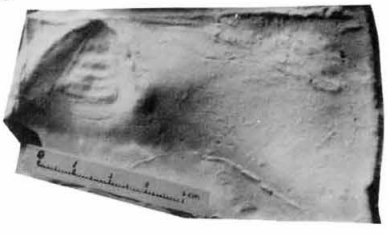

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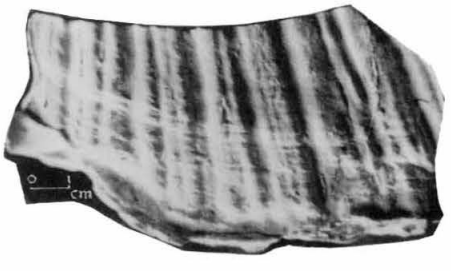

3

left auricle being not truncated.

It is noticed that in *M. tryblium tryblium*, the outline of both lateral ridges around its resilial pit is roundish in shape, whereas it is triangular in the present one like *M. yessoensis* and *M. tokyoensis*.

M. nakatombetuensis (AKIYAMA) differs from this new species by the elevated flat-topped, squarish radial ribs.

In short, this species can not be identified with any known species of *Mizuhopecten* (=*Patinopecten* of authors) in Japan, or with forms of *Patinopecten* of Northwest America, therefore the writer proposes the new species name, "*kamagai*" after the name of the collector.

Geological Age:—Probably Pliocene, inferred from the reasons: Among the numerous species of fossil *Mizuhopecten* (recorded as *Patinopecten*), the species having more than 20 radial ribs and morphological characters related to this new species are known only from the Pliocene of Japan and, abundant Pliocene fossils have been dredged from the sea bottom of the Japan Sea, as off the coast of Yamaguchi, Shimane, Niigata, Yamagata, and Akita Prefectures, and from the Korea and Tsushima Straits.

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Akita	秋田
Danjo Islands	男女列島
Fukue Islet	福江島
Goto Islands	五島列島
Niigata	新潟
Onmma	大桑
Shimane	島根
Tomie-machi	富江町
Tushima Straits	対馬海峡
Yamagata	山形
Yamaguchi	山口

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 59, pp. 114-125, pls. 13, 14, Sept. 20, 1965

493. ON A LOWER CRETACEOUS PELECYPOD, "*CYRENA*" *NAUMANNI*, FROM JAPAN*

ITARU HAYAMI and ISAO NAKAI

Department of Geology, Kyushu University

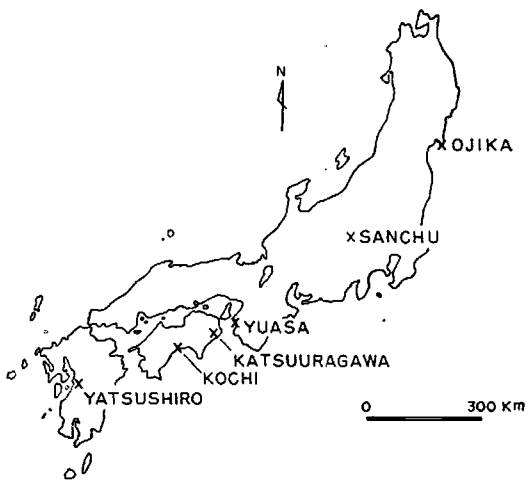
下部白亜紀斧足類 "*Cyrena*" *naumanni* について: "*Cyrena*" *naumanni* NEUMAYR, 1890 は古くから本邦白亜系最下部の領石層群に多産することが知られ，指準化石に乏しい同属群の汽水性動物群の中で注目されてきた種であるが，その分類学上の位置は不明確であつた。最近筆者等は本種の模式地である徳島県勝浦川盆地の柳谷において多数の標本を採集し，検討を加えた結果，この種は VOKES (1946) が Lebanon の Aptian 階から提唱した *Protocyprina* の模式種に近似することがわかつた。ここに *Protocyprina* 属を再定義して，種の記載を行つた。本属はジュラ紀に繁栄した *Eomiodon* COX, 1935 に由来すると考えられ，その蝶番構造は Corbiculidae の諸属とは根本的に異り，CASEY (1955) の定義した Neomiodontidae に一致する。

速水　格・中居　功

Introduction

"*Cyrena*" *naumanni* NEUMAYR is a celebrated pelecypod which occurs commonly in the brackish-water deposits of the Ryoseki group of Japan. It was first described by NEUMAYR *in* NAUMANN and NEUMAYR (1890) from Yanagidani of the Katsuuragawa basin of eastern Shikoku. NAUMANN and NEUMAYR interpreted it to be a Jurassic species, but the actual locality is situated in the outcrop area of the Tatsukawa formation, which is a representative of the Ryoseki group in this area and is presumed to be Neocomian (probably lower Neocomian) in age. At the same time NEUMAYR described also *Cyrena gravida* and *Cyrena lithocardium* from the same locality, but, as interpreted by many authors, the two must be synonyms of *Cyrena naumanni*.

Subsequently the present species was reported to occur by many stratigraphers from the Ryoseki group and its comparable strata at various localities of the Outer Zone of Southwest Japan and also of Northeast Japan. Since index fossils are scarce in the Ryoseki fauna, the occurrence of this species has been particularly noticed by a number of stratigraphers. (Text-fig. 1)



Text-fig. 1. Map indicating the localities of *Protocyprina naumanni*.

* Received Feb. 29, 1965; read June 20, 1965, at Kanazawa.

YABE, NAGAO and SHIMIZU (1926) redescribed many specimens from Yanagidani and referred several ones from the Shiroi formation of the Sanchu area of the Kwanto mountains to *Cyrena naumanni*. Besides, this species has been reported to occur from the Kawaguchi formation of the Yatsushiro area (MATSUMOTO and KANMERA, 1952; MATSUMOTO, 1954), the Ryoseki formation of the Monobegawa basin and in the vicinity of Kochi City, the Yuasa formation of the Yuasa-Aritagawa area (MATSUMOTO, 1947; MATSUMOTO, 1954), and the Ayukawa formation of the Ojika area (ONUKI, 1955).

Little has been done, however, about the palaeontological reexamination of this pelecypod. Jurasso-Cretaceous nonmarine pelecypods were investigated by KOBAYASHI and SUZUKI (1936, 1937, 1939). They assigned some other Lower Cretaceous cyrenoids to *Polymesoda* RAFINESQUE, 1820. Since then, *Cyrena naumanni* has been conventionally referred to *Polymesoda* and especially to its "section" *Isodomella* KOBAYASHI and SUZUKI, 1939, without any solid foundation (SUZUKI, 1949, etc.). HAYAMI *in* MATSUMOTO (1963, ed.), in which NAUMANN and NEUMAYR's original figures of *Cyrena naumanni*, *C. gravida* and *C. lithocardium* were reproduced, pointed out that the reference of "*C.*" *naumanni* to *Polymesoda* is not acceptable and that it would belong to an unnamed genus. Incidentally, *Polymesoda* is now living in the brackish- and fresh-water environments of North and Middle Americas (PRIME, 1865; KEEN, 1958), and the genus is quite unrelated to Japanese Cretaceous cyrenoids which should be mostly referred to other groups than the Corbuculidae.

In 1963, we collected a large number of well-preserved specimens of "*Cyrena*" *naumanni* from the type locality, i.e. the Tatsukawa formation of Yanagidani, and also from a few other localities in cooperation of Prof. T. MATSUMOTO, Prof. Y. OTA and Mr. K. NUMANO. One of us (I. H.) examined also many specimens of this species which had been described by YABE, NAGAO and SHIMIZU (1926) and are now kept in the Tohoku University. A few specimens from the Kawaguchi, Yuasa, Shiroi and Ayukawa formations are also available for study. The result of our observation on these specimens is reported in this paper. One of us (I. H.) is responsible for the further note on the taxonomic position of "*Cyrena*" *naumanni*.

Before going into description, we express our sincere thanks to Prof. Tatsuro MATSUMOTO of the Kyushu University for his kind guidance and supervision of this manuscript. Acknowledgements are also due to Prof. Yoshihisa OTA of the Fukuoka Gakugei University and Mr. Kôichirô NUMANO of the Tanabe High School for their kind assistance in the laboratory and field works.

Systematic description

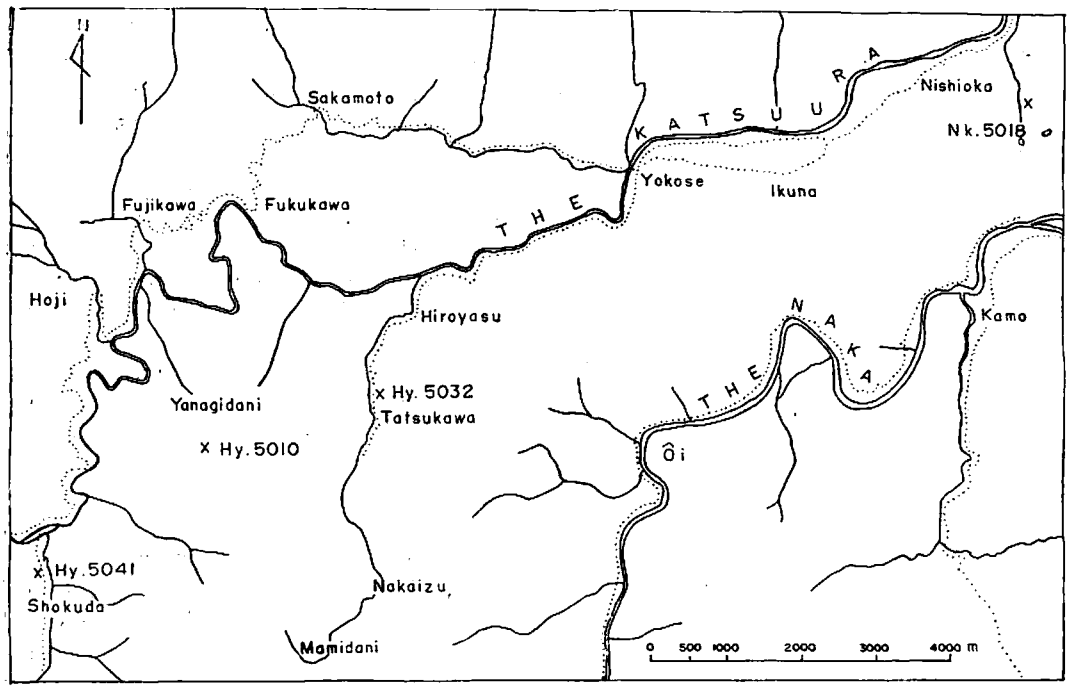
Family Neomiodontidae

Genus *Protocyprina* VOKES, 1946

(=*Amphiaraus* VOKES, 1946)

Type-species.—*Astarte libanotica* FRAAS, 1878, Aptian, Lebanon (original designation).

Diagnosis (emended).—Shell unusually large for the Neomiodontidae, inequilateral, trigonally ovate or cuneiform, moderately inflated; test thick especially in the gerontic stage; lunule weakly impressed; escutcheon distinct; surface commonly marked with *Astarte*-like concentric ribs in the juvenile stage but



Text-fig. 2. Map showing the localities of *Protocyprina naumanni* in the Katsuuragawa area of eastern Shikoku.

nearly smooth except for somewhat rugose growth-lines in the adult stage; radial ornament and marginal crenulations absent; umbo very prosogyrous; hinge essentially similar to that of *Eomiodon*, as formulated:

$$\frac{\text{AIII AI 3a 3b 5b PI}}{\text{AII 2 4b PII}}$$

cardinal tooth 3b especially thick; 5b distinctly separated from nymph; lateral teeth comparatively short in the adult stage; transverse crenulations on the lateral teeth, if present, very weak; pallial line simple but bent somewhat abruptly beneath the posterior adductor scar; umbonal cavity comparatively shallow.

Remarks.—In a study of the Neomiodontidae CASEY (1955) regarded *Protocyprina* VOKES, 1946, as a subjective synonym of *Eomiodon* COX, 1935. In fact, *Protocyprina* is similar to *Eomiodon* in many characters. The type species of *Protocyprina*, i.e. *Astarte libanotica* FRAAS, 1878, occurs from the Aptian beds at "Olive locality" of Lebanon. The immature specimens of *Protocyprina libanotica* are especially similar to some species of *Eomiodon*, such as *E. fimbriatus* (LYCETT) from the Bathonian of Europe, not only in the internal structure but also in the external features. The concentric sculpture on the surface of immature shells (VOKES, 1946, pl. 5, figs. 4, 5, 9) and also on the umbonal area of mature shells (VOKES, 1946, pl. 5, figs. 2, 3, 6) reminds us that of many species of *Eomiodon*. As to the dentition no marked difference is recognized between *Eomiodon* and *Protocyprina*, although the cardinal tooth 5b may be

slightly stronger and the posterior lateral teeth PI and PII may be proportionally shorter in the latter than in the former. We regard here, however, *Protocyprina* as a distinct genus from *Eomiodon* in view of the following characters.

1) The maximum length of an adult shell is only about 10-25 mm in *Eomiodon* but frequently exceeds 70 mm in *Protocyrina libanotica* and "*Cyrena*" *naumanni*.

2) The lunule is less clearly demarcated in *Protocyprina* than in *Eomiodon*.

3) The concentric sculpture in the adult stage is less prominent in *Protocyprina* than in *Eomiodon*.

VOKES (1946, p. 170-172) described the hinge structure of *Protocyprina libanotica*, interpreting that the species belongs to the Arcticidae. He compared the hinge with that of *Cyprina* [=*Arctica*] *islandica* (LINNAEUS) from the north Atlantic and *Venilicardia bifida* (ZITTEL) from the Upper Cretaceous Gosau beds of Alps. But the dentition of *Arctica*, *Venilicardia* and other genera of the advanced Arcticidae is characterized by the presence of the nearly complete cardinal tooth 1, as CASEY (1952) called such a state of dentition "*cyprinoid*". VOKES suggested furthermore that *Protocyprina* might be considered to be ancestral to, or very near the ancestral line of, *Cyprina* itself, but from the above mentioned evidences it is clear that *Protocyprina* is not directly related to the Arcticidae of the present sense. The ancestry of *Arctica*, we think, should be sought in such genera as *Venilicardia* STOLICZKA, 1871, in the Upper Cretaceous and *Somarctica* TAMURA, 1960, in the Upper Jurassic.

Amphiaraus VOKES, 1946, was originally referred to the Astartidae with a query, but it is likewise referable to the Neomiodontidae. CASEY assigned its type-species, *Amphiaraus seleniscus* VOKES, 1946, from the Aptian of Lebanon, also to *Eomiodon*. The arrangement of the cardinal teeth agree well with that of *Eomiodon* and *Protocyprina*, while the comparatively short posterior lateral teeth are quite identical with those of *Protocyprina libanotica*. Since the holotype of *Amphiaraus seleniscus* (ca. 28 mm long) is larger than normal species of *Eomiodon*, it is better referable *Protocyprina* than to *Eomiodon*. We treat here *Amphiaraus* VOKES, 1946 (p. 175) as a subjective synonym of *Protocyprina* VOKES, 1946 (p. 170) by page preference.

Eomiodon appeared already in the Hettangian of Japan (HAYAMI, 1958) and flourished in the Bathonian-Purbeckian of N. W. Europe and Tethyan province. A few Cretaceous species have been listed by CASEY (1955), but they are mostly not typical for the genus. *Astarte sakawana* KOBAYASHI and SUZUKI, 1939, from the Lower Cretaceous of Japan is probably a member of *Eomiodon*, but so far as we are aware, there is no other species of typical *Eomiodon* in the Cretaceous. *Protocyprina* is known at present only from the Aptian of Lebanon and the Neocomian of Japan. Judging from the stratigraphic occurrence and also from the resemblance between *Eomiodon* and immature shells of *Protocyprina*, the latter was probably derived from the former in early Cretaceous times.

Protocyprina naumanni (NEUMAYR)

Pl. 13, figs. 1-3; Pl. 14, figs. 1-8; Text-fig. 3

1890. *Cyrena naumanni* NEUMAYR, *in* NAUMANN and NEUMAYR, *Denkschr. Math.-Naturw. Cl. Kaiserl. Akad. Wiss.*, Bd. 57, p. 33, pl. 4, figs. 3, 4.

1890. *Cyrena gravida* NEUMAYR, *in* NAUMANN

and NEUMAYR, *Ibid.*, Bd. 57, p. 34, pl. 4, fig. 2.

1890. *Cyrena lithocardium* NEUMAYR, *in* NAUMANN and NEUMAYR, *Ibid.*, Bd. 57, p. 34, pl. 4, fig. 1.

1926. *Cyrena naumanni*, YABE, NAGAO and SHIMIZU, *Sci. Rep. Tohoku Imp. Univ.*, Ser. 2, Vol. 9, No. 3, p. 49, pl. 12, figs. 23, 24, 26, 29, 30, 31.

1926. *Cyrena naumanni*, YABE and NAGAO, *Chikyu*, Vol. 5, p. 434.

1927. *Cyrena naumanni*, YABE, *Sci. Rep. Tohoku Imp. Univ.*, Ser. 2, Vol. 11, No. 1, pl. 3, figs. 5a, b.

1947. *Polymesoda* (*Isodomella*) *naumanni*, MATSUMOTO, *Sci. Rep. Fac. Sci., Kyushu Univ., Geol.*, Vol. 2, No. 1, p. 3, listed.

1949. *Polymesoda* (*Isodomella*) *naumanni*, SUZUKI, *Japan. Jour. Geol. Geogr.*, Vol. 21, Nos. 1-4, p. 119, listed.

1952. *Polymesoda* (*Isodomella*) *naumanni*, MATSUMOTO and KANMERA, Guide book for the geological excursions. The lower valley of the Kuma, p. 38, listed.

1954 [for 1953]. *Polymesoda* (*Isodomella*) *naumanni*, MATSUMOTO, Cret. System, Japan, Islands, pp. 63, 74, 81, 85, 110, listed.

non 1955. *Polymesoda* (*Isodomella*) *naumanni*, YAMAGIWA, *Jour. Osaka Gakugei Univ.*, No. 3, p. 47, pl. 1, figs. 5-15.

1956. *Polymesoda* (*Isodomella*) *naumanni*, ONUKI, Explanatory text of the geologic map of Iwate Prefecture, p. 145, listed.

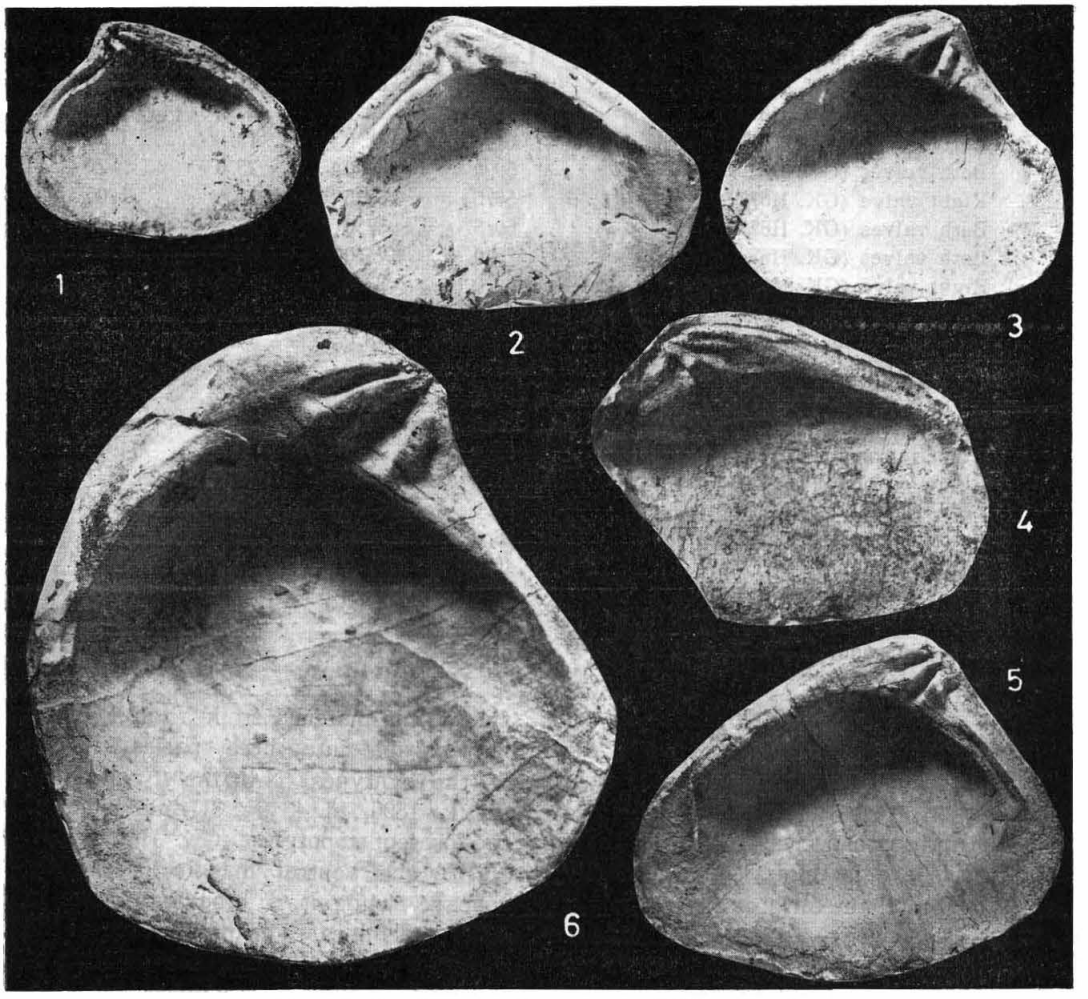
1963. "*Cyrena*" *naumanni*, HAYAMI *in* MATSUMOTO (ed.), A survey of the fossils from Japan illustrated in classical monographs, p. 34, pl. 52, figs. 1-4. (reproduction of original figures of *C. naumanni*, *C. gravida* and *C. lithocardium*)

Material.—The syntypes (NAUMANN and NEUMAYR, 1890, pl. 4, figs. 3, 4; HAYAMI *in* MATSUMOTO, 1963, pl. 52, figs. 3, 4), which are to be preserved at Geologisch-Paläontologische Abteilung des Natur-historisch Museum, Wien, are not accessible to us. They were collected at Yanagidani, Kamikatsu town (≒Menuki), Katsuura County, Tokushima Prefecture. 24 specimens (GK. H6726-GK. H6749) from the Katsuuragawa area including the type locality (MATSUMOTO, OTA, NUMANO, HAYAMI and NAKAI coll.) are preserved in the Kyushu University. Seven other topotypes, which were illustrated by YABE, NAGAO and SHIMIZU (1926, pl. 12, figs. 6, 17, pl. 13, fig. 25, pl. 14, figs. 23, 26, 29, 31) and are now kept in the Tohoku University, are also concerned with the description below.

Description.—Shell very large, equivalve, inequilateral, usually exceeding 70 mm in length in the adult stage, triangular-ovate in outline, more or less longer than high, moderately inflated; test fairly thick especially in the gerontic stage; antero-dorsal margin relatively long, faintly concave in front of umbo, passing gradually into antero-ventral margin; postero-dorsal margin strongly convex; siphonal margin not clearly defined from postero-dorsal margin; ventral margin broadly arcuate but sometimes a little concave in its posterior part; an indistinct carina extends from umbo to the postero-ventral extremity; umbo very prosogyrous, placed at about one-fourth or one-third of shell-length from the anterior end; lunule moderate in width, rather shallow, very weakly defined; escutcheon well demarcated by an angular ridge; ligament external, short but highly elevated above the dorsal margin; surface marked numerous concentric lines of growth, which are somewhat rugose and quite irregular in prominence; no prominent concentric ribs on the umbonal region; hinge plate broad especially in adult shells; dentition characterized by much modified lucinoid cardinal teeth and corbiculoid elongated lateral teeth, as formulated:

$$\frac{\text{AIII AI 3a 3b 5b PI}}{\text{AII 2 4b PII}};$$

3a comparatively small, tubercular, acline, represented by a terminal thickening of AIII; 2 fairly stout, highly elevated, prosocline, separated from AII by a wide interruption; 3b especially large, very stout and broad; 4b moderately thick, obliquely elongated, very prosocline; 5b narrow, short but distinctly separated from nymph; anterior lateral teeth linearly elongated along the antero-dorsal



Text-fig. 3. *Protocyprina naumanni* (NEUMAYR)

1. Rubber cast taken from a right internal mould (GK. H6749) ×1.5. [See also Pl. 14, Fig. 5]
2. Rubber cast taken from a right internal mould (GK. H6747) ×1. [See also Pl. 14, Fig. 8]
3. Rubber cast taken from a left internal mould (GK. H6745) ×1.5. [See also Pl. 14, Fig. 3]
4. Rubber cast taken from a right internal mould (GK. H6746) ×1. [See also Pl. 14, Fig. 6]
5. Rubber cast taken from a left internal mould (GK. H6739) ×1. [See also Pl. 14, Fig. 2]
6. Rubber cast taken from a left internal mould (GK. H6737) ×1. [See also Pl. 14, Fig. 7]

margin, but AI and AIII ill-defined from margin of hinge plate; posterior lateral teeth PI and PII remote from cardinal teeth, much weaker than anterior laterals, comparatively short in the adult stage; PIII not defined; no prominent transverse crenulations on lateral teeth; adductor scars subovate, subequal in size; pallial line abruptly bent beneath the posterior adductor scar, but never sinuate; pedal scar not clearly marked; umbonal cavity comparatively shallow.

Measurements in mm.—

Specimen	Length	Height	Thickness	L/H
Both valves (GK. H6726)	85.5	68.0	31.0	1.26
Both valves (GK. H6727)	78.0	73.5	24.5	1.06
Left valve (GK. H6728)	61.0	42.0+	13.0	1.45—
Both valves (GK. H6729)	59.0+	46.0+	25.0	?
Right valve (GK. H6730)	56.5	53.5	13.0	1.06
Both valves (GK. H6731)	60.5	57.0	28.5	1.06
Both valves (GK. H6732)	75.0	75.0	28.0+	1.00
Right valve (GK. H6734)	30.0	22.5	6.5	1.33
Left valve (GK. H6735)	36.0	33.5	8.5	1.07
Left in. mould (GK. H6737)	69.5+	78.0	13.5	0.89+
Right in mould (GK. H6738)	36.0	27.0	7.0	1.33
Left in. mould (GK. H6739)	50.0	39.5	8.5	1.27
Both valves (GK. H6740)	56.0	48.0	23.5	1.17
Right in. mould (GK. H6741)	21.0	17.0	5.0	1.24
Right in. mould (GK. H6742)	41.0	29.0	8.0	1.41
Left in. mould (GK. H6743)	37.0	32.0	7.0	1.16
Left in. mould (GK. H6745)	28.0	24.5	5.5	1.14
Right in. mould (GK. H6746)	46.0	37.0	8.0	1.24
Right in. mould (GK. H6747)	44.5	35.0	7.5	1.27
Right in. mould (GK. H6748)	33.5	24.5	5.5	1.37
Right in. mould (GK. H6749)	23.0	18.5	4.0	1.24

Observations and comparisons.—In addition to the 31 specimens above described, many specimens from the type and other areas at hand are referable to the present species. Most of these specimens are more or less secondarily deformed, and the ratio of length/height apparently varies to a great extent. Most specimens with two valves in juxtaposition are crushed and secondarily depressed, and the thickness is generally much decreased. On the grounds of measurements of undeformed specimens, it is evident that the range of the intraspecific variation is fairly wide; hence NEUMAYR (1890) previously considered his material from Yanagidani to be separable into three species. In one of the syntypes (NAUMANN and NEUMAYR, 1890, pl. 4, fig. 3) and some of the present topotypes (GK. H6728, GK. H6729) the ventral margin is slightly concave, while it is broadly arcuate in other specimens. The prominence of the posterior carination and the position of the umbo are also somewhat variable, but it may be partly due to the different states of secondary deformation.

Beside the type area i.e. the Katsuragawa valley, the present species occurs also from the Yatsushiro, Yuasa, Sanchu and Ojika areas. So far as we

observed the present material, no marked morphological difference is discernible between the groups of specimens from one area to another. Although they are variable in the state of preservation and generally more strongly deformed than the specimens from the type area, two specimens (GK. H6750, GK. H6751) from the Yuasa formation of the Yuasa area, one specimen (GK. H6752) from the Kawaguchi formation of the Yatsushiro area, one specimen (GK. H6753) and several ones in the Tohoku University from the Shiroi formation of the Sanchu area, and two ill-preserved moulds from the Ayukawa formation of the Ojika area are certainly referable to *Protocyprina naumanni* in view of the similar external and/or internal characters.

The immature shells of this species, which are represented by several specimens (GK. H6734, GK. H6741, GK. H6745, GK. H6749), show an *Eomiodon*-like internal structure. The disposition of the cardinal teeth is essentially similar to that of many Jurassic species of *Eomiodon*, although the anterior lateral teeth are not so strongly curved inwards as in *Eomiodon*. In some gerontic specimens (GK. H6737, etc.), however, the hinge plate is extraordinarily thickened, the lateral teeth become somewhat obsolete, and the cardinal tooth 5b is proportionally much thickened. The hinge structure in various ontogenetic stages is well exhibited in the specimens GK. H6736, GK. H6737, GK. H6741, GK. H6742, GK. H6746, GK. H6748, GK. H6749 (Text-fig. 3) and also in the specimen IGPS reg. no. 35153 (YABE, NAGAO and SHIMIZU, 1926, pl. 12, fig. 6) preserved in the Tohoku University. In the specimens GK. H6726, GK. H6727, GK. H6731, the opisthodetic external ligament is well preserved, as is usually so in other cyrenoids from the Jurassic and Cretaceous brackish-water sediments of Japan.

It is probably a general tendency that the ratio of length/height decreases with growth. In most of the young specimens the ratio is slightly larger than 1.20, while in many adult specimens it scarely exceeds 1.10. The tendency is well recognizable also from the growth-lines of one specimen.

The present species is closely related to *Protocyprina libanotica* (FRAAS, 1878) from the Aptian of Lebanon (NOETLING, 1886; VOKES, 1946; CASEY, 1955), because they are similar in every essential character. The distinctly separated cardinal tooth 5b and the much thickened 3b show that they are equally distinguishable from *Eomiodon*. The size of the adult specimens of *P. libanotica* (ca. 80 mm in maximum length) is just comparable with that of the present species. The Lebanon species is, however, different from the present one in the more centrally placed umbo and the presence of conspicuous concentric sculpture on the umbonal surface.

We agree with YABE, NAGAO and SHIMIZU (1926) and other subsequent investigators in considering that the three nominate species of NEUMAYR (1890), *Cyrena naumanni*, *C. gravida* and *C. lithocardium*, are actually conspecific; the specific name of *Cyrena naumanni* is applicable on account of its page priority. YABE, NAGAO and SHIMIZU (1926, p. 50) noted the presence of three cardinal teeth in each valve, regarding the dentition of this species as cyrenoid. However, as described above, the left valve has only two cardinals 2 and 4b, the cardinal 1 is absent, and the hinge structure is certainly a kind of lucinoid type.

YAMAGIWA (1955) interpreted "*Cyrena*" *shiroiensis* YABE and NAGAO *in* YABE, NAGAO and SHIMIZU (1926) to be a

synonym of "*Cyrena*" *naumanni*, considering that the two species are hardly separable as regards his material from the Lower Cretaceous of the Shima area. But the syntypes of "*Cyrena*" *shiroiensis* (YABE, NAGAO and SHIMIZU, 1926, pl. 14, figs. 4-6, 19, 20, 22, 25), from the Shiroi formation of the Sanchu area, are clearly distinguishable from the typical specimens of *Protocyprina naumanni* in the much smaller dimensions, the deeper umbonal cavity, the presence of transverse crenulations on the side slopes of the cardinal teeth, and the different disposition of the cardinal teeth of *C. shiroiensis*, as is well exhibited in the hypotypes from the Yoshimo formation of the Shimonoseki area (KOBAYASHI and SUZUKI, 1939). These characters do not agree with the diagnosis of any known genus of the Neomiodontidae. Although further studies are needed on the taxonomic position of "*C.*" *shiroiensis*, it is evidently distinct from *Protocyprina naumanni* in a generic level. YAMAGIWA's specimens are probably referable to "*C.*" *shiroiensis* instead of *P. naumanni* in view of the deep umbonal cavity and small dimensions, although their hinge structure is unknown in detail.

Occurrence. — Kochian (approximately lower Neocomian) and (?) Aritan (approximately upper Neocomian). Dark grey shale of the Tatsukawa formation at Hy. 5010, south of Yanagidani (type locality) and at Hy. 5041, south of Shokuda, Kamikatsu town, Katsuura County, Tokushima Prefecture. Weathered sandy shale of the same formation at Hy. 5032, near Tatsukawa, Katsuura town, the same county, and at Nk. 5018, south of Nishioka, the same town. Above noted localities are indicated in Text-fig. 2. Black shale of the Kawaguchi formation at a road-cut between Kawaguchi and Shimofukami, Sakamoto town, Yatsushiro County, Kumamoto Prefecture (KANMERA coll.). Dark grey sandy shale of the Yuasa formation at Tataki cape, south of Suhara, Yuasa town, Arita County, Wakayama Prefecture (MATSUMOTO, OTA and HAYAMI coll.). Black shale of the Shiroi formation at Bomekisawa, Ohinata village, Minamisaku County, Nagano Prefecture (YABE et al. coll.). Grey sandy shale of the Ayukawa formation at Kukunari, Ojika town, Ojika County, Miyagi Prefecture (HAYAMI coll.).

YABE, NAGAO and SHIMIZU (1926) reported this species also from "cyrenoid beds" at Shiroi and Hachimanzawa of the eastern part of the Sanchu area in Gumma Prefecture, where Aritan and Miyakoan deposits are distributed HIRAYAMA et al. (1956) and some others re-

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Explanation of Plate 13

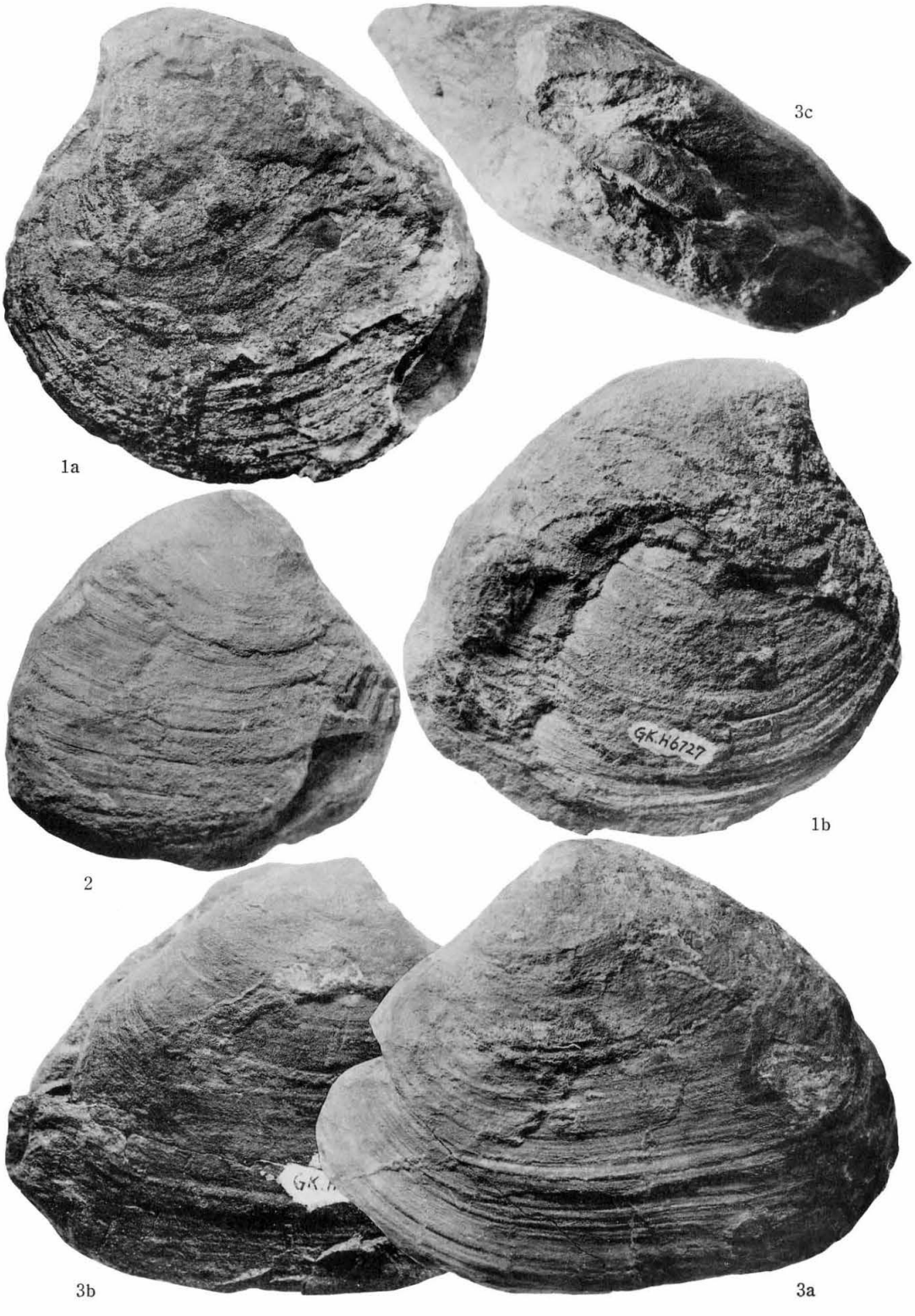
Protocyprina naumanni (NEUMAYR) ..... p. 117

Fig. 1. Bivalved specimen (GK. H6727) ×1. Tatsukawa formation at Hy. 5010, Yanagidani, Kamikatsu town, Katsuura County, Tokushima Pref. 1a: left valve, 1b: right valve.

Fig. 2. Right valve (GK. H6731) ×1. Loc. ditto.

Fig. 3. Bivalved specimen (GK. H6726) ×1. Loc. ditto. 3a: left valve, 3b: right valve, 3c: upper view.

All specimens illustrated are kept in the Department of Geology, Kyushu University. Photos by HAYAMI and NAKAI.


3c
1a
GK.H6727
1b
2
3b
3a

ported that "*Cyrena*" *naumanni* occurred also from certain brackish-water beds in the Hanoura formation of the Katsuuragawa area. Those occurrences, however, are doubtful, because the pelecypod specimens from those localities are certainly referable to the species which are distinct from *Protocyprina naumanni*.

Further notes on the taxonomic position of "*Cyrena*" *naumanni* and the classification of the Neomiodontidae

By Itaru HAYAMI

As has been precisely described above, "*Cyrena*" *naumanni* is clearly different from any species of the Corbiculidae in the hinge structure. All the species of the Corbiculidae, including *Polymesoda* RAFINESQUE, 1820, have in each valve three cardinal teeth, of which the central cardinal tooth 1 is well developed. In "*Cyrena*" *naumanni*, however, this tooth is absent, the cardinal tooth 2 is never differentiated into 2a and 2b, and the weak cardinal tooth 5b is clearly demarcated from the nymph. In the disposition of the cardinal and lateral teeth and also in external features, this species is especially similar to *Astarte libanotica* FRAAS, 1878, from the Aptian of Lebanon, which is the type-species of *Protocyprina* VOKES, 1946. It is considered here the two species are congeneric. In other words "*Cyrena*" *naumanni* is assigned to *Protocyprina*.

The dentition of *Protocyprina* is not of cyrenoid but of lucinoid type. The elongated lateral teeth may remind me those of corbiculids, but in the general hinge structure it is best referred to the Neomiodontidae defined by CASEY (1955).

It is here suggested that the Neomiodontidae are separable into two phylogenetical suites: one is the group of *Neomiodon* FISCHER, 1887 (=*Miodon* SANDBERGER, 1871, non DUMÉRIL, 1859, nec CARPENTER, 1865; ?=*Protomiodon* ANDERSON and COX, 1948), including *Myrene* CASEY, 1955 and *Crenotrapezium* HAYAMI, 1958, and the other is the group of *Eomiodon* COX, 1935 (non CHAVAN, 1936), including *Pseudasaphis* MATSUMOTO, 1938, *Protocyprina* VOKES, 1946, and *Costocyrena* MATSUMOTO and KANMERA, 1952 (MS*).

The group of *Neomiodon* is generally characterized by the thin test, the more or less conspicuously carinate shell, the absence of a well defined lunule, the undeveloped cardinal tooth 5b, the well developed transverse crenulations on the lateral teeth and the smoothly arcuate pallial line. In many characters this group is fairly similar to *Eotrapezium* DOUVILLÉ, 1913, a primitive genus of the Arcticidae from the marine Lower Jurassic. The group of *Eomiodon*, on the contrary, shows thick test, a weak postero-ventral carina, a clearly defined lunule and a well developed cardinal tooth 5b. The transverse crenulations on the lateral teeth are less distinctly developed. The pallial line is generally abruptly bent beneath the posterior adductor scar in the group of *Eomiodon*. The surface, especially the umbonal region, is commonly marked with concentric ribs and rarely also with radial riblets. In some characters the group of *Eomiodon* is more similar to the Astartidae than to the Arcticidae. Although the Neomiodontidae have been referred to the Arcticacea, the two groups were probably derived independently from

* The diagnosis of this genus will be given on another occasion.

two marine heterodont pelecypods which are unrelated with each other. If the Neomiodontidae had dual origin, they could be separated into two subfamilies or even into two families.

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Explanation of Plate 14

Protocyprina naumanni (NEUMAYR) ..... p. 117

Fig. 1. Left valve (GK. H6728) ×1. Tatsukawa formation at Hy. 5010, Yanagidani, Kamikatsu town, Katsuura County, Tokushima Pref.
Fig. 2. Left internal mould (GK. H6739) ×1. Loc. ditto.
Fig. 3. Left internal mould (GK. H6745) ×1.5. Loc. ditto.
Fig. 4. Right valve (GK. H6740) ×1. Loc. ditto.
Fig. 5. Right internal mould (GK. H6749) ×1.5. Tatsukawa formation at Nk. 5018, south of Nishioka, Katsuura town, Katsuura County, Tokushima Pref.
Fig. 6. Right internal mouth (GK. H6746) ×1. Loc. same as Fig. 1.
Fig. 7. Obliquely compressed left internal mould (GK. H6737) ×1. Loc. same as Fig. 1.
Fig. 8. Right internal mould (GK. H6747) ×1. Loc. same as Fig. 5.

All specimens illustrated are kept in the Department of Geology, Kyushu University. Photos by HAYAMI and NAKAI.

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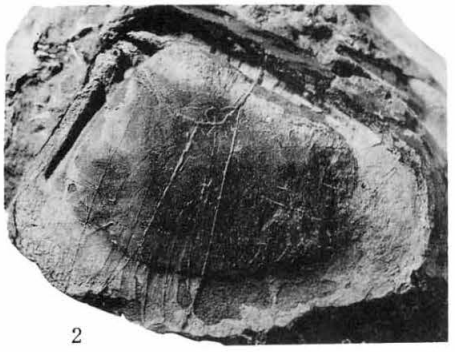

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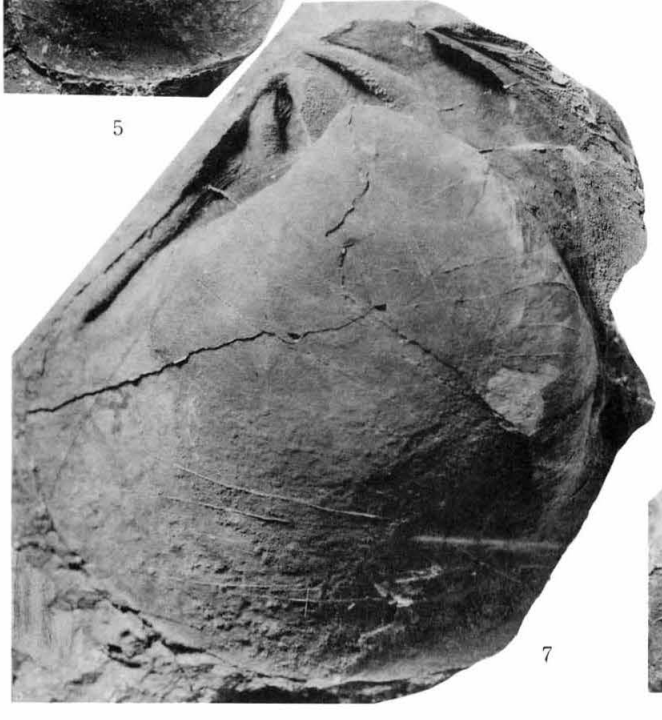

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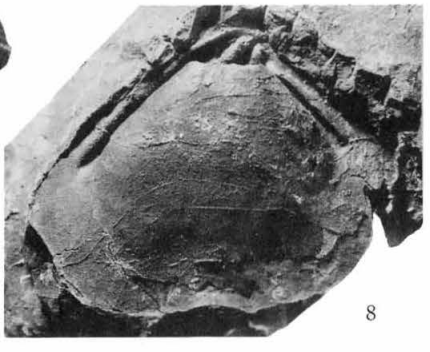

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mountains, Republic of Lebanon. Part 3. The pelecypod fauna of the "Olive locality" (Aptian) at Abeih. *Bull. American Museum Nat. Hist.*, 87, (3), 143-215, pls. 1-10.

YABE, Hisakatsu, NAGAO, Takumi and SHIMIZU, Saburo (1926): Cretaceous Mollusca from the Sanchu graben in the Kwanto mountainland. *Sci. Rep. Tohoku Imp. Univ.*, [2], 9, (2), 33-76, pls. 12-15.

YAMAGIWA, Nobuo (1955): Cretaceous Mollusca from the Shima peninsula, Japan. *Jour. Osaka Gakugei Univ.*, (3), 43-56, pls. 1, 2. (in Japanese with English resumé)

Ayukawa	鮎川	Shima	志摩
Bomekisawa	ボーメキ沢	Shimofukami	下深水
Hachimansawa	八幡沢	Shiroi	白井
Kamikatsu town	上勝町	Shokuda	喰田
Katsuura town	勝浦町	Suhara	栖原
Kawaguchi	川口	Tataki	端崎
Kukunari-hama	十九浜	Tatsukawa	立川
Monobegawa	物部川	Yanagidani	柳谷
Nishioka	西岡	Yatsushiro	八代
Ohinata village	大日尚村	Yuasa	湯浅

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 59, pp. 126-142, pls. 15-16, Sept. 20, 1965

494. CRETACEOUS ECHINOIDS FROM THE SANCHU GRABEN, CENTRAL JAPAN*

KEISAKU TANAKA

Geological Survey of Japan

山中地溝帯白堊紀海胆化石：関東山地山中地溝帯の下部白堊系（主として石堂層）から産出した海胆化石について，6 属 8 種（2 新種，3 既知種，1 類似種，2 同定不能種）を識別し，記載した。

田 中 啓 策

Introduction and Acknowledgements

The Cretaceous deposits in the Sanchu graben, about 100 km northwest of Tokyo, have been hitherto investigated by many persons from the standpoint of stratigraphy and paleontology. Nevertheless, the detailed geological map published still covers only the eastern part of the area; and moreover the paleontological works have been done chiefly on the molluscan fossils alone. As to the echinoids which are very subordinate constituents among the Cretaceous fauna in this area, only a few species have been reported by Y. YABE and others (1955), F. ARAI and others (1958), and K. TAKEI (1962) without paleontologic descriptions. Such being the case, for the purpose of a more complete collection of specimens together with examination of the stratigraphic occurrence, the writer visited the Sanchu graben in 1953, and again in 1958. Meanwhile some other investigators' collections from this area were offered to the writer. Thus, many specimens from the Lower Cretaceous in the Sanchu graben were ready to his hand. As the result of the study, discriminated among them were six genera and eight species; one of these species was already described by the writer and his co-worker under the name of *Aphelaster serotinus* TANAKA and SHIBATA, and two others are new to science. Some of the species here described are found also in the Lower Cretaceous of several other areas in the Outer side of Southwest Japan. So, for the description of such species here complementally dealt with are materials obtained from the Barremian Arita formation in the Yuasa area in the western part of the Kii Peninsula.

The writer expresses his cordial thanks to the following persons: Dr. Masahiro OKUBO of the Geological Institute, University of Tokyo for his much help in the collecting of materials and photographing: Mr. Yukio YABE of the Japanese Information Center of Science and Technology and Mr. Kensaku TAKEI of the Chichibu Natural Science Museum for their kind offer of materials and information on the stratigraphy; Dr. Noboru YAMASHITA of the Geological Institute, University of Tokyo and Mr. Mankichi HORIGUCHI of the Department of Earth Science, Saitama University for

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their kind offer of materials; Mr. Yoshio MASAI of the Geological Survey of Japan for the photographing.

Stratigraphical Note

The Cretaceous deposits in the Sanchu graben, 40 km long and 2-3.5 km broad, are in fault relation to the Paleozoic on both the northern and southern sides, being in a direction subparallel to the general trend of the Paleozoic. They show a synclinorium structure complicated by numerous longitudinal and transversal faults. According to TAKEI (1963), the stratigraphic succession in the eastern part of the area is as follows in descending order.

Sanyama formation (lower part of the Upper Cretaceous): About 500 m thick, beginning with basal conglomerate which, in turn, is succeeded by shale and subordinate sandstone. Marine fossils are sporadic.

~~~~~ Unconformity ~~~~~

Sebayashi formation (Aptian-Albian): Less than 600 m thick, composed of arkose sandstone in the lower and alternation of sandstone and shale in the upper. Molluscan remains, chiefly of brackish origin are sporadic and a plant bed is found in the lower.

Ishido formation (Neocomian): About 400 m thick, begining with conglomerate and composed mainly of sandy shale or siltstone. Marine molluscan fossils such as ammonites, trigonians and other bivalves occur in abundance. Brackish shells and plant remains are also common in certain horizons.

The Ishido formation is to be correlated to the Hauterivian and Barremian from the ammonite assemblages.

Fossil Localities

Most of the materials here dealt with were collected from the Ishido formation, and only a few of them from the presumed Ishido formation. Their localities are as follows (Fig. 1).

Loc. 1:—About 1.1 km south of Hikage, Ogano-cho, Chichibu-gun, Saitama Prefecture; dark gray, massive, sandy siltstone in the lower part of the Ishido formation; echinoids scarce.

Loc. 2:—About 800 m northwest of Sebayashi, Nakazato-mura, Tano-gun, Gumma Prefecture; dark gray, massive, sandy siltstone in the lower part of the Ishido formation; echinoids sporadic.

Loc. 3:—About 500 m north of Myoke, Nakazato-mura, Tano-gun, Gumma Prefecture; dark gray, massive, sandy siltstone in the lower part of the Ishido formation; echinoids scarce.

Loc. 4:—About 600 m north of Shiroi, Ueno-mura, Tano-gun, Gumma Prefecture; dark gray, massive, silty fine-grained sandstone to sandy siltstone in the lower part of the Ishido formation; echinoids sporadic.

Loc. 5:—About 2.5 km northwest of Shiroi, Ueno-mura, Tano-gun, Gumma Prefecture; dark gray, massive, silty fine-grained sandstone to sandy siltstone in the lower part of the Ishido formation; echinoids common in some laminae.

Loc. 6:—Upper course of the Honya, Minamimaki-cho, Shigaraki-gun, Gumma Prefecture; dark gray siltstone in the lower part of the Ishido formation; echinoids scarce.

Loc. 7:—Ishido, Saku-cho, Minamisaku-gun, Nagano Prefecture; dark gray, rather massive siltstone in the lower part of the Ishido formation; echinoids sporadic.

Loc. 8:—Lower course of the Onozawa, Saku-cho, Minamisaku-gun, Nagano Prefecture; bluish gray, massive, medium-grained sandstone in the presumed Ishido formation; echinoids scarce.
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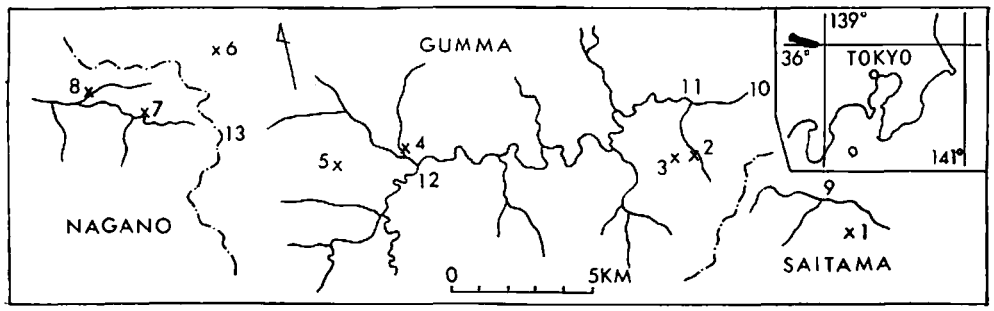


Fig. 1. Map showing the fossil localities. 1–8, fossil localities; 9, Kawarazawa; 10, Kanna river; 11, Kagahara; 12, Shiroi; 13, Jukkoku-toge. Inset is a map of Kwanto, indicating the Cretaceous outcrop in the Sanchu graben.

Echinoids occur scarcely also in the Sanyama formation. But they are not dealt with in this paper.

Description of Species

Order Cassiduloida DUNCAN

Suborder Cassidulina DELAGE and HÉROUARD

Family Clypeidae LAMBERT, 1898

Genus *Pygurus* L. AGASSIZ, 1839

Subgenus *Pygurus* (s.s.) L. AGASSIZ

Pygurus (*Pygurus*) *complanatus* n. sp.

Pl. 15, figs. 1a-c, 2a-c

Type specimens:—Holotype, GSJ. 6090; paratype, GSJ. 6091.

Description:—Test small, subovate, low, slightly longer than wide, widest well behind the center, rounded in front, lacking the anterior notch, nearly straight in the postero-lateral margins, slightly produced behind. Adapical surface broadly convex, highest somewhat behind the center, steeper in front than behind, rather acute at the ambitus; adoral surface concave around the peristome, somewhat pulvinate, less strongly inflated in the antero-lateral interambulacra than in the others. Apical system somewhat in front, small, with four genital pores and a large central madreporite.

Ambulacra all similar, superficial, petaloid; petals lanceolate, closed apically, slightly open distally, extending almost to the ambitus; anterior petal shorter, narrower than the others; anterior paired petals widest, diverging at an angle of 120° to 130°; posterior paired petals longest, diverging at an angle approximating 60°. Poriferous zones narrower than the interporiferous; pores conjugate, outer pores long slit-like, inner pores small, round to oval in the petaloid part; pore pairs minute, rounded, obliquely set near the ambitus. Ambulacra on the adoral surface lodged in distinct furrows.

Peristome somewhat in front, directly under the apical system; pentagonal, sunken; phyllodes short, widened, depressed; bourrelets conspicuous, elongated. Periproct transversely oval, inframarginal, not visible from above. Tubercles small, perforate, crowded, larger on adoral surface than on adapical surface.

Measurements (in mm.):—

	GSJ. 6090	GSJ. 6091
Length	21.2	19.7
Width	19.0	16.6
Height	7.5	6.1
Distance of apex from the anterior end	8.9	8.4

Remarks:--The paratype (Pl. 15, figs. 2a-c) shows a slightly more elongated outline than the holotype (Pl. 15, figs. 1a-c) which represents the general form of the test. According to KIER's classification of the genus *Pygurus* (1962), the present species is to be placed in the subgenus *Pygurus*. This species is clearly distinguished from the Japanese known species, *Pygurus* (*Pygurus*) *asiaticus* TOKUNAGA*. The latter has a tumid test, a distinct anterior notch and a large posterior rostrum. This new species resembles to some extent *Pygurus* (*Pygurus*) *impar* GAUTHIER from the Upper Neocomian of Algeria, although in the latter features of the posterior part of test is unknown. However, *Pygurus* (*Pygurus*) *complanatus* differs from *P.* (*P.*) *impar* in having shorter, narrower and more tapering petals. The species here described is furthermore easily distinguishable from *Pygurus* (*Pygurus*) *montmollini* (AGASSIZ) from the Middle Neocomian of France and Switzerland. In *P.* (*P.*) *montmollini* the test is higher, distinctly notched in front and largely rostrated behind.

Occurrence:—Loc. 8, presumed Ishido formation, medium-grained sandstone, Lower Cretaceous (GSJ. 6090, 6091, 6125, 6126, coll. by Y. YABE; GSJ. 6106, coll. by K. TANAKA and Y. YABE).

* Although this species was collected from the presumed Cretaceous strata in the southern part of Shikoku, it exact horizon is still unknown. The horizon was misled to be the Cenomanian in the Essai de nomenclature raisonnée.

Order Spatangoida L. AGASSIZ

Suborder Meridosternata (LOVÉN) MORTENSEN

Family Holasteridae ZITTEL, 1879 emend. LAMBERT, 1917

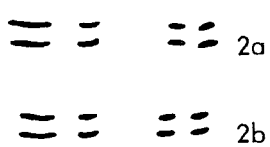
Subfamily Holasterinae MORTENSEN, 1950

Genus *Pseudholaster* POMEL, 1833

Pseudholaster n. sp. (?)

Pl. 15, figs. 3a-d, 4a-c; Text-figs. 2a-b

Description:—Test medium-sized, cordate, nearly as wide as long, widest a little in front of the midpoint, contracted behind; adapical surface rather flat-topped, highest on the margin of the anterior sulcus somewhat in front of the apical system, sloping abruptly in front, truncated behined; posterior truncated surface slightly concave, thus the posterior margin showing a shallow sinus; adoral surface slightly convex. Apical system somewhat in front, elongated, the length about three times the width; apical system, though its detailed structure being not observable, probably intercalary type because the anterior paired ambulacra and the posterior are somewhat distant from each other at



Figs. 2a, b. *Pseudholaster* n. sp. (?). Pore pairs in the left anterior paired ambulacra (2a) and left posterior paired ambulacra (2b), ×6. (GSJ. 6046).

the apex. Anterior sulcus deep, rather short, increasing in width and depth toward the ambitus, forming a distinct anterior notch, bordered by sharp keel-like elevations on both sides, extending to the peristome as a less distinct groove on the adoral surface.

Anterior ambulacrum lodged in the deep anterior sulcus, shortest, not petaloid; poriferous zones much narrower than half the width of the interporiferous zones; pores similar, smaller, oval, closely set, transverse. Paired ambulacra open distally, superficial, subpetaloid; anterior ambulacra slightly flexuous, wider than the posterior ambulacra which are straight; pores opposite, not conjugate. In the anterior paired ambulacra, anterior poriferous zones much narrower than the posterior, nearly half the width of the latter; interporiferous zones somewhat narrower than the posterior zones. Pores in the anterior zones elongated oval, opposite, rather near together. Posterior zones composed of longer slit-like outer pores and shorter slit-like inner pores; pores of each pair opposite, widely set. In the posterior paired ambulacra, two poriferous zones less unequal in comparison with those of the anterior paired ambulacra; anterior poriferous zones narrower than the posterior; interporiferous zones somewhat narrower than the posterior poriferous zones. Pores in the anterior zones elongated oval, opposite, rather closely set; pores in the posterior zones slit-like, opposite, widely set, a little longer in the outer row than in the inner.

Peristome semicircular, deep, situated at about one-fourth from anterior end, lying in the recurved end of the anterior sulcus; plastron meridosternous. Periproct high up on the posterior truncated surface which is concave, longitudinally elongated oval. Tubercles small, similar-sized, more closely spaced on plastron than elsewhere. No fascioles.

Measurements (in mm.):—

	GSJ. 6050
Length	26.8
Width	26.8
Height	13.8
Distance of apex from the anterior end	10.9

Remarks:—The specimen registered GSJ. 6050 (Pl. 15, figs. 4a-c), though lacking about half of the anterior marginal part of the test, is regarded as showing the general form of the test in the present species. The specimens at hand are fairly close to *Pseudholaster baconicus* SZÖRÉNYI from the Albian and Cenomanian of Hungary in general features of the test. But there is a minor but distinct difference between the two. In *P. baconicus* tubercles are larger on the margin of the adoral surface and on that of the plastron than elsewhere. The present form is distinguished from *Pseudholaster bicarinatus* (AGASSIZ) from the Cenomanian of France in many respects. In the former, the test is not arcuate but rounded at the ambitus and the apical system is somewhat forward, thus the anterior sulcus is shorter than in the latter species. In *P. bicarinatus*, moreover, the posterior interambulacral area on the adapical surface is elevated in the form of carina. To sum up, the species here described probably represents a new species. The establishment of this new species is, however, suspended until more specimens are obtained. The occurrence of *Pseudholaster* from the Upper Neocomian of Japan requires correction of the stratigraphic distribution of this genus.

Occurrence:—Loc. 5, Ishido formation, silty fine-grained sandstone to sandy siltstone, Neocomian (GSJ. 6044-6050, 6129, coll. by K. TANAKA and M. OKUBO).

Suborder Amphisternata (LOVÉN) MORTENSEN

Family Toxasteridae LAMBERT, 1920

Genus *Toxaster* L. AGASSIZ, 1840

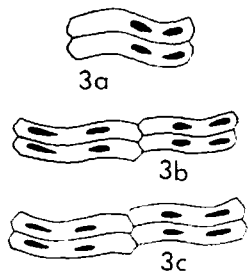
Toxaster sanchuensis n. sp.

Pl. 15, figs. 5a-b, 6a-b; Pl. 16, figs. 1a-c, 2a-c; Text-figs. 3a-c

Type specimens:—Holotype, GSJ. 6124; paratypes, GSJ. 6041, 6042, 6110.

Description:—Test medium-sized, cordate, widest somewhat in front of the midpoint, not greatly contracted behind; adapical surface inflated, rather flat-topped, highest at the apical system, truncated behind; adoral surface nearly flattish. Apical system somewhat in front of the midpoint, with four genital pores, ethmophract. Anterior sulcus rather shallow, becoming wider, much shallower toward the frontal margin, extending to the peristome; anterior notch rather indistinct.

Anterior ambulacrum depressed throughout the way, somewhat shorter, wider than the paired ambulacra; poriferous zones much narrower than the interporiferous zones, somewhat less than half the width of the latter in the middle part, widest near the middle, tapering toward the ambitus and apical system. Pores in the middle part oval to elongated oval, near together; outer pores nearly transverse or slightly oblique, inner pores oblique; pores in the proximal and distal parts smaller, oval; pores near the ambitus minute, round, obliquely set, near the anterior outer corner of ambulacral plates; pores of each pair not separated by a granule. Paired ambulacra unequal, open distally, slightly sunken, subpetaloid; petaloid part longer in the anterior paired ambulacra than in the posterior. Anterior paired ambulacra slightly shorter, wider than the posterior ambulacra, diverging at an angle approximating 110°, slightly flexuous; petaloid part about two-thirds the way to the margin; poriferous zones somewhat unequal, anterior zones narrower than the posterior zones. Pores in the anterior poriferous zones composed of short slit-like outer pores and elongated oval inner pores, pores of each pair opposite, rather widely set; pores in the posterior zones slit-like, opposite, widely set, outer pores longer than inner pores, acuminated inward. Pores in the distal part diminishing in length, becoming closer together; pores near the ambitus minute, almost circular, near together, obliquely set, near the anterior outer corner of ambulacral plates. Interporiferous zones somewhat narrower than the posterior poriferous zones. Posterior paired ambulacra nearly straight, diverging at an angle approximating 60°; petaloid part shorter than that of the anterior ambulacra, about



Figs. 3a-c. *Toxaster sanchuensis* n. sp. 3a, Anterior ambulacrum, ×6. 3b, Left anterior paired ambulacra, ×6. 3c, Left posterior paired ambulacra, ×6. (GSJ. 6124).

half the way to the margin, somewhat closed at the end, composed of two equal poriferous zones. Poriferous zones nearly equal to the interporiferous zones in width; pores elongated, opposite, widely set, outer pores longer than inner pores, slit-like; features of the pores in the distal part and near the ambitus similar to the case of the anterior paired ambulacra.

Peristome subpentagonal, somewhat transverse, near the anterior fourth to fifth, shallowly sunken; plastron amphisternous. Periproct longitudinally oval, pointed at both ends, high up on the posterior truncated surface, visible from above. Tubercles small, perforate, crenulate, rather crowded near the ambitus and on the plastron, rather sparsely spaced on the remainder; interporiferous zones of all the ambulacra dotted with much smaller tubercles; numerous microscopic granules between tubercles. No fascioles.

Measurements (in mm.):—

	GSJ. 6041	GSJ. 6042
Length	27.2	22.4
Width	22.8	21.0
Height	12.5	13.5
Distance of apex from the anterior end	12.2	11.2

The largest specimen reaches about 44 mm. in length.

Remarks:—The general form of the test is well represented by one of the paratypes (GSJ. 6042; Pl. 16, figs. 1a-c), although this paratype is of small size, probably an immature form. The present species resembles *Toxaster gibbus* AGASSIZ from the Barremian and Aptian of the Circum-Mediterranean region and *T. peroni* LAMBERT from the Neocomian of Morocco in the features of pore pairs in the anterior ambulacrum, the depressed paired ambulacra and the anteriorly eccentric position of the apical system. But in *T. gibbus* the test is more inflated and the petals are longer than in *T. sanchuensis*, and moreover the interporiferous zones of the paired petals have no tubercles. *T. sanchuensis* is distinguished from *T. peroni*, which has tubercles in the interporiferous zones of the paired petals like the former species, by its much narrower petals. This new species is similar also to *Toxaster collegnoi* (SISMONDA) from the Aptian of the Circum-Mediterranean region as far as the features of pores pairs in the anterior petal and the depressed paired petals are concerned. However, the former differs from the latter in having narrower anterior sulcus and less flexuous anterior paired petals. Furthermore, in *T. collegnoi* the posterior interambulacral area on the adapical surface has a slightly carina-like elevation, while such is not the case in *T. sanchuensis*. *Toxaster sanchuensis* is clearly distinguished from *T. retusus* (LAMARCK) from the Hauterivian of Europe and the Hauterivio-Barremian of North Africa. In the former the apical system is anteriorly eccentric and the anterior sulcus becomes much shallower at the ambitus, while in the latter the apical system is backward and the anterior sulcus is considerably deep at the frontal margin. Moreover, in *T. retusus* the pores of each pair in the posterior poriferous zones of the paired petals are separated by a granule.

Occurrence:—Loc. 2, Ishido formation, sandy siltstone, Neocomian (GSJ. 6107, coll. by K. TANAKA and Y. YABE); loc. 4, Ishido formation, silty fine-grained sandstone to sandy siltstone, Neocomian (GSJ. 6130, coll. by K. TAKEI); loc. 5, Ishido formation, silty fine-grained sand-

stone to sandy siltstone, Neocomian (GSJ. 6041–6043, coll. by K. TANAKA and M. OKUBO; GSJ. 6110-6113, 6118, coll. by K. TANAKA and Y. YABE; GSJ. 6124, coll. by N. YAMASHITA; GSJ. 6130, coll. by Y. YABE); loc. 6, Ishido formation, siltstone, Neocomian (GSJ. 6059, coll. by Y. YABE). Furthermore, a specimen probably identical with this species was obtained from the Barremian Arita formation in the Yuasa area (GSJ. 6035, coll. by K. TANAKA).

Genus *Aphelaster* LAMBERT, 1920

Aphelaster serotinus TANAKA and SHIBATA

1961. *Aphelaster serotinus* TANAKA and SHIBATA, *Trans. Proc. Pal. Soc. Japan, N.S.*, No. 42, p. 68-72, pl. 10, figs. 1-6, text-figs. 1, 2.

Occurrence:—Loc. 7, Ishido formation, siltstone, Neocomian (GSJ. 6092, 6093, 6095, 6096, coll. by Y. YABE).

Genus *Heteraster* D'ORBIGNY, 1853

(=*Enallaster* D'ORBIGNY, 1853)

Heteraster macroholcus (NISIYAMA)

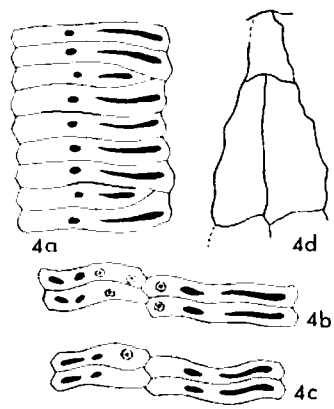
Pl. 16, figs. 3, 4a-b; Text-figs. 4a-d

1950. *Washitaster* (?) *macroholcus* NISIYAMA, *Short Papers IGPS*. No. 1, p. 45, figs. 4-7.

1954. *Washitaster macroholcus*, TANAKA and OKUBO, *Jour. Geol. Soc. Japan*, Vol. 60, No. 705, p. 221, pl. 7, figs. 1, 2, text-figs. 5, 7.

1954. *Washitaster barremicus*, TANAKA and OKUBO, *Ibid.*, Vol. 60, No. 705, p. 220, pl. 7, fig. 3, text-fig. 7.

Description:—Test large, ovate, rather low, widest near the midpoint, not greatly contracted behind; adapical surface gently arched, highest on the margin of the anterior sulcus just in front of the apical system, sloping gently forward, more steeply behind, truncated behind; adoral surface rather flat, deeply depressed around the peristome, somewhat inflated in the posterior interambulacral area. Apical system very eccentric behind, near the posterior fourth; genital pores four in number. Anterior sulcus deep, very long, about three-fourths the length of the test, somewhat constricted and shallower just back of the anterior margin, biconvex, with sides nearly straight, extending to the peristome; anterior notch distinct.



Figs. 4a-d. *Heteraster macroholcus* (NISIYAMA). 4a. Anterior ambulacrum, ×5.5. 4b, Right anterior paired ambulacra, ×5.5. 4c, Right posterior paired ambulacra, ×5.5. (GSJ. 6128, Arita formation). 4d, Plastron, ×0.75. (GSJ. 6002, Arita formation).

Anterior ambulacrum longest, lodged in the deep anterior sulcus, widest midway between the apical system and the frontal margin; poriferous zones somewhat narrower than the interporiferous. Pores in the main part of the petaliferous part very unequal, opposite, rather close together; in the outer row pores slit-like, acuminated inward, several

longer pores irregularly alternating with one shorter pore; in the inner row pores round to oval, pores opposite shorter outer ones slightly smaller, somewhat inward, thus pore pairs lining up in three (or better to say rather four) files. Pores in the proximal part becoming less unequal, inner pores round, outer pores oval to elongated oval. Paired ambulacra very unequal in length, superficial, flexuous, subpetaloid. Anterior paired ambulacra much longer than the posterior, diverging at an angle approximating 120° then turn forwards and laterally, angle between mid-line of each petal about 70°, and then diverge laterally and cross the ambitus far anteriorly; poriferous zones very unequal, anterior zones much narrower than the posterior zones. Pores of the anterior zones oval in the outer row, round to oval in the inner row, opposite, near together; pores of the posterior zones elongated oval in the inner row, slit-like in the outer row, opposite, rather close together. Interporiferous zones nearly equal to the posterior poriferous zones in width, enlarging toward the extremity, which are open. Posterior paired ambulacra shortest, broad, bulging in the center, diverging at an angle approximating 130° and then converge laterally; poriferous zones very unequal, anterior zones much narrower than the posterior. Anterior zones composed of elongated oval outer pores and oval inner pores, pores of each pair opposite, near together. Pores in the posterior zones elongated oval in the inner row, slit-like in the outer row, opposite, rather close together. Interporiferous zones nearly equal to the posterior poriferous zones in width, enlarging toward the extremity, which are open.

Peristome transversely oval, deeply sunken, far anteriorly, near the anterior fourth, lying in the recurved end of the anterior sulcus. Plastron amphisternous, labrum slightly emarginate, sternal plates nearly symmetrical, equal in size and shape. Periproct longitudinally oval, high up on the posterior truncated surface. Tubercles small, perforate, crenulate, scrobiculate, rather widely scattered; tubercles smaller, more closely spaced on both sides of the anterior sulcus and at the ambitus; interporiferous zones of the paired ambulacra dotted with tubercles; plastron covered with close-set tubercles; numerous microscopic granules between tubercles. No fascioles.

The largest of the specimens at hand including those from the Yuasa area attains about 8 cm in length.

Remarks:—The above description is based principally upon observations of a fairly large number of specimens from the Arita formation. This species was provisionally referred to *Washitaster* by the original author. However, it was made clear by the writer's subsequent investigation that fasciole is not present although a broad, ill-defined granular band decorated with tubercles surrounds the petals and that the pore pairs in the anterior ambulacrum exhibit arrangement of *Heteraster* type. Thus the present species is undoubtedly referred to *Heteraster*. Except that the apical system may be ethmophract, its detailed structure is not unfortunately ascertained due to ill-preservation of the apical system.

The outline of the test is ordinarily ovate as exemplified by the specimen illustrated in the writer's previous report (TANAKA and OKUBO, 1954, Pl. 7, figs. 1a-c), but it shows some extent of variation. As compared with the normal form, some individuals are provided with more anteriorly enlarged, namely ovate-cordate outline (Pl. 16, figs. 4a, b), while some others exhibit more elongated out-

line as illustrated by NISIYAMA (1950, figs. 4-7). There are furthermore recognized considerable variation in the mode of alternation of the pore pairs in the anterior ambulacrum. In the outer row of the pore pairs several longer pores alternate with one shorter pore. The number of the longer pores varies from place to place in one specimen and is also dissimilar between individuals, being most commonly two to five except in the proximal and distal parts. The number of the shorter pore alternating with the longer pores is usually one, but with only one exception two.

The present species is clearly distinguished from the two Japanese contemporary species, *Heteraster nexilis* NISIYAMA and *H. yuasensis* (TANAKA and OKUBO) by the more posteriorly eccentric position of the apical system, the longer, deeper anterior sulcus and the features of pore pairs in the anterior ambulacrum. In addition, there are some other differences mentioned below. The outline of the periproct is longitudinally oval in *H. macroholcus*, while transversely oval in *H. nexilis*. In *H. yuasensis* the depressed anterior paired ambulacra are more petaloid, the posterior ambulacra are more petaloid, less flexuous and more narrowly divergent and the peristome is less deeply sunken than in *H. macroholcus*. The species here described is fairly close to *H. oblongus* (BRONGNIART) from the Barremian of France and the Aptian of the Circum-Mediterranean region in general features of the test. But it differs from the latter in that the apical system is far backward, the peristome is transversely oval in outline and the periproct is longitudinally oval. *H. macroholcus* is furthermore distinguished from the two foreign Neocomian species, *H. couloni* (AGASSIZ) and *H. cesarensis* COOKE by the position of the apical system, the outline of the peristome, etc. It should be noticed that the species here described exhibits nearly symmetrical disposition of the sternal plates, which is regarded as being a much advanced character in the evolution of plastron in toxasterids by DEVRIÈS (1960), like the contemporary *H. yuasensis* described below, although it is an earlier representative of the genus *Heteraster*.

Occurrence:—Loc. 6, Ishido formation, siltstone, Neocomian (some specimens deposited in the Institute of Geology and Mineralogy, Tokyo University of Education, coll. by Y. YABE).

Heteraster cf. *nexilis* NISIYAMA

Pl. 16, fig. 5

Compared with:—

1950. *Heteraster nexilis* NISIYAMA, *Short Papers IGPS*, No. 1, p. 42, text-figs. 1-3.

1954. *Enallaster* cf. *nexilis*, TANAKA and OKUBO, *Jour. Geol. Soc. Japan*, Vol. 60, No. 705, p. 224, pl. 7, fig. 7, text-fig. 7.

Remarks:—The two specimens at hand are fairly similar to *Heteraster nexilis* NISIYAMA in general features of the test, although they are deformed and fragmentary. Moreover, paying special attention to the shape and arrangement of pore pairs in the anterior ambulacrum, one may can refer these specimens to *H. nexilis*. A peculiar feature of pore pairs is observed in one of the specimens (GSJ. 6105): two long pairs alternate with a short pair four times in the anterior poriferous zone of the left antero-lateral ambulacrum. Such an abnormality in the arrangement of pore pairs in the anterior paired petals is known also in certain foreign species. As a result of the writer's subsequent observation of the two specimens from the Arita for-

mation (GSJ. 6006, 6032) which are identical with *Heteraster nexilis* by the writer's reexamination, it is made clear that in *H. nexilis* the apical system is ethmophract and the posterior genital plates are in contact, thus not separated by the madreporite (Text-fig. 5). The

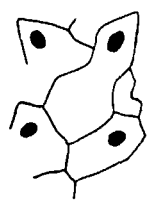


Fig. 5. *Heteraster nexilis* NISIYAMA. Apical system. ×10. (GSJ. 6006, Arita formation).

above-mentioned structure of the apical system is observable also in one of the specimens from the Sanchu graben (GSJ. 6127). It is furthermore noted that in *Heteraster nexilis* the pore pairs of the anterior ambulacrum line up in four files, thus showing the disposition of *Enallaster* type. The larger of the specimens at hand is a little more than 4 cm in length.

Occurrence:—Loc. 2, Ishido formation, sandy siltstone, Neocomian (GSJ. 6127, coll. by M. AIBA); loc. 7, Ishido formation, siltstone, Neocomian (GSJ. 6105, coll. by Y. YABE).

Heteraster yuasensis (TANAKA and OKUBO)

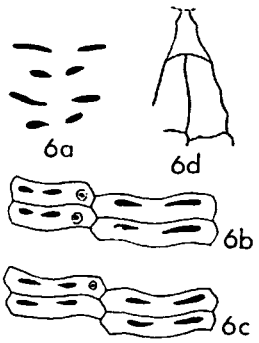
Pl. 16, figs. 6a-c, 7; Text-figs. 6a-d

1954. *Enallaster yuasensis*, TANAKA and OKUBO, *Jour. Geol. Soc. Japan*, Vol. 60, No. 705, p. 223, pl. 7, fig. 6, text-fig. 7.

Type specimens:—This species was established on several syntypes. The lectotype, here designated, is GSJ. 6007, from loc. 1, Arita formation, Wakayama Prefecture (TANAKA and OKUBO, 1954, pl. 7, fig. 6).

Description:—Test medium-sized, nearly circular, slightly cordiform, nearly as wide as long, rather low, widest somewhat in front of the center, not greatly contracted behind; adapical surface rather flat-topped, highest at the apical system, sloping gently in front, truncated behind; adoral surface nearly flattish. Apical system behind the center, with four genital pores, ethmophract. Anterior sulcus rather shallow, distinct through about two-thirds the way to the margin, becoming much shallower, indistinct toward the anterior margin, thus the anterior notch, if any, very indistinct.

Anterior ambulacrum lodged in the shallow anterior sulcus, slightly wider than the paired ambulacra, subpetaloid; petaloid part about two-thirds the way to the anterior margin, poriferous zones somewhat narrower than the interporiferous zones. Near the middle part a pair of elongated oval, closely spaced pores alternates regularly with a pair of long slit-like, widely spaced pores, thus pore pairs lining up in four files; outer pore longer than inner in each pair. Near the proximal and distal parts long pair decreases in number, thus a long pair alternating with several short pairs. Anterior paired ambulacra longer, slightly wider than the posterior paired ambulacra, flexuous, slightly sunken, subpetaloid; petaloid part about two-thirds the way to the margin; poriferous zones much unequal, anterior zones much narrower than the posterior zones, nearly half the width of the latter. Pores elongated oval, opposite, close together in the anterior zones, while in the posterior zones slit-like, opposite, widely set, the outer pores longer than the inner. Interporiferous zones somewhat narrower than



Figs. 6a-d. *Heteraster yuasensis* (TANAKA and OKUBO). 6a, Anterior ambulacrum, ×12. 6b. Right anterior paired ambulacra, ×9. 6c. Right posterior paired ambulacra, ×9. (GSJ. 6108). 6d. Plastron, ×0.9. (GSJ. 6007, Arita formation).

the posterior poriferous zones, dotted with tubercles. Posterior paired ambulacra shorter, less flexuous than the anterior ambulacra, very slightly sunken or nearly flush, subpetaloid; petaloid part halfway, somewhat narrower than that in the anterior paired ambulacra, somewhat closed at the end; anterior poriferous zones narrower than the posterior; pores slit-like, opposite, widely set, slightly longer in the outer row than in the inner row; interporiferous zones somewhat narrower than the poriferous, dotted with tubercles.

Peristome transversely oval, situated at about one fourth the length from the frontal margin, shallowly sunken. Plastron amphisternous; labrum slightly emarginate; sternal plates nearly symmetrical, equal in size and shape. Periproct longitudinally oval, well up on the posterior truncated surface. Tubercles small, perforate, more closely spaced on both sides of the anterior sulcus and on the plastron than elsewhere; tubercles on the plastron slightly larger, arranged in a concentric form with the center at the posterior end. No fascioles.

Measurements (in mm.):—

	GSJ. 6108
Length	23.0
Width	23.6
Height	8.8

The largest of all the specimens at hand including those from the Yuasa area attains a little more than 4 cm in length.

Remarks:—The description of this species is based on observations of the specimens from the Yuasa area in addition to those from the Sanchu graben. The present species is clearly distinguished from the contemporary *Heteraster nexilis* NISIYAMA in many respects. In the latter the anterior sulcus is rather deep, the anterior notch is distinct, the paired ambulacra are superficial and the periproct is transversely oval. *Heteraster yuasensis* has more petaloid paired ambulacra and less flexuous, more closed posterior paired ambulacra than *H. nexilis*. The distinction is moreover recognized in the features of pore pairs in all the ambulacra. *H. yuasensis* is also different from the contemporary *H. macroholcus* and the comparisons with that species are as described above. This species resembles *Heteraster obliquatus* (CLARK) from the Albian of Texas in the slightly depressed paired ambulacra and the mode of alternation of pore pairs in the anterior ambulacrum. But it differs from that species in having a very indistinct anterior notch and a longitudinally oval periproct. Further, *H. yuasensis* is distinguished from *H. obliquatus* by the shape of pore pairs in all the ambulacra. The species here described is similar also to *H. fittoni*

(DESOR) from the Aptian of Switzerland and England in the slightly depressed paired ambulacra and the shape of pore pairs in the anterior ambulacrum. However, there are distinct differences with regard to the shape of pore pairs in the paired ambulacra between the two species. Furthermore, *Heteraster yuasensis* is easily distinguished from the foreign Neocomian species, *H. couloni* (AGASSIZ), *H. oblongus* (BRONGNIART) and *H. cesarensis* COOKE, the second of which occurs also in the Aptian, by its general features of the test.

It draws one's attention that the species here described shows almost symmetrical disposition of the sternal plates, which is regarded as being a much advanced character in the evolution of plastron in toxasterids by DEVRIÈS (1960), although it is an earlier representative of the genus *Heteraster*.

Occurrence:—Loc. 2, Ishido formation, sandy siltstone, Neocomian (GSJ. 6108, coll. by K. TANAKA, GSJ. 6123, coll. by M. HORIGUCHI; loc. 3, Ishido formation, sandy siltstone, Neocomian (some specimens deposited in the Department of Earth Science, Saitama University, coll. by K. WANIBUCHI).

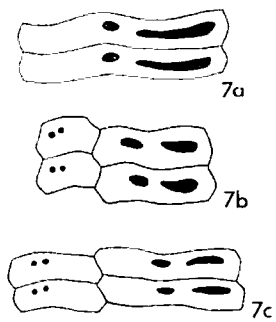
Genus *Washitaster* LAMBERT, 1927

Washitaster (?) sp.

Pl. 16, figs. 8, 9; Text-figs. 7a-c

Description:—The two specimens at hand are considerably deformed or fragmentary. It, however, seems very likely that the horizontal outline of the test is longer than wide, the apical system is situated far backward and the anterior sulcus is long and deep.

Anterior ambulacrum lodged in the anterior sulcus, long, wide; poriferous zones broader than half the width of the interporiferous zones. Pores slit-like in the outer row, while round to oval in the inner; pores of each pair opposite, rather close together. Paired ambulacra very unequal, flexuous, open distally. Anterior paired ambulacra very long, considerably narrow almost throughout the way, but rapidly widening near the ambitus, very slightly sunken or nearly flush, diverging at a smaller angle than the posterior paired ambulacra then turn forwards and laterally, becoming almost straight, and then diverge laterally and cross the ambitus far anteriorly. Anterior poriferous zones very narrow; pores minute, round, near together. Posterior zones much wider than the anterior zones; pores oval in the inner



Figs. 7a-c. *Washitaster* (?) sp. 7a, Anterior ambulacrum, ×10. 7b, Right anterior paired ambulacra, ×10. 7c, Right posterior paired ambulacra, ×10. (GSJ. 6116).

row, while elongated oval in the outer row; pores of each pair opposite, rather widely set. Interporiferous zones nearly equal to the poriferous zones in width near the midway between the apical system and the ambitus. Posterior paired ambulacra shortest, wide, flush, diverging at a very large angle and then converge laterally. Anterior poriferous zones much narrower than the posterior

zones, composed of minute round pores closely spaced. Posterior poriferous zones composed of oval inner pores and slit-like outer ones; pores of each pair opposite, rather widely set. Interporiferous zones wider than the posterior poriferous zones.

Peristome very eccentric in front, poorly preserved; periproct not preserved. Tubercles small, of varing sizes, perforate, crenulate; the largest scattered in the anterior interambulacral areas, widely scrobiculate; interporiferous zones in the paired ambulacra dotted with tubercles; numerous microscopic granules between tubercles. Comparatively well-defined narrow peripetalous fasciole (or better to say pseudo-fasciole) observable, crossing the anterior paired ambulacra at about one-fourth the way from the ambitus.

Length attains about 5.8 cm.

Remarks:—Although structure of the apical system and outline of the peristome can not be ascertained due to ill-preservation of the test, the presence of peripetalous fasciole and many other peculiar features mentioned above may remined us of *Washitaster*. However, in the specimens at hand the pores in the anterior ambulacrum are oval in the inner row, while slit-like in the outer row, the pores of each pair are not separated by a granule and the peripetalous fasciole is not multiple but single. These features prevent us from identification of the present form with *Washitaster*. On the other hand, differing from *Heteraster* the pores in the anterior ambulacrum are aligned in each of the outer and inner rows as in *Washitaster*. There are, however, recognized abnormal disposition of the outer pores in the anterior ambulacrum in one of the specimens (GSJ. 6116). That is, in each of the two poriferous zones where pores are count about 40 pairs in the preserved middle and proximal parts respectively, the inner pores aligned, while among the outer pores only one shorter pore is placed somewhat inward or quite inward beyond the others, thus the pores therein lining up in three files as in *Heteraster*. Such arrangement of pores in the anterior ambulacrum is in this case regarded as being quite anomalous and exceptional for this individual. To sum up, the present form is here provisionally referred to *Washitaster* on the general features of the test, although it is better to establish a new separated genus for the form when more specimens are obtained.

This form closely resembles *Washitaster japonicus* TANAKA and OKUBO from the Albian Yatsushiro formation in middle Kyushu in general features of the test, but is distinguished from that species especially by the course of the peripetalous fasciole. In the former the peripetalous fasciole crosses the anterior paired ambulacra much less distally than in the latter. The present form is to some extent similar to the two Albian species of Texas, *Washitaster longisulcus* (ADKINS and WINTON) and *W. riovistae* (ADKINS). But it is distinguished from *W. longisulcus* by the much larger size of the test, the larger number of pore pairs in the ambulacra and the greater dissimilarity in shape of pore pairs in the anterior ambulacrum. Comparison with *W. riovistae* are given below. In the specimens here described the peripetalous fasciole is not multiple but single, and the pores of each pair in the anterior ambulacrum are very unequal in shape and are not separated by a granule. Furthermore, it attracts one's attention that the anterior paired ambulacra are considerably narrow in the present form as well as in *W. japonicus*

and *W. longisulcus*.

Occurrence:—Loc. 1, Ishido formation, sandy siltstone, Neocomian (a specimen deposited in the Chichibu National Science Museum, coll. by K. TAKEI); loc. 7, Ishido formation, siltstone, Neocomian (GSJ. 6116, 6117, coll. by K. TANAKA and Y. YABE).

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Explanation of Plate 15

Figs. 1a-c. *Pygurus (Pygurus) complanatus* n. sp.
1a, Adapical side, ×2. 1b, Adoral side, ×2. 1c, Left lateral side, ×2. Presumed Ishido formation. (Holotype, GSJ. 6090).

Figs. 2a-c. *Pygurus (Pygurus) complanatus* n. sp.
2a, Adapical side, ×2. 2b, Adoral side, ×2. 2c, Left lateral side, ×2. Presumed Ishido formation. (Paratype, GSJ. 6091).

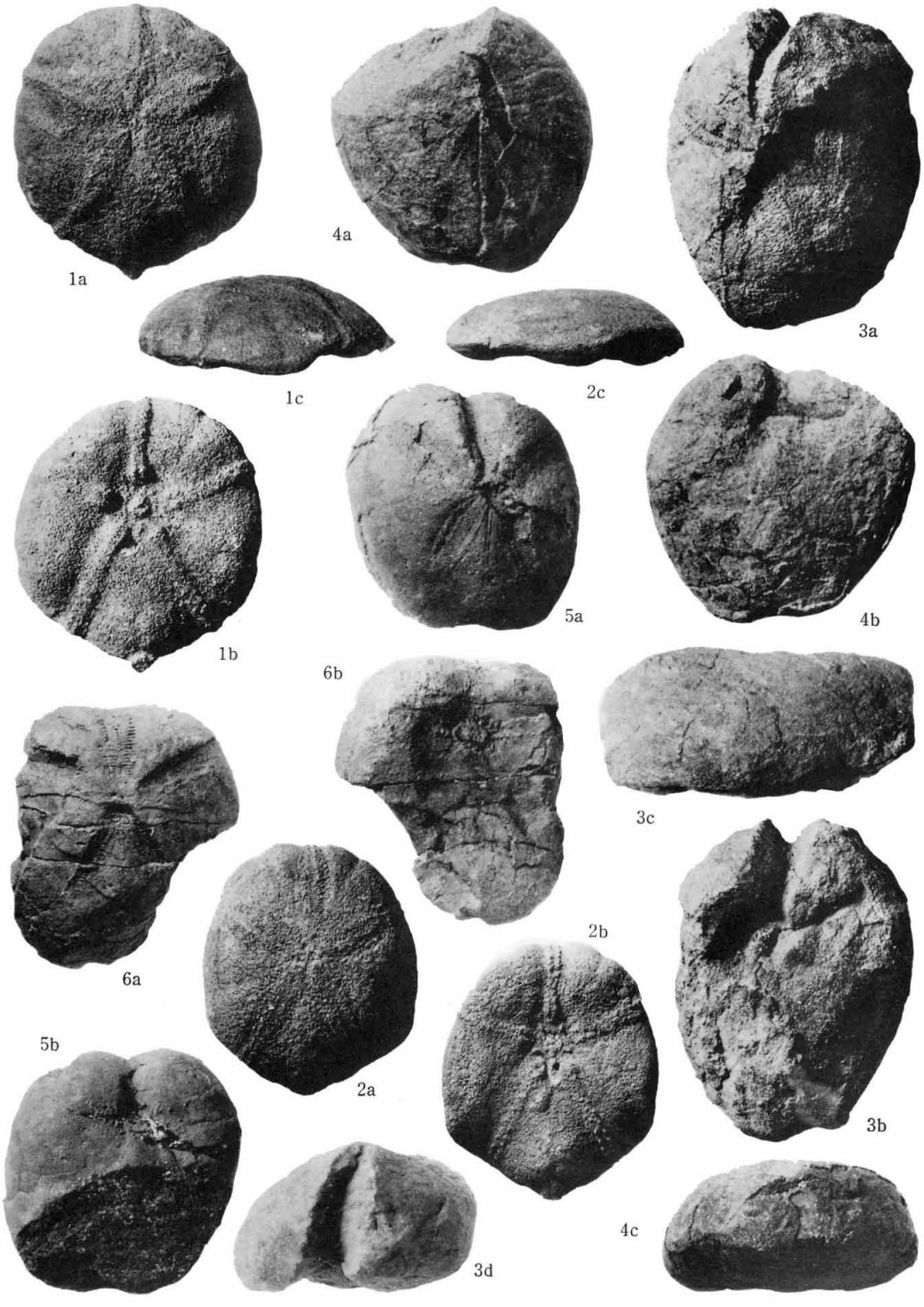
Figs. 3a-d. *Pseudholaster* n. sp. (?)
3a, Adapical side, ×1.5. 3b, Adoral side, ×1.5. 3c, Left lateral side, ×1.5. 3d, Anterior side, ×1.5. Ishido formation. (GSJ. 6046).

Figs. 4a-c. *Pseudholaster* n. sp. (?)
4a, Adapical side, ×1.5. 4b, Adoral side, ×1.5. 4c, Posterior side, ×1.5. Ishido formation. (GSJ. 6050).

Figs. 5a, b. *Toxaster sanchuensis* n. sp.
5a, Adapical side, ×1.2. 5b, Adoral side, ×1.2. Ishido formation. (Holotype, GSJ. 6124).

Figs. 6a, b. *Toxaster sanchuensis* n. sp.
6a, Adapical side, ×1.2. 6b, Adoral side, ×1.2. Ishido formation. (Paratype, GSJ. 6110).

All specimens here illustrated are internal moulds.


1a
4a
3a
1c
2c
1b
5a
4b
6b
3c
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5b
2a
3b
4c
3d

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Arita	有田	Onozawa	大野沢
Chichibu-gun	秩父郡	Saku-cho	佐久町
Hikage	日影	Sanyama	三山
Honya	本谷	Sebayashi	瀬林
Minamimaki-cho	南牧町	Shigaraki-gun	甘楽郡
Minamisaku-gun	南佐久郡	Shiroi	白井
Myoke	明家	Tano-gun	多野郡
Nakazato-mura	中里村	Ueno-mura	上野村
Ogano-cho	小鹿野町	Yuasa	湯浅

Explanation of Plate 16

Figs. 1a-c. *Toxaster sanchuensis* n. sp.
1a, Adapical side, ×1.5. 1b, Adoral side, ×1.5. 1c, Left lateral side, ×1.5. Ishido formation. (Paratype, GSJ. 6042).

Figs. 2a-c. *Toxaster sanchuensis* n. sp.
2a, Adapical side, ×1.5. 2b, Adorsal side, ×1.5. 2c, Left lateral side, ×1.5. Ishido formation. (Paratype, GSJ. 6041).

Fig. 3. *Heteraster macroholcus* (NISIYAMA)
Adapical side, ×1. Ishido formation.

Figs. 4a, b. *Heteraster macroholcus* (NISIYAMA)
4a, Adapical side, ×1. 4b, Adoral side, ×1. Arita formation.

Fig. 5. *Heteraster* cf. *nexilis* NISIYAMA
Adapical side, ×1.5. Ishido formation. (GSJ. 6105).

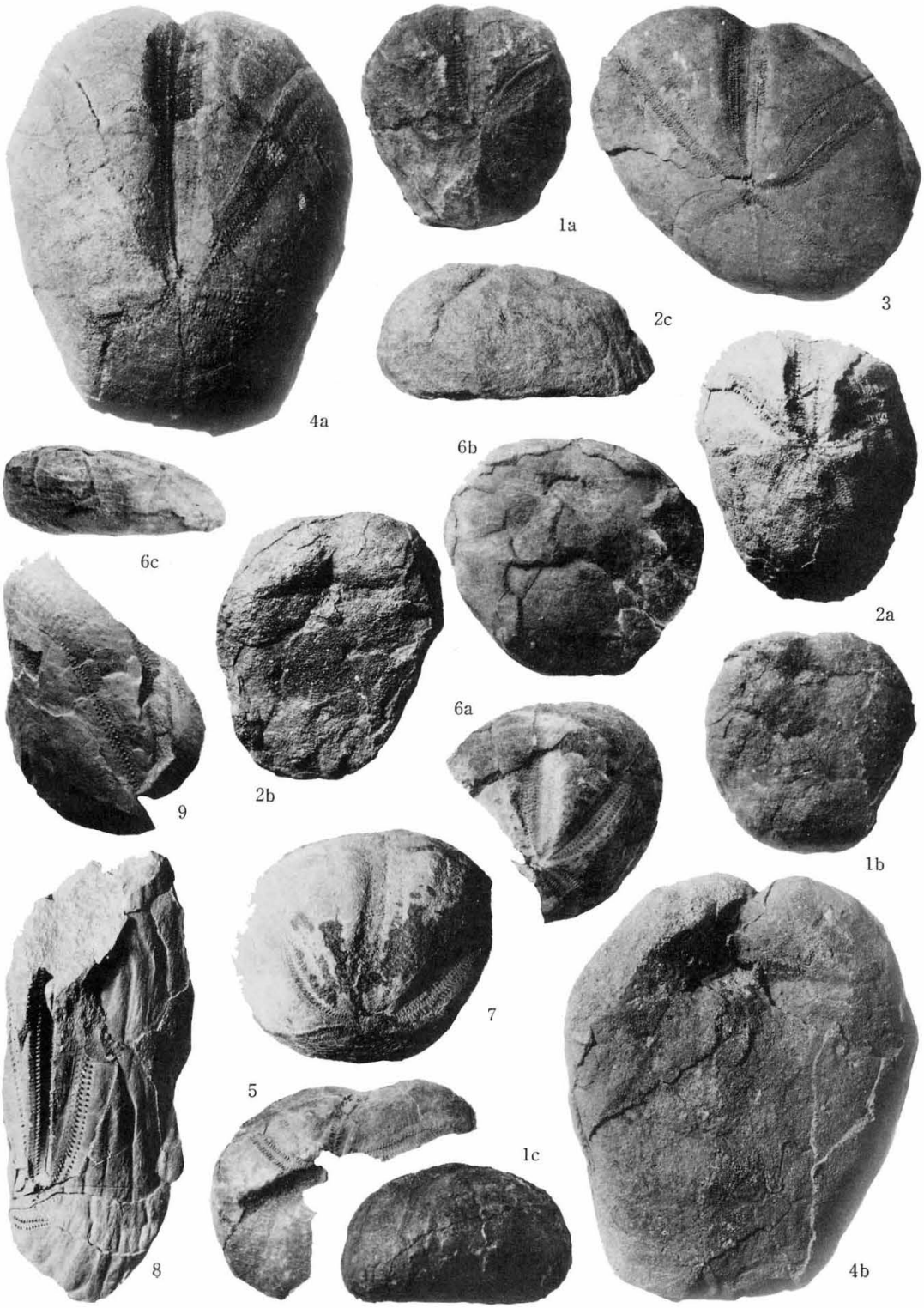
Figs. 6a-c. *Heteraster yuasensis* (TANAKA and OKUBO)
6a, Adapical side, ×1.5. 6b, Adoral side, ×1.5. 6c, Right lateral side, ×1.5. Ishido formation. (GSJ. 6108).

Fig. 7. *Heteraster yuasensis* (TANAKA and OKUBO)
Adapical side, ×1.5. Ishido formation. (GSJ. 6123).

Fig. 8. *Washitaster* (?) sp.
Adapical side, ×1.2. Ishido formation. (GSJ. 6116).

Fig. 9. *Washitaster* (?) sp.
Adapical side, ×1.5. Ishido formation. (GSJ. 6117).

All specimens here illustrated are internal moulds.


1a
3
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1c
4b

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第90回例会および「北陸地方を中心とした新生代後半の古地理と古生物の変遷(主として古植物群を中心に)」についてのシンポジウムは1965年6月20日(日)金沢大学理学部地質学教室において開催された(参加者22名)。

個人講演

Planktonic Foraminifera from Oga Peninsula, Akita Prefecture (代読) ....Yokichi TAKAYANAGI & Tadamichi OBA

Asanonella shozii, n. gen., n. sp., (Family Discorbidae) from Tokunoshima, Kagoshima Prefecture, Japan (代読) .... Tunyow HUANG

Carboniferous conodonts from the Atetsu Limestone..Toshio KOIKE & Hisayoshi IGO

On the *Daonella* and *Halobia* bearing facies in the Malayan Peninsula ....Teiichi KOBAYASHI & Akira TOKUYAMA

On a Lower Cretaceous pelecypod, "*Cyrena naumanni*", from Japan ....Itaru HAYAMI & Isao NAKAI

銚子の *Pterotrigonia* について.....前田四郎

夕張炭田の中新世初期の貝化石群集 (朝日動物群) について .....大原 隆

A new species of a whale tympanic bone from Taiwan, China (代読) .... Tunyow HUANG

富山湾周辺の埋没林とその絶対年代 .... 藤井昭二・木越邦彦

A Mesozoic Ammonite from the Island of Curacao, West Indies (代読) ....Tatsuro MATSUMOTO & D. J. BEETS

飛騨山地産コレニア .....小西健二・大村明雄

Two Fossil Species of *Discinisca* (Brachiopoda) from North Honshu (代読) ....Kotora HATAI & Shozo HAYASAKA

Planktonic Foraminifera from the Somachi Formation, Kikai-jima, Kogoshima Prefecture (代読) .....Tunyow HUANG

シンポジウム「北陸地方を中心とした新生代後半の古地理と古生物の変遷 (主として古植物群を中心に)」

北陸地方新第三系概観 .....紐野義夫

中新世の化石珪藻群 .....市川 渡

葉体化石による植物群の変遷 .....松尾秀邦

富山盆地の第四紀植物遺体 .....藤井昭二

News

◎ 第2回国際花粉学会議 (2nd International Conference on Palynology) は1966年8月29日より9月3日までオランダの Utrecht で開催され野外巡検の他, 次の討論会が持たれる予定である。
Palaeophytic; Mesophytic; Upper Cretaceous and Tertiary; Pollen and Spore Morphology and Pollen Dispersal; Palynomixtum.
連絡先は次の通り。
Secretariat Working Committee, 2nd International Conference on Palynology,
c/o Royal Netherlands Industries Fair, Vredenburg, Utrecht, Netherland

◎ 国際古生物学連合 (International Palaeontological Union) の会合は1964年12月16日—21日にインドのニューデリーで開かれ下記の事項が決定された。

1) 会長: M. R. Sahni (インド)
副会長: B. Boucek (チェッコスロバキヤ); C. L. Arambourg (フランス); K. M. Sultanov (ソ連)
幹事: B. S. Tewari (インド)
会計: A. L. McAlester (アメリカ合衆国)
執行委員9名のうち日本よりは, 松本達郎・小林貞一両君が参加している。

2) 世界諸国を5行政区に分けた。

1 ヨーロッパ（ウラルまで）	会長 M. Lecompte（フランス）：幹事 R. Conil（フランス）
2 アジア	会長 小林貞一（日本）：幹事 高井冬二（日本）
3 アメリカ（南北）	会長 J. W. Wells（合衆国）：幹事 A. R. Palmar（合衆国）
4 アフリカ	会長 H. Hollard（モロッコ）：幹事 M. S. Willefert（モロッコ）
5 オセアニア	会長 C. A. Fleming（ニュージーランド）：幹事 G. R. Stevens（ニュージーランド）

3) 次の委員会（既設を含む）及び小委員会を設立した。

1 Palaeontologia Universalis　委員長 R. Dehm（ドイツ）

2 Directory of the Palaeontologists of the World　委員長 L. G. Love（イギリス）

2 Palaeoecology　委員長 N. D. Newell（合衆国）

Sub-Committee—Reef Building Organisms

4 Palaeobiogeography　委員長 C. J. Stubblefield（イギリス）委員中に日本より浅野清君が参加している。

Sub-Committee—Migration

5 Evolution　委員長 O. H. Schindewolf（ドイツ）委員中に日本より鹿間時夫君が参加している。

Sub-Committee—Biometrics: Sexual dimorphism in fossils: Ontogeny and phylogeny.

4) 国際古生物学連合は国際地学連合及び国際生物学連合の両方に加盟する段取りとなつた。

◎ 日本学術会議太平洋学術研究連絡委員会より下記の通り通知がありましたのでお知らせします。

第11回太平洋学術会議において Divisional Meetings で論文を発表したい人は，英文・ダブルスペース1枚の Abstract を付して，組織委員会の当該部門（Section）に御申し込み下さい。

また，開閉会式，Tours. 会議への論文発表なしの参加希望者も，組織委員会の各当該部門に御申し込み下さい。

いずれも人数に限りがありますので，その取捨撰択は当該部門に一任してあります。

なお，古生物学関係の当該部門（Section）の申込先は

東京都本郷局区内　東京大学理学部地質学教室

第11回太平洋学術会議・第4部門地質学関係組織委員会　委員長 渡辺武男

である。

会　員　消　息

◎ 会員田村実・猪郷久義の両君は7月中旬より約1ケ月にわたりマライ半島の地質・古生物学調査を行ない8月中旬帰国した。

◎ 会員首藤次男君は古生態学研究のためデンマーク・オランダへ向け9月上旬出発した。

◎ 会員森川六郎君は紡錘虫研究のため9月上旬米国へ向け出発した。

◎ 会員鈴木好一君の建築学ならびに都市工学の分野における地質学的協力に対し日本建築学会賞が授与された。

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

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

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

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

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

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

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

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

例会通知

	開催地	開催日	講演申込締切日
第92回例会	千葉大学	1965年11月6,7日	1965年10月10日
1966年総会・年会	東北大学	1966年1月24.25日予定	1965年12月20日

第92回例会（千葉大学）：

11月6日（土）東南アジア及び中近東の古生物・地史のシンポジュウム（世話人：橋本　亘・前田四郎），午前9時30分開始。午前及び午後前半：討論会，午後後半：東南アジアの古生物調査のスライド映画。

11月7日（日）個人講演，午前9時30分開始。

会場：千葉大学文理学部（西千葉駅北口下車，徒歩6分）。

宿泊希望者：係に至急連絡のこと（前田四郎宛）。

学会記事

常務委員会議事抜萃

◎ 日本学術会議第七期会員（第4部・地質学・全国区）候補者として前会長小林貞一君を推薦した。

◎ 朝日科学奨励金候補に連水格君の中生代二枚貝の研究を，偕成学術奨励金候補に菅野三郎君の本邦新期漸新世層序並びに軟体動物化石群の研究をそれぞれ推薦した。

◎ 昭和41年度科研費配分委員候補には，評議員の投票の結果を参考にして内尾高保・金谷太郎・勘米良亀齢・菅野三郎・鹿間時夫・棚井敏雅・花井哲郎（アイウエオ順）を推薦した。配分委員会で決定した本学会の関係委員には，この中から棚井敏雅が選ばれた旨の通知があつた。

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CONSTITUTION
of the
PALAEONTOLOGICAL SOCIETY OF JAPAN

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

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

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

1. Issue the Society journal and other publications.
2. Hold or sponsor scientific le6tures and meetings.
3. Popularize the science by field trips, scientific lectures and other projects.
4. Aid and encourage research work; award outstanding contributions to the Society; carry out the objectives stated in Article 2.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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