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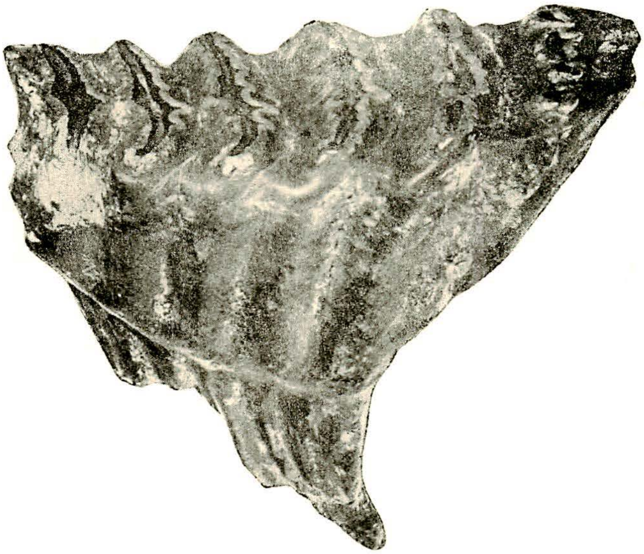

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Fossil on the cover is left lower M2 of *Palaeoloxodon naumanni* (MAKIYAMA, 1924) from the uppermost part of the Tokyo formation (Upper Pleistocene) at Ikebukuro, Tokyo.

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574. J. FLEMING'S SPECIES OF BRITISH LOWER CARBONIFEROUS CORALS

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フレミング氏記載の英国前期石炭紀珊瑚化石： フレミングは現在おこなわれている命名法にもとづいて英国の石炭紀珊瑚を記載した最初の著者の一人である。筆者はエジンバラ市にある王立スコットランド博物館所蔵のフレミングの原標本について再研究をおこない，あるものについては後模式標本を選定し，再記載をおこない，また彼の記載にかゝる15の種について，それぞれその分類上の位置などについて論じた。 加藤　誠

The first description of British Lower Carboniferous coral was by Eduardi LUIDI (LHUYD), a pre-Linnéan author, in 1699. The name *Lithostrotion* dates back to this publication, although LHUYD's work is not available for taxonomic purpose.

In 1793 William MARTIN described and figured two Lower Carboniferous corals from Derbyshire. And in 1809 these were redescribed by him together with the four other species.

They are as follows:

Coralliolithus (*Madreporae Caespitosae*) *Madreporae* (MARTIN, 1793) = *Erismolithus* (*Madreporae Caespitosae*) (MARTIN, 1809).
Coralliolithus (*Tubiporae radiatae*) *tubiporae tubis* (MARTIN, 1793) = *Erismolithus tubiporites* ? (*radiatus*) (MARTIN, 1809).
Erismolithus Madreporites (*duplicatus*) (MARTIN, 1809).
Erismolithus Madreporites (*affinis*) (MARTIN, 1809).
Erismolithus Tubiporites (*catenatus*) (MARTIN, 1809).
Erismolithus Madreporites (*floriformis*) (MARTIN, 1809).

These species had long been known as MARTIN's species until the International Commission of Zoological Nomenclature officially rejected both of MARTIN's works from nomenclatorial purpose (Opinion 231, 1948). MARTIN did not employ binominal nomenclature, thus his species became unavailable.

In 1956 two of MARTIN's species were however, revived and validated by the ICZN Opinion 419, in fixing neotypes of them, chosen by SMITH (1916) as officially recognized.

Now we have *Lonsdaleia duplicata* (MARTIN) and *Actinocyathus floriformis* (MARTIN) (KATO, 1966).

Yet the rest of "MARTIN's species" has to be attributed to later authors who first named them according to modern procedure of taxonomy as introduced by LINNÉ. Thus *Lithodendron caespitosa* M'COY (1844) is the first name for MARTIN's *Erimolithus* (*Madreporae caespitosae*)... J. FLEMING (1828) is available as the author for the British Lower Carboniferous corals.

During the course of my study on British Lower Carboniferous corals it became necessary to re-examine FLEMING's collection which is now housed

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at the Royal Scottish Museum, Edinburgh, in order to establish and to interpret FLEMING's old species.

It is the purpose of this article to mention the present status of the FLEMING's original material of Lower Carboniferous corals and to choose and describe lectotypes of some species whenever possible and desirable.

FLEMING, as many other naturalists of his days, did not necessarily possess all the specimens of his own for the species he named, described and arranged in order.

Sometimes he had seen specimens in other collections. Therefore, for the recognition of FLEMING's species all the specimens of the forms described by previous authors and were later quoted by FLEMING as synonymous with his species have to be considered as constituting syntypes of that species, together with of course his own materials. FLEMING's collection was at least partially re-examined, once by THOMSON (1887), and then by SMITH and LANG (1930). But it is still necessary to study it, for ambiguity exists in some of his species.

In 1960 the author was able to examine FLEMING's collection at the Royal Scottish Museum. And in connection with the nomenclatorial problem concerned he also examined David URE collections of the Hunterian Museum, Glasgow, and the coral collection of the British Museum (Natural History), London and the Sedgwick Museum, Cambridge. The result is also incorporated in this articles.

In the following remarks will be given for each FLEMING's species in original order.

Lithostrotion striatum

This species was officially fixed as the type species of genus *Lithostrotion* by the ICZN Opinion 117 (1931).

FLEMING (1828, p. 508) quotes LHUYD's (1699) and PARKINSON's (1808) corals as synonymous with his *Lithostrotion striatum*. Both of the latter two materials are believed to be lost. A single specimen, RSM 1870. 14. 370 has been registered in the FLEMING collection at the Royal Scottish Museum. But unfortunately this specimen is not traceable at present. However THOMSON (1887) studied FLEMING's original specimen, redescribed and figured this specimen. It appears quite possible that THOMSON borrowed FLEMING's specimen which was destroyed in the fire of Kilmarnock Museum together with all the THOMSON collection.

In the absence of LHUYD's and PARKINSON's specimens (HILL, 1940, p. 166), and being the only specimen it is appropriate to select FLEMING's original specimen for the lectotype of *Lithostrotion striatum*. But we must interpret the species based on THOMSON's figure (1887, pl. XII, fig. 1). PARKINSON gave the name of *Madrepora vorticalis* to LHUYD's coral, and this name antedates FLEMING's *striatum*. Also CONYBEARE and PHILLIPS (1822) called the same coral *Lithostrotion basaltiforme*. LANG, SMITH & THOMAS (1940) and HILL (1940) say that *Lithostrotion striatum* should be known as *Lithostrotion vorticalis* (PARKINSON).

However in selecting FLEMING's original specimen of *Lithostrotion striatum* for lectotype, it is not necessarily synonymous with LHUYD's or PARKINSON's corals. This holds true to CONYBEARE and PHILLIP's form as well.

The author thinks best to lapse both *Madrepora vorticalis* PARKINSON and *Lithostrotion basaltiforme* CONYBEARE and PHILLIPS because their descriptions and illustrations are too imperfect to interpret their species, besides all the type specimens for them are lost. Therefore it is no way possible to fix these two species in terms of modern taxonomy.

On the other hand, though the actual specimen is still missing, it is possible to recognize *Lithostrotion striatum*, when we interpret THOMSON's illustration for *Lithostrotion striatum*. It appears that *Lithostrotion striatum* stands morphologically in between *Lithostrotion minus* and *Lithostrotion portlocki*. Also it may be still possible that the FLEMING's specimen is turned up if we search closely the THOMSON collection which was recovered and gathered from the burnt down Museum of Kilmarnock, and is now kept at the Glasgow Museum and Art Gallery.

The name of *Lithostrotion vorticalis* has not been used for a long time. Therefore it may be allowed to lapse. But the name *basaltiforme* has been often employed in both palaeontological and stratigraphical papers. And *Lithostrotion basaltiforme* has been applied to such *Lithostrotion* with cerioid coralla and relatively large corallites and numerous septa. Tabulae are dome shaped. For such *Lithostrotion* a number of species, *bristoliense* VAUGHAN, *aranea* M'COY, *arachnoides* M'COY, *septosus* M'COY, *major* M'COY, and *ishnon* HUDSON were proposed. They are all available and all the type specimens for these later species are kept in either the British Museum of Natural History or the Sedgwick Museum of Cambridge. It may not at all be necessary to retain the old name of *Lithostrotion basaltiforme* with much ambiguity.

Lithostrotion floriforme

FLEMING clearly indicated that his *Lithostrotion floriforme* corresponded to MARTIN's *floriformis*. Though LONSDALE (1845) selected *Lithostrotion floriforme* as the type species of the genus *Lithostrotion*, this was invalidated by the ICZN Opinion in 1931. The species *floriformis* remains as MARTIN's species (ICZN Opinion 419, 1956), and the genus *Actinocyathus* may be properly applied to the species (KATO, 1966).

The neotype of MARTIN's *floriformis* is the Sedgwick Museum collection A 2359, selected by SMITH (1916). The specimen is the type of *Strombodes conaxis* M'COY.

Four specimens of "*Lithostrotion*" *floriforme* have been registered in the FLEMING collection at the Royal Scottish Museum. They are:

RSM 1870. 14.	124	from	Wenlock limestone
"	329		Derbyshire
"	373		Colebrookdale (not traceable)
"	379		"

THOMSON (1887) studied one of FLEMING's specimens (presumably the one that is not traceable at present), which was figured as figure 2 on his plate 12 (erroneously stated as fig. 3 in his explanatory text). This form undoubtedly belongs to *Actinocyathus floriformis* (MARTIN). Other FLEMING's corals are all conspecific with that species. The said horizon for one specimen is from the Wenlock limestone. This is obviously erroneous. That specimen might be obtained also from Colebrookdale, not far from the Wenlock Edge, from the Mountain limestone.

Lithostrotion marginatum

FLEMING (1828, p. 508) originally stated that he had two corallites of this species. But these are not registered and cannot be found in his collection. THOMSON in 1887 (p. 377) mentioned that he could not find specimens of this species in FLE-

MING's collection. So it appears that these specimens were lost before FLEMING collection was acquired by the Royal Scottish Museum.

As THOMSON indicated FLEMING's form was probably a *Hexaphyllia*. FLEMING did not mention its locality, but he described the size of his specimens which had corallite diameter of 1/10 inch. In *Hexaphyllia*, being a columnar coral, the size of corallite is diagnostic. Therefore the species may be interpreted by FLEMING's description alone.

HILL (1940) described and figured *Hexaphyllia marginata* from Scotland. If a neotype is necessary HILL's coral may be suitable for the purpose. This coral bears Geological Survey collection (Edinburgh) 3882 f/b.

Hexaphyllia marginata is thus the oldest named species in the genus *Hexaphyllia*.

Caryophyllea (sic) *fasciculata*

The species is now known as *Diphyphyllum fasciculatum* (FLEMING). SMITH and LANG (1930) selected lectotype for the species, which is RSM 1870. 14. 374 (A & B). A part of the lectotype is in the British Museum (BMR 28799).

FLEMING's specimen is a large colony of 15 cm long with 10 cm wide. Corallites measure as long as 6 mm in its maximum diameter. Axial structure is completely absent. Corallite increase is by " fission ". Fine structure of septa is fibro-normal. Dissepiments are only in one row. Minor septa are a little longer than the width of dissepiments. Stereoplasmic thickening is seen in the dissepimentarium.

FLEMING considered PARKINSON's *Madreporite* (1808) and MARTIN's *caespitosae* (1809) as synonymous with his species. But this is probably not the case. No precise information beyond that these latter two forms are fasciculate corals of different size is available as to both forms above mentioned. They may be species of either *Siphonodendron* or *Diphyphyllum*.

Caryophyllea (sic) *duplicata*

FLEMING (1828, p. 509) quoted MARTIN's *duplicata* (1809) as synonymous. FLEMING left no specimens of this species in his collection. Though MARTIN's original specimens have also been lost, the species was officially recognized as MARTIN's species in stating SMITH's (1916) unofficial neotype as officially recognized (ICZN Opinion 419). The specimen is Sedgwick Museum A 2419.

Caryophyllea (sic) *affinis*

Although the name of *Lithostrotion affine* is sometimes to be seen in various stratigraphical papers, the species has never been fully scrutinized up to present. The specific name " *affine* " was originated from MARTIN's " Petrificata Derbiensia " (1809), and had been known as his species until the ICZN rejected the validity of MARTIN's papers in 1953. Since that time the author of this species should have been attributed to FLEMING who first legally described it.

FLEMING's original description (1828, p. 509) runs as follows: " Stems slightly branched, cylindrical, equal, smooth, rather distant, and about half an inch in diameter. M. Aff. Mart. Derb. t. 31, 'Carbon. Lst."

MARTIN's specimen is lost. FLEMING had two specimens of this species, of which one is not traceable. This latter specimen is registered as having been obtained from the Wenlock limestone, and is therefore not suitable for the type material of this species. The remaining specimen is accompanied with a label with FLEMING's own hand writing, and is a *Siphonodendron*. It is thought appropriate to select this specimen as the lectotype of *Caryophyllea* (sic) *affinis*.

Siphonodendron affine (FLEMING)

Pl. 1, figs. 1-4

1828. *Caryophyllea* (sic) *affinis* FLEMING, p. 509.
1940. *Lithostrotion proliferum* HILL, p. 174, pl. ix, figs. 11-14 (For further synonymy see HILL, 1940).
non *Lithostrotion affine* auctt.

Syntype: Erismolithus Madreporites (*affinis*) MARTIN (1809) from Winster etc. (Specimens lost).

RSM 1870. 14. 125 from Wenlock limestone (not traceable).

RSM 1870. 14. 381 from West Lothian.

Lectotype (*here chosen*)*:* RSM 1970. 14. 381 from West Lothian, Scotland.

Description of the lectotype: Corallum compound, fasciculate and phaceloid. The colony is embedded in black, fine grained muddy limestone. Corallites cylindrical and subparallel, closely arranged and are often in contact with each other. Surface character is unknown.

In transverse section corallite has round and smooth configuration. The size of corallite reaches up to 10.5 mm in diameter. Epitheca is thin. Dissepimentarium is relatively narrow, occupies less than 1/3 of the radius of corallite. Dissepiments are regular and concentric at the periphery where minor septa develop, and are mostly inosculating at the inner margin of the dissepimentarium. Sometimes, when corallites are relatively large dissepiments show pseudoherringbone pattern in the space between major and minor septa. About 4 to 5 series of dissepiments can be counted in the dissepimentarium. No lonsdaleoid dissepiments developed. The boundary between tabularium and dissepimentarium is not very clear. Tabularium is wide, remains open at the centre, being not traversed by the axial ends of major septa. Major septa fall short to the centre of corallite, extend about one half of the radius of corallite. Major septa are subequal in their length except the counter and cardinal septa. The counter septum is usually a little longer than the other major septa and is sometimes connected with columella. The cardinal septum is on the contrary a little shorter than the other majors and is thus forming a little, shallow cardinal fossula. Major septa are counted as many as 39, but are commonly 32 to 34. Minor septa alternate with the majors and are very short, mostly confined to the periphery of dissepimentarium, sometimes reach 1/2 the length of the majors. Peripheral part of the corallite and the centre of each septum are often altered to massive, yellowish parts. Septal fine structure is probably diffuso-trabecular, but is not definitely determined as they are thin and the structure is obscurated by alteration. All the skeletal elements are notably thin, but intrathecal dilation is observed in some corallites. Tabulae are concentric and sparsely situated in the tabularium and the axial ends of major septa are often terminated by the ring like cut edges of tabulae. Axial structure is very simple, lath shape columella, straight to sinuous, occasionally provided with one or two septal lamellae like projections on each side, sometimes surrounded by the cut edges of axially elevated tabulae. New buds appear in the dissepimentarium as a vesicular portion for the first time. So the increase is peripheral.

In longitudinal section corallite surface is only feebly undulated. Dissepimentarium is clearly differentiated from tabularium, and consists of 4 to 5, or sometimes more rows of dissepiments of varied size. Dissepiments are small and regular at the periphery of corallites, but are rather large and irregular at the inner margin of the dissepimentarium. Tabularium is wide. Tabulae are complete, gently domed but are sometimes supplemented by the development of peripheral tabulae. Six to nine tabulae are to be counted in the vertical distance of 5 mm. Axial structure is simple, thin and sinuous.

Remarks: "*Koninckophyllum*" *proliferum* THOMSON & NICHOLSON is identical with *Siphonodendron affine* here described. The former species was redescribed by HILL (1940) as a *Lithostrotion*, and she gave a complete synonymy for that species. Thus this synonymy holds also good for *Siphonodendron affine.*

Siphonodendron affine is characterized mainly by its short minor septa, weak and lath shaped columella, and generally thin skeletal elements. Major septa are short and diphymorphism is common. The number of septa is numerous for the size of corallite of *Siphonodendron. Lithostrotion proliferum* described by DOBROLYUBOVA (1958) and DOBROLYUBOVA & KABAKOVITSH (1966) from Soviet Union may not be conspecific with the same named species from Scotland. They have much larger corallites, longer minor septa and stouter columella than the British form.

The specific name "*affine*" has been applied to such Siphonodendra having relatively large corallites and "*Martini*" type morphology. To this kind of *Siphonodendron* the species *sociale* may be available. MARTIN's coral of "*affine*" might be such a coral and was probably not conspecific with *Siphonodendron affine* here described.

Caryophyllea (sic) *juncea*

Only one specimen (RSM 1870. 14. 346) of this species is registered at the Royal Scottish Museum. The specimen is, however, a small tip of marly limestone containing *Tryplasma, Heliolites* and brachiopods, and is lithologically very similar to Wenlock limestone of Dudley.

THOMSON (1887) wrote that he once examined FLEMING's material of this species and found that it was a species of *Syringopora.* The specimen THOMSON examined is not traceable at present.

Although the specific name *Juncea* is now attributed to FLEMING, this was originated from *Junci Lepidi* of URE (1793). FLEMING, of course, quoted URE's form as synonymous with the present species. Very fortunately URE's specimen of "*Junci Lepidi*" has been kept at the Hunterian Museum, Glasgow, but bears no registration number. This is a small, fragmental corallum of what has been long recognized as *Lithostrotion junceum.* The presence of columella can be perceived externally. But the specimen is not necessarily a figured specimen of "*Junci Lepidi*" of URE, since he illustrated only a detached, cylindrical, slender corallite of that species.

At any rate the specimens above mentioned are all to be considered as syntypes of "*Caryophyllea*" *juncea* FLEMING. And it is reasonable to select URE's specimen as lectotype of this species, in order to fix the specific contention as has been constantly understood.

The species has long been treated as a *Lithostrotion.* However this has phaceloid corallum, fibro-normal septa and no dissepiments. Therefore this is definitely not a *Lithostrotion*, which should have massive, cerioid coralla and trabecular septa and dissepiments. *Siphonodendron* is also not an appropriate genus for the species. The author thinks that

Kwangsiphyllum GRABAU & YOH is available for this species. Both columellate and diphymorphic forms may be grouped together under this genus of *Kwangsiphyllum*.

Turbinolia Fungites

URE's *fungites* (1793) was cited as a synonym by FLEMING (1828).

There are six specimens for this species registered as RSM 1870. 14. 428 in the FLEMING collection. They belong to a single species, *Aulophyllum* of *fungites pachyendothecum* type of SMITH (1913). URE's figured specimen is now stored at the Hunterian Museum, Glasgow, where it carries the number HMC 4366, and also belongs to the same species as above. All these specimens can be considered as constituting syntypes of the species concerned. SMITH and LANG (1930) selected URE's specimen as the lectotype of the present species. The locality of URE's form is written on a label at the Hunterian Museum as " probably Shields Farm, Eastkilbride ".

The specimen was cut and figured by THOMSON (1882, 1883), in which intrathecal dilation of major septa is not conspicuous and minor septa intrude into tabularium.

Porites cellulosa

PARKINSON's form (1808, ii, 39, t. v, f. 9) from Masburg, Mendip was listed by FLEMING (1828, p. 511) as a synonym of this species. PARKINSON's specimen is however, believed to have been lost. FLEMING's own collection does not contain specimens assignable to the present species. Presumably FLEMING established his species based on PARKINSON's description and figure of the Masburg specimen.

FLEMING described the age of this species as Carboniferous with querry. But according to WELCH (1924) who mapped the Mendips, Masburg and its neighbourhood is the area where K and Z zones are developed. PARKINSON's illustration also reveals that the form is a species of *Michelinia*. Hence its geological age is definitely Carboniferous.

If a neotype is necessary for this species, a specimen of *Michelinia*, from Masburg, which fits the PARKINSON's figure may be selected for the purpose. Otherwise the species may be allowed to lapse, since it has not been in use for more than 100 year.

EDWARDS and HAIME (1852) put *cellulosa* in the synonymy of *Mamon Favosum* GOLDFUSS (1826). The author also would like to support this synonymy.

Tubipora catenata

No specimen for the present species is found within the FLEMING collection. FLEMING (1828, p. 529) quoted MARTIN's (1809) and PARKINSON's (1808) forms as synonyms of the species, though original specimens of both two forms are not traceable. Apparently FLEMING had MARTIN's *Erismolithus Tubiporites* (*Catenatus*) in mind in describing his species. MARTIN's coral undoubtedly belongs to the genus *Syringopora*, but appears to contain at least two different forms of that genus, as seen from the illustration of " *catenatus* ". The one form has slender corallites and is *Syringopora catenata* as has been commonly under stood. The other form may be referable to *Syringopora reticulata* with medium sized corallites. Therefore it is necessary to select a neotype for *Syringopora catenata* in order to fix the species in a sense hitherto recognized. Until that time *Syringopora catenata* (FLEMING) is not available.

The author's preliminary study on British Carboniferous Syringoporae reveals that there exist at least seven forms. One form among them is provided with loosely phaceloid coralla with slender corallites of about 1 mm diameter. Wall is thin and septal spines are sparse. And *S. catenata* is best to be applied to this kind of *Syringopora.*

Tubipora ramulosa

Although FLEMING (1828, p. 529) did not quote GOLDFUSS (1826) in the synonym list of this species, the authorship of this species is attributable to the latter who described *Syringopora ramulosa* prior to the former. No specimens of this species is left in the FLEMING collection.

Tubipora radiatus

The FLEMING collection does not contain specimens of this species, but his description suggests a *Sarcinula* like coral. He most probably recognized this species based upon MARTIN's *Erismolithus Tubiporites* ? (*radiatus*) (1808), which is *Coralliolithus* (*Tubipora radiatae*) *tubiporae tubis* of MARTIN (1793). FLEMING (1828, p. 529) listed only MARTIN's form as a synonym.

MARTIN's coral might be a form like *Orionastraea phillipsi,* but it is not possible to confirm this synonymity at the absence of type material. The specific name has been largely ignored by later authors and is better lapse.

FLEMING described two species of *Favosites* from Carboniferous. Both of them were later redescribed by SMITH and LANG (1930). Therefore only mention will be made on these two species.

For *Favosites septosus* there is only one specimen registered in the FLEMING collection at the Royal Scottish Museum (RSM 1870. 14. 123). The specimen was obtained from an unknown locality, and was thought by SMITH and LANG (1930) as the holotype of this species. But this single specimen is better considered as the lectotype for the species concerned, chosen by SMITH and LANG in 1930. Because FLEMING did not fix the type specimen and monotypy in the present case is not all clear. A part of the lectotype is now kept at the British Museum (Natural History) bearing the numbers R 28797-8.

EDWARDS and HAIME (1852) erroneously considered the present species as an *Alveolites,* and several subsequent authors followed this classification. But SMITH and LANG (1930) rightly regarded this species to be a *Chaetetes.*

The corallum of this species is massive, with divergently arranged small corallites, the wall of which is completely trabecular. Thus FLEMING's species undoubtedly belongs to the genus *Chaetetes* redefined by SOKOLOV (1939). *Favosites* has, on the other hand, typically fibronormal wall structure and is provided with relatively large corallites with mural pores (KATO, 1963, 1968).

SMITH and LANG's illustration for *Chaetetes septosus* should actually be as figure 2 on their plate 8 (1930), instead of being figure 1 as they erroneously stated in an explanatory text.

Favosites depressus

In the FLEMING collection there is only one specimen for the species (RSM 1870. 14. 122). And it is from an unknown locality. The specimen is to be considered as the lectotype (designed as holotype) of this species chosen by SMITH & LANG (1930) who thought it to belong to the genus *Chaetetes.*

However, this species has tabular corallum, as FLEMING (p. 529) originally described, and is better classified under the genus *Chaetetella* SOKOLOV, 1939.

Besides the species above enumerated Fleming (1828, p. 251) following Sowerby (1814), classified *Amplexus coralloides* Sowerby under the section of Cephalopods, but he described it might be a coral. Lectotype of *Amplexus coralloides* was chosen by Smith and Thomas (1963) as BM 44115 and BMR 29093-29095.

Summing up the above description Fleming's corals from the British Carboniferous are now listed as follows:

Lithostrotion striatum Fleming
Actinocyathus floriformis (Martin)
Hexaphyllia marginata Fleming
Diphyphyllum fasciculatum (Fleming)
Lonsdaleia duplicata (Martin)
Siphonodendron affine (Fleming)
Kwangsiphyllum junceum (Fleming)
Aulophyllum fungites (Fleming)
Michelinia cellulosa (Fleming)
Syringopora catenata (Fleming)
S. ramulosa Goldfuss
Orionastraea radiata (Fleming)
Chaetetes septosus (Fleming)
Chaetetella depressa (Fleming)
Amplexus coralloides Sowerby

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Explanation of Plate 1

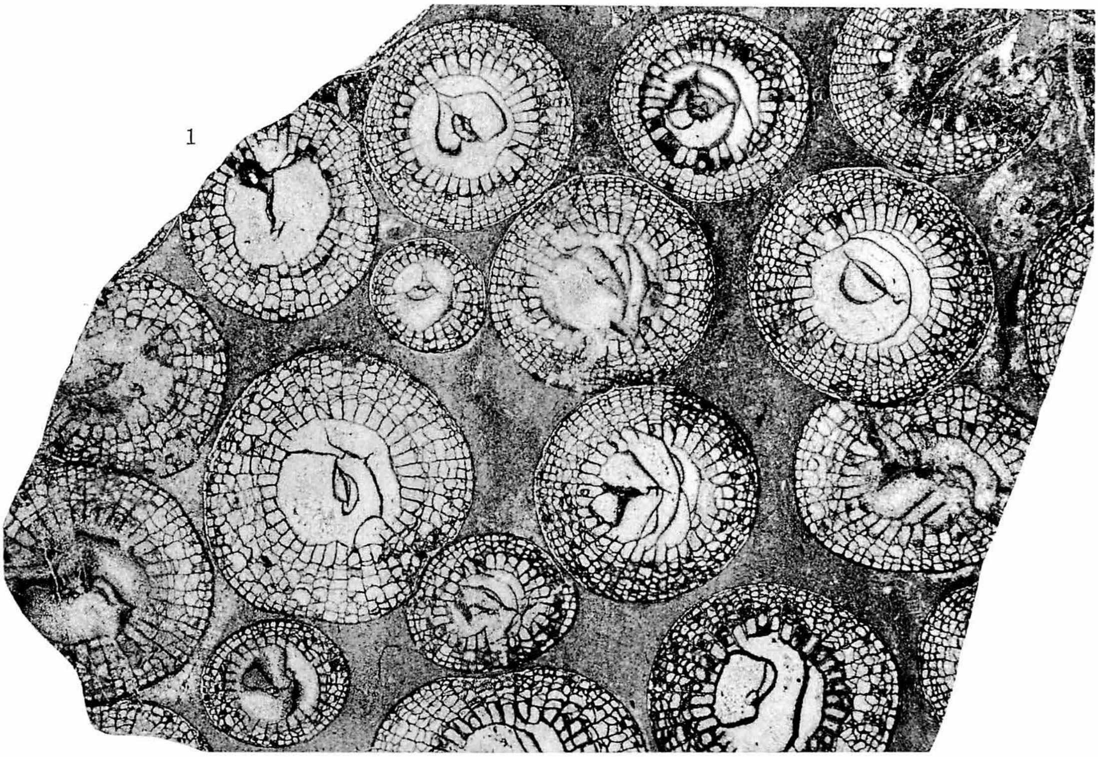
(All figures three times natural size)

Siphonodendron affine (FLEMING)

Fig. 1. Transverse section.

Fig. 2. Longitudinal section.

The lectotype of *Caryophyllea affinis* FLEMING, 1828. Royal Scottish Museum 1870. 14. 381 from West Lothian, Scotland. Both figures are of celluloid peels.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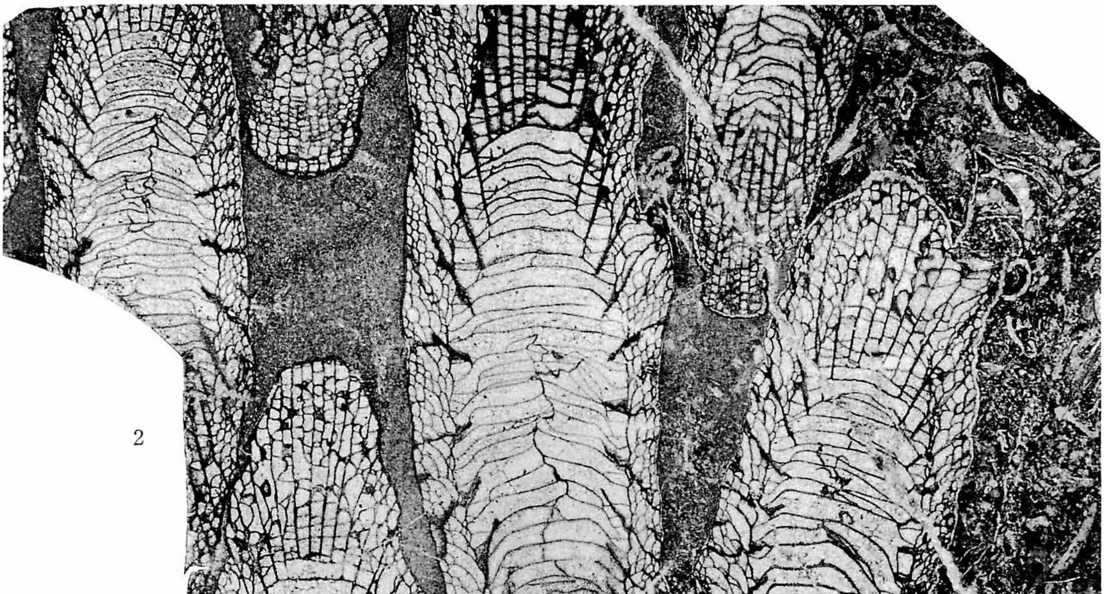
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S. KUMANO photo

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 81, pp. 11-26, pls. 2-5, April 20, 1971

575. MICROFOSSILS FROM THE PLEISTOCENE SEDIMENTS OF THE ARIAKE SEA AREA, WEST KYUSHU*

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西九州有明海域の洪積世堆積物産の微化石：島原半島北端神代（長崎県南高来郡国見町）の沖合の有明海々底から得られたボーリングコア 34 本中 11 本 17 試料から，また熊本県長洲町長洲港の北東約 3 km 付近の長洲層の 8 試料から多数のマイクロプランクトンを見出した。Dinoflagellates としては *Spiniferites ramosus*, *Hystrichosphaeridium* cf. *ferox*, *H.* cf. *tiara*, *H.* spp., *Hemicystodinium* cf. *zoharyi*, *Hystrichokibotium* sp. を，acritarchs としては *Micrhystridium ariakense* n. sp., *M. densum* n. sp., *Baltisphaeridium* sp., ? *Baltisphaeridium* sp., *Cymatiosphaera globulosa*, *C. reticulosa*, *Leiosphaeridia globulifera* n. sp. を，また所属不明微化石 *Ovoidites* cf. *microligneolus* を見出した。長崎県南高来郡国見町と有明町の境をなす栗谷川下流のボーリングコアの 8 試料から多数の所属不明の微化石 *Ovoidites ellipsoideus* n. sp. を発見した。あわせて記載報告する。

高橋　清

Introduction

Investigations on the stratigraphy and pollen assemblages of the Pleistocene sediments in the Ariake Sea area were previously made by K. TAKAHASHI, S. KAWASAKI and H. FURUKAWA (1968, 1969). They divided the Pleistocene sediments into five formations, viz. the lowest, lower, middle, upper, and pumice tuff formations, and established a zonation by differences in the pollen-spore assemblages.

The present author found many microplankton and other microfossils of unknown affinities in the same slides that were originally prepared for the earlier research on spores and pollen grains. This is a report and description of dinoflagellates, acritarchs, and other microfossils recovered from the Pleistocene formations in the Ariake Sea area.

D. WALL and B. DALE (1970) have clarified that the parental dinoflagellate of *Spiniferites ramosus* is the living species *Gonyaulax spinifera*, and *S. bentori* is the spore of *Gonyaulax digitalis*. Their incubation experiments are very interesting and important for establishing taxonomic relationships among extant and fossil dinoflagellates, "hystrichospheres", and other acritarchs.

In this paper the author refers to *Spiniferites ramosus* (EHRENBERG) MANTELL, which is identifiable with *Hystrichosphaera ramosa*, according to the opinion of WALL and DALE (1970).

Many suitable samples for the investigation were provided by Mr. Satoshi KAWASAKI, formerly of the Nagasaki Reclamation Office, Ministry of Agriculture and Forest, from eleven cores of the Ariake Sea bottom, off the coast of Kōjiro, and two cores in the Kuriya River

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* Received June 23, 1970; read June 27, 1970 at Mito.

area at the boundary of Kunimi and Ariake towns.

The author thanks Mr. Satoshi KAWASAKI, Bureau of Development of Hokkaido, for his kind offering of the boring cores. Thanks are also due to Professor Dr. Glenn E. ROUSE, Departments of Botany and Geology, University of British Columbia, Canada, for his valuable advice and for reading the manuscript.

Location and stratigraphy

The Pleistocene sediments of the Ariake Sea bottom, off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture, are divided into five formations, that is, the lowest, lower, middle, upper, and pumice tuff formations. These formations were originally described and charted in K. TAKAHASHI, S. KAWASAKI and H. FU-

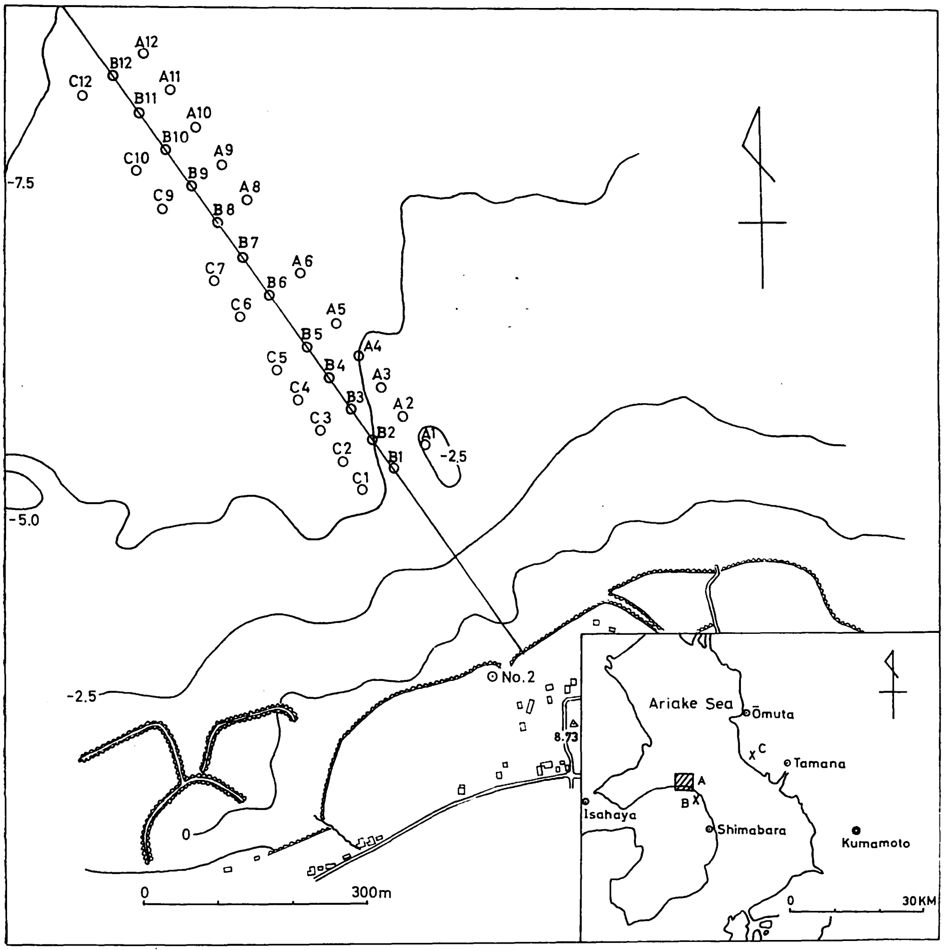

Fig. 1. Map showing the positions of the samples collected.

A_1–A_{12}, B_1–B_{12}, C_1–C_{12}, and No. 2: boring positions.
B: Kuriyagawa silt or clay bed.
C: Nagasu Formation.

RUKAWA, 1969, p. 53-57.

1) Lowest formation

This formation occurs deeper than −43 m in core no. B-3, and −35 m in core no. B-9; it consists mainly of coarse sand and gravel. In horizons deeper than −50 m of the core no. B-3, a bluish gray clay continues down for more than 5 m. A gravel bed is composed mainly of the round or subround pebbles, 1-2 cm in diameter, consisting hornblende biotite andesite and a sand matrix containing many pieces of biotite.

2) Lower formation

This formation contains facies of tuff breccia, volcanic breccia, and beds of silt-clay.

(a) Tuff breccia (0-12.7 m+ in thickness)

This formation occurs at depths of more than −12 m or −20 m. The rocks contain pyroclastics, consisting mainly of grayish-white, coarse, hornblende-biotite-andesitic breccia, within a sand matrix containing many crystals of hornblende and biotite. This grades locally into volcanic breccia.

(b) Volcanic breccia (0-30 m in thickness)

This bed does not occur on the northern side of the line connecting the boring stations A-8, A-9, B-10, B-11, and B-12 or in the neighborhood of the core C-9. The upper surface occurs at a depth shallower than −17.5 m from the sea bottom in the area of the boring positions B-4, B-5, B-6, B-7, and B-8. In this area, the bed measures about 15-20 m in thickness. This volcanic breccia contains large cobbles of hornblende-biotite andesite, and in places becomes partly lava.

(c) Silt-clay beds (generally 0.7-2.5 m; max. more than 9.5 m in thickness)

Beds ranging from clay to silt are intercalated between various horizons, and consist of greenish-gray, hard, silt to clay.

3) Middle formation (0.4-2.5 m in thickness)

This formation, consisting of brown clay, silt, or sand, contains dark gray or black carbonized plant fragments; it can be called a humus clay or sand. It is distributed mostly on the southern side of the line A_2-B_3-C_2, and occurs at −14 to −16 m below the sea bottom.

4) Upper formation (0.9-12.2m in thickness)

Consists mostly of volcanic sediments, i.e., volcanic ash, tuff breccia, silt, sand, and tuffaceous gravel, all of which originated as volcanic ejecta.

(a) Tuff breccia

This bed showing a wide distribution, consisting of many boulders and cobbles of dark gray, pyroxene andesite, and partialy hornblende-biotite andesite, with a matrix of tuffaceous sand or mud.

(b) Sandy tuff

The hard sandy tuff is light purplish gray or grayish brown, and is not so continuous. Its thickness varies from 1.7 to 4.3 m.

The soft sandy tuff is distributed discontinuously, and is light gray or gray.

(c) Sand bed

A dark gray, fine-medium, loose sand contains many carbonized plant fragments. The thickness varies from 1.2 to 2.9 m, and the upper surface varies from −9 to −11 m.

(d) Clay bed

This bed consists of dark green loose clay, clay mixed with gravel, or sandy clay containing many plant fragments, and varies from 0.15 to 2.6 m in thickness. It can be correlated with the Kuriyagawa clay bed occurring in the downstream area of Kuriya River, because of similar rock facies and pollen assemblages. Its upper limit is −12.30 to −17.00 m.

(e) Tuffaceous fine gravel bed

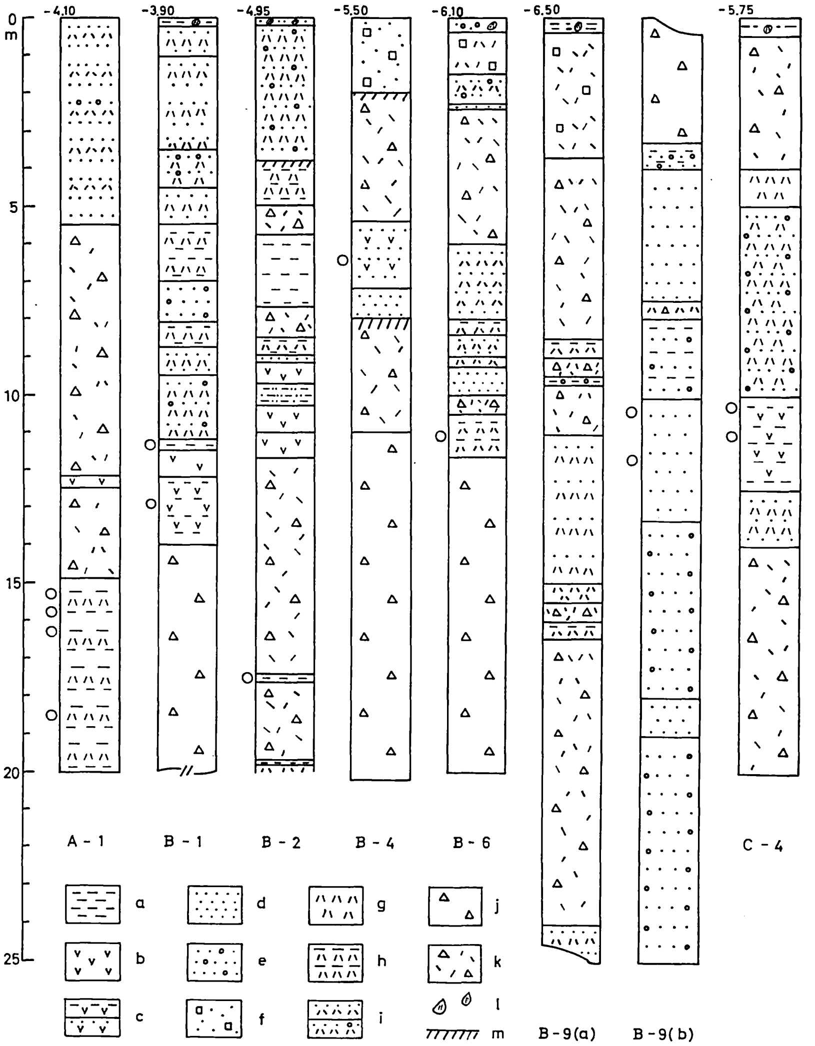

Fig. 2. Seven columnar sections of the Pleistocene sediments of the Ariake Sea bottom.

a : Silt or clay
b : Humus mud
c : Silt-clay or sand containing carbonized plant fragments
d : Sand
e : Gravel
f : Pumice sand
g : Tuff
h : Tuffaceous silt
i : Sandy tuff or (lapilli tuff) tuffaceous sand or pebble
j : Volcanic breccia
k : Tuff breccia
l : Shell remains
m : Horizon of weathered rocks
○ : Horizon showing the occurrence of microplankton

This bed consists of many coarse sands, granules, or pebbles from volcanic rocks. It is situated on the northern side of borings A-6, B-6, and C-6, and varies from 0.6 to 3.6 m in thickness.

5) Pumice tuff bed

This pumice bed, the so-called "ejecta of Aso volcano", occurs on the northern side of borings B-1, A-3, A-4, A-5, and A-6. It contains many pebbles, an occasional boulder of pumice, and small granules of black andesite in a matrix of loose pumice sand.

In the downstream area of Kuriya River, the uppermost horizon consists of tuffaceous granules to coarse sand, and is 20 cm thick. The lower horizon contains a gray silt to clay bed up to 190 cm in thickness. In horizons deeper than 190 cm, this bed also contains pumice or granules.

The outcrop of the Nagasu Formation, being gray or bluish gray silt or clay containing carbonized plant fragments and shell fossils, is situated about 700 m north of Takamoto, near Nagasu Harbor, Kumamoto Prefecture. It provided many good samples. H. FURUKAWA and H. MITSUSHIO (1965) reported that the lower part of the Nagasu Formation contains shell remains, such as *Theora lata, Raeta pulchella, Barnea japonica,* etc., indicating an inner bay environment.

The foregoing Pleistocene formations respectively correspond with the four zones of pollen assemblages (K. TAKAHASHI, S. KAWASAKI and H. FURUKAWA, 1968 and 1969).

The A type pollen group corresponding to the upper formation, consists mainly of *Pinus,* Gleicheniaceae, *Tsuga, Ilex, Fagus, Picea,* Polypodiaceae, etc.

The B type pollen group represents the middle formation and shows the spectrum of Taxodiaceae (mostly *Metasequoia*), *Alnus, Picea,* etc.

The lower formation corresponding to the C type pollen group, contains *Quercus, Castanea,* Chenopodiaceae, *Pinus,* etc.

The lowest formation shows the D type pollen group consisting of *Fagus, Pinus, Quercus,* etc.

Dinoflagellates, acritarchs, and other microfossils

Seventeen samples and horizons yielded many microplankton remains, are as follows:

Boring No.	Depth (m)	Formation	Pollen group
A-1	15.00-15.50	lower	C
A-1	15.80-16.00	lower	C
A-1	16.00-16.20	lower	C
A-1	18.40-18.50	lower	C
A-5	16.50-17.00	lower	C
A-11	18.30-18.40	lower	C
B-1	11.40-11.50	middle	B
B-1	13.00	lower	C
B-2	17.50-17.60	lower	C
B-3	12.30-12.40	lower	C
B-4	6.50- 6.70	upper	A
B-6	11.20-11.30	upper	(A)
B-9	35.30-35.50	lowest	D
B-9	36.40-36.60	lowest	D
B-11	16.55-16.65	lower	C
C-4	10.00-10.50	lower	C
C-4	11.00-11.50	lower	C

The author found many microfossils of Incertae sedis *Ovoidites* only from eight samples of the Kuriyagawa silt or clay bed. The Kuriyagawa silt or clay contains the A type pollen group.

Eight samples from the Nagasu Formation yielded many microplankton remains. In the pollen assemblage of the Nagasu Formation, *Fagus* and *Pinus* are the most predominant, and *Picea, Tsuga, Quercus, Castanea, Ilex,* Gleicheniaceae, *Zelkova* or *Ulmus,* etc. are next. This assemblage appears comparable to the D type pollen group, although an exact correlation cannot as yet be made.

1) Dinoflagellates

The author identified the following as dinoflagellates: *Spiniferites ramosus* (EHRENBERG) MANTELL; *Hystrichosphaeridium* cf. *ferox* DEFLANDRE; *Hystrichosphaeridium* cf. *tiara* KLUMPP; *Hystrichosphaeridium* spp.; *Hemicystodinium* cf. *zoharyi* (ROSSIGNOL) WALL, and *Hystrichokibotium* sp.

Spores of *Spiniferites ramosus* (EHRENBERG) MANTELL, occurring commonly from the Pleistocene sediments of the Ariake Sea area, have been isolated recently by D. WALL and B. DALE (1970) from the sediments of a marine lagoon in Bermuda. Their incubation experiments show that living dinoflagellate spores of *Spiniferites ramosus* (EHRENBERG) MANTELL have excysted in vitro to produce a motile thecate dinoflagellate of the *Gonyaulax spinifera* type.

2) Acritarchs

Micrhystridium ariakense n. sp., *Micrhystridium densum* n. sp., *Baltisphaeridium* spp., *Cymatiosphaera globulosa* TAKAHASHI, *Cymatiosphaera reticulosa* TAKAHASHI, and *Leiosphaeridia globulifera* n. sp. were identified. *Micrhystridium ariakense* appears especially abundantly from many samples.

3) Other microfossils

Ovoidites ellipsoideus n. sp. was commonly found only from the Kuriyagawa silt or clay bed. Only one specimen of *Ovoidites* cf. *microligneolus* KRUTZSCH was found in core B-6, 11.20-11.30 m in depth. The biological affinities of *Ovoidites* are unknown.

All type material is kept in the Department of Geology, Nagasaki University.

Systematic descriptions

Class Dinophyceae

Family Gonyaulaceae LINDEMANN

Genus *Spiniferites* MANTELL, 1850

Spiniferites ramosus (EHRENBERG) MANTELL

Pl. 2, figs. 1-3

1937. *Hystrichosphaera ramosa*, G. DEFLANDRE, *Ann. Pal.*, 26, p. 64, pl. 11, figs. 5, 7.
1937. *Hystrichosphaera furcata*, G. DEFLANDRE, *Ann. Pal.*, 26, pp. 61-63, pl. 11, figs. 1, 3, 4.
1958. *Hystrichosphaera furcata*, A. EISENACK, *N. Jb. Geol. Paläont.*, 106, 3, p. 406, pl. 25, figs. 4-8.
1959. *Hystrichosphaera furcata*, H. GOCHT, *Paläont. Z.*, 33, 1/2, p. 74, pl. 4, fig. 4; pl. 5, fig. 11.
1964. *Hystrichosphaera furcata*, I.C. COOKSON and N.F. HUGHES, *Palaeontology*, 7, 1, p. 45, pl. 9, figs. 1, 2.
1964. *Hystrichosphaera ramosa*, I.C. COOKSON and N.F. HUGHES, *Palaeontology*, 7, 1, p. 45, pl. 9, figs. 4, 5.
1966. *Hystrichosphaera furcata*, P. MORGENROTH, *Palaeontographica*, B, 119, p. 14, pl. 7, figs. 5, 6.
1967. *Hystrichosphaera furcata*, D. WALL, *Palaeontology*, 10, 1, pp. 98-100, pl. 14, figs. 1, 2, text-fig. 2.
1969. *Hystrichosphaera ramosa*, H. GOCHT, *Palaeontographica*, B, 126, pp. 30-31, pl. 4, figs. 10, 11.
1970. *Spiniferites ramosus* (EHRENBERG) MANTELL, D. WALL and B. DALE, *Micropaleontology*, 16, 1, pp. 49-51, pl. 1, figs. 1-15, text-figs. 1-9.

Description:—The test is ovoid. The test wall is thin and smooth or fine punctate. The plate-areas are defined by distinct sutural septa and are completely developed in number and arrangement. The processes are set along the sutures and at corners of plate-areas. They are relatively long, either bifurcate or trifurcate. The tabulation is 4′, 0a, 6″, 6c,

$6'''$, 1p, $1''''$ and the archeopyle is developed from plate-area $3''$. Its shape is subrectangular.

Dimensions:—Test 50-54×44-52 μ; length of process 15 to 8 μ; width of girdle: ventral 4 to 6 μ, dorsal 7 to 8 μ.

Remarks:—The present specimens are very similar to *Spiniferites ramosus* (EHRENBERG) MANTELL (=*Hystrichosphaera ramosa* (EHRENBERG) DAVEY and WILLIAMS) (D. WALL and B. DALE, 1970, 47-58, pl. 1) from modern marine lagoonal sediments in Bermuda.

WALL and DALE (1970) have informed that living specimens of *Spiniferites ramosus* (EHRENBERG) have been isolated from the sediments of a marine lagoon in Bermuda and have excysted in vitro to produce a motile dinoflagellate of *Gonyaulax spinifera*. This fact establishes the synonymy of *Spiniferites* (=*Hystrichosphaera*) and *Gonyaulaux*.

Age and occurrence:—Pleistocene; Nagasu Formation (marine silt), near Nagasu Harbor, Kumamoto Prefecture. Slide GN 673 and GN 751.

Family Hystrichosphaeridiaceae EVITT, 1963, emend. SARJEANT and DOWNIE, 1966

Genus *Hystrichosphaeridium* DEFLANDRE, 1937, emend. DAVEY and WILLIAMS, 1966

Hystrichosphaeridium cf. *ferox* DEFLANDRE

Pl. 3, fig. 6

1937. *Hystrichosphaeridium ferox* DEFLANDRE, *Ann. Pal.*, 26, p. 72, pl. 14, figs. 3, 4.
1958. *Hystrichosphaeridium ferox*, A. EISENACK, *N. Jb. Geol. Paläont.*, 106, pp. 401-402, pl. 27, figs. 1-2.
1959. *Hystrichosphaeridium ferox*, H. GOCHT, *Paläont. Z.*, 33, 1/2, p. 71, pl. 4, fig. 1.
1962. *Hystrichosphaeridium ferox*, I.C. COOKSON and A. EISENACK, *Micropaleontology*, 8, 4, p. 491, pl. 4, fig. 15.
1967. "*Hystrichosphaeridium*" *ferox*, W.R. EVITT, *Stanford Univ. Publ. Geol. Sci.*, 10, 3, p. 76, pl. 8, figs. 1-5.

Description:—The test is ovoid with somewhat truncated base. The test diameter is about 33×27 μ. Large compound processes are broad at the base, divide into two or more forked spines which taper toward the tips, and correspond to pre- and postcingular plates. Smaller processes are sometimes between the compound processes and correspond to apical, cingular, and sulcal plates. The large compound processes are about 9 to 11 μ long and about 8.3 to 8.6 μ broad at the base. The small processes are about 5 to 7 μ, scarcely 10 μ long and about 1.3 to 1.6 μ broad at the base.

Remarks:—The characteristics of the present specimen are comparable with those of *Hystrichosphaeridium ferox* DEFLANDRE in the form and arrangement of the compound processes.

Age and occurrence:—Pleistocene; lower formation of the Ariake Sea bottom, off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture; core C-4, depth 11.00-11.50 m. Slide GN 395.

Hystrichosphaeridium cf. *tiara* KLUMPP

Pl. 4, fig. 16

1953. *Hystrichosphaeridium tiara* KLUMPP, *Palaeontographica*, A, 103, pp. 390-391, pl. 17, figs. 8-10.

Description:—The test is originally spherical and thin-walled, with the numerous processes of the small bifurcated or bugle-like tips. The test diameter is about 55.5 to 69 μ. The numerous processes are relatively slender and often curved, and range from 9.5 to 14 μ in length. Archaeopyle apical. The processes around archaeopyle are somewhat smaller.

Remarks:—Hystrichosphaeridium tiara KLUMPP was described by B. KLUMPP (1953, pp. 390-391, pl. 17, figs. 8-10) from the Upper Eocene sediments of Kiel and Wöhrden, Germany. The present specimen is closely similar to the German species *H. tiara* KLUMPP excepting wall-thickness. The latter possesses the thicker wall, 4 μ, than the former.

Age and occurrence:—Pleistocene; lower formation of the Ariake Sea bottom, off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture; core A-1, depth 16.00-16.20 m. Slide GN 476. Core A-5, depth 16.50-17.00 m. Slide GN 581.

Hystrichosphaeridium sp. a

Pl. 2, figs. 4a-b

Description:—The test is ellipsoidal in outline, but originally spherical (?). The test diameter is about 46×31 μ. The numerous processes are relatively slender, long, and cyrindrical with the somewhat broader base and the bi- or trifurcated tips. Their length varies from 7.8 to 10.3 μ. The wall is very thin, 0.4 μ and fine punctate. Archaeopyle unseen.

Remarks:—The author describes here the present specimen as *Hystrichosphaeridium* sp. due to no apparent plate-areas.

Age and occurrence:—Pleistocene; lower formation of the Ariake Sea bottom, off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture; core B-2, depth 17.50-17.60 m. Slide GN 234.

Hystrichosphaeridium sp. b

Pl. 4, figs. 15a-b

Description:—The test is originally spherical or oval, with the numerous processes. The test diameter is about 31×26 μ. The processes are relatively short and slender with the trumpet mouth-like tip. Their length ranges from 5.0 to 5.2 μ. The wall is thin. Archaeopyle apical.

Remarks:—The present specimen is similar to *Hystrichosphaeridium tiara* KLUMPP (B. KLUMPP, 1953, pp. 390-391, pl. 17, figs. 8-11) from the Upper Eocene sediments of Kiel and Wöhrden, Germany and *H.* cf. *tiara* from the Pleistocene sediments of the lower formation of the Ariake Sea bottom. The former is smaller in size and length of process than the latter.

Age and occurrence:—Pleistocene; lower formation of the Ariake Sea bottom, off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture; core A-1, depth 15.80-16.00 m. Slide GN 463.

Family Incertae sedis

Genus *Hemicystodinium* WALL, 1967

Hemicystodinium cf. *zoharyi* (ROSSIGNOL) WALL

Pl. 3, figs. 1a-b

1962. *Hystrichosphaeridium Zoharyi* ROSSIGNOL, *Pollen et spores*, 4, 1, p. 132-134, pl. 2, fig. 10.
1967. *Hemicystodinium zoharyi* (ROSSIGNOL) WALL, *Palaeontology*, 10, 1, p. 110, pl. 15, figs. 18-20.

Description:—The hemisphaerical, rim of hemisphere with somewhat smaller projection and displacement at the mid-ventral point. Test smooth, 45×42 μ long in diameter. Spines numerous; their length about 7 to 7.5 μ and breadth about 1.3 to 1.6 μ.

Remarks:—The present specimen is comparable with *Hemicystodinium zoharyi*

(ROSSIGNOL) WALL (*Hystrichosphaeridium zoharyi*, M. ROSSIGNOL, 1962, pp. 132-134, pl. 2, fig. 10; D. WALL, 1967, p. 110, pl. 15, figs. 18-20) in the test diameter, the sulcal notch probably at anterior position of the longitudinal furrows, and the spine form.

Age and occurrence:—Pleistocene; lower formation in the Ariake Sea area, off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture. Core C-4, depth 11.00-11.50 m. Slide GN 395.

Genus *Hystrichokibotium* KLUMPP, 1953

Hystrichokibotium sp.

Pl. 3, figs. 4a-c

Description:—The test is smooth and spherical. The test diameter is 30.8×28.0 μ. The wall is two-layered (?), about 1 μ thick. The processes are broad at the base and taper rapidly to the tips which are usually bifurcate or trifurcate. The processes arise from the junctures of the polygonal fields. Some processes are interconnected for a considerable distance up from the bases by web-like membranes. The processes are about 8 μ long and about 3 μ wide at the base. No girdle is present.

Remarks:—The genus *Hystrichokibotium* was established by B. KLUMPP (1953, pp. 387-388) under the type species *Hystrichokibotium pseudofurcatum* from Upper Eocene of Wöhrden, North W-Germany. This species is far larger in test size and length of processes than the present species.

Age and occurrence:—Pleistocene; Nagasu Formation (marine silt), near Nagasu Harbor, Kumamoto Prefecture. Slide GN 615.

Incertae Sedis

Group Acritarcha EVITT, 1963

Subgroup Acanthomorphitae DOWNIE, EVITT, and SARJEANT, 1963

Genus *Micrhystridium* DEFLANDRE, 1937, emend. DOWNIE and SARJEANT, 1963

Micrhystridium ariakense n. sp.

Pl. 4, figs. 1-10

Holotype:—Plate 4, fig. 7; test 14×12.5 μ; specimen slide GN 478, core A-1, depth 16.00-16.20 m, bottom of Ariake Sea.

Diagnosis:—Test originally spherical, smooth, thin-walled; spines fine and small, straight, with a little conical base; number of spines countless, length of spines less than 1/10 of the test diameter.

Dimensions:—

Figs.	Test diameter (μ)	Test wall (μ)	Length of spines (μ)
1	16.7×16.7	0.7	0.8
2	16.7×15.0	0.5	0.8
3	16.0×14.0	0.7	0.9
4	15.2×13.7	0.7	0.7
5	11.1×10.0	thin	0.8
6	13.5× 9.8	thin	0.7
7	14.2×12.5	0.4	0.9
8	14.4×10.9	thin	0.8
9	16.4×11.4	thin	0.9
10	12.5× 9.8	thin	0.6

Test diameter 11×10 μ to 16.7×16.7 μ; test wall 0.5 μ±thick (0.4 to 0.7 μ); length of spines 0.6 to 0.9 μ.

Occurrence:—Lower formation of the Ariake Sea bottom and Nagasu Formation; common.

Description:—The test is originally spherical in outline. The thickness of the test wall is less than 5 per cent of the test diameter. The spines are very small, straight, and somewhat broaden at their point of insertion and their spacing is regular. The spine bases are circular, 0.5 μ or less than 0.5 μ wide.

The length of spines is constant respectively, less than 1 μ. The surface of the test between spines is smooth. The test often folds.

Remarks:—This species is very closely similar to *Micrhystridium minus* TAKAHASHI from the Oligocene sandstone of the Asagai Formation, Jōban coal-field (K. TAKAHASHI, 1964, p. 203, pl. 30, figs. 2-4; pl. 33, fig. 2), but differs from the latter in that the present species possesses larger test and stronger spines than the latter.

Micrhystridium densum n. sp.

Pl. 4, figs. 11a-b

Holotype:—Pl. 4, figs. 11a-b; test 14.6×13.2 μ; specimen slide GN 346, core C-4, depth 10.00-10.50 m, bottom of Ariake Sea.

Diagnosis:—Test spherical, smooth, thin-walled; smaller spines numerous, stronger spines with a little conical bases scattered; length of stronger spine a little more than 10 per cent of the test diameter and smaller spines less than 10 per cent of the test diameter.

Dimensions:—Test diameter 13 to 14.6 μ; stronger spines 1.7 μ long and smaller spines 0.7 to 0.9 μ long; diameter of conical base of stronger spine 0.8 μ.

Occurrence:—Lower formation of the Ariake Sea bottom; uncommon.

Description:—The test is spherical and thin-walled, 0.7 to 0.8 μ thick. The spines are numerous, simple, and small, 0.7 to 1.7 μ long. Some stronger and larger spines, 1.7 μ long, are found in the irregular disposition between the numerous small spines. The larger spine has a little conical base.

Remarks:—The specimen, which was described as *Micrhystridium* sp. a from the Asagai Formation (K. TAKAHASHI, 1964, p. 206, pl. 30, figs. 5a-b), belongs to the present species *Micrhystridium densum*.

This species is also similar to *Micrhystridium ariakense* (pl. 4, figs. 1-10), but the former possesses some stronger spines which arrange irregularly.

Genus *Baltisphaeridium* EISENACK, 1958, emend. DOWNIE and SARJEANT, 1963

Baltisphaeridium sp.

Pl. 3, fig. 5

Description:—The test is smooth, thin-walled, and spherical. The test diameter is 26.7×24.5 μ. The spines are relatively strong, straight or somewhat curved, and broaden somewhat at their point of insertion. The number of spines is numerous. Their length is about 4 to 6 μ and their breadth at the base is 1.8 to 2.2 μ.

Remarks:—The similar species, *Baltisphaeridium hirsutum* (EHR.) DOWNIE and SARJEANT, 1963 (G. DEFLANDRE, 1937, 26, p. 78, pl. 13, fig. 8; I. C. COOKSON and

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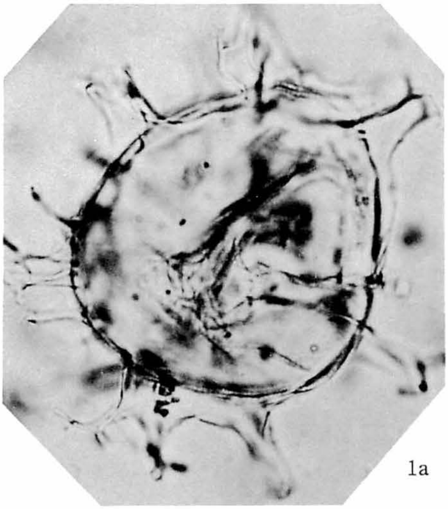
Explanation of Plate 2

Figs. 1a-b, 2, 3. *Spiniferites ramosus* (EHRENBERG) MANTELL
Fig. 1a. Approximately dorsal view; Nagasu Formation; slide GN 673; ×875.
Fig. 1b. Ventral view; Nagasu Formation; slide GN 673; ×875.
Fig. 2. Approximately dorsal view; Nagasu Formation; slide GN 673; ×500.
Fig. 3. Ventral view; Nagasu Formation; slide GN 751; ×875.
Figs. 4a-b. *Hystrichosphaeridium* sp. a
Lower formation; core B-2, 17.50-17.60 m in depth; slide GN 234; ×1250.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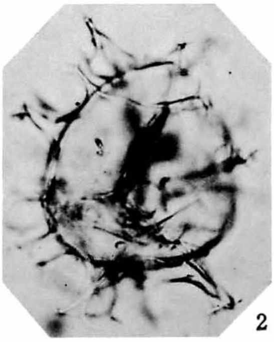
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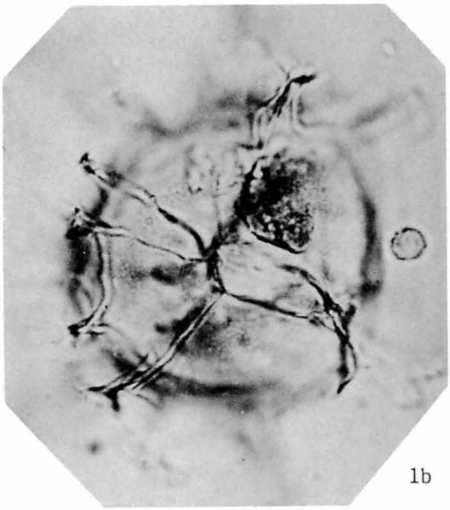
4a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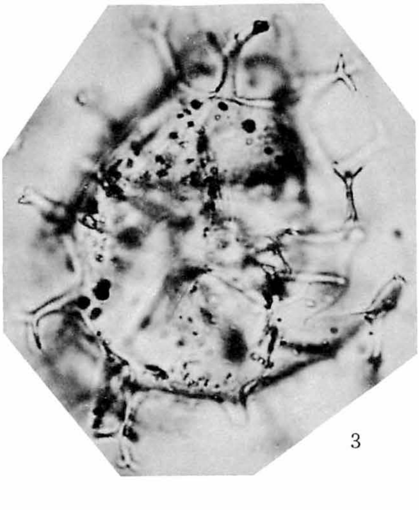
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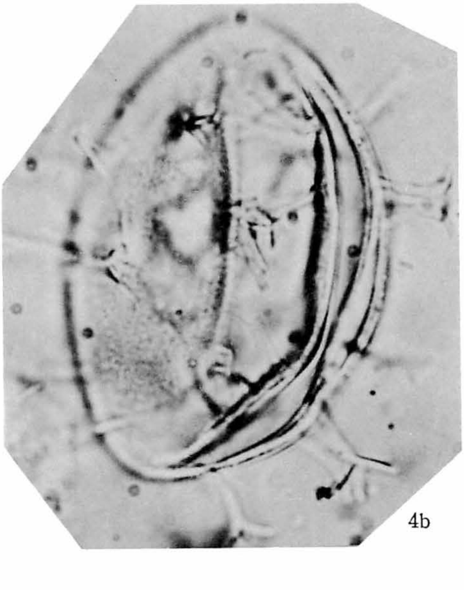

4b

N. F. HUGHES, 1964, p. 55, pl. 10, figs. 1, 2; N. BALTES, 1967, p. 332, pl. 4, figs. 13 20), has been recorded from Cretaceous sediments in some regions of Europe, but differs from the present specimen in the test dimension. The former is far larger than the present specimen.

Age and occurrence:—Pleistocene; Nagasu Formation (marine silt), near Nagasu Harbor, Kumamoto Prefecture. Slide GN 674.

? *Baltisphaeridium* sp.

Pl. 3, figs. 2, 3

Description:—The test is cracked, but originally spherical. The test diameter is about 60×63 μ. The numerous spines are relatively small and straight, and their forms are various, that is, spiny, lanceolate, and broad cylindrical with cuspidate tip. Only one large spine possesses attenuate-acuminate tip. The length of large spine is about 23 μ and the spine base is about 15 μ wide. Small spines are 7 to 9 μ long.

Remarks:—The present specimen is similar to *Baltisphaeridium multipilosum* (EISENACK) EISENACK (A. EISENACK, 1962, pl. 3, fig. 8; C. DOWNIE and W. A. S. SARJEANT, 1963, p. 90, size 45-60 μ) in the shell size and the form of spine, but the former possesses two or three kinds of smaller spines and one larger spine.

Age and occurrence:—Pleistocene; lower formation of the Ariake Sea bottom, off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture; core A-1, depth 15.80-16.00 m. Slide GN 457.

Subgroup Herkomorphitae DOWNIE, EVITT, and SARJEANT, 1963

Genus *Cymatiosphaera* O. WETZEL, 1933, emend. DEFLANDRE, 1954

Cymatiosphaera globulosa TAKAHASHI

Pl. 4, figs. 13a-b

1964. *Cymatiosphaera globulosa* TAKAHASHI, *Trans. Proc. Palaeont. Soc. Japan, N.S.*, 54, p. 210, pl. 30, figs. 6a-b, 7a-b.

Description:—The test is spherical and thin-walled, with fifteen or seventeen polygonal fields. The test diameter is about 16 μ. The width of networks varies from 6.3 to 7.9 μ. The spines are relatively slender and short; their length ranges from 1.7 to 2.5 μ. The thickness of wall is 0.8 μ. The networks connect with the straight line.

Remarks:—This specimen belongs to *Cymatiosphaera globulosa* described by the author from the Asagai Formation (Oligocene) (K. TAKAHASHI, 1964, p. 210, pl. 30, figs. 6a-b, 7a-b). This Pleistocene specimen is larger than the Asagai specimens in shell diameter.

Age and occurrence:—Pleistocene; upper formation of the Ariake Sea bottom, off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture; core B-4, depth 6.50-6.70 m. Slide GN 295.

Cymatiosphaera reticulosa TAKAHASHI

Pl. 4, figs. 12a-b, 14a-b

1964. *Cymatiosphaera reticulosa* TAKAHASHI, *Trans. Proc. Palaeont. Soc. Japan, N.S.*, 54, pp. 210-211, pl. 30, figs. 8a-b, 9a-c.

Description:—The test is spherical and thin-walled, with fifteen to twenty polygonal fields divided by the undulate line. The test diameter is 12.3 to 15 μ. The width of networks is 4.2 to 5.7 μ. The relatively short and stout spines arise at the junctions of net-ridges; their length varies from 1.8 to 2.3 μ. The thickness of wall is about 0.7 μ.

Remarks:—The present specimens possess the morphological characteristics of *Cymatiosphaera reticulosa* TAKAHASHI from the Oligocene Asagai Formation, Fukushima Prefecture. These Pleistocene specimens are smaller in size than those from the Asagai Formation.

Age and occurrence:—Pleistocene; lower formation of the Ariake Sea bottom; core B-1, depth 12.00-14.10 (13.00) m; core A-1, depth 15.80-16.00 m; off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture. Slides GN 156 and GN 459.

Subgroup Sphaeromorphitae DOWNIE, EVITT, and SARJEANT, 1963

Genus *Leiosphaeridia* EISENACK, 1958, emend. DOWNIE and SARJEANT, 1963

Leiosphaeridia globulifera n. sp.

Pl. 5, figs. 1, 2

Holotype:—Pl. 5, fig. 1; body 211.5× 94.5 μ; specimen slide GN 388, core C-4, depth 11.00-11.50 m, bottom of Ariake Sea.

Diagnosis:—Ellipsoidal bodies with no process, collapsed. No pylome. Wall granular or globular, thin. Both ends of body often lacking.

Dimensions:—Body 211.5-204×94.5-83 μ; wall 0.9 to 1.1 μ; granular or globular protuberance 1.3 to 1.7 μ high and 1.7 to 2 μ wide.

Occurrence:—Lower formation of the Ariake Sea bottom, off the coast of Kōjiro; uncommon.

Description:—The bodies are ellipsoidal in outline. It is very difficult to decide whether the body is originally spherical or not. The length of bodies is more than twice of the width. The wall is very thin, ornamented with numerous granular or globular balls or knobs including small ones as well as somewhat big ones, which are more or less densely scattered, collapsed and folded. No pylome and no transverse girdle. Both ends of body often lack.

Remarks:—The present species is very similar to the features of specimens which were illustrated by A. EISENACK (1958, p. 19, pl. 2, figs. 11-13). *Leiosphaeridia* sp. (A. EISENACK, 1958, pl. 2, fig. 11) resembles the present specimens, but the former possesses no ornamentation of ball or knob, judging from EISENACK's photograph (fig. 11).

Incertae Sedis

Formgenus *Ovoidites* R. POTONIÉ, 1966

Ovoidites ellipsoideus n. sp.

Pl. 5, figs. 3-10

Explanation of Plate 3

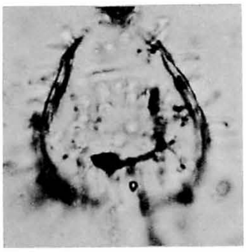
Figs. 1a-b. *Hemicystodinium* cf. *zoharyi* (ROSSIGNOL) WALL
Lower formation; core C-4, 11.00-11.50 m in depth; slide GN 395; ×500.

Figs. 2, 3. ? *Baltisphaeridium* sp.
Lower formation; core A-1, 15.80-16.00 m in depth; slide GN 457; fig. 2: ×500; fig. 3: ×875.

Figs. 4a-c. *Hystrichokibotium* sp.
Nagasu Formation; slide GN 615; ×875.

Fig. 5. *Baltisphaeridium* sp.
Nagasu Formation; slide GN 674; ×1250.

Fig. 6. *Hystrichosphaeridium* cf. *ferox* DEFLANDRE
Lower formation; core C-4, 11.00-11.50 m in depth; slide GN 395; ×1250.



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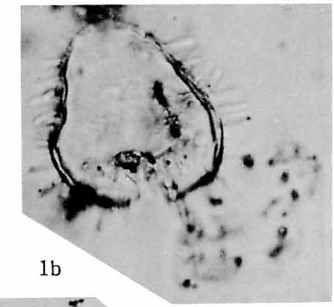

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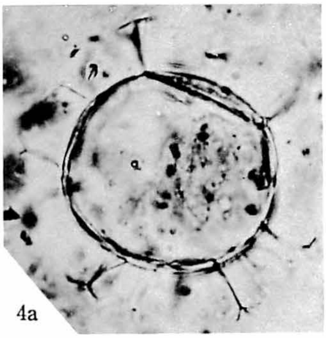

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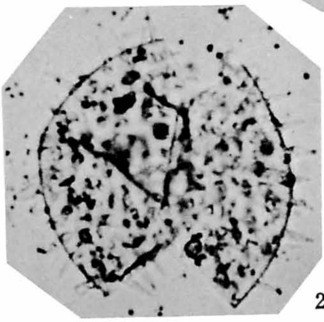

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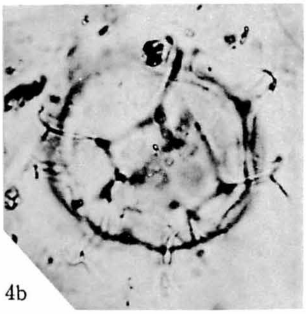

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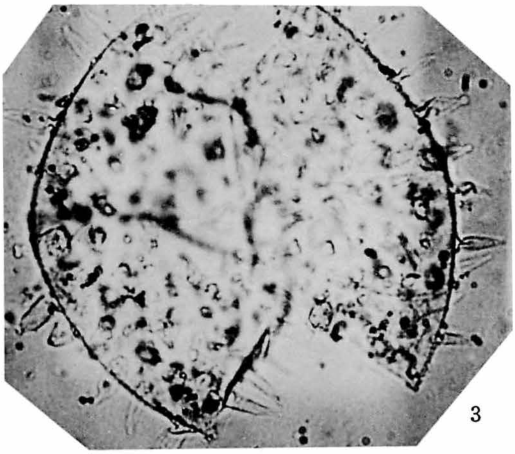

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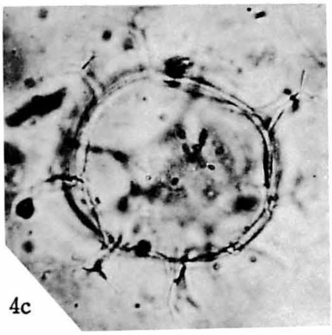

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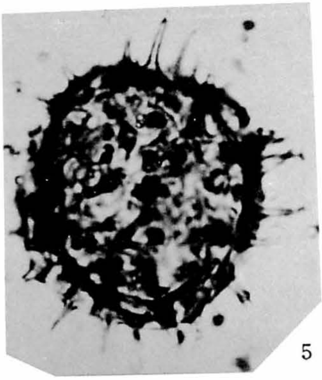

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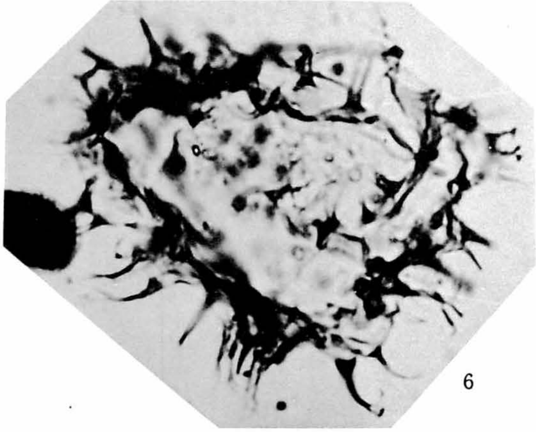

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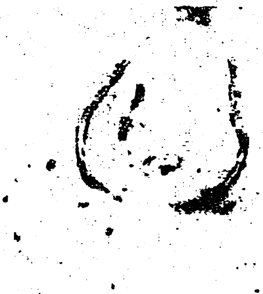

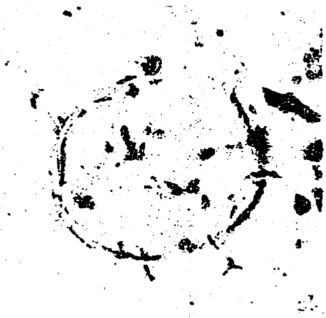

Holotype:—Pl. 5, fig. 5; size 120×45 μ; slide GN 1423, core Ku 1-1d, depth 100 cm, Kuriya River on the boundary between Kunimi and Ariake.

Diagnosis:—Elongated ellipsoidal to fusiform in outline; exine one or two layers, ektexine thicker than endexine. Sculpture fine punctate or rugulate, rarely smooth, and often slenderly reticulate with lumina elongated in the direction of long diameter of the grain.

Dimensions:—Grain size and thickness of exine of the figures illustrated in the plate 5.

Figs.	Long diameter (μ)	Short diameter (μ)	Thickness of exine (μ)
3	125	38.4	2.8
4	122	36	1.5
5	120	45	2
6	126	58.2	1.5
7	132.6	57.8	2
8	56.7	24.7	1.3
9	87	46.3	2.0
10	81	38	1.5

Occurrence:—Kuriyagawa silt or clay bed, upper formation in the Ariake Sea area.

Description:—The grains are elongated ellipsoidal to fusiform in outline. The length of grains varies from 56.7 to 132.6 μ and their width ranges from 24.7 to 58.2 μ. The exine of grains is one or two layers, 1.3 to 2.8 μ thick, and the ektexine is thicker than the endexine. The sculpture of exine is very finely punctate or rugulate, rarely smooth, and often slenderly reticulate with lumina elongated in the direction of long diameter of the grains. Both ends of grain are round. A fissure often divides the grain in half.

Remarks:—*Ovoidites* is very similar to *Schizosporis* in characteristic feature. *Ovoidites ligneolus* (POTONIÉ) differs from the present species in sculpture. The latter is more slender in sculpture of network than the former.

Botanical affinities:—Unknown.

Ovoidites cf. *microligneolus* KRUTZSCH

Pl. 5, fig. 11

1959. *Ovoidites microligneolus* KRUTZSCH, *Geologie*, Jg. 8, Beih. 21/22, p. 254, pl. 49, figs. 635-637.

Description:—The grain is fusiform. Its length is about 93 μ and its width is about 47 μ. The exine of grain is 1.7 μ thick and two layers. The exine sculpture is roughly rugulate, and slender reticulation with rough lumina in outer layer. The grain is divided by tear in half.

Remarks:—The present specimen is very similar to *Ovoidites microligneolus* KRUTZSCH (1959, p. 254, pl. 49, figs. 635-637) from the Middle Eocene Geiseltal seam of Germany. It is difficult to distinguish the present specimen from *O. microligneolus* by the morphological characteristics.

Age and occurrencs:—Pleistocene; upper formation in the Ariake Sea area, off the coast of Kōjiro, Shimabara Peninsula, Nagasaki Prefecture. Core B-6, depth 11.20-11.30 m. Slide GN 1207.

Botanical affinities:—Unknown.

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Explanation of Plate 4

Figs. 1-10. *Micrhystridium ariakense* n. sp., ×1250.

Fig. 1. Lowest formation; core B-9, 36.40-36.60 m in depth; slide GN 1275.

Fig. 2. Lower formation; core A-1, 15.80-16.00 m in depth; slide GN 461.

Figs. 3, 7, 10. Lower formation; core A-1, 16.00-16.20 m in depth; figs. 3, 7: slide GN 478; fig. 7: holotype; fig. 10: slide GN 479.

Fig. 4. Nagasu Formation; slide GN 611.

Figs. 5, 6, 9. Lower formation; core A-1, 18.40-18.50 m in depth; figs. 5, 9: slide GN 497; fig. 6: slide GN 498.

Fig. 8. Lower formation; core A-1, 15.00-15.50 m in depth; slide GN 437.

Figs. 11a-b. *Micrhystridium densum* n. sp.

Lower formation; core C-4, 10.00-10.50 m in depth; slide GN 346; ×1250.

Figs. 12a-b, 14a-b. *Cymatiosphaera reticulosa* TAKAHASHI, ×1250.

Fig. 12. Lower formation; core B-1, 13.00 m in depth; slide GN 156.

Fig. 14. Lower formation; core A-1, 15.80-16.00 m in depth; slide GN 459.

Figs. 13a-b. *Cymatiosphaera globulosa* TAKAHASHI

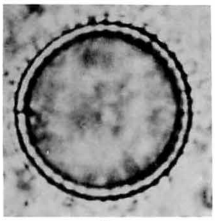
Upper formation; core B-4, 6.50-6.70 m in depth; slide GN 295; ×1250.

Figs. 15a-b. *Hystrichosphaeridium* sp. b

Lower formation; core A-1, 15.80-16.00 m in depth; slide GN 463; ×1250.

Fig. 16. *Hystrichosphaeridium* cf. *tiara* KLUMPP

Lower formation; core A-1, 16.00-16.20 m in depth; slide GN 476; ×1250.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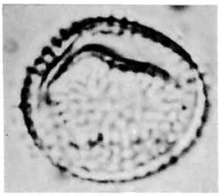
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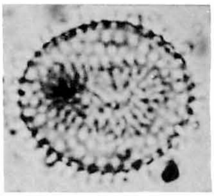
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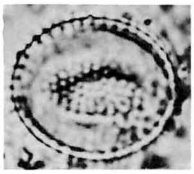
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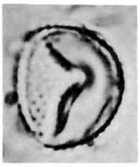
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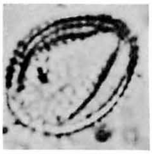
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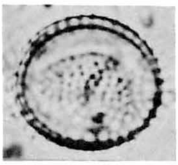
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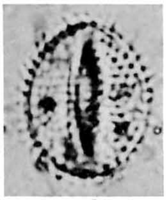
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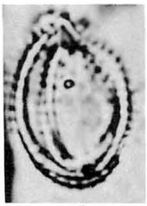
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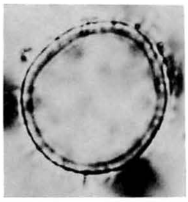
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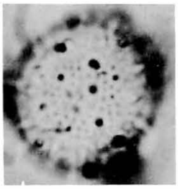
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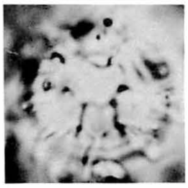
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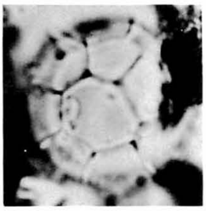
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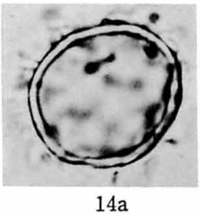
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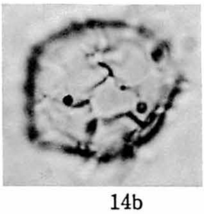
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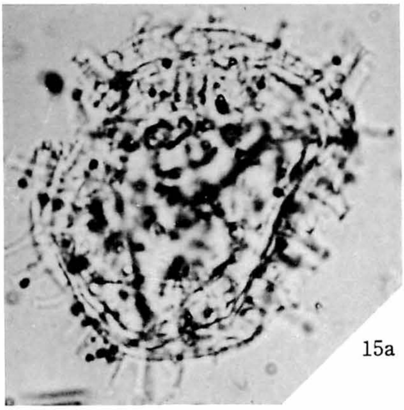
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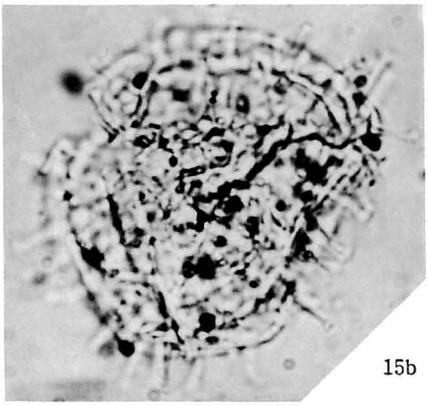
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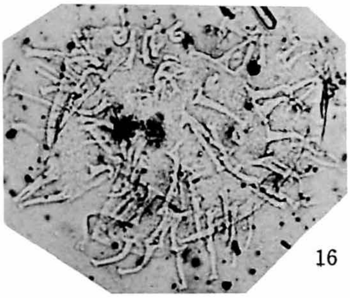
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Ariake	有明
Kōjiro	神代
Kunimi	国見
Kuriyagawa	栗谷川
Nagasu	長洲
Shimabara	島原

Explanation of Plate 5

Figs. 1, 2. *Leiosphaeridia globulifera* n. sp.
Lower formation; core C-4, 11.00-11.50 m in depth; slide GN 388; fig. 1: holotype; ×350.

Figs. 3-10. *Ovoidites ellipsoideus* n. sp., ×500.
Kuriyagawa silt or clay bed; figs. 3, 4: slide GN 1477; figs. 5-7, 9: slide GN 1423; fig. 8: slide GN 1441; fig. 10: slide GN 1496; fig. 5: holotype.

Fig. 11. *Ovoidites* cf. *microligneolus* KRUTZSCH
Upper formation; core B-6, 11.20-11.30 m in depth; slide GN 1207; ×500.


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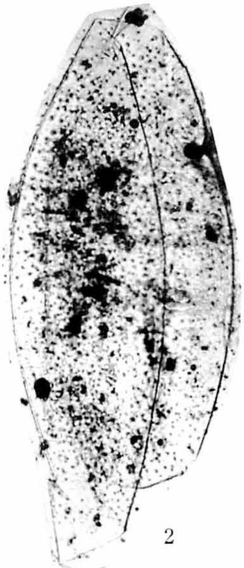
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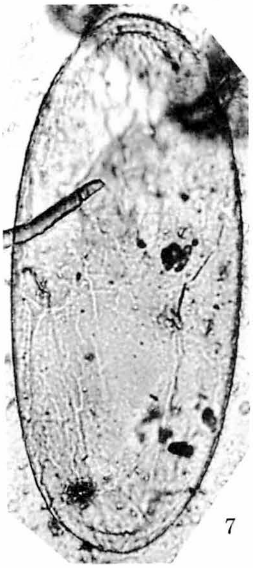
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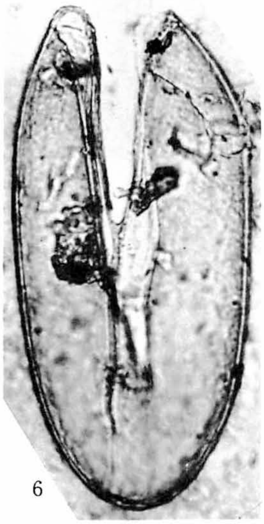
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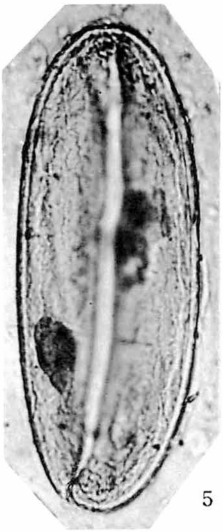
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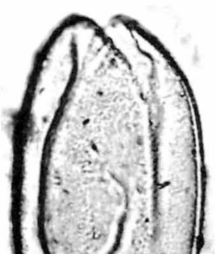
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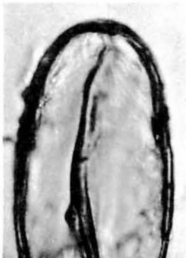
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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 81, pp. 27-51, pls. 6, 7, April 20, 1971

576. NEW ANADARID AND ASSOCIATED MOLLUSCAN FAUNA FROM THE HANEJI FORMATION, OKINAWA-JIMA, RYUKYU ISLANDS*

HIROSHI NODA

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

琉球沖縄本島羽地層産 *Anadara* の新種とその共産貝化石群について： 沖縄本島の本部半島羽地村一帯に分布する新第三系からは豊富な貝化石，オパキユリナ等が産出することが知られていた。層位学的調査の結果，MacNeil (1960) が Nakoshi Sand として取扱った含貝化石砂岩層の下部に約 15 m の厚さをもつ礫岩を主とする地層の発達することが判明し，それらの検討の結果，Kogachi Member と Nakoshi Sandstone Member を含む Haneji Formation を新しく提唱した。本論文では主として Kogachi Member の地質及び地質学的意義に重点をおき，その上部に発達するシルト岩中に新たに Kogachi Fauna を認めた。Kogachi Fauna は *Anadara* (*Hataiarca*) *kogachiensis* n. sp. を含む二枚貝 13 種と巻貝 7 種よりなり，鮮新世初期の羽地海進初期の内湾泥底に生息した群集である。Haneji Formation 下部から上部にかけての貝化石群によってしめされる環境の変遷がその岩相の垂直的変化とよく一致していることを示した。特に *Anadara* については Kogachi Member からは *Anadara* (*Hataiarca*) *kogachiensis* Noda, n. sp., が，Nakoshi Sandstone Member からは *Anadara* (*Scapharca*) *suzukii* (Yokoyama) 及び *Anadara* (*Scapharca*) *takaoensis* (Nomura) の *Anadara suzukii* Group が産出し，年代及び対比の有力な手がかりとなり西南日本の掛川一穴内一高鍋層に対比される。*Hataiarca* に属しとくに中部中新世初期の *Anadara* (*Hataiarca*) *kakehataensis* Hatai and Nisiyama に近似する *Anadara* (*Hataiarca*) *kogachiensis* との差異及び現棲種 *Anadara* (*Hataiarca*) *subcrenata* (Lischke) との差異を検討した結果，それらは互に類縁し，同一系統上のものであることを結論した。

野　田　浩　司

Introduction

The stratigraphic unit called the Nakoshi Sand was proposed by MacNeil (1960) for the sandy and silty facies in the lower part of the Ryukyu Group (Hanzawa, 1935a) distributed on the Motobu Peninsula in the northern part of Okinawa-jima. According to MacNeil (1960), the Nakoshi Sand contains abundant marine molluscan fossils, some of which have been described by Nomura and Zinbô (1936) and Yabe and Hatai (1941). The fossiliferous sandstone is underlain by 20 feet thick, presumably basal conglomerate at Nakoshi. The Nakoshi Sand is distributed only in the Motobu Peninsula. Rock facies stratigraphically lower than the fossiliferous Nakoshi Sand (MacNeil, 1960) have been found during the writer's study. The lower part of the Nakoshi Sand of MacNeil (1960) consists mainly of basal conglomerate, overlain in upward succession by

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* Received June 30, 1970; read June 27, 1970, at the 104th Meeting of the Society held at Ibaraki University, Mito.

granular sandstone, thin acidic tuff and massive greenish gray to deep olive gray fossiliferous siltstone. The basal conglomerate and granular sandstone at Haneji almost correspond to the conglomerate at Nakoshi as stated by MACNEIL (1960). The Nakoshi Sand of MACNEIL (1960) is here re-defined because it contains other characteristic rock facies and a newly discovered molluscan fauna both of which were not described by MACNEIL. The fauna from the lower part of the Haneji Formation is characterized by the occurrence of numerous *Anadara* (*Hataiarca*) *kogachiensis*, n. sp. which do not occur in the Nakoshi Sandstone Member. Some paleontological features of the Haneji Formation based upon the molluscan fauna are discussed in this article.

Acknowledgements

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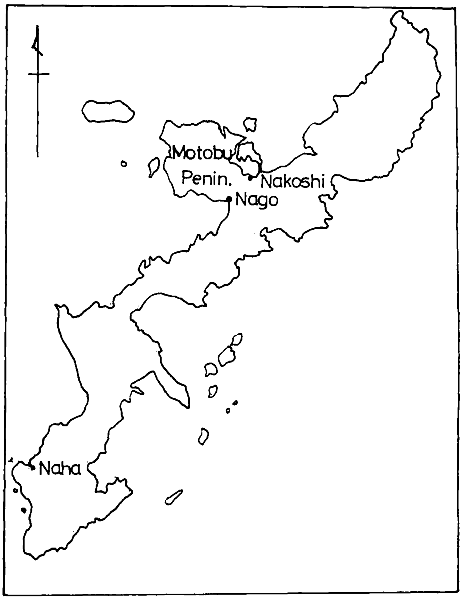
Deep thanks are expressed to Mr. Tomohide NOHARA of the Department of Geology, Ryukyu University for his suggestions on the geology in the field and to Mr. Kimiji KUMAGAI of the Tohoku University for photographic work. Thanks are due to the Ministry of Education of the Japanese Government for financial support.

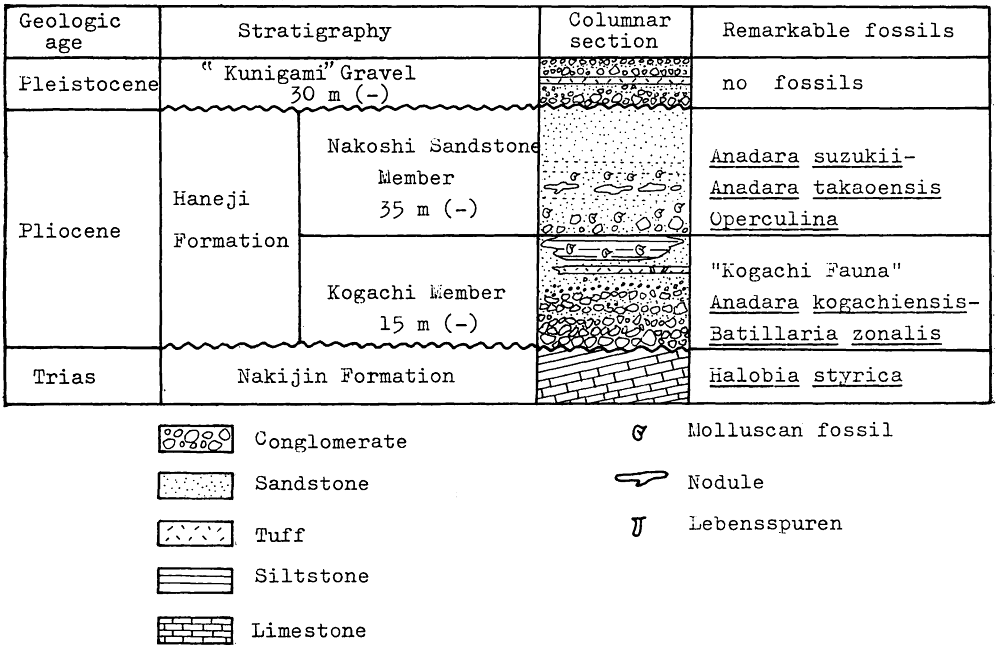
Stratigraphy of the Haneji Formation

The Nakoshi Sand was proposed by MACNEIL (1960) for the fossiliferous sandstone distributed around Nakoshi, Haneji-son in the Motobu Peninsula, in the northern part of Okinawa-jima (Text-fig. 1), where younger Tertiary rocks had been recognized by TOKUNAGA (1901, formerly YOSHIWARA), HANZAWA (1935a) and SHOJI (1968). According to MACNEIL (1960), the Nakoshi Sand distributed typically around Nakoshi, Haneji-mura, commences with basal conglomerate of about 20 feet in thickness and is covered with unconformity by the Ryukyu Limestone and Kunigami Gravel. The writer's field survey showed that the " Nakoshi Sand " of MACNEIL (1960) is composed mainly of basal conglomerate, granular sandstone, acidic tuff, massive siltstone, granular fossiliferous sandstone and limy massive medium grained sandstone in ascending order. These rocks lie upon the Triassic Formation of ISHIBASHI (1969) and KOBAYASHI and ISHIBASHI (1970) with unconformity. The weathered reddish brown

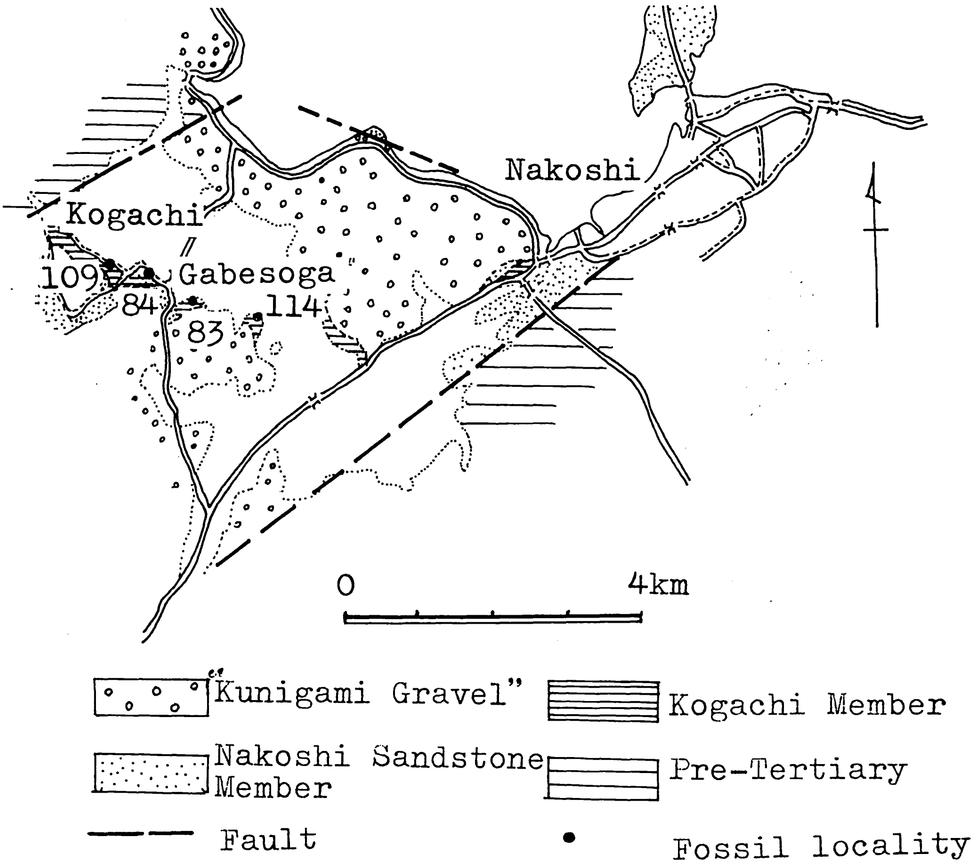


Text-fig. 1. Index map of the area studied.

to reddish gray clay beds at the basal part of the formation is covered by the "Ryukyu Limestone" or Conglomerate. From the lithofacies mentioned above the Nakoshi Sand of MacNeil (1960) may better be named the "Haneji Formation". The Haneji Formation proposed in this work is subdivided into two units named the Kogachi Member and the Nakoshi Sandstone Member in ascending order (Text-fig. 2). The Nakoshi Sandstone Member nearly corresponds to the Nakoshi Sand of MacNeil (1960) and its details will be discussed in another opportunity. The Kogachi Member is distributed mainly around Kogachi (Type locality), Gabesoga and Nakoshi in Haneji-son (Text-fig. 3) and is composed mainly of conglomerate intercalated with granular sandstone, thin acidic tuff and fossiliferous siltstone. The base of the Nakoshi Sandstone Member is defined by the fossiliferous, granular or pebbly, massive, pale brownish gray to bluish gray sandstone; it yielded numerous individuals of brown colored *Operculina* (Hanzawa, 1935b) and abundant molluscan fossils (Nomura and Zinbo, 1936; Yabe and Hatai, 1941). The Nakoshi Sandstone Member corresponds to the main part of the Nakoshi Sand of MacNeil (1960). The sandstone just mentioned is underlain with light greenish gray to deep olive gray, massive siltstone which yielded numerous individuals of *Anadara* (*Hataiarca*) *kogachiensis* n. sp., associated with *Ostrea denselamellosa*, *Umbonium moniliferum decoratum*, *Batillaria zonalis* and others (Table 1). The sandstone is succeeded downward with poorly sorted granular sandstone, basal conglomerate and basal weathered reddish brown clay beds. The basal conglomerate consists mainly of pebble to cobble size, well rounded to subrounded rocks.



Text-fig. 2. The stratigraphy and columnar section of the northern part of the Motobu Peninsula, Okinawa-jima.



Text-fig. 3. Geological map and fossil localities.

of pre-Haneji Formation age as siltstone, sandstone, graywacke, chert and slate and is intercalated with loose, very coarse grained sandstone layers. The Kogachi Member lies on the reddish brown clay beds, a weathered product of the so-called Triassic Formation. The upper part of the basal conglomerate grades upward into coarse to fine grained sandstone intercalated with 20 to 30 cm thick acidic white, and sandpipe-bearing sandy tuff-beds. Some imperfect specimens of *Anadara* (*Hataiarca*) *kogachiensis*, *Ostrea denselamellosa*, *Batillaria zonalis* and plant remains were found from the sandy tuff. The light gray to deep olive gray siltstone facies yielded many individuals of *Anadara* (*Hataiarca*) *kogachiensis*, *Ostrea denselamellosa*, *Batillaria zonalis*, etc. The siltstone facies just mentioned lies on sandy tuff or tuffaceous fine grained sandstone in the vicinity of Kogachi (type locality of the Member) and Gabesoga and in the western part of the Motobu Peninsula* and is covered with the Nakoshi Sandstone Member with conformity

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* The stratigraphy and plant remains are being studied by Mr. Tomohide NOHARA of the Ryukyu University.

Table 1. Molluscan fossils from the Kogachi Member of the Haneji Formation, northern Motobu Peninsula, Okinawa-jima.

Species \ Localities	83	84	109	114
Striarca interplicata (Grabau and King)			○	
Anadara (*Hataiarca*) *kogachiensis* Noda, n. sp.	○	*	**	+
Modiolus sp.			+	
Pteria cf. *coturnix* (Dunker)		+		
Pododesmus (*Monia*) *noharai* Noda, n. sp.	○	○	*	
Ostrea (*Ostrea*) *denselamellosa* Lischke	+	*	*	+
Lucina sp.		+	+	
Codakia (*Jagonia*) *okinawazimana* Nomura and Zinbo	○		○	
Laevicardium sp.			+	
Fulvia sp.			+	
Macoma (*Macoma*) *praetexta* (v. Martens)		+	+	
Clementia (*Clementia*) *vatheleti* Mabille		+	+	
Gastrochaena grandis (Dunker)			+	
Umbonium (*Suchium*) *moniliferum decoratum* Makiyama		+	+	
Lunella coronatus granulatus (Gmelin)			+	
Lunella sp.			+	
Batillaria zonalis (Bruguière)	○	○	**	
Polinices cumingianus madioenensis Altena			+	
Tonna sp.			+	
Nassarius (*Zeuxis*) *caelatus* (A. Adams)			○	

Abbreviation: ** = more than 20 individuals, * = 10 to 20 individuals, ○ = 4 to 10 individuals, + = less than 4 individuals.

Loc. no. 83 = Small cliff at Gabesoga, Haneji-son.

Loc. no. 84 = Road side cliff between Kogachi and Gabesoga, Haneji-son.

Loc. no. 109 = Hill-side cliff, west of Kogachi, Haneji-son.

Loc. no. 114 = Small stream side cliff, east of Gabesoga, Haneji-son.

at the localities just mentioned. The siltstone is not distributed around Nago and Nakoshi because of the unconformity between the Nakoshi and the upper Conglomerate[+]. As stated above, there are thick conglomerates above and at the lower part of the Kogachi Member. The upper conglomerate is thrust up on the Nakoshi Sandstone Member at Nakao, in the northern part of the Motobu Peninsula and faulted at Kogachi and Nakoshi and at those two localities the conglomerate is intercalated with fine to medium grained sandstone, acidic white, green and brown tuff layers (about 40–60 cm in thickness) and lignitic siltstone. This facies was hitherto known as the Kunigami Gravel (Hanzawa, 1935a; MacNeil, 1960; Shoji, 1968). This conglomerate covers the Nakoshi Sandstone Member and Kogachi Member of the Haneji Formation with unconformity. The lower conglomerate corresponds in part to the

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[+] This conglomerate, previously treated as the Kunigami Gravel, needs further study.

lower part of the Kogachi Member and is distributed sporadically in the western part of Okinawa-jima. The distribution of the Haneji Formation is restricted and the strata are nearly horizontal but with slight dip northeastward.

From the distribution of the Haneji Formation and the paleoecological significance of the molluscan fossils, it is considered that after a long period of subaerial erosion and weathering as indicated by the reddish gray to reddish brown basal clay beds, the pre-existing land now represented by the Motobu Peninsula submerged gradually and was flooded by shallow marine waters which brought characteristic (Pliocene) Pelecypoda, Gastropoda, decapod crabs and foraminifers into the basinal trough which was opened towards the north and south between the land areas of Pre-Tertiary rocks in the west (NNE-SSW fault represented by crushed graphite zone in the Mesozoic Formation) and east (detail relationship unknown). The Kogachi Member is preserved only in the central part of the trough but its basal conglomerate or the basal part of the formation crops out at Yamairihabaru, Biimatabaru and Yurushida. This distribution indicates that the Early Pliocene Haneji marine transgression extended at least to the western part of Okinawa-jima but may not have covered the whole island. At present, the upper part of the formation is preserved only in the northern part of Motobu Peninsula.

Geological Age and Faunal Characteristics of the Kogachi Member

The siltstone facies of the Kogachi Member of the Haneji Formation is characterized by the occurrence of numerous, well preserved specimens of *Anadara* (*Hataiarca*) *kogachiensis*, n. sp., and *Batillaria zonalis* associated with the molluscan fossils shown in Table 1. *Umbonium moniliferum decoratum*, *Nassarius caelatus*, *Batillaria zonalis*, *Striarca interplicata*, *Ostrea denselamellosa*, and *Clementia vatheleti* listed in Table 1, are known from the Pliocene and younger geological formations in the Japanese Islands. *Umbonium moniliferum decoratum* is restricted to the Pliocene and the present record is its first from Okinawa-jima. Numerous molluscan fossils also occur from the Nakoshi Sandstone Member as mentioned by NOMURA and ZINBO (1936), YABE and HATAI (1941), and MACNEIL (1960). From the anadarid biostratigraphy (NODA, 1965, 1966), the Nakoshi Sandstone Member is characterized by the occurrence of *Anadara* (*Scapharca*) *suzukii*, *Anadara* (*Scapharca*) *takaoensis*, *Anadara* (*Tosarca*) *sedanensis* and *Striarca interplicata*, and was correlated with the zone of *Anadara castellata*/*Anadara suzukii* in southwestern Japan of Early Pliocene age.

Once the writer stated (NODA, 1965, p. 96, table 1) that the Nakoshi Sand (MACNEIL, 1960) can be correlated to the Pliocene Takanabe-Ananai-Kakegawa formations and to the Formosan Pliocene. This procedure is similar to MACNEIL's (1960) correlation. As the Kogachi Member is covered by the Nakoshi Sandstone Member without stratigraphic hiatus, it is considered to be a little older than the zone of *Anadara castellata*/*Anadara suzukii*.

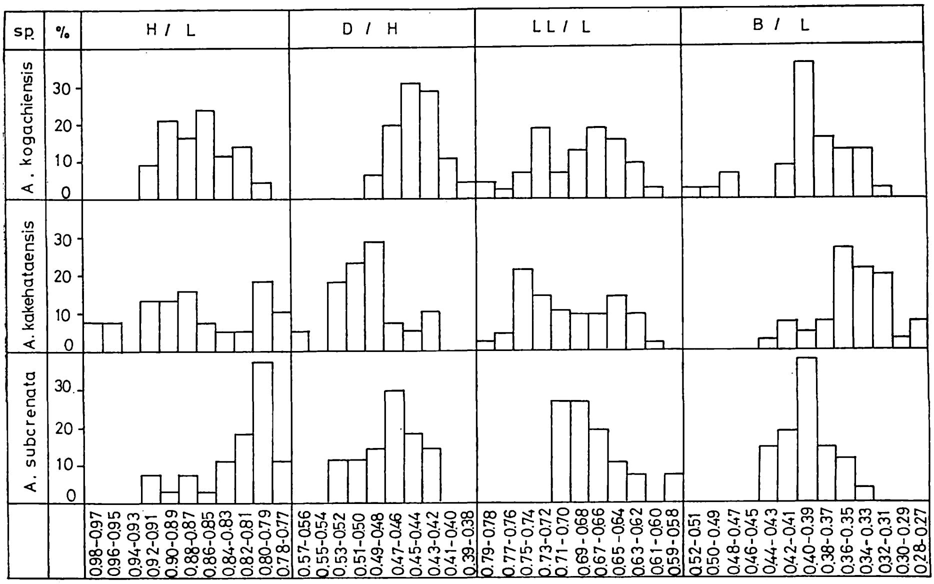
As shown in Table 1, the Kogachi Member yielded 7 species of Gastropoda and 13 of Pelecypoda. They are all shallow water dwellers and especially, *Anadara*, *Modiolus* sp., *Laevicardium* sp., *Fulvia* sp., *Macoma praetexta*, and *Clementia vatheleti* are infaunal, and *Batillaria zonalis*, *Polinices cumingianus madioen-*

ensis and *Nassarius caelatus* are epifaunal species which prefer a muddy bottom. Some of the epifaunal species live on or near the surface of the muddy bottom and others burrow shallowly into the bottom sediments. *Pteria coturnix*, *Pododesmus* and *Ostrea denselamellosa* adhere to firm substrata. The ecological characteristics of the molluscan fauna correspond with the sedimentary facies. Namely, the basal part of the Haneji Formation is composed of coarse grained sandstone and conglomerate and yielded from its middle part *Ostrea denselamellosa*, *Anadara kogachiensis* and *Batillaria zonalis*, molluscs of embaymental to brackish water dwellers and plant remains and crustacean sandpipes from the sandy siltstone or poorly sorted silty sandstone. The bed of deep olive gray to light brownish gray massive siltstone slightly higher than the sandstone and conglomerate yielded the species listed in Table 1; the molluscan assemblage is named the Kogachi Fauna. Above the Kogachi Fauna, there is a fossiliferous sandstone which yielded the molluscan fossils described by NOMURA and ZINBO (1936), YABE and HATAI (1941) and MACNEIL (1960). The molluscan assemblage is associated with numerous individuals of *Operculina* and is a pure marine open sea fauna compared with the Kogachi Fauna.

Regarding only the anadarids, the Recent species of the subgenus *Hataiarca* live in the muddy bottom of shallow brackish warm water, whereas the species of the *Anadara suzukii* Group are the deep water dwellers of the genus *Anadara*. This characteristic feature is represented in the Nakoshi Sandstone Member by *Anadara suzukii* and in the Kogachi Member by *Anadara kogachiensis*. Therefore, the succession in faunal development from the lower to the upper parts of the Haneji Formation agree well with the sedimentary facies. The succession and development of the fauna in the upper part of the Haneji Formation is similar to that of the so-called Ryukyu Limestone as will be discussed in another opportunity. It is interesting that the Kogachi Fauna is more intimate with the fauna of mid-latitudinal areas than with those of subtropical regions, whereas that of the Nakoshi Sandstone Member is related to subtropical faunas.

Remarks on the New Anadarid and its Related Species

An interesting anadarid from the siltstone of the Kogachi Member of the Haneji Formation is described in this article as *Anadara* (*Hataiarca*) *kogachiensis* n. sp. The new species belongs to the subgenus *Hataiarca* which was proposed based upon *Anadara kakehataensis*, an Early Middle Miocene species described from the Miocene Kurosedani Formation in Toyama Prefecture by HATAI and NISIYAMA (1949). Twelve species of anadarids are known of the subgenus *Hataiarca*, which ranges from Early Middle Miocene to Recent (NODA, 1966). The new anadarid is allied to *Anadara* (*Hataiarca*) *kakehataensis* (type species of the subgenus *Hataiarca*), *Anadara subcrenata* (Late Pliocene ? to Recent) and *Anadara* (*Hataiarca*) *shimonakaensis* HAYASAKA (1969) originally described from the Miocene Kawachi and Osaki formations in Kagoshima Prefecture. Some morphological differences of the above cited species are illustrated in Text-fig. 4, and discussed in later pages. From the statistical figures, the new Pliocene anadarid resembles the Miocene species *Anadara* (*Hataiarca*) *kakehataensis* in



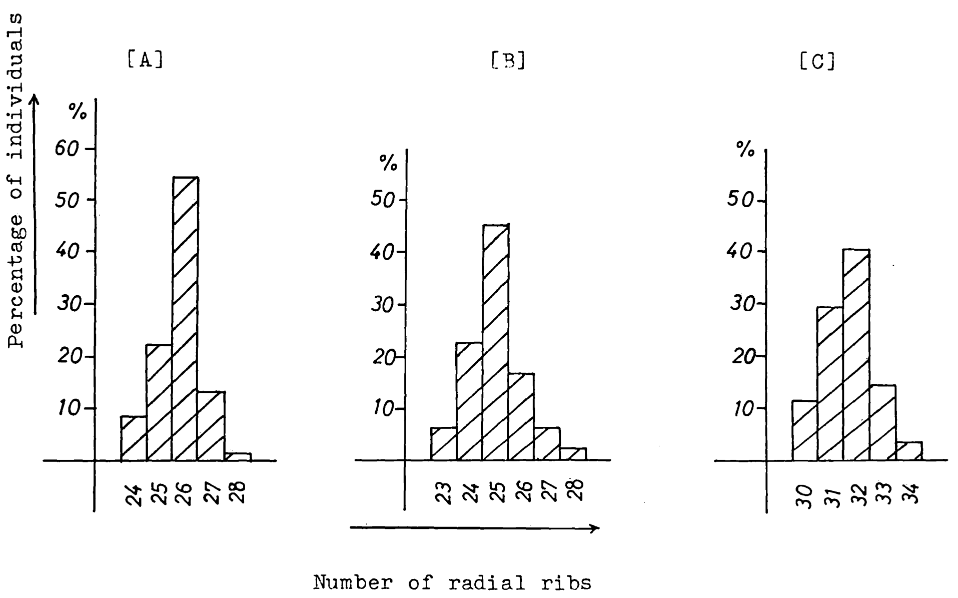
Text-fig. 4. Histograms of different statistical relations of *Anadara kogachiensis* (Pliocene, 43-46 individuals), *Anadara kakehataensis* (Miocene, 38-42 individuals) and *Anadara subcrenata* (Pleistocene, 26-27 individuals); H=Shell height, L=Shell length, D=Shell depth, LL=Length of ligament, B=Position of beak from anterior end of shell.

certain important morphological characters (Text-figs. 4, 5, 6).

The species of *Hataiarca* can be distinguished from other anadarids by the distinct depressed area extending from near the beak to the postero-ventral margin and by the granulations on the non-dichotomous, strongly squarish in cross section, elevated radial ribs on the anterior part of the right and left valves.

From the granulations on the radial ribs stated above, it is inferred that they represent the burrowing forms of the subgenus *Hataiarca*, based upon the observations of the anadarid cultured in the laboratory. The shell body with granulated radial ribs on the main part of the left valve and on the anterior part of the right valve, is found on anadarids that burrow into muddy bottom sediments, and the non-granulated part of the valves represents the parts exposed above the sea bottom. Therefore the shell body burrows obliquely, the left valve below and the right valve up to the bottom plane. The parts of the shell exposed to the sea bottom are characterized by the rather smooth radial ribs, mainly of the depressed posterior area. The granulations of the radial ribs are distinct on the immature or younger stage (medium to small size) but become obscure in the adult or large specimens. From the above, the *Hataiarca* species may have burrowed into the bottom sediments during the younger stage but with growth gradually changed the mode of life to live in the bottom sediments exposing nearly half of the shell body.

Regarding the number of radial ribs (Text-fig. 5), *Anadara* (*Hataiarca*) *kogachiensis* has 26 in general, the Miocene species *Anadara* (*Hataiarca*) *kakehataensis* is



[A] Anadara (Hataiarca) kogachiensis, 68 valves from the Haneji Formation.

Radial ribs	Individuals	Percent
24	6	8.82
25	15	22.05
26	37	54.41
27	9	13.23
28	1	1.47
Total	68	99.98

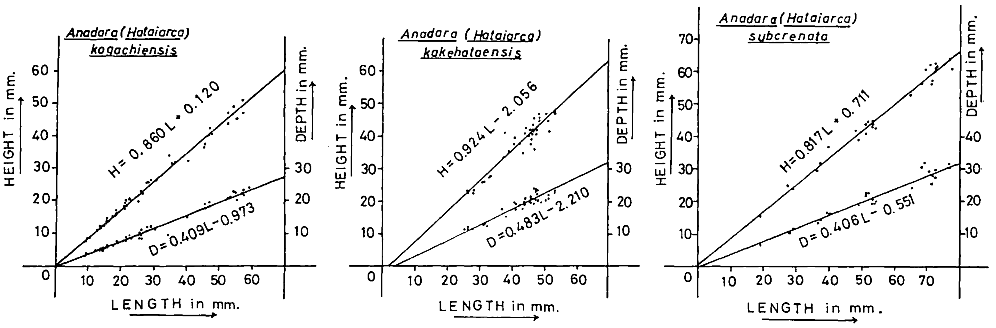
[B] Anadara (Hataiarca) kakehataensis, 48 valves from various localities of Miocene formations.

Radial ribs	Individuals	Percent
23	3	6.25
24	11	22.91
25	22	45.83
26	8	16.66
27	3	6.25
28	1	2.08
Total	48	99.98

[C] Anadara (Hataiarca) subcrenata, 27 valves from various localities of Pleistocene formations.

Radial ribs	Individuals	Percent
30	3	11.11
31	8	29.62
32	11	40.74
33	4	14.81
34	1	3.70
Total	27	99.98

Text-fig. 5. The number of radial ribs of the new anadarid and of its related species.



Text-fig. 6. The regressive lines of the new anadarid and of its related species for the comparisons of each others by the method of least squares. Shell height, length and depth are measured according to the method of NODA (1966).

provided with 25, and the Recent form, *Anadara* (*Hataiarca*) *subcrenata* possesses 32 radial ribs. So far as the number of radial ribs of the species related to *Anadara kogachiensis* is concerned is there an increase from the Miocene to Recent. The shell form indicated by the angle of height against shell length among the allied species as shown in Text-fig. 6, changes from aclinal to prosoclinal and this is similar to the Recent anadarid growth series. From the data mentioned above, it can be said that *Anadara* (*Hataiarca*) *kogachiensis* is a descendant of the Miocene *Anadara* (*Hataiarca*) *kakehataensis* HATAI and NISIYAMA (1949). The Recent form, *Anadara* (*Hataiarca*) *subcrenata* is related to the Pliocene species which have similar statistical and morphological features as shown in Text-figs. 4, 5, 6. At least, the series, *Anadara kakehataensis*—*Anadara kogachiensis*—*Anadara subcrenata* may be on the same phylogenetic trend, and other species related to the above are expected from the middle to late Miocene. HAYASAKA (1969) discovered *Anadara* (*Hataiarca*) *shimonakaensis* from the Early Middle Miocene Kawachi Formation and Early Late Miocene Osaki Formation in Tanega-shima, Kagoshima Prefecture. The Kawachi Formation yielded the *Vicarya*-*Anadara* fauna and the Osaki Formation such characteristic species as *Paphia* (*Paphia*) *exilis exilis* SHUTO, *Clementia nakosoensis* KAMADA, and *Cultellus izumoensis jobanicus* KANNO. It is noteworthy that there are no species among the *Hataiarca* in Japan, known to cross the *Vicarya*-Anadarid faunal stage to extend to the Late Middle Miocene age up to HAYASAKA's record. If similar *Hataiarca* species with rather long time range are found, it is expected that a more reliable phylogenetic trend of *Hataiarca* will be established in the Japanese Islands and in the Indo-Pacific regions.

Descriptions of the Characteristic Species

Family Arcidae LAMARCK, 1809

Subfamily Arcinae LAMARCK, 1809

Genus *Striarca* CONRAD, 1862

Striarca interplicata (GRABAU and KING, 1928)

Pl. 6, figs. 6a-7b

1928. *Arca* (*Barbatia*) *interplicata* GRABAU and KING, *Educ. Handb.* (2), *Peking Soc. Nat. Hist.*, p. 161, pl. 1, fig. 1. (*fide* HABE, 1958)

1920. *Arca symmetrica* (non REEVE), YOKOYAMA, *Jour. Coll. Sci., Tokyo Imp. Univ.*, vol. 39, art. 6, p. 166, pl. 17, figs. 7-8.

1933. *Arca* (*Barbatia*) *yokoyamai* NOMURA, *Sci. Rep., Tohoku Imp. Univ., 2nd Ser.*, vol. 16, no. 1, p. 41, pl. 1, figs. 3a-d.

1935. *Barbatia yokoyamai* NOMURA, OTUKA, *Bull. Earthq. Inst. Tokyo Imp. Univ.*, no. 13, pt. 4, p. 883, pl. 55, fig. 112.

1954. *Striarca* (*Galactella*) *yokoyamai* NOMURA, TAKI and OYAMA, *Palaeont. Soc. Japan, Spec. Pap.*, no. 2, pl. 18, figs. 7a-b, 8a-b.

1954. *Striarca* (*Spinarca*) *interplicata* (GRABAU and KING), KIRA, *Col. Illust. Shells Japan*, pl. 42, fig. 1.

1958. *Striarca* (*Spinarca*) *interplicata* (GRABAU and KING), HABE, *Publ. Seto Mar. Biol. Lab.*, vol. 6, no. 3, p. 255, pl. 12, fig. 15.

1963. *Striarca interplicata* (GRABAU and KING), YAMADA, *Bull. Mie Univ., Dept. Lib. Arts*, no. 27, figs. 2a-b.

1966. *Striarca interplicata* (GRABAU and KING), NODA, *Sci. Rep., Tohoku Univ., 2nd Ser.*, vol. 38, no. 1, p. 72, pl. 11, figs. 16-18, table 33.

The present species has been recorded from the younger Pliocene to Recent in Japan and Formosa. The species was described in detail by NODA (1966) and recorded from the Nakoshi Sand of MACNEIL (1960).

Locality and Formation: Loc. no. 109, siltstone of the Kogachi Member, four perfect specimens.

Depository: IGPS coll. cat. no. 86888.

Subfamily Anadarinae REINHART, 1935

Genus *Anadara* GRAY, 1847

Subgenus *Hataiarca* NODA, 1966

Anadara (*Hataiarca*) *kogachiensis* NODA, n. sp.

Pl. 6, figs. 1–5, 8–17

Type Locality: Loc. no. 109, West of Kogachi, Haneji-son, Okinawa-jima.

Depository: IGPS coll. cat. no. 86757, (Holotype); IGPS coll. cat. no. 86756, 86887 (Paratypes).

Shell medium in size, slight discrepancy between right and left valves, the former smaller than the latter, ovately rounded, swollen, anterior side narrowly rounded, posterior side truncated, posterior ventral corner elongated according to posterior depressed area extending from beak to posterior ventral corner, ventral margin smoothly rounded. Beak prominent, strongly incurved, II type of NODA (1966), and situated at 0.36–0.38 anterior to shell length. Cardinal profile of joined shells of both valves is of A type of REINHART (1943) and NODA (1966), ligamental area of III type with A, C or D type ligamental grooves (NODA, 1966). Teeth arranged vertically to straight ligament of III type (NODA, 1966) with fine longitudinal striations on both sides of teeth; anterior teeth fewer than posterior ones. Both anterior and posterior muscle scars depressed, the latter larger than the anterior, A type of NODA (1966). Inner ventral crenulations rather strong according to external radial ribs and interspaces. External surface generally with 26 radial ribs (Text-fig. 5), strongly elevated, rather narrow compared with interspaces, left valve and anterior one third of radial ribs of right valve granulated, granulations indistinct on backs of other radial ribs, squarish in cross section and both radial ribs and interspaces sculptured with crowded, fine concentric growth lines.

Dimension of the types (*in mm*).

Holotype	right	Length=55.9	Height=49.9	Depth=22.1	Ribs=26
	left	Length=55.9	Height=50.2	Depth=22.7	Ribs=26
Paratype	right	Length=57.5	Height=47.4	Depth=21.9	Ribs=26
(IGPS no. 86756)					
Paratype	right	Length=47.1	Height=40.0	Depth=19.0	Ribs=26
	left	Length=46.9	Height=40.8	Depth=19.4	Ribs=26
(IGPS no. 86887)					

Comparison and Affinities: The present species resembles *Anadara* (*Hataiarca*) *kakehataensis* HATAI and NISIYAMA originally described from the Miocene Kurosedani Formation in Toyama Prefecture. HATAI and NISIYAMA's species is characterized by the narrow umbonal angle, strongly depressed posterior area and 24–25 radial ribs (Text-fig. 5) and differs from the present new species as shown in Text-figs. 4, 5, 6.

At a glance of the histogram (Text-fig. 4), *Anadara* (*Hataiarca*) *kogachiensis* can be distinguished from the Miocene species *An.* (*Hataiarca*) *kakehataensis* in the ratios of D/H, LL/L and B/L. The ratio of H/L of both species is nearly similar yet slightly smaller in the new species compared with *An.* (*Hataiarca*) *kakehataensis.* Although the ratio of H/L of the species is nearly equal, the small ratios of D/H and LL/L of *An.* (*H.*) *kakehataensis* and *An.* (*H.*) *kogachiensis* imply that the depth of the shell and the length of the ligament of the latter are small compared with *An.* (*H.*) *kakehataensis.* The B/L of both species shows that the beak of *An.* (*H.*) *kakehataensis* is situated more anteriorly than in *An.* (*H.*) *kogachiensis.* The radial ribs number 26 in maximum mean value in the new species and 25 in *kakehataensis.* The differences cited above between the two species are only statistical and they bear no resemblance in their external form in their immature stage as shown in pl. 6, figs. 1-5, 11-14. The immature *An. kogachiensis* resembles *An.* (*Hataiarca*) *subcrenata* (LISCHKE). *An.* (*Hataiarca*) *subcrenata* is another species allied to *kogachiensis* but it differs from the new species in having more radial ribs. However, it is thought that *An. kogachiensis* is related with *An. kakehataensis* (Early Middle Miocene species) and the Recent *An. subcrenata.* The interrelation of the three species is indicated by the angle between the shell height against shell length; *An. kakehataensis* shows the angle of 42°, *An. kogachiensis* 41° and *An. subcrenata* 40°. There are few discrepancies among the three species but the angle just mentioned becomes smaller from the lower to the upper horizon. This development from the aclinal form to the prosoclinal form in growth series is also recognized in the *Anadara suzukii* group. The relative growth of the shell is known in Recent species and the same relation is evident chronologically as already pointed out by NODA (1965, 1966) in the *Anadara suzukii* and other groups.

Locality and Formation: Loc. no. 83, Loc. no. 84, Loc. no. 109, Loc. no. 114, siltstone of the Kogachi Member, many well preserved specimens.

Depository: IGPS coll. cat. nos. 86756, 86757, 86759, 88063, 88064.

Family Mytilidae RAFINESQUE, 1875

Genus *Modiolus* RÖDING, 1798

Modiolus sp.

Pl. 7, fig. 15

A small right valve is at hand. Shell fragile, interior pearly, ovately elongated in form, posterior blunt ridge extends from near beak to elongated posterior ventral corner; concentric fine growth lines cover the surface. *Modiolus nipponensis* OYAMA resembles the present species but differs in having wider posterior ridge.

Locality and Formation: Loc. no. 109, siltstone of the Kogachi Member, one rather perfect specimen.

Depository: IGPS coll. cat. no. 86760.

Family Pteridae BRODERIP, 1839

Subfamily Pterinae BRODERIP, 1839

Genus *Pteria* SCOPOLI, 1777

Pteria cf. *coturnix* (DUNKER, 1882)

Pl. 7, fig. 16

Compared with:

1882. *Avicula coturnix* DUNKER, *Index Moll. Mar. Jap.*, p. 288, pl. 10, figs. 1-2.

Pteria is a rare in the Neogene formations of Japan and in Okinawa. It has been recorded from the Ryukyu Limestone of Kikai-jima, Ryukyu Islands (NOMURA and ZINBO, 1934). The present species is conferable with *Pteria coturnix* (DUNKER, 1882) originally described from the Recent sea of Japan. The left valve of the species at hand is characterized by its trapezoidal form, acute and narrow anterior border, elongate and expanded posterior border, concaved anterior ventral margin, rounded posterior ventral one, swollen form near umbo to posterior ventral corner, both inflated extremities, straight and long hinge-line, small and prominent beak situated at one fourth from anterior of shell length, posterior auricle not well preserved, and shell surface rather smooth with very fine concentric growth lines with faint radial striations on anterior part and mottled colorations.

The present species resembles the Recent species *Pteria zebra* (REEVE, 1858), in form except for the posterior auricle and shape of the postero-ventral curvature. *Pteria tomlini* PRASHAD (1932) is another species allied to the present one and is of similar shell form but differs from the present one in having narrower anterior border and roundly wider posterior side and in the pattern of coloration. *Pteria* n. sp. illustrated by OYAMA (1959, *Pteria* (3), fig. 1) from the sea of Amakusa, Kyushu is allied to the present species in shell outline but differs in having wider anterior part and more swollen umbonal area.

Locality and Formation: Loc. no. 84, siltstone of the Kogachi Member, one nearly perfect specimen.

Depository: IGPS coll. cat. no. 86761.

Family Anomiidae RAFINESQUE, 1815

Genus *Pododesmus* PHILIPPI, 1837

Subgenus *Monia* GRAY, 1849

Pododesmus (*Monia*) *noharai* NODA, n. sp.

Pl. 7, fig. 17

Type Locality: Loc. no. 109, West of Kogachi, Haneji-son, Okinawa-jima.

Depository: IGPS coll. cat. no. 86762 (Holotype).

Shell pearly, flimsy, medium to large in size. Subround to elongate in form. Ventral margin irregularly rounded, dorsal margin rather smooth but elongated or narrowly inclined below. External shell rather smooth at umbonal area, very fine, irregular, radially elevated wrinkles on surface and finer striations but indistinct between them on ventral margin, whole surface with undulated growth lines. Umbonal area rather flat, beak low and small, cardinal crura and cardinal area indistinct. Inner surface smooth, pearly bright, inner ventral margin smooth, two muscle scars posteriorly, well depressed.

Dimension of Holotype (*in mm*).
Length=55.2, Height=58.1, Depth=11.8

Comparison and Affinities: The present new species is distinguished from *Pododesmus* (*Monia*) *macroschismus* DESHAYES (REEVE, 1859) by not having distinct radial ribs on the external surface. *Pododesmus* (*Monia*) *macroschismus* from the Upper Pleistocene San Pedro Series, California illustrated by GRANT and GALE (1931, p. 241, pl. 12, figs. 3-4b) differs from the original species, in having rather faint regular radial ribs. *Pododesmus* (*Monia*) *macroschismus ezoana* originally described from the Pliocene Setana Formation in Hokkaido (KANEHARA, 1942) resembles the present new species rather than REEVE's (1859) species mentioned above but the latter has more faint wrinkly radial striations than the former. *Monia denselineata* HATAI, MASUDA and SUZUKI (1961) described from the Pliocene Hamada Formation in Aomori Prefecture resembles the present new species in the faint, dense radial striations on the external surface but differs in having faint radial irregular ribs and fainter striations between them.

Locality and Formation: Loc. no. 84, Loc. no. 109, Loc. no. 114, siltstone of the Kogachi Member, several perfect specimens.

Depository: IGPS coll. cat. nos. 86763, 88065, 88066.

Family Ostreidae RAFINESQUE, 1815

Genus *Ostrea* LINNAEUS, 1758

Subgenus *Ostrea* LINNAEUS, 1758

Ostrea (*Ostrea*) *denselamellosa* LISCHKE, 1869

Pl. 7, figs. 10, 18

1869. *Ostrea denselamellosa* LISCHKE, *Jap. Meeres Conch.*, Bd. 1, p. 177-179, pl. 13, figs. a-b, pl. 14, fig. 1.
1874. *Ostrea denselamellosa* LISCHKE, LISCHKE, *Jap. Meeres. Conch.*, Bd. 3, p. 114-115.
1906. *Ostrea denselamellosa* LISCHKE, TOKUNAGA, *Jour. Coll. Sci., Imp. Univ. Tokyo*, vol. 21, no. 2, p. 68, pl. 4, fig. 6.
1926. *Ostrea denselamellosa* LISCHKE, YOKOYAMA, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2*, vol. 1, pt. 9, p. 375, pl. 43, fig. 11.
1929. *Ostrea denselamellosa* LISCHKE, WAKIYA, *Japan. Jour. Zool.*, vol. 2, no. 3, p. 366, pl. 9, figs. 3-4.
1930. *Ostrea denselamellosa* LISCHKE, KURODA, *Venus*, vol. 2, append. p. 49, fig. 55.
1930. *Ostrea denselamellosa* LISCHKE, HIRASE, *Japan. Jour. Zool.*, vol. 3, no. 1, p. 5-18, figs. 4-30.
1933. *Ostrea denselamellosa* LISCHKE, NOMURA, *Sci. Rep., Tohoku Imp. Univ., 2nd Ser.*, vol. 16, no. 1, p. 46-47, pl. 4, fig. 6.
1951. *Ostrea* (*Ostrea*) *denselamellosa* LISCHKE, HABE, *Genera Jap. Shell.*, no. 1, figs. 187-188 on p. 92.
1961. *Ostrea* (*Ostrea*) *denselamellosa* LISCHKE, HAYASAKA, *Sci. Rep., Tohoku Univ., 2nd Ser.*, vol. 33, no. 1, p. 34.
1963. *Ostrea denselamellosa* LISCHKE, KIRA, *Col. Illust. Shells, Japan*, p. 127, pl. 50, fig. 1.
1965. *Ostrea denselamellosa* LISCHKE, HABE and ITO, *Shell. World, Col.*, vol. 1, p. 126, pl. 42, fig. 10.
1967. *Ostrea denselamellosa* LISCHKE, HABE and KOSUGE, *Moll. Shells*, p. 137, pl. 51, fig. 9.

This species was originally described on the specimens from Tokyo bay and Nagasaki by LISCHKE in 1869. It is characterized by having the external sculpture different on the right and left valves. The left valve is sculptured with irregular concentric growth lamellae and radial ribs and the right with rather smooth concentric growth lines only. The inner ventral margin of the left valve is sometimes crenulated according to the surface radial ribs; the margin is smooth in the right valve. Resilifer pit of the left valve is larger than that of the right. Along the ligament of the right valve, small crenulations are observed but none on the left valve.

The present species was collected from the siltstone facies of the Kogachi Member of the Haneji Formation. The species is known from the Pliocene to Pleistocene formations in the Kwanto region where crowded or intact shells are known to occur. This species is variable in form. It is an important species as an indicator of the ecology. The coloration, inner features and morphological variations have been described by LISCHKE (1869, 1874). LISCHKE (1874) described that *Ostrea auriculata* SOWERBY in REEVE (1871, *Conch. Icon., Ostrea* sp., p. 60, pl. 25, figs. 60a, b, c) which was described three years after LISCHKE's (1869) *denselamellosa* resembles his species and he questioned it as a synonymous species in his description (1874). KURODA (1930) listed SOWERBY's species as a synonym of LISCHKE's (1869) species without reason.

Locality and Formation: Loc. no. 83, Loc. no. 84, Loc. no. 109, Loc. no. 114, siltstone of the Kogachi Member, many well preserved specimens.

Depository: IGPS coll. cat. nos. 86764, 88067.

Family Lucinidae FLEMING, 1828

Genus *Codakia* SCOPOLI, 1777

Subgenus *Jagonia* RÉCULZ, 1946

Codakia (*Jagonia*) *okinawazimana* NOMURA and ZINBO, 1936

Pl. 7, figs. 9a-9b

1936. *Codakia okinawazimana* NOMURA and ZINBO, *Sci. Rep., Tohoku Imp. Univ., 2nd Ser.*, vol. 16, no. 1, p. 241, pl. 11, figs. 9a-b.

The present species was proposed based on the specimens collected from the Simaziri Beds (Nakoshi Sandstone Member) at Gabesoga, Haneji-son by NOMURA and ZINBO (1936). The present species is small in size, generally 3-5 mm in shell length and is characterized by its inequilateral subrounded form, fine concentric growth lines crossed with slightly elevated, fine ribs being distinct on both extremities but indistinct on central part of the surface, fine crenulations on inner margin of shell, and anterior muscle scar large and long, posterior one rounded, small cardinal teeth and rather distinct lunule in front of small prominent anteriorly curved beak. The present species resembles *Codakia divergens* PHILIPPI, 1850 in shell form but differs in having strong lateral teeth, and indistinct radial ribs on the central part of shell. *Codakia paytenorum* (IREDALE, 1927) is distinguished from the present species by the blunt radial ribs on the shell surface.

Locality and Formation: Loc. no. 83, Loc. no. 109, siltstone of the Kogachi Member, numerous perfect intact shells.

Depository: IGPS coll. cat. no. 86765.

Family Cardiidae LAMARCK, 1809

Genus *Laevicardium* SWAINSON, 1840

Laevicardium sp.

Pl. 7, fig. 11

One imperfect right valve was examined. The shell is characterized by the higher than long (Length 29.4 mm, Height 34.7 mm), strong, prosoclinal form, sculptured with flat-topped, elevated radial ribs and narrow rather smooth interspaces, small, prominent beaks, two small cardinal teeth, and internal ventral margin crenulated according to external sculptures.

The present species is comparable with *Laevicardium biradiatum* (BRUGUIÈRE), a Recent species and recorded from the Nakoshi Sand of MACNEIL, 1960 (=Nakoshi Sandstone Member) by NOMURA and ZINBO (1936) but unfortunately the state of preservation of the present species does not permit a close comparison.

Locality and Formation: Loc. no. 109, siltstone of the Kogachi Member, one imperfect specimen.

Depository: IGPS coll. cat. no. 86766.

Genus *Fulvia* GRAY, 1853

Fulvia sp.

Pl. 7, fig. 8

One imperfect left valve was collected from the siltstone of the Kogachi Member. The species is characterized by the roundly swollen, thin shell with indistinctly elevated radial ribs and small prominent beak. *Fulvia mutica* (REEVE, 1843), a Recent species of Japan resembles the present species in shell form and external sculpture but the state of preservation of the present species does not permit identification.

Locality and Formation: Loc. no. 109, siltstone of Kogachi Member, one imperfect specimen.

Depository: IGPS coll. cat. no. 86767.

Family Tellinidae BLAINVILLE, 1824

Genus *Macoma* LEACH, 1819

Subgenus *Macoma* LEACH, 1819

Macoma (Macoma) praetexta (v. MARTENS, 1865)

Pl. 7, fig. 12

1865. *Tellina praetexta* MARTENS, *Ann. Mag. Nat. Hist., 3rd Ser.*, vol. 16, p. 430.
1871. *Tellina praetexta* MARTENS, LISCHKE, *Jap. Meeres. Conch.*, Bd. 2, p. 113, pl. 10, fig. 14.
1922. *Macoma praetexta* (MARTENS), YOKOYAMA, *Jour. Coll. Sci., Imp. Univ. Tokyo, Sec. 2*, vol. 44, art. 1, p. 142, pl. 10, figs. 2-3.
1954. *Macoma praetexta* (MARTENS), TAKI in HIRASE, *Illust. Handb. Shell. Nat. Col.*, pl. 45, fig. 2.
1961. *Macoma (Macoma) praetexta* (v. MARTENS), HAYASAKA, *Sci. Rep., Tohoku Univ., 2nd Ser.*, vol. 33, no. 1, p. 58-59, pl. 7, figs. 10a-b.
1963. *Macoma praetexta* (v. MARTENS), KIRA, *Col. Illust. Shells, Japan*, p. 155, pl. 59, fig. 16.
1967. *Macoma praetexta* (v. MARTENS), HABE and KOSUGE, *Moll. Shells*, p. 163, pl. 61, fig. 23.

The subelongated shell and somewhat rostrated posterior characters are the features of the species named by MARTENS (1865). *Macoma incongrua* (v. MARTENS) resembles the present species but has a higher shell.

Locality and Formation: Loc. no. 84, Loc. no. 109, siltstone of the Kogachi Member, two rather perfect specimens.

Depository: IGPS coll. cat. no. 86768.

Family Veneridae RAFINESQUE, 1815

Subfamily Clementiinae FRIZZELL, 1936

Genus *Clementia* GRAY, 1840

Subgenus *Clementia* GRAY, 1840

Clementia (Clementia) vatheleti MABILLE, 1910

Pl. 7, fig. 13

1901. *Clementia vatheleti* MABILLE, *Bull. Soc. Philos. Paris, Ser. 8*, no. 3, p. 57. (*fide* JUKES-BROWNE, 1913)
1913. *Clementia vatheleti* MABILLE, JUKES-BROWNE, *Ann. Mag. Nat. Hist., 8th Ser.*, vol. 12, p. 61-62, pl. 1, figs. 3-4.
1927. *Clementia vatheleti* MABILLE, MAKIYAMA, *Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B*, vol. 3, no. 1, p. 45.
1937. *Clementia vatheleti* MABILLE, NOMURA, *Japan. Jour. Geol. Geogr.*, vol. 14, p. 72.
1941. *Clementia (Clementia) vatheleti* MABILLE, YABE and HATAI, *Ibid.*, vol. 18, nos. 1-2, p. 74-75, pl. 7, fig. 4.
1951. *Clementia (Clementia) vatheleti* MABILLE, HABE, *Genera Jap. Shells*, no. 2, p. 185, fig. 423 on p. 183.
1959. *Clementia vatheleti* MABILLE, YAMAMOTO and HABE, *Bull. Mar. Biol. Stat. Asamushi, Tohoku Univ.*, vol. 9, no. 3, p. 99, pl. 7, fig. 14.
1961. *Clementia (Clementia) vatheleti* MABILLE, HAYASAKA, *Sci. Rep., Tohoku Univ., 2nd Ser.*, vol. 33, no. 1, p. 51, pl. 6, figs. 7a-b.

1965. *Clementia vatheleti* MABILLE, KASENO and MATSUURA, *Sci. Rep., Kanazawa Univ.*, vol. 10, no. 1, pl. 16, figs. 5-6.

The present species is characterized by its thin shell, swollen ovately rounded form, nearly straight posterior dorsal margin, broadly rounded ventral margin, and concentric growth lines, somewhat wavy at the umbonal area to middle part of the external surface but dense near the ventral margin.

Clementia nakamurai OTUKA (1938), *Clementia kokozuraensis* KAMADA (1962) and *Clementia papyracea* (GRAY) (SHUTO, 1960) are known from the Japanese Miocene formations. *Clementia vatheleti* which was once referred to the subgenus *Egesta* CONRAD, 1845 by WOODRING in 1926, has been recorded from the silty facies of the Pliocene formations in the Japanese Islands and ranges to the Recent. The present species resembles *Clementia papyracea* of SOWERBY (1855), VREDENBURG (1928) and SHUTO (1960) in the characteristic external concentric growth lines but differs from the species in having elongated shell form and long posterior dorsal margin and widely rounded ventral margin. *Clementia papyracea* according to SHUTO (1960) is variable in shell form. The American Miocene species *Clementia inoceriformis* (WAGNER, 1839) of WOODRING (1926) resembles the present species in its shell form and pallial sinus but differs in having less strongly elevated growth lines near the ventral border. WOODRING (1926) pointed out that *Clementia* lives on muddy-bottoms of shallow warm water regions.

Locality and Formation: Loc. no. 84, Loc. no. 109, siltstone of the Kogachi Member, three rather perfect specimens.

Depository: IGPS coll. cat. no. 86769.

Family Trochidae RAFINESQUE, 1815

Subfamily Umboniinae PILSBRY, 1886

Genus *Umbonium* LINK, 1807

Subgenus *Suchium* MAKIYAMA, 1924

Umbonium (*Suchium*) *moniliferum decoratum* MAKIYAMA, 1924

Pl. 7, figs. 6a-7c

1924. *Umbonium* (*Suchium*) *decoratum* MAKIYAMA, *Japan. Jour. Geol. Geogr.*, vol. 3, nos. 3-4, p. 130, pl. 20, fig. 8.

1935b. *Umbonium* (*Suchium*) *moniliferum decoratum* MAKIYAMA, SUGIYAMA, *Jour. Geol. Soc. Japan*, vol. 42, no. 503, p. 467-468, pl. 11, fig. 26; fig. 30 on p. 467.

The present species was first described from the Naganuma Beds in Kanagawa Prefecture by MAKIYAMA (1924); it is characterized by its broad basal callus, basal spiral striations, five to six spiral grooves on a whorl and roundly elevated 12-14 tubercules on the penultimate subsutural band. SUGIYAMA (1935a) examined numerous Recent specimens of *Umbonium moniliferum* and *Umb. costatum* and concluded that both species resemble each other in having roundly elevated tubercules on the subsutural band and basal striations in some specimens but in general both have no tubercules or basal spiral striations. Though MAKIYAMA (1924) described *Umb.* (*Suchium*) *decoratum* as a new species based upon the roundly elevated tubercles and basal striations, large basal callus and inflated shell, it should be lowered to subspecific rank of *moniliferum* according to the examination of *Umb. moniliferum* by SUGIYAMA (1935a). The present specimens from the siltstone facies of the Kogachi Member are the first record from Okinawa-jima. These specimens have 16 or 17 rounded tubercles on the penultimate subsutural band, in spite of the 12-14 on *Umb. moniliferum.*

Suchium jyoganjiense, allied to the present subspecies was originally described from the Miocene Kurosedani Formation in Toyama Prefecture by FUJII (1963). It is characterized by the small size, roundly elevated tubercles on the subsutural band and basal spiral striations but differs from the present subspecies in having narrow basal callus and fewer tubercles.

Locality and Formation: Loc. no. 84, Loc. no. 109, siltstone of the Kogachi Member, two perfect specimens.

Depository: IGPS coll. cat. no. 86770.

Family Turbinidae RAFINESQUE, 1815

Subfamily Turbininae RAFINESQUE, 1815

Genus *Lunella* RÖDING, 1798

Lunella coronatus granulatus (GMELIN, 1875)

Pl. 7, figs. 5a-5b

1922. *Turbo (Marmorostoma) granulatus* GMELIN, YOKOYAMA, *Jour. Coll. Sci., Imp. Univ. Tokyo, Sec. C*, vol. 44, art. 1, p. 107, pl. 5, fig. 10.

1954. *Turbo coronatus granulatus* GMELIN, HIRASE, *Illust. Handb. Shell. Nat. Col.*, pl. 74, fig. 2.

1961. *Lunella coronatus coreensis* (RÉCULZ), HAYASAKA, *Sci. Rep., Tohoku Univ., 2nd Ser.*, vol. 33, no. 1, p. 70, pl, 9, figs. 22a-b.

1963. *Lunella coronatus coreensis* (RÉCULZ), KIRA, *Col. Illust. Shell. Japan*, p. 23, pl. 11, fig. 9.

1967. *Lunella coronata* (GMELIN), HABE and KOSUGE, *Moll. Shells*, vol. 3, p. 20, pl. 9, fig. 30.

The present species is known from the southern seas of Japan, the Ryukyu Islands and from the Pliocene to Pleistocene formations of Japan. The species is characterized by three bands of small beads on each whorl and 15-16 large tubercles just below the suture line from the second whorl, becoming small to large but indistinct on the younger whorls. The shoulder of the body whorl is rather strong, with prominent tuberculous keel. Base with two or three strongly elevated spiral tubercular bands and two or three internal spiral bands of small beads. Umbilicus slightly swollen and deeply open. Parietal callus smooth, narrow, aperture subcircular.

The present species resembles *Lunella coronatus coreensis* (RÉCULZ) (TRYON, 1888) in shell form but the former has more distinct tubercles and beaded structures on the external surface and the latter has only spiral ribs and weak beaded sculpture. *Lunella* sp. from the Kogachi Member differs from the present subspecies in having more distinct tubercles on the shell surface, consisting of three rows of distinct tubercular bands on the body whorl except for the strong tubercles just below the suture lines.

Locality and Formation: Loc. no. 109, siltstone of the Kogachi Member, one perfect specimen.

Depository: IGPS coll. cat. no. 86771.

Lunella sp.

Pl. 7, figs. 4a-4b

Shell pearly, thick, medium in size, younger whorls rather flat, low, body whorl rather swollen. Each whorls with three or two rows of small granular beads and strong tubercles just below the suture lines from the second or third whorl. From half of penultimate whorl, strong tubercular bands begin and develop along shoulder of body whorl. Base with three strongly rounded tubercular bands and two or three interstitial rows of beads. Aperture subcircular in form, parietal callus stout and umbilicus narrowly open. Apertural part slightly broken but measures 15.5 in height and 16.2 in width in mm.

The present species seems to be new to science but is left un-named because only a single specimen is at hand. The species differs from the other subspecies of *Lunella coronatus* in having strong tubercles on the external shell. HABE and KOSUGE (1967) mentioned that the umbilical opening in *Lunella coronatus* (GMELIN) at the immature stage is open but becomes closed at the adult stage. An examination of many individuals of the species and subspecies preserved in the collection of our Institute showed that the umbilical opening is an important subspecific character because in the present case the umbilicus was observed to be opened in many mature forms and closed in the immature specimens, and in other subspecies the umbilicus was closed at both the immature and mature stages. Except for the feature just mentioned, the subspecies of *Lunella coronatus* are variable in shell features, therefore they should be treated carefully.

Locality and Formation: Loc. no. 109, siltstone of the Kogachi Member, one perfect specimen.

Depository: IGPS coll. cat. no. 86797.

Family Potamididae COSSMANN, 1906

Genus *Batillaria* BENSON, 1842

Batillaria zonalis (BRUGUIÈRE, 1792)

Pl. 7, figs. 2-3

1855. *Cerithium zonalis* BRUGUIÈRE, SOWERBY, *Thes. Conch.*, vol. 2, p. 884, pl. 185, figs. 264-265.

1858. *Lampania zonalis* BRUGUIÈRE, H. and A. ADAMS, *Gen. Res. Moll.*, vol. 1, p. 289, pl. 30, figs. 5-5a.

1866. *Lampania zonalis* BRUGUIÈRE, REEVE, *Conch. Icon.*, vol. 15, pl. 1, figs. 5a-c.

1869. *Lampania zonalis* LAMARCK, LISCHKE, *Japan. Meeres Conch.*, vol. 1, p. 73-74, pl. 6, figs. 15-16.

1887. *Potamides (Lampania) zonalis* BRUGUIÈRE, TRYON, *Man. Conch.*, vol. 9, p. 167, pl. 34, figs. 3-4.

1924. *Potamides (Batillaria) zonalis* BRUGUIÈRE, YOKOYAMA, *Jour. Coll. Sci., Imp. Univ. Tokyo*, vol. 45, art 1, p. 20-21, pl. 5, fig. 18.

1935. *Batillaria zonalis* (BRUGUIÈRE), NOMURA, *Sci. Rep., Tohoku Imp. Univ., 2nd Ser.*, vol. 18, no. 2, p. 186-187, pl. 9, fig. 17.

1954. *Batillaria zonalis* (BRUGUIÈRE), TAKI in HIRASE, *Illust. Handb. Shell. Nat. Col.*, pl. 84, fig. 14.

1961. *Batillaria zonalis* (BRUGUIÈRE), HAYASAKA, *Sci. Rep., Tohoku Univ., 2nd Ser.*, vol. 33, no. 1, p. 70-71, pl. 9, fig. 7.

1967. *Batillaria zonalis* (BRUGUIÈRE), HABE and KOSUGE, *Moll. Shells*, p. 34, pl. 13, fig. 18.

Several Recent *Batillaria* species are known from around the Japanese Islands. They are variable in external form as pointed out by NAGASAWA (1962, 1963) and KOTAKA and HAYASAKA (1956). The batillarids collected from the siltstone facies of the Kogachi Member are characterized by having rather distinct tubercles below the suture lines, they are distinct on the lower whorls but change into longitudinal folds on the younger whorls. The specimens illustrated by SOWERBY (1855), REEVE (1866) and TRYON (1887) have rather indistinct tubercles and spiral bands, whereas the specimens figured by LISCHKE (1869) are quite similar to the one from Kogachi and those shown by YOKOYAMA (1924), NOMURA (1935), TAKI in HIRASE (HIRASE, 1954) and HABE and KOSUGE (1967) may be identified with one of MACNEIL's (1960) *Batillaria* cf. *zonalis* from the Yontan Limestone in Okinawa-jima. Among more than 20 specimens examined none were of the smooth type and all had distinct tubercles. The present species differs from *Batillaria cumingi* and *Bat. multiformis* in having distinct tubercles and in the form of the aperture.

Locality and Formation: Loc. no. 83, Loc. no. 84, Loc. no. 109, all from the siltstone of the Kogachi Member, many perfect specimens.

Depository: IGPS coll. cat. nos. 86746, 86798, 88068.

Family Naticidae FORBES, 1838

Subfamily Polinicinae MONTFORT, 1817

Genus *Polinices* MONTFORT, 1810

Polinices cumingianus madioenensis ALTENA, 1941

Pl. 7, fig. 14

1941. *Polinices* (*Polinices*) *cumingianus* var. *madioenensis* ALTENA, *Leides Geol. Mededel.*, vol. 12, p. 58, fig. 18.
1960. *Polinices* cf. *cumingianus madioenensis* ALTENA, MACNEIL, *U.S. Geol. Surv., Prof. Pap.*, 339, p. 53, pl. 2, fig. 19, pl. 13, fig. 1.

The present species resembles *Polinices hyugaensis* SHUTO (1964) from the Middle Miocene to Lower Pliocene Miyazaki Group in Miyazaki Prefecture but the latter differs from the former by the shape of its umbilicus. The present species is characterized by its strong parietal callus extending backward with shallow furrows, oblique to the inner lip. The lower half of the umbilicus is opened and there are regular spiral growth lines on the shell surface.

Locality and Formation: Loc. no. 109, siltstone of the Kogachi Member, two nearly perfect specimens.

Depository: IGPS coll. cat. no. 90767.

Family Nassidae COSSMANN, 1901

Genus *Nassarius* DUMÉRIL, 1805

Subgenus *Zeuxis* H. and A. ADAMS, 1853

Nassarius (*Zeuxis*) *caelatus* (A. ADAMS, 1851)

Pl. 7, figs. 1a–1b

1851. *Nassa caelata* A. ADAMS, *Proc. Zool. Soc. London*, pt. 19, p. 97.
1928. *Nassa* (*Hinia*) *verbeeki* MARTIN, YOKOYAMA, *Rep., Imp. Geol. Surv. Japan*, no. 101, p. 40, pl. 2, figs. 9, 13.
1935. *Nassarius* (*Zeuxis*) *caelatus* (A. ADAMS), NOMURA, *Sci. Rep., Tohoku Imp. Univ., 2nd Ser.*, vol. 18, no. 2, p. 152.
1935. *Nassarius* (*Zeuxis*) *caelatus* (A. ADAMS), OTUKA, *Bull. Earthq. Res. Inst. Tokyo Imp. Univ.*, no. 13, pt. 4, p. 871, pl. 52, fig. 44.
1936. *Nassarius* (*Alectrion*) *caelatus* (A. ADAMS), NOMURA and ZINBO, *Sci. Rep., Tohoku Imp. Univ., 2nd Ser.*, vol. 18, no. 3, p. 256, pl. 11, fig. 24.
1960. *Nassarius* (*Niotha*) *caelatus* (A. ADAMS), MACNEIL, *U.S. Geol. Surv., Prof. Pap.*, 339, p. 79, pl. 13, fig. 30.
1963. *Nassarius* (*Zeuxis*) *caelatus* (A. ADAMS), KIRA, *Col. Illust. Shells*, p. 73, pl. 28, fig. 16.

The present species has been described from the younger Pliocene to Recent in Japan and Formosa. This species from the siltstone of the Kogachi Member consists of specimens that are well preserved but unfortunately lack the protochonch which is an important character for identification (SHUTO, 1969). From the apertural features and external sculpture the present specimens are referred to NOMURA's (1936) figured species and to the one illustrated by MACNEIL (1960).

Locality and Formation: Loc. no. 109, siltstone of the Kogachi Member, several nearly perfect specimens.

Depository: IGPS coll. cat. no. 90768.

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Explanation of Plate 6

(All in natural size)

Figs. 1-5, 8-17. *Anadara* (*Hataiarca*) *kogachiensis* NODA, n. sp., p. 37, figs. 1 and 14, 2 and 13, 3 and 12, 4 and 11, 9a and 9b intact shells showing the different stages of growth; figs. 9a-9d, Holotype (IGPS coll. cat. no. 86757), external (figs. 9a-b) and internal (figs. 9c-d) views; figs. 8, 15, Paratype (IGPS coll. cat. no. 86887) ; figs. 16-17, Paratype (IGPS coll. cat. no. 86756), left valve (fig. 17) and ligamental view (fig. 16), all from Loc. no. 109, Kogachi Member of the Haneji Formation, Pliocene.

Figs. 6a-7b. *Striarca interplicata* (GRABAU and KING), ×1, p. 36, Loc. no. 109, IGPS coll. cat. no. 86888, Kogachi Member of the Haneji Formation, Pliocene.

1

3

4

6a

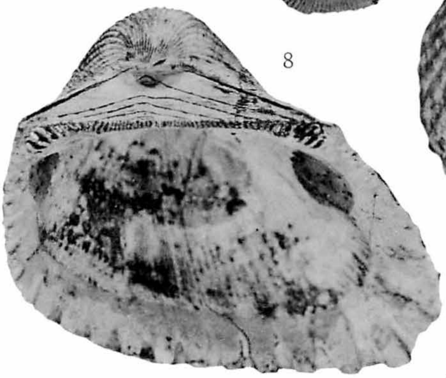
6b

7b

2

7a

9a



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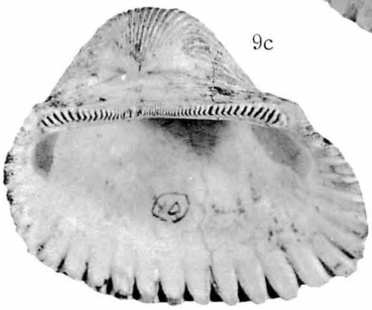

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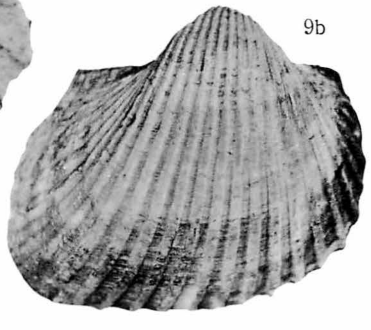

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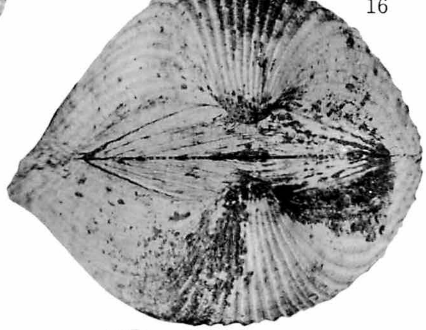


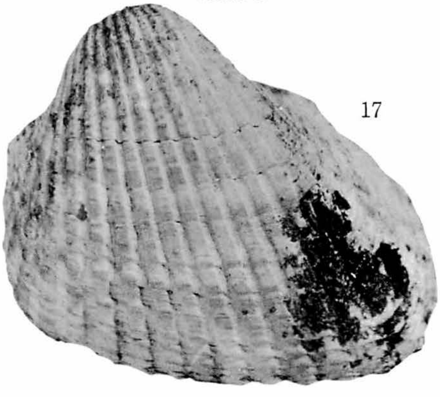
16

9d

11

12

15



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13

14

KUMAGAI and OTOMO photo

1-35.

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Explanation of Plate 7

Figs. 1a-1b. *Nassarius* (*Zeuxis*) *caelatus* (A. ADAMS), x2, p. 46, Loc. no. 109, IGPS coll. cat. no. 90768.

Figs. 2-3. *Batillaria zonalis* (BRUGUIÈRE), x1, p. 45, Loc. no. 109, IGPS coll. cat. no. 86798.

Figs. 4a-4b. *Lunella* sp., x1, p. 44, Loc. no. 109, IGPS coll. cat. no. 86797.

Figs. 5a-5b. *Lunella coronatus granulatus* (GMELIN), x1, p. 44, Loc. no. 109, IGPS coll. cat. no. 86771.

Figs. 6a-7c. *Umbonium* (*Suchium*) *moniliferum decoratum* MAKIYAMA, p. 43, x2, fig. 6a; apertural view, 6b; apical view, 6c; umbilical view; 7a; apertural view, 7b; apical view, 7c; umbilical view, Loc. no. 109, IGPS coll. cat. no. 86770.

Fig. 8. *Fulvia* sp., x1, p. 41, Loc. no. 109, IGPS coll. cat. no. 86767.

Figs. 9a-9b. *Codakia* (*Jagonia*) *okinawazimana* NOMURA and ZINBO, x3, p. 41, Loc. no. 109, IGPS coll. cat. no. 86765.

Figs. 10, 18. *Ostrea* (*Ostrea*) *denselamellosa* LISCHKE, p. 40, fig. 10, x0.5, fig. 18, x1, Loc. no. 84, IGPS coll. cat. no. 88067.

Fig. 11. *Laevicardium* sp., x1, p. 41, Loc. no. 84, IGPS coll. cat. no. 86766.

Fig. 12. *Macoma* (*Macoma*) *praetexta* (v. MARTENS), x1, p. 42, Loc. no. 84, IGPS coll. cat. no. 86768.

Fig. 13. *Clementia* (*Clementia*) *vatheleti* MABILLE, x1, p. 42, Loc. no. 109, IGPS coll. cat. no. 86769.

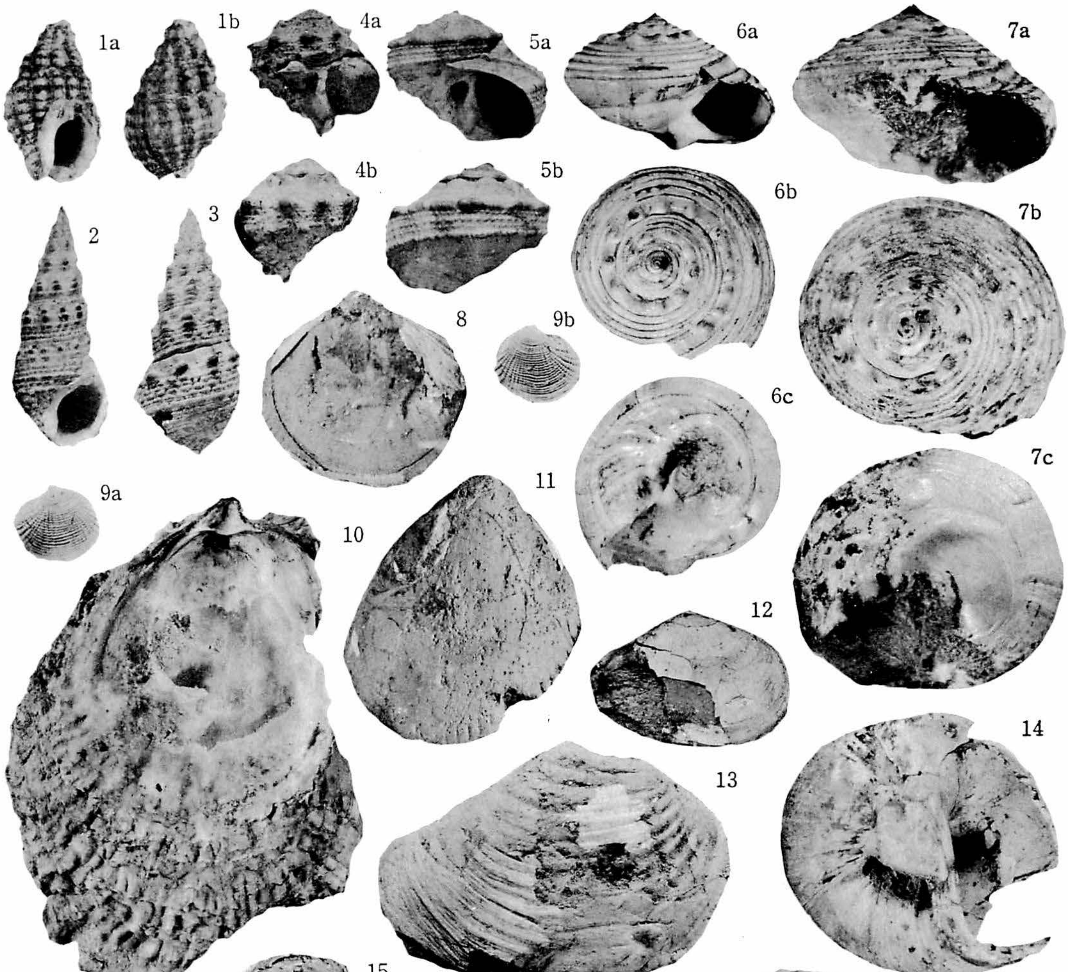
Fig. 14. *Polinices cumingianus madioenensis* ALTENA, x1, p. 46, umbilical view, Loc. no. 109, IGPS coll. cat. no. 90767.

Fig. 15. *Pteria* cf. *coturnix* (DUNKER), x1, p. 38, Loc. no. 84, IGPS coll. cat. no. 86761.

Fig. 16. *Modiolus* sp., x2, p. 38, Loc. no. 109, IGPS coll. cat. no. 86760.

Fig. 17. *Pododesmus* (*Monia*) *noharai* NODA, n. sp., x1, p. 39, Holotype, IGPS coll. cat. no. 86762, Loc. no. 109.

All from the Kogachi Member of the Haneji Formation, Pliocene.



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Ananai	穴内
Biimatabaru	為又原
Gabesoga	我部祖河
Hamada	浜田
Haneji	羽地
Kakegawa	掛川
Kawachi	河内
Kikaigashima	喜界ケ島
Kogachi	古我知
Kunigami	国頭
Kurosedani	黒瀬谷
Motobu	本部
Naganuma	長沼
Nago	名護
Nakoshi	仲尾次
Nakijin	今帰仁
Nakao	仲尾
Okinawa	沖縄
Osaki	大崎
Ryukyu	琉球
Setana	瀬棚
Shimajiri	島尻
Takanabe	高鍋
Yamairihabaru	山入端原
Yurushida	許田

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 81, pp. 52-58, April 20, 1971

577. SOME COPROLITES FROM WAKAYAMA PREFECTURE*

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和歌山県産の糞化石について： 和歌山県西牟婁郡北部や田辺市東方に分布する牟婁層群分領山層（始新統？）および，日高川層群福定層・会津川層（上部白亜系）より，多くの不規則な形態をもつ団塊が発見される。これらは，その形態，表面の模様，産出状態，同時に産出する生物起源の条痕（生痕など），および，すでに糞化石として記載されたものとの酷似などから，海棲生物の糞化石と考えられる。

これらの糞化石の起源生物の属種の決定はできなかったが，他の地域から発見され，記載された生痕化石などについて考察しながら，和歌山県産糞化石の特徴的なものの記載をした。

畑井小虎・小高民夫

Many nodular structures of spindle, elongate, straight and of twisted shapes were found in the muddy rocks of the Muro and Hidagawa groups distributed in the northern part of Nishi-Muro-gun, Kii Peninsula, Wakayama Prefecture. These nodular structures are of varied shapes, due in part to their state of preservation, and were found only from the muddy sediments. They occurred more or less parallel though some at an angle with the bedding plane of the rocks in which they were buried, not in accumulations as if piled-up, but in a random orientation and one near the other. Sometimes a rather long, twisted tightly or broadly curved and many more or less straight tubular structures, although more or less flattened by subsequent pressure probably at the time of burial by the accumulating sediments, occurred in the same and in different formations, sometimes nearby and sometimes rather remote from one another. These peculiar shaped nodular structures are the scope of the present article.

The nodular structures were found from the Bunreizan Formation of the Muro Group of probable Eocene age, and from the Fukusada and Aizugawa formations of the Hidagawa group of probable Cretaceous age. The stratigraphic position of the formations just mentioned and their lithofacies are shown in Table 1.

The formations of both the Muro and Hidagawa groups are characterized by their flysch-like alternations in which abundant trace fossils are frequently found on the undersurface of the sandstone layers. The deep-water aspect of the formations can be inferred from their good development of flysch-like alternations of shale and sandstone and by the presence of trace fossils, which are so characteristic of flysch deposits. The trace fossils, some of which are of unknown origin and some of which are more or less analogous with forms known from the deep waters of present day seas, are abundant in the Bunreizan, Fukusada and Aizugawa formations.

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* Received June 30, 1970; read June 27, 1970 at Mito.

Table 1. Stratigraphic sequence of the rocks distributed in the northern part of Nishi-Muro-gun, Wakayama Prefecture (after Y. OWAKI, 1963, MS).

Group name and age	Formation name	Estimated thickness (in m)	Lithology and remarks
Muro (Upper Eocene ?)	Chikatsuyu	1300+	Alternation of fine grained sandstone and shale. Sedimentary structures. Cf. *Nereites tosaensis* KATTO
	Ouchigawa and	1500+	Sandy shale. Sedimentary structures
	Bunreizan	2000+	Alternation of sandstone and shale. Sedimentary structures
	Hirase	3000+	Alternation of medium to coarse grained sandstone, sandy shale and shale. Sedimentary structures
	fault contact		
Hidagawa (Upper Cretaceous)	Seijozan	2500+	Alternation of sandy shale. Sedimentary structures
	Jujo	2700+	Massive black shale
	Fukusada	2500+	Alternation of sandy shale and shale. Sedimentary structures
	Aizugawa	1000+	Alternation of granule to coarse grained sandstone and fine sandy shale. Desiccation breccia
	base not observed		

The trace fossils from the flysch-like rocks distributed in the northern part of Nishi-Muro-gun, are comparable in part with the ones described and figured by KATTO (1960a, b) from the Eocene rocks of the Muroto Peninsula, Kochi Prefecture on the opposite side of the Kii Strait separating the Muroto from the Kii Peninsula. Besides the trace fossils found in the Muro and Hidagawa groups, it can also be mentioned that the rock facies of the Nishi-Muro-gun area resemble those of the Muroto Peninsula, and were probably once continuous and deposited in the same geosynclinal basin, although separated by the Kii Strait at present. This geological data suffices to explain the mutual occurrence of similar kinds of trace fossils from geographically isolated areas.

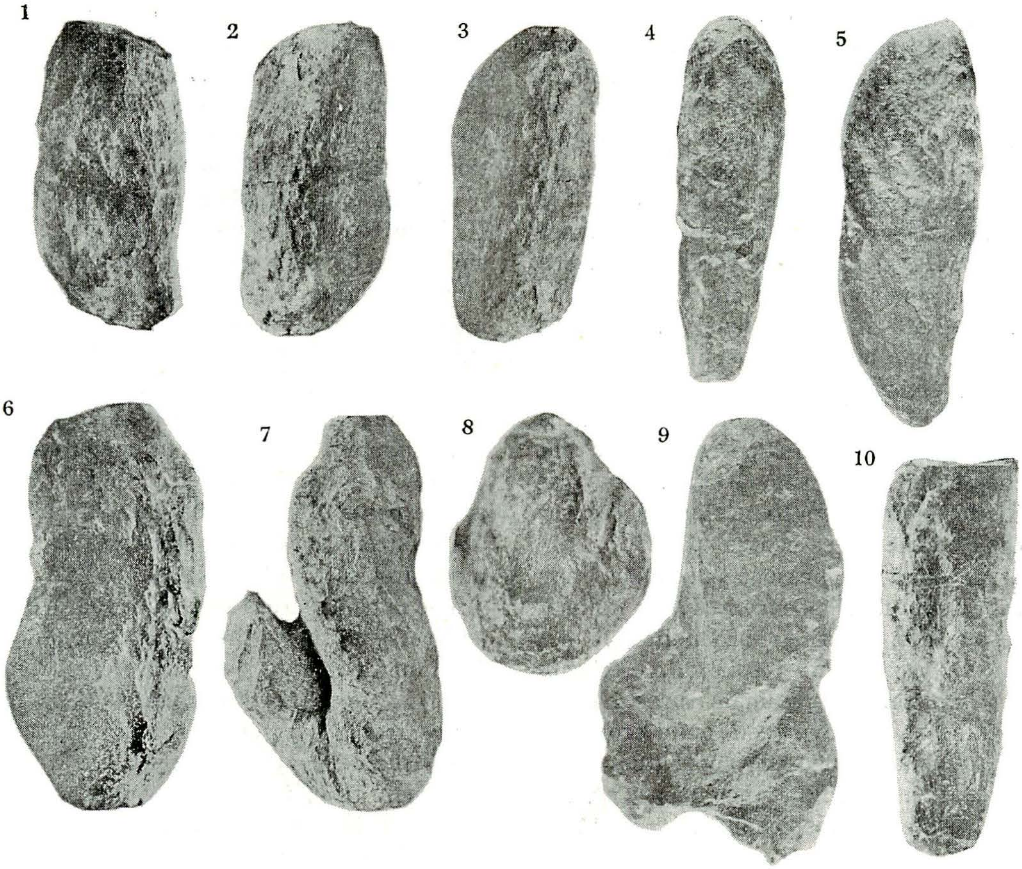
Coprolites or fossilized excrements of animals have been given very little attention in Japan. As known at present there are only a few published articles on the subject. Recent molluscan faeces have been studied in detail by ARAKAWA (1962, 1963, 1965, 1968), and among the numerous ones described and figured by him, the ones of *Batillaria cumingii* (CROSSE) resemble Fig. 4 in the present work, differing only in being much smaller, measuring only about 1.73 mm in maximum length and 0.32 mm in diameter of the broadest part, whereas the present fossil (Fig. 5) attains about 48 mm in length. Although of similar shape, the animal responsible for the fossil coprolite was probably different. Many small pellets, probably of molluscan origin, were described and figured by HATAI and KOTAKA (1968) from the Early Miyagian of Kogota-machi in Miyagi Prefecture. From a horizon of similar geological age, HATAI and NODA (1968) reported on some pellets from the Early Miyagian Tatsunokuchi Formation in Sendai City. These pellets were stated to be due to some *Callianassa* species. The casting named *Magarikune akkesiensis*, n. gen. and n. sp., by MINATO and SUYAMA (1949) and subsequently placed in the synonymy of *Helminthopsis* HÄNTZSCHEL (1962) was described as being similar to the excrements of the marine worm, *Arenicola*. Worm casting were reported by KATTO (1960a) from the Shimizu Formation (Eocene) distributed along the sea coast of Tosashimizu City, Kochi Prefecture, and stated to be related to the castings of either *Nereites* or *Balanoglossus*; he also figured some Recent castings of *Balanoglossus* from Uranouchi Bay, Kochi Prefecture for comparison. In another paper of the same year (1960b) KATTO figured some castings and stated that they are probably of the marine worm *Nereites*; these are from the Muroto Formation (Eocene) distributed along the sea coast of Hanezaki, Muroto City, Muroto Peninsula, Kochi Prefecture. In 1964, KATTO figured some excreta of unknown origin from the Muroto Formation (Eocene) in Muroto City, Kochi Prefecture. TAKAHASHI and YAGI (1929) have also reported on the occurrence of pellets of probable mud-eating marine animals.

The nodular structures upon which this article is based are here considered to be coprolites of marine animals because of their shapes, surface sculpture, mode of occurrence, association with other structures of probably organic origin, and their resemblance to previously described ones (HÄNTZSCHEL and AMSTUTZ, 1968).

The Nodular Specimens

Description:—The nodular specimen from the Aizugawa Fromation at Chikatsuyu, Nakahechi-cho, measures 5.5 cm in maximum length and up to nearly 3 cm in maximum width, although typical ones are about 1.5 cm in width. They generally, unless somewhat deformed by subsequent pressure by the accumulating sediments or diagenesis, are spindle-shaped, roundly or bluntly pointed at both ends, though more sharply at one end. All of the specimens exhibit distinct longitudinal striae showing a strong tendency to slight twisting towards both ends, though more distinctly near the most expanded middle part. The striae are strong, rather elevated and narrower than their interspaces in some specimens (Figs. 1-3, 6), but rather weak in others (Figs. 4, 5). Both ends of the specimens appear as if somewhat pinched, the narrower side more distinctly than the larger. The surfaces of all of the specimens are more or less smooth except for the longitudinally somewhat twisted striae already referred to and for the shallow longitudinal troughs irregularly distributed. In cross section some of the specimens are regularly or almost uniformly rounded (Figs. 4, 5), in others somewhat flattened (Figs. 8, 9), and some appear with irregular cross-section (Figs. 1-3). All of the specimens consist of muddy sediments, fine to medium grained, so far as the naturally broken cross-sections show under low magnification (×10). None of the specimens show evidence of wavy lines, corrugations, distinct spiral sculpture, laminae or creases arranged laterally.

Thin-slices and polished cross-sections of the nodular specimens reveal sporadic, irregular and marginal development of pyrite and a dark zone separating the mother rock of black mudstone from the lighter colored inner mudstone. In the lighter colored mudstone a few rounded and elongated-oval particles of foreign



Figs. 1, 2, 3, 8, 10. Coprolites from the Fukusada Formation of the right side cliff of the Hiki River at about 2,000 meters upstream from Chikatsuyu, Nakahechi-cho, Wakayama Prefecture.

Figs. 4, 5, 6, 9. Coprolites from the Aizugawa Formation at Kamo-Oridami, Chikatsuyu, Nakahechi-cho, Wakayama Prefecture.

Fig. 7. Coprolites from the Bunreizan Formation of a road side cliff at the Ichiburi, Daito-mura, Wakayama Prefecture.

All figures except Fig. 8 are in natural size. Fig. 8, ×2.

substances are found near the marginal part of the nodular specimen.

Locality:—Kamo-Oridani, Chikatsuyu, Nakahechi-cho, Wakayama Prefecture. Aizugawa Formation. Cliff of the Hiki River about 2,000 m upstream from the Chikatsuyu, Nakahechi-cho, Wakayama Prefecture. Fukusada Formation.

Remarks:—The spindle or elongated shaped specimens showing distinct longitudinal, somewhat twisted striae on the surfaces are considered to be fossil coprolites. The bluntly and narrowly rounded terminal parts with irregular shape, shallowly incised longitudinal troughs and pits and with striae are structures thought to have been developed during sausaging. The differences in the grade of bluntness at the two ends may represent the commencement and termination in their development.

The differences in sediment-color of the inner and outer parts of the specimens, development of sporadic yet irregular pyrite and a dark zone at the marginal part separating the inner from the outer, and of some foreign particles in the inner part, all may point to the nature of the specimens. So far as megascopic observations are concerned, the grain-size of the sediments of the inner and outer parts of the specimens appear almost the same except for that the sediments at the outer-inner part of the specimen seem to be slightly coarser than at the inner central part.

Although the present specimens may represent fossil coprolites the animal responsible for their production is not known because no fossils of vertebrate or invertebrate animals probable of making them have been found from the strata that yielded the coprolites. However, it is thought that some marine vertebrate was responsible for the coprolites.

Specimens identical with the ones under consideration (Figs. 1-6, 9, 10) are unaware to the writers.

Description:—A small specimen measuring 17 mm in length, 13 mm in width and about 8 mm in thickness and of irregular shape was found in the Fukusada Formation associated with the specimen (Figs. 1-3) referred to a fossil coprolite. This irregularly shaped specimen (Fig. 8) shows several creases more or less parallel with the outline of the specimen at its broader part, and some small irregular pits on both surfaces.

Remarks:—Whether this specimen is a coprolite different from the ones mentioned above, or merely a kind of concretion is questionable. It is thought to represent some kind of coprolite because of the surface markings and peculiar shape, although it is also probable that the specimen was deformed and thus does not permit any accurate imagination of this original shape.

Description:—Another specimen (Fig. 7), from the Bunreizan Formation, considered to be an excrement of some kind of marine animal not related to the annelids is the casting of non-uniform thickness. This specimen is about 17 mm thick at the widest part and about 8 mm thick at the narrowest bent part. It is sigmoidal or twisted in shape more or less circular in cross-section, winkled at the point of maximum bending, minutely pitted but without striations on the more or less rough surface.

The polished cross-section of the twisted specimen shows that the sediments of the inner part are quite different from that of the mother or country rock, in being much coarser. A very narrow dark colored zone separates the twisted specimen from the country rock. The coarse sediments in the specimen are in general coarser towards the outer side and finer in the central part, sporadically distributed throughout and with scattered dark colored, very short streaks.

Other specimens from the same horizon and locality of the Bunreizan Formation and from the Fukusada Formation are oval to rounded in cross-section, sides straight to subparallel, with one end broadly rounded, with very irregular surfaces with small pits, and many latitudinal creases. The sediment making the specimen differs from that of the country rock in being coarser grained and of lighter color. There is a dark discontinuous zone separating the specimen from the country rock or forming its outer part. The grains inside the specimen are coarser and more sporadically distributed at the marginal parts than in the inner portions.

Remarks:—The sigmoidal or twisted specimen differs from those produced by marine annelids in not being of about the same thickness throughout, in having a rather rough surface with minute pits sporadically distributed.

Arenicola-like castings named *Magarikune akkesiensis* n. gen. n. sp. by MINATO and SUYAMA (1949) was placed in the synonymy of *Helminthopsis* HEER, 1877 by HÄNTZSCHEL (1962, p. W 200). The present specimen (Fig. 7) differs from MINATO and SUYAMA's species by the thickness variation and degree of bending. Also, the present specimen is considered to have been deposited in deep water whereas that of MINATO and SUYAMA is of an animal that probably lived in shallow water. The castings of *Balanoglossus* figured by KATTO (1960a, pl. 1, figs. 9, 10) also differ from the present fossil in having rather uniform thickness throughout.

The straight specimen of oval cross-section shows the same kind of sediment distribution and materials as the twisted one, and is thus thought to have been derived possibly from the same or similar kind of marine animal, that is to say, an animal that was a bottom feeder, taking in bottom sand, devouring the organic remains and then casting the remains. However, as to the identity of the twisted specimen with the straight one, further investigation seems necessary.

Several specimens from the Fukusada Formation at Komatsubara, Nakahechi-cho, Wakayama Prefecture, differ from the others from the same formation at different localities in being broadly curved to broadly sigmoidal in extension, of rounded to oval shaped cross-section, and of having rough external surface with lateral constrictions when strong and of obscure lateral striations when weak. The specimens were found in black, well indurated mudstone. In cross-section the specimens consist of fine to medium grained sandy sediments in both of rounded and oval shaped ones. The rounded cross-sections measure about 15 mm in diameter whereas the oval shaped ones 20×17 mm (largest) to about 14×16 mm, and in length the first mentioned measures about 11 cm as preserved and the others are shorter.

These specimens do not show markings as would be produced by the members of *Nereites* (MACSOTAY, 1967, pl. 5, figs. 11, 14) and are similar to the ones of *Helminthopsis* (HÄNTZSCHEL, 1962, p. W 197, fig. 112-4a), and referred to that genus with some doubt. The specimen with oval cross-section may have been deformed by subsequent pressure.

Two other incomplete specimens similar to both the rounded and the oval-cross-section types mentioned above were found from the Chikatsuyu Formation at an outcrop of the Hiki River at Chikano, Nakahechi-cho, Wakayama Prefecture. These are considered to belong to *Helminthopsis*. Both are similar to the above mentioned in size, shape of the cross-section and in sculpture of the external surface.

Although nothing is known as to the kind of marine animals responsible for the coprolites described and figured in the present article, it seems worthy to record the occurrence of peculiar shaped nodular specimens because such may be found in other geological formations of the Japanese Islands. Should more specimens from more geological formations be found and studied, it is quite probable that they may prove to be important or useful for interpretation of the paleoecology and paleoenvironmental conditions of non-fossiliferous marine deposits. However, until more specimens are found further remarks will be reserved.

Locality:—Road side cliff at Ishiburi, Daito-mura, Wakayama Prefecture. Bunreizan Formation. Chikatsuyu, and Komatsubara both in Nakahechi-cho, Ibid. Fukusada Formation.

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Aizugawa	会津川
Bunreizan	分領山
Chikatsuyu	近露
Fukusada	福定
Hanezaki	羽根岬
Hidagawa	日高川
Hiki River	日置川
Hirase	平瀬
Ishiburi	石船
Jujo	十丈
Kii Peninsula	紀伊半島
Kogota	小牛田
Muro	牟婁
Muroto	室戸
Nakahechi-cho	中辺路町
Nishi-Muro-gun	西牟婁郡
Daito-mura	大塔村
Ouchigawa	大内川
Seijozan	政城山
Sendai	仙台
Shimizu	清水
Tatsunokuchi	辰ノ口
Tosashimizu	土佐清水

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会1971年・年会・総会は，1971年1月23日（土），24日（日）東京大学理学部地質学教室において開催された（参加者70名）。

海外学会出席報告

18th Symposium on Vertebrate Palaeontology and Comparative Anatomy, Cambridge, England..........................高井冬二

2nd International Conference on Planktonic Microfossils, Rome, Italy ....氏家　宏

1st Interamerican Micropaleontological Colloquium, Texas, U.S.A. ....高柳洋吉

Colloque sur la paleoécologie des Ostracodes, Pau, France......................花井哲郎

Symposium, Recent and Fossil Marine Diatoms.—Modern Trend in Research, Bremerhaven, Germany..............金谷太郎

Working Group for Correlation of Cretaceous and Cenozoic Marine Deposits, 2nd Meeting, Zürich, Switzerland....金谷太郎

総　　会

個　人　講　演

米谷産 *Taeniopteris* について ....浅間一男

坂本沢層元岩沢砂岩部層より産出した植物化石について................浅間一男・村田正文

Second addition to the Liassic Iwamuro Flora ....Kimura, T.

Radiolarian fossils from the so-called Permian of Unuma, north of Inuyama, Gifu Prefecture............................ Yao, A., Ichikawa, K. & Hashimoto, T.

Mesozoic Radiolaria from the Chichibu belt in the Yura district, Wakayama Prefecture............Yao, A. & Ichikawa, K.

三浦半島葉山層群の放散虫・珪質鞭毛虫化石について ....Ling, H.Y.・栗原謙二

Two new species of larger Foraminifera from the Philippines .... Hanzawa, S. & Hashimoto, W.

Lepidolina multiseptata (Deprat) の化石個体群にみられる形質の時間的変化について‥ ....小沢智生

Fusulinacean from Loei, North Thailand.. .... Igo, H.

Sarawakia ellipsactinoides, gen. et sp. nov., an *Ellipsactinia*-like Coelenterata from the Bau limestone of Sarawak, Malaysia .... Hashimoto, W. & Tamura, M.

Yabestroma philippinensis, a new stromatoporoid ? from the limestone of Mindoro, Philippines ....Hashimoto, W.

Preliminary report on the stratigraphy and paleontology of Cedros Island, Baja California, Mexico ....Kilmer, F.H.

Carboniferous brachiopods from S. Lembing districts, Northwest of Kantan, Malaysia ....Yanagida, J.

大船貝層の ^{14}C 年代と貝化石群集（その1）.... ....松島義章

Amussiopecten from North America and northern South America ....Masuda, K.

Lower Jurassic Bivalvia from the environs of Saigon ....Hayami, I.

Upper Triassic ammonites from Okinawajima, Pt. II ....Ishibashi, T.

Some lower Jurassic ammonites from South Viet-Nam ....Sato, T.

豊浦層群産のアンモナイトについて ....平野弘道

和田川（富山県）上流の手取統に産出した *Parkinsonia* sp. について ..大村一夫・坂東祐司

On the Dalmanitidae and Raphiophoridae (Trilobita) ....Kobayashi, T. & Hamada, T.

Silurian trilobites from the Langkawi Islands, Northwest Malay................ ....Kobayashi, T. & Hamada, T.

日本の第三紀ハダカイワシ類の耳石 ....青木直昭

訂正　「日本古生物学会報告・紀事，新篇第80号」(1970年12月20日発行）の398頁，右段26〜27行目に誤りがありましたので次のように改めます。

誤	正
On the Paleozoic Bryozoa collected by Dr. C.K. Burton from Chumphon, Peninsular Thailand (代読) ....Hayami, T.	On the Paleozoic Bryozoa collected by Dr. C.K. Burton from Chumphon, Peninsular Thailand ....Sakagami, S.
	On some fossil Bryozoa from near Namioka-cho, Minami-Tsugaru-gun, Aomori Prefecture, Japan (代読) ....Hayami, T.

学会記事

◎ 1971年度よりの入会者（1971年1月22日の評議員会で承認）普通会員14名，在外会員1名。（順不同敬称略，以下同様）金森邦夫，北里　洋，松岡数充，尾田太良，青山尚友，木下　勤，紺田　功，久次米旭，大木公彦，奥田　尚，棚部一成，横山道昭，小林文夫，滝沢　茂，Inst. Geol. Paläont., Univ. Tübingen。

◎ 1970年度中に逝去された会員1名。福井玉夫。

◎ 1970年度中の退会者1名。須貝貫二。

◎ 1971年1月22日の評議員会において，次の3名の諸君が特別会員に推薦された。太田喜久，浦田英夫，柳田寿一。

◎ 1971年1月22日の評議員会において，藤本治義，今野円蔵，小林貞一の諸君が名誉会員に，また，小林貞一君が名誉会長に推薦され，翌23日の1971年総会において決定した。

◎ 1970年末に行なわれた1971, 1972年度の評議員選挙の結果，次の諸君が当選した。浅野　清，市川浩一郎，尾崎　博，金谷太郎，勘米良亀齢，小高民夫，小林貞一，鹿間時夫，高井冬二，高柳洋吉，鎮西清高，畑井小虎，花井哲郎，速水　格，松本達郎（次点，浜田隆士）

◎ 1971年1月22日の評議員会における会長選挙の結果，鹿間時夫君が選出された。

◎ 小林貞一君の名誉会員推薦に伴ない，評議員に一名の欠員が生じたので，次点の浜田隆士君が繰上げ当選となった。

◎ 1970年度学会誌論文賞は，胡　忠恒君の“The ontogenies of *Ponumia obscura* (Cochman), N.G., and of *Housia canadensis* (Walcott) (Trilobita) from the upper Cambrian of the Big Horn Mountains, Wyoming”に贈られることになり，1971年総会の席上披露された。

◎ 1971年度の学術奨励金は，浜田隆士君（古生代三葉虫及びサンゴの研究）に贈られた。

◎ かねて公募中であった日本古生物学会特別号No. 16の原稿には，菅野三郎君の“Tertiary molluscan fauna from the Yakataga district of southeastern Alaska”が採用された。文部省に対し刊行助成金を申請中である。

◎ 1971年度発行の「日本古生物学会報告・紀事・新篇」81号より定価を1冊900円に改訂した。

会則変更 (Change in Constitution)

1971年1月23日東京大学で開かれた日本古生物学会総会で次の如く会則第12条が変更された。

普通会員会費年1500円が2000円に
特別会員会費年2200円が3000円に
在外会員会費年 $ 7 が $.10 にそれぞれ変更された。

On the Occasion of the Annual Meeting of the Palaeontological Society of Japan, held on January 23, 1971, it was decided upon to revise Article 12 as indicated (in italic) below.

Article 12. Rates for annual dues: Regular Members, *Yen 2,000*, Fellows, *Yen 3,000*, and Foreign Members, *$ 10*.

お知らせ

◎ 日本古生物学会特別号No. 15, “Early Devonian Brachiopods from the Lesser Khingan District of Northeast China”（浜田隆士著）が刊行されました。(98 pp. 30 pls.) 定価は2,500円（〒200円）$ 12，但し会員は1冊2,000円（〒200円）$ 9です。購入希望の方は，福岡市箱崎町，九州大・理・地質内，日本古生物学会特別号編集委員会へ。

例会通知

	開催地	開催日	講演申込締切日
107回例会	奈良教育大学	1971年6月27日	1971年5月~~1~~20日
108回例会	九州大学	1971年10月22-24日	1971年6月10日*
1972年 総会・年会	千葉大学	1972年1月下旬	1971年12月10日

◎ 108回例会（九州大学）は日本地質学会ほか3学会と共催。本会に関連あるシンポジウムとしては，「九州周辺海域の地質学的諸問題」（世話人・奈須紀幸，鹿間時夫，星野通平，水野篤行，鎌田泰彦，加賀美英雄，小西健二，高橋良平，首藤次男）が予定されている。

* 108回例会の講演申込みは，プレプリント作成など地質学会方式に従いますので締切が早くなります。本会会員各位の講演は「⑦古生物」部門で行われることになると思われます。地質学会々員を兼ねて居られる方は，その所定用紙で申込まれれることをお薦めしますが，本誌 Proceedings に掲載する必要上同時に本会にもその旨御一報下さい。本会（本部）のみに申込まれた方は，そのことが明記してあれば一括して連合学術大会準備委員に連絡し，所定の用紙をお送りします。なお個人講演はこの例会に限り1人1件に制限されております。

◎ 本会の1971，1972年度の事務分担は表紙裏の通りになりました。会員各位との事務連絡は，夫々の担当部門が行いますので，御承知下さい。封筒には内容を明記して下さい。

会費納入———本部・会計係
入会申込———本部・会員係
投稿・購入（報告・紀事関係）本部・編集係
〃　（“化石”関係）東北大・化石編集部
〃　（特別号関係）　九州大・特別号編集委員会
講演申込———本部
その他の連絡・問合せ———本部・庶務係

◎「化石」購入について

「化石」（年2回発行）は昭和46年度から独立採算制で刊行されることになりました。バックナンバーもあるので下記へ申込んで下さい。

予約購読料（年2回）	日本古生物学会会員	1,000円
	非会員	1,200円

バックナンバーは旧定価。予約とは，その年の2冊の刊行完了までとします。

仙台市青葉山東北大学理学部地質学古生物学教室内
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TRANSACTIONS