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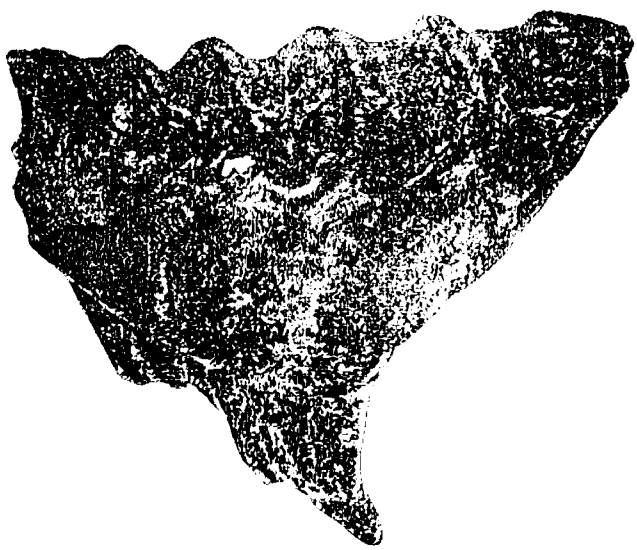

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607. UPPER TRIASSIC CEPHALOPODS FROM THE TANOURA DISTRICT, KUMAMOTO PREFECTURE, JAPAN*

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熊本県田浦地域の上部三畳系産頭足類：熊本県南部，田浦地域に分布する三畳系田浦層および鹿河内層より産出した頭足類を検討した結果，オーム貝類1種，菊石類5種を検出した。うち菊石1種は新種である。これらの頭足類は不完全ではあるが，日本の三畳系より初めて報告される種類もあり，頭足類動物群の研究には貴重である。これまで主に二枚貝化石にもとづき時代が論じられていたが，ここで頭足類化石による時代について若干論じ，田浦層の上部層はノーリアンに達する可能性を指摘した。 石橋 毅

Introduction and acknowledgments

The cephalopods described in this article were collected from the Upper Triassic Tanoura (TAMURA et al., 1958) and Takagochi (ORITA, 1962) Formations distributing in the Tanoura district, Kumamoto Prefecture. TAMURA (1959) and ORITA (1962) studied the stratigraphy and molluscan fossils of the Tanoura Formation. Almost all the specimens used in this study were collected by them, except for a few which were collected by myself.

ORITA (1962) listed several ammonoids which were preliminarily examined by MATSUMOTO. Based on the bivalves and ammonoids, the Tanoura Formation was referred to as the Carnian and the Takagochi Formation as the Carnian to Norian in geologic age (TAMURA 1959; ORITA, 1962).

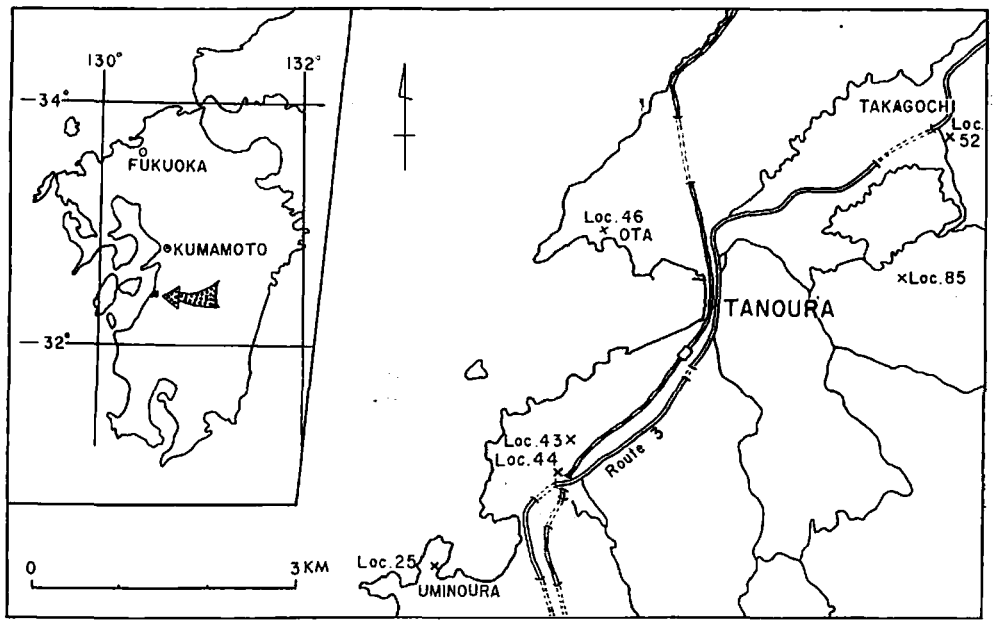
According to ORITA (op. cit.), the Tanoura Formation is about 250 m in thickness and is divided into the lower and upper members. The lower member yields cephalopod fossils, which were collected from the following localities denoted by numbers**:

Loc. 85 *Buchites kumamotoensis* n. sp.
Loc. 43 *Phormedites* sp.
Loc. 46 *Rhacophyllites* sp.
Loc. 25 *Buchites kumamotoensis* n. sp.
Arcestes sp. cf. *A.* (*Proarcestes*) *ausseeanus* (HAUER)
Ussuritidae or Discophyllitidae gen. et sp. indet.
Loc. 44 *Holconautilus* sp.

The Takagochi Formation is about 400 m in thickness (ORITA, op. cit.), and yields molluscan fossils through out the formation. Ammonoid was found in its middle part (loc. 52 and 55), and is represented by only a single species, *Placites* sp. aff. *P. oxyphyllus* (MOJSISOVICS). This ammonite is associated with *Pleuromysidia kanmerai* TAMURA, *Paleoneilo iwaiensis* ICHIKAWA, *Halobia* sp., etc. *Pleuromysidia kanmerai* TAMURA and

* Received May 25, 1972; read Jan. 23, 1972 at Chiba.

** The numbers of locality correspond with those of ORITA (1962).



Text-fig. 1. Location of samples collected.

Halobia (?) sp. occur in the lower part (loc. 54), whereas *Monotis* (*Entomonotis*) sp. cf. *M.* (*E.*) *typica* (KIPARISOVA) is known from the upper part (loc. 56). On the basis of the molluscan fossils ORITA (op. cit.) concluded that the upper part was early Norian, and the middle and lower parts were Carnian in age. NAKAZAWA (1964b) also considered that the middle horizon (locs. 52, 55) of Takagochi Formation was referable to the Late Carnian.

I investigated the cephalopod fossils collected from the Tanoura and Takagochi Formations, and identified one nautiloid species and five ammonoid species, of which one is new. On the basis of this ammonoid faunule the lower member of the Tanoura Formation is correlated with the Late Carnian. Accordingly the upper member probably extends to the Early Norian. *Placites* sp. aff. *oxyphyllus* from the middle part of Takagochi Formation is suggestive of the Norian, conservatively the Carno-Norian age.

The cephalopod fauna of the present study generally resembles that of Saragai Group of Northeast Japan which includes species of *Placites*, *Rhacophyllites* and *Arcestes* (SHIMIZU and MABUCHI, 1932; NAKAZAWA, 1964a). ISHIBASHI (1970) reported numerous Carnian ammonites from the Okinawa-jima, but little genera are common between the Tanoura district and the Okinawa-jima, except for *Arcestes*. Two species of *Buchites* and *Phormedites* to be described in this article are known from the Japanese Islands for the first time.

I wish to express my sincere thanks to Professor Tatsuro MATSUMOTO of Kyushu University for his arrangements of the material, criticisms and reading of the manuscript, and to Professor Ryuzo TORIYAMA of the same university

for kindly reading preliminary draft and encouragement. Thanks are also due to Professor Minoru TAMURA of Kumamoto University for the offer of his ammonoid collections. I am obliged to Miss Seiko HAYAKAWA for typewriting the manuscript.

Repository.—All specimens illustrated in this article are deposited in the Department of Geology, Kyushu University with the registered number using a symbol of GK. F.

Systematic paleontology

Class Cephalopoda CUVIER, 1797

Subclass Ammonoidea AGASSIZ, 1847

Order Ceratitida HYATT, 1884

Superfamily Clydonitaceae MOJSISOVICS, 1879

Family Buchitidae HYATT, 1900

Genus *Buchites* MOJSISOVICS, 1893

Type-species.—*Ceratites* (*Buchites*) *aldrovandii* MOJSISOVICS, 1893.

Remarks.—The genus *Buchites* was originally established by MOJSISOVICS (1893) as one of the subgenera of *Ceratites*. The species belonging to *Buchites* are known only from the Carnian to Norian of the Tethys region, such as the Alps, Greece, Sicily, Himalayas and Timor. *Buchites* has flexuous ribs which are projected at the ventrolateral shoulder and gradually disappear on the rounded venter but occasionally cross over it in the last whorl of a mature specimen. Whorls are moderately involute, increasing its height at a moderate rate. Ribs are distinct and intercalated with the short ones.

Buchites kumamotoensis ISHIBASHI, sp. nov.

Pl. 54, Figs. 1–9, 10? and 11?

1962. *Helictites*? sp., ORITA, *Sci. Rept., Fac. Sci., Kyushu Univ.*, Vol. 6, No. 1, p. 4, listed.

Material.—The holotype (GK. F 458) and some of paratypes (GK. F 459–462), collected by Dr. TAMURA from the Uminoura area (loc. 25), Kumamoto Prefecture. Two others (GK. F 374, 375) listed already as *Helictites*? sp. collected by Mr. ORITA and the rest (GK. F 463–466) by myself.

Description.—Shell considerably involute and compressed, increasing gradually its height. Whorl embracing about a half or one-third of the inner whorl; umbilicus narrow and moderately deep; ribs strong, rounded, flexiradiate on the flank and projected on the ventrolateral part, with irregularly intercalated secondaries, without crossing over the venter; venter round, smooth where ribs gradually disappear; suture ceratitic, with serrated lobes.

Remarks.—The present species is somewhat similar to *Helictites beneckei* reported by MOJSISOVICS (1893) from the Alps in lateral view, but the ribs of the latter cross straight over venter.

The present new species rather resembles *Buchites aldrovandii* (MOJSISOVICS) from the Alps but the whorl of the latter is more evolute than that of the former.

The other known species from the Alps and Himalayas are characterized by the appearance of the flexuous short lateral ribs at the ventrolateral area. *B. kumamotoensis* has bifurcating ribs some of which diverge from the main ribs at or near the umbilical shoulder, and its suture-line has the serrated accessary

lobes. The suture-line of *B. kumamotoensis* is rather similar to *B. modestus* (BUCH) from the Alps, but the latter is evidently different in that the ribs slightly cross over the venter and has a broad umbilicus. *B. emersoni* and *B.* cf. *hilaris* described by DIENER (1906) have evolute whorls and primitive sutures.

Buchites heteroplichus reported by GEMMELLARO (1904) is very similar to the present new species with respects to only the whorl volution, but is different from the latter in the characteristics of ribs, whorl size, venter, etc. It is resonable to establish a new species in the genus *Buchites* for the present form.

Occurrence.—Locs. 25 and 85. With *Arcestes* sp. cf. *A.* (*Proarcestes*) *ausseeanus* (HAUER) and *Halobia*? sp. (Loc. 25), and *Pleuromysidia kanmerai* TAMURA (Loc. 85).

Genus *Phormedites* MOJSISOVICS, 1893

Type-species.—*Ceratites* (*Phormedites*) *juvavicus* MOJSISOVICS, 1893

Remarks.—MOJSISOVICS (1893) established the subgenus *Phormedites* in the genus *Ceratites* of the family Ceratitidae. ZITTEL (1900), GEMMELLARO (1904) and DIENER (1906) also treated it as a subgenus of *Ceratites*. DIENER (1923) ranked it as a genus of the same family, but SPATH (1951) included the genus *Phormedites* in the family Buchitidae. SPATH's classification seems to be reasonable at present. The species referable to this genus, including the type-species designated by DIENER (1915), have been known from the Carnian and Norian ages. The Carnian species, *Ph. pygmaeus* and *Ph. schopeni* were described by GEMMELLARO (1904) from Sicily, and *Ph.* aff. *pygmaeus* was reported by PAKUCKAS (1928) from Timor. On the other hand, the Norian one, *Ph. juvavicus* was described by MOJSISOVICS (1893) from the Alps and by PAKUCKAS (1928) from Timor. *Ph. fasciatus* was reported by MOJSISOVICS (1893), DIENER (1906) and PAKUCKAS (1928) from the Alps, Himalayas and Timor, respectively.

Based on the original descriptions of these species, species of *Phormedites* are divided into the following two groups:

1. The group of *Ph. schopeni-Ph. juvavicus*

Shell is considerably involute with fine, prorsiradiate ribs. The ribs cross over the venter. The venter is round. The type-species, *Ph. juvavicus*, is about 28 mm in diameter.

2. The group of *Ph. pygmaeus-Ph. fasciatus*

The shell is evolute with fine, prorsiradiate ribs. The ribs are bundled. The venter is rounded with a faint groove. *Ph. fasciatus* is about 32 mm in diameter. The characteristics of this group are very similar to those of the genus *Daphinites* as pointed out by MOJSISOVICS (1893).

Phormedites sp. indet.

Pl. 54, Figs. 13 and 14

1962. *Phormedites* (?) sp., ORITA, *Sci. Rept., Fac. Sci., Kyushu Univ.*, Vol. 6, No. 1, p. 4, listed.

Material.—A part of outer whorl of rubber cast which was made from an external mould (GK. F 377a) and a fragmental part of ventral part (GK. F 377b). These specimens were collected by Mr. ORITA.

Descriptive remarks.—The shell is considerably involute and compressed. Judging from outer whorl, it is at least about 60 mm in diameter, though the

umbilical part is lost. The venter is narrowly arched. The lateral surface of shell has numerous, gently flexiradiate ribs which are projected sharply forward at the ventrolateral shoulder. The ribs are slender, keep almost the same width from the umbilical shoulder to the ventral part, and cross over the venter. The intercostal space is very narrow near umbilical shoulder. These characters suggest that the present specimens belong to the genus *Phormedites*.

Among the species of *Phormedites*, only two, *Ph. pygmaeus* and *Ph. schopeni*, have been known from the Carnian of Sicily. Others have been reported from the Norian of the Alps, Himalayas and Timor. As mentioned above, all these species are smaller than the species from Tanoura, being one-third or a half in diameter. There are many differences in respect to ribs, volution, size and venter between the species from the Alps, Sicily and Japan.

The specimens at hand are so poor that the present species has been left unnamed until better preserved material becomes available.

Occurrence.—Loc. 43. Shale bed of upper Lower Member of Tanoura Formation. With *Halobia* sp., *Halobia molukkana* WANNER, and *Pleuromya forsbergi* (BÖHM).

Superfamily Arcestaceae MOJSISOVICS, 1875

Family Arcestidae MOJSISOVICS, 1875

Genus *Arcestes* SUESS, 1865

Type-species.—Ammonites galeiformis HAUER, 1850

Subgenus *Proarcestes* MOJSISOVICS, 1893

Type-species.—Arcestes bramantei MOJSISOVICS, 1869

Arcestes (*Proarcestes*) sp. cf. *A.* (*P.*) *ausseeanus* (HAUER)

Pl. 54, Fig. 15, Text-figs. 2 and 3

Compare—

1847. *Ammonites ausseeanus* HAUER, *Haidingers Nat. Abhandl.*, I, p. 268, pl. 8, figs. 6-8.

1875. *Arcestes* (*Proarcestes*) *ausseeanus* HAUER: MOJSISOVICS, *Jahrb. Geol. Reichsanst., Wien*, No. 6, Heft. 1, pl. 51, figs. 1 and 4, pl. 53, figs. 28 and 31.

1907. *Arcestes* (*P.*) *ausseeanus* HAUER: FRECH, *N. Jahrb. f. Min. Festbd.*, p. 20, pl. 4, fig. 5.

1914. *Arcestes* (*P.*) *bicarinatus-ausseeanus* HAUER: WELTER, *Paläont. von Timor*, I, p. 180.

1927. *Arcestes* (*P.*) *ausseeanus* HAUER: ARTHABER, *Jahrb. Mijnw. Nederl. Ind.*, Vol. 55, No. 2, p. 51, pl. 5, figs. 1-6.

Material.—One external mould (GK. F 467) and its plaster cast (GK. F 468) are examined here. The external mould was collected by Dr. M. TAMURA of Kumamoto University.

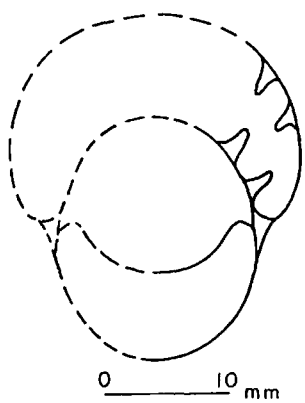
Description.—Shell, involute, globose, about 30 mm in diameter; whorl, broad, 24 mm in width deeply embracing and indented by the inner volutions; helmet-shape in section; surface with three oblique, periodic constrictions cross over the ventral part, no striae and ribs; venter narrow, its shoulder abruptly rounded; suture, ammonitic, deeply digitate, having numerous lobes and saddles, with accessary lobes.

Remarks.—Arcestes (*Proarcestes*) *ausseeanus* has been known from the Carnian of the Northern Alps, Timor, Greece, Himalayas, etc. This species was originally described by HAUER (1847). MOJSISOVICS (1873) included this

species into the group of *A.* (*P.*) *bicarinatus* (MÜNSTER), and RENZ (1910) and WELTER (1914) reported *ausseeanus* as a variety of *A.* (*P.*) *bicarinatus*. *A.* (*P.*) *ausseeanus* has three constrictions on the lateral part, but the specimens described by MOJSISOVICS (1875, pl. 51, figs. 4a-b) have evidently four constrictions. ARTHABER (1927) described *A.* (*P.*) *ausseeanus* from Timor. One of the Timor specimens (pl. 5, fig. 5) is immature and has two constrictions, but the other mature ones have four constrictions. *A.* (*P.*) *hanieli*, which was originally described by WELTER (1914) from Timor, was also reported by ARTHABER (1927) from the same region. *A.* (*P.*) *hanieli* described by ARTHABER closely resembles *A.* (*P.*) *ausseeanus*, though the latter has a higher whorl than the former.

SMITH (1927) described several new species of *Proarcestes* from the Carnian of California, of which *A.* (*P.*) *pacificus* is similar to the present specimen in whorl section, but the former has a smaller shell and a simpler, flared suture-line in which the accessary lobes are not developed.

The following species of arcestids have been known from the Japanese Islands:



Text-fig. 2. Whorl section of *Arcestes* (*Proarcestes*) cf. *ausseeanus* (HAUER).

Text-fig. 3. Suture-line preserved at the external mould of *Arcestes* (*Proarcestes*) cf. *ausseanus* (HAUER). ×5.

Arcestes (*A.*) aff. *oligosarcus* MOJSISOVICS. SHIMIZU and MABUCHI (1932) (Saragai Group, Kitakami)

Arcestes sp. NAKAZAWA (1964) (Saragai Group, Kitakami)

Arcestes (*Stenarcestes*) sp. NAKAZAWA (1959) (Jito Formation, Nariwa, Okayama)

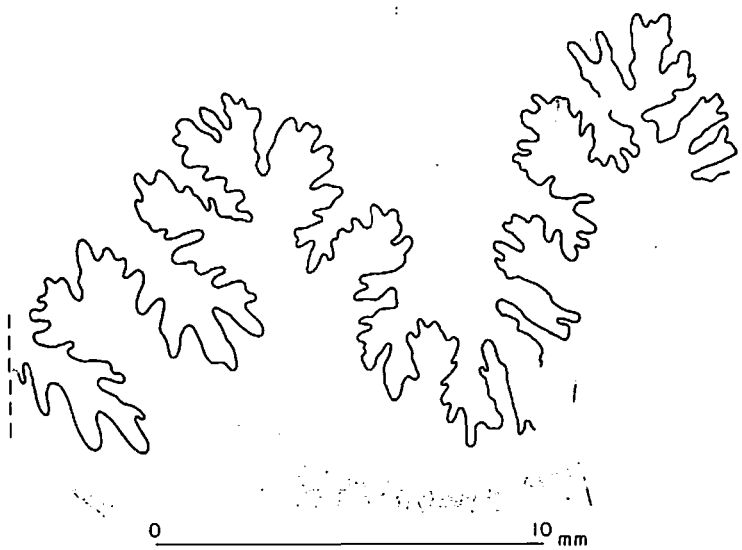
Arcestes (*Proarcestes*) aff. *hanieli* WELTER. SHIMIZU (1931) (*Proarcestes* Bed, ICHIKAWA (1951))

Arcestes (*P.*) aff. *bicarinatus* (MÜNSTER) SHIMIZU (1931) (Kochigatani Group, Shikoku)

The first two species came from the Norian strata, whereas the last three from the Carnian. The present species is easily distinguished from these species by whorl section, suture-line and other characteristics.

To sum up the present specimen is best comparable to and may be identified with *A.* (*P.*) *ausseeanus* with respects to whorl section, ornamentation, suture-line and other characteristics.

Occurrence.—Loc. 25. Shale bed of upper Lower Member of Tanoura Forma-



Text-fig. 4. Suture-line of *Placites* aff. *oxyphyllus* (MOJSISOVICS).

tion, where *Buchites kumamotoensis* ISHIBASHI and *Halobia*? sp. are associated.

Superfamily Pinacocerataceae MOJSISOVICS, 1879

Family Pinacoceratidae MOJSISOVICS, 1879

Genus *Placites* MOJSISOVICS, 1896

Placites sp. aff. *P. oxyphyllus* (MOJSISOVICS)

Pl. 54, Figs. 12a-c and Text-fig. 4

1962. *Placites*? sp.; ORITA, *Sci. Rept., Fac. Sci., Kyushu Univ.*, Vol. 6, No. 1, p. 9, listed.

Material.—One individual formed of three parts (GK. F 379) is here examined. They are two external moulds and an internal mould collected by Mr. ORITA.

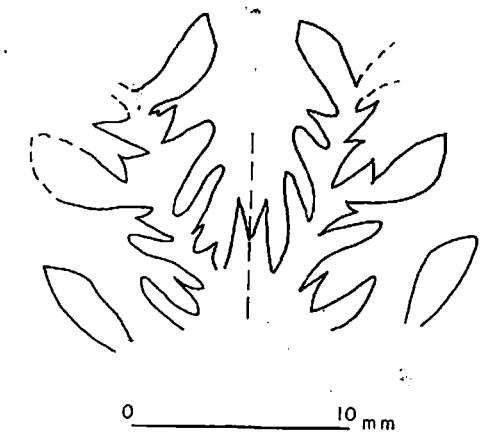
Descriptive remarks.—The shell is compressed with a narrowly arched venter, rather involute and smooth on the surface. The essential part of the suture is well preserved on the present specimen, showing the typical pattern of *Placites*, which consists of numerous, deeply incised elements (Text-fig. 4).

The present species closely resembles *Pl. oxyphyllus* (MOJSISOVICS, 1873), from the Norian of the Alps and Sicily, in that its external saddle has shallow lobules. *Placites perauctus* (MOJSISOVICS, 1873), from the Norian of the Alps, has deep lobules on the external saddle but differs from *Pl. oxyphyllus* by the deep lobules in the lateral saddles.

Two ammonoids, *Placites* aff. *oxyphllus* and *Arcestes* aff. *oligosarcus* have been listed by SHIMIZU and MABUCHI (1932) from the Norian Saragai Group, Kitakami, but their specimens have been lost (NAKAZAWA, 1964a p. 25). So it is impossible to compare the present specimen with them. The Takagochi Formation, in which the present specimen occurs, has been considered by ORITA

(1962) as the Carno-Norian in age. There is a possibility that the bed containing *Placites* aff. *oxyphyllus* belongs to the Norian age, though the present specimen is not so well preserved that the specific name has not been determined with certainty.

Occurrence.—Loc. 52. Shale in the middle part of Takagochi Formation, Kumamoto Prefecture. It occurs with *Pleuromysidia kanmerai* TAMURA, *Paleoneilo iwaiensis* ICHIKAWA, *Halobia* spp., *Camptonectes* sp., *Oxytoma* sp., etc. according to ORITA (1962).



Text-fig. 5. Suture-line of *Rhacophyllites* sp.

Order Phylloceratida ARKELL, 1950

Superfamily Phylloceratacea ZITTEL, 1884

Family Discophyllitidae SPATH, 1927

Genus *Rhacophyllites* ZITTEL, 1884

Rhacophyllites sp. indet.

Pl. 54, Fig. 16 and Text-fig. 5

1962. *Rhacophyllites* ? sp.; ORITA, *Sci. Rept., Fac. Sci., Kyushu Univ.*, Vol. 6, No. 1, p. 4, listed.

1964. *Rhacophyllites* sp.; NAKAZAWA, *Mem. Coll. Sci., Univ. Kyoto*, Vol. 30, No. 4, p. 29, 4th line from the top.

Material.—One fragmental specimen (GK. F 371) is examined here, which was collected by Mr. ORITA.

Descriptive remarks.—The shell is involute with a rounded venter. The umbilical part is almost lost. The suture is exposed on the ventrolateral part of the shell, in which the first lateral saddle shows a diphyllitic type (Text-fig. 5). The phylloid leaf is slender for the genus, probably because of the immature state of the shell. *Rhacophyllites* is close to *Discophyllites*, in the whorl shape and ornamentation. The difference of the two genera is mainly in the pattern of the sutures. Namely *Rhacophyllites* is diphyllitic or triphyllitic, whereas *Discophyllites* is monophyllitic. The species of *Rh.* are known from the Upper Carnian to Norian in the various part of the world.

When NAKAZAWA (1964a) described *Rhacophyllites* sp. from the Saragai Group, the present specimen was examined by him. He said that the characters of *Rh.* sp. of the Saragai Group resembled especially those of the Carnian *Rhacophyllites* sp. of the Tanoura Formation rather than those of Norian species such as *Rh. debilis* and *Rh. neojurensis* and those of Carnian species reported by TRECHMANN (1917) as *Discophyllites* cf. *ebneri*.

As mentioned above, the species of *Rhacophyllites* from the Tanoura Formation and the Saragai Group certainly resemble each other in the character of suture. The sutural patterns of these two specimens are also quite similar to that of *Rh.* "*neojurensis*" illustrated by

WELTER (1914, pl. 30, fig. 6*, text-fig. 72) from the Norian of Timor which was excluded by WIEDMANN (1970) from the synonym list of the true *neojurensis* of WELTER. I would support the opinion of WIEDMANN. Unfortunately the specific name was not given by WIEDMANN for the Timor specimens at that time.

On the basis of suture-line, the present specimen may be suggestive of the Early Norian in age.

Occurrence.—Loc. 46. Shale of the upper Lower Member of Tanoura Formation. With *Pleuromysidia kanmerai* TAMURA.

Subclass Nautiloidea AGASSIZ, 1847

Order Nautilida AGASSIZ, 1847

Superfamily Tainoceratacea HYATT, 1883

Family Tainoceratidae HYATT, 1883

Genus *Holconautilus* MOJSISOVICS, 1902

Type-species.—Nautilus semicostatus BEYRICH, 1867

Holconantilus sp. indet.

Pl. 54, Fig. 17

Material.—One specimen (GK. F 378) collected by Mr. ORITA, in 1962, is examined here.

Descriptive remarks.—Only outer whorl (ca. 60 mm in diameter) is preserved. The shell is very evolute and presumably widely umbilicate. The whorl is nearly as high as broad, increasing its height gradually. The rectiradiate, distant ribs develop on the flank. The venter is round and smooth. The suture-line runs almost parallel to ribs and shows one lateral lobe. The siphonal position is not observable in the present specimen.

On the grounds of the observed characters the present specimen is referable to the genus *Holconautilus*. The species of *Holconautilus* are known from the Anisian to Carnian of the Alps, Germany, the Mediterranean region, Timor, and Japan. The present specimen is closely similar to *H. semicostatus* (BEYRICH) in volution, ribs and suture. The other species of *Holconautilus* are different from the present species in the characters of whorl. The whorls in the former species increase height quicker than *H. semicostatus* and the present species, and sometimes have a ventrolateral tubercle on the rib.

BANDO (1964) described *Pleuronautilus* (*Holconautilus*) *yabei* BANDO from the Ladinian Rifu Formation of Northeast Japan. The present specimen is evidently distinguished from it in that it has a quadrate whorl section, with a flattened venter, two spiral rows of nodes on the venter and less prominent ribs.

Pleuronautilus(?) sp. reported by YABE and SHIMIZU (1927) without text-figure is ornamented with distant umbilical tubercles.

Occurrence.—Loc. 44. Shale bed of the Lower Member of Tanoura Formation with *Freguelliella* (*Kumatrigonia*) *tanourensis* TAMURA, Bakevelliid sp., *Costatoria*(?) sp.

* WIEDMANN did not exclude the figs. 5 and 7 in the same plate but the suture of fig. 6 seemed to be drawn from the specimen of figs. 5 and 7.

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Utigegeven soor Dr. H. A. BROUWER, 4, *Jaarb. Mijnw. Nederl. Ind.*, Vol. 55, Pt. 2, pp. 1-174, pls. 1-20 (1926)

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Explanation of Plate 54

Figs. 1-11. *Buchites kumamotoensis* ISHIBASHI, n. sp.
Fig. 1 GK. F 463: Fig. 2 GK. F 375 ventral part ×2: Fig. 3 GK. F 459 ×2: Fig. 4 GK. F 465: Fig. 5 GK. F 464: Fig. 6 GK. F 462: Fig. 7 GK. F 460: Fig. 8 GK. F 458, Holotype: Fig. 9 GK. F 461: Fig. 10 GK. F 374: Fig. 11 GK. F 466 ×2.

Figs. 12 a-c. *Plactes* sp. aff. *P. oxyphyllus* (MOJSISOVICS) GK. F 379 ×2.

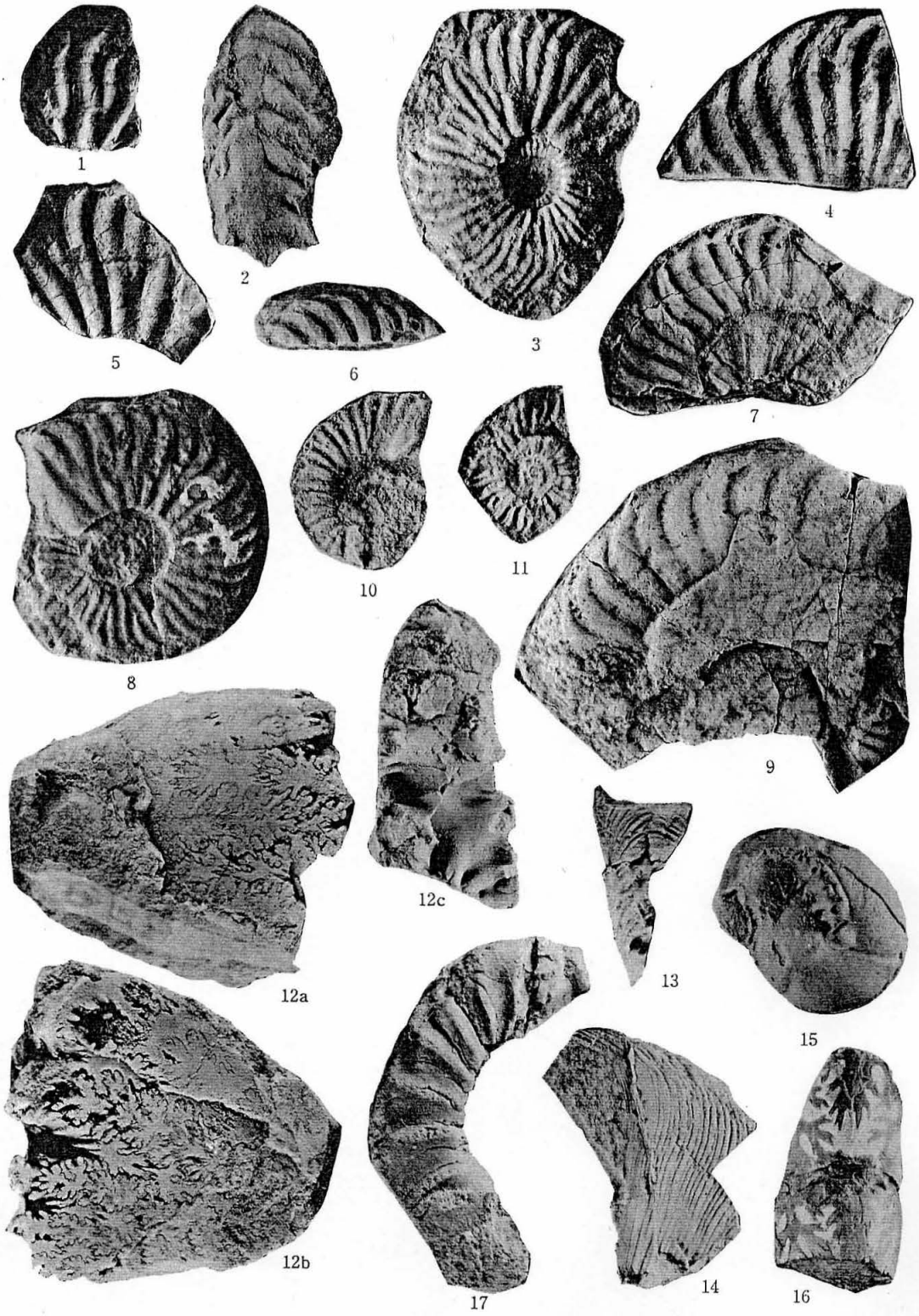
Figs. 13 and 14. *Phormedites* sp. Fig. 13 GK. F 377b ventral part: Fig. 14 GK. F 377 a.

Fig. 15. *Arcestes* sp. cf. *A. (Proarcestes) ausseeanus* (HAUER) GK. F 468.

Fig. 16. *Rhacophyllites* sp. GK. F 371 ventral part.

Fig. 17. *Holconautilus* sp. GK. F 378.

(Figures in natural size except as indicated)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Jito	地頭	Rifu	利府
Kitakami	北上	Saragai	皿貝
Kochigatani	河内ヶ谷	Takagochi	鷹河内
Nariwa	成羽	Tanoura	田浦
Okinawa-jima	沖縄島	Uminoura	海浦
Ota	太田		

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 88, pp. 458-461, pl. 55, December 20, 1972

608. A FOSSIL WORM TRAIL FROM THE UPPER CRETACEOUS NAKAMINATO FORMATION, IBARAKI PREFECTURE*

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茨城県上部白亜系那珂湊層産こん跡化石について：茨城県那珂湊市平磯海岸に分布する上部白亜系那珂湊層中部の平磯町部層から産出したはい跡化石は円形状の長さ約 29 cm，巾 1.2～2.0 cm の腹側面をしめし，約 3 cm の部分に約 8 列の環状体節が見られ，形態的に類似する *Nerites* の仲間のような管状中央部の溝状彫刻や肢状痕跡も見られない。また，環状体節が類似する *Arenicola*, *Balanoglossus*, *Chaetopterus* との比較検討も行なったが，平磯町部層産のはい跡化石は *Hitachia nakaminatoensis* なる新属・新種であることを認めた。さらに，本化石産出により平磯部層が大洗層堆積後の海浸時初期の沿岸海域の堆積物であることを考察した。

畑井小虎・野田浩司

Introduction and acknowledgments

Exposed on the surface of a weathered sandstone at the sea-side of Hiraiso, Nakaminato City, Ibaraki Prefecture, was found a trail of a worm, probably of marine origin. This trail, impressed on the sandstone of the Hiraiso-machi Member of the Nakaminato Formation is the first discovery of a trail fossil from the member and is thus considered important for interpretation of the conditions under which that part of the formation was deposited. The Hiraiso-machi Member occupies the middle part of the Nakaminato Formation of Upper Cretaceous age.

According to SAITO (1961) the type locality of the Hiraiso-machi Member of the Nakaminato Formation is "at the sea coast of Hiraiso-machi where it attains about 510 meters in thickness and comprises chiefly dark gray sandstone with interbedded graded sandstone layers." The Hiraiso-machi Member yielded to SAITO (1961, p. 112), *Didymoceras awajiense* (YABE), *D. nakaminatoense* (SAITO), *Nipponaster nakaminatoensis* SAITO, besides several other fossil molluscs. And the discovery of the fossil worm trail verifies that the Hiraiso-machi Member was deposited in shallow water.

The worm trail uppon which the present article is based was collected by the junior writer during the writer's field trip to the Nakaminato area with the students majoring in geology of the Faculty of Education, Ibaraki University, guided by Associate Professor Toshio SAITO and Research Associate Haruyuki TAKAHASHI of the same University.

At this place the writers express their deep appreciation to Associate Professor Toshio SAITO and Research Associate Haruyuki TAKAHASHI for their kind guidance to the Cretaceous deposits distributed along the coast of Hiraiso, Na-

* Received June 3, 1972; read June 3, 1972, at Utsunomiya.

Tertiary System	
unconformity	
Nakaminato Formation	Isoai Member, 730 m thick. Graded sandstone and siltstone. *Inoceramus* cf. *shikotanensis*, *Nipponaster nakaminatoensis*, *Baculites inornatus*, etc.
	Hiraiso-machi Member, 510 m thick. Siltstone with intercalated sandstone. *Didymoceras awajiense*, *Pravitoceras* sp., etc.
	Chikko Member, 35 m thick. Granule sandstone in lower and coarse to fine grained sandstone in upper.
conformity	
Oarai Formation	1030 m thick. Conglomerate intercalated with thin sandstone layers, coal seams, and plant fossils.
Base not exposed	

kaminato City, and also for their information on the geology of the area. Thanks are due to Mr. Kimiji KUMAGAI for photographic work and to Mrs. Kimiko SHIBUYA for typing the manuscript.

Stratigraphic position of the worm trail

The stratigraphic position of the Hiraiso-machi Member in the geological column of the Cretaceous deposits distributed along the sea coast of Nakaminato City, is, according to SAITO (1961), as follows.

The fossil trail forming the subject of the present article was found in the upper part of the Hiraiso-machi Member, and represents the first discovery of a trail fossil from the Member. All of the three members of the Nakaminato Formation are conformable with one another, unconformable with the superjacent Tertiary System, and also conformable with the underlying Oarai Formation.

The worm trail

The worm trail, which consists of a single specimen, lacks both anterior and posterior extremities, and thus its original length remains unknown. But, as shown in the annexed figure, features suggesting the original segments of the body, and the approximate thickness of the rounded body are still preserved. Since the sandstone layer in which the worm trail is preserved is not overturned, the exposed morphological features represent the original ventral surface of the worm.

The worm trail measures about 29 cm in length measured along its longitudinal middle part and the width, although variable at places according to the state of preservation, measures from 12 to 20 mm in minimum and maximum widths, and there are about 8 segments within a distance of about 30 mm. The body as can be judged from the preserved outline is rounded elongate. No longitudinal mesial depression or podia-like structures are observed and features suggesting *Nereites* affinity could not be observed.

Since the preserved segment-structures are interpreted to represent the original ventral surface of the worm, affinity is found with such living genera of marine worms as *Arenicola*, *Balanoglossus* and *Chaetopterus*, all of which have well developed segments. Among

the mentioned genera, the present fossil worm trail shows resemblance with the Recent species *Arenicola cristata* STIMPSON, now living along the coast of Japan. That species, according to OKUDA and IIZUKA (1949) attains about 60-90 mm in length and about 18 mm in width. *Cristata* lives in sandy mud or muddy sand in shallow depths along the coast of Japan. *Arenicola claparedii* LEVINSON (OKUDA and IIZUKA, 1949), which attains about 100-200mm in length also lives in sandy mud or muddy sand in shallow water, and is distributed from Central Japan to the Kurile Islands. Of these two Recent species, the present fossil worm impression seems to be more similar to *A. cristata* than to *A. claparedii*, although differing from both.

Among the fossils reported by HOWELL (1962), none expect possibly the genus *Tosalorbis* proposed by KATTO (1962) based upon specimens from the Eocene Muroto Formation in Kochi Prefecture, Shikoku, Japan, seem to be comparable with the present fossil. However, *Tosalorbis* differs from the present specimen in having closer set segments and much shorter body length. Specimens comparable with the present one were not noticed in the recently published work "Trace Fossils" edited by CRIMES and HARPER (1970).

Under the circumstances mentioned above it seems that a new name should given to the present interesting worm trail, the first of its kind from the Cretaceous of Japan, in order that its usage in biostratigraphy, paleoecology and taxonomic classification be emphasized.

Genus *Hitachia* HATAI & NODA, n. gen.

Type species:—*Hitachia nakaminatoensis* HATAI and NODA, n. gen. et n. sp.

Type locality, formation, geological age, and depository:—Upper Part of the Hiraiso-machi Member of the Nakaminato Formation exposed along the sea coast at Hiraiso, Nakaminato City, Ibaraki Prefecture, Cretaceous. Preserved in the collection of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University (Reg. No. 91765).

Diagnosis:—Body rounded elongate, measuring 12-20 mm in minimum and maximum widths, and 29 cm in length, segments well developed, strong, numbering 8 in a distance of 30 mm. Without longitudinal mesial depression or podia-like structures.

Hitachia nakaminatoensis HATAI and NODA, n. sp.

Pl. 55

Description:—Worm trail impression elongate, winding, 29 cm in length; body rounded, thicker at middle part than at extremities, measuring 12 to 20 mm in minimum and maximum widths; segments well developed, strong, number 8 within a distance of 30 mm, broader than interspaces, indistinct at or near extremities; external morphology arenicoloid.

Remarks:—Comparison and affinity of

Explanation of Plate 55

Hitachia nakaminatoensis HATAI and NODA, natural size. Locality: Sea coast near Hiraiso, Nakaminato City, Ibaraki Prefecture, Upper Cretaceous Hiraiso-machi Member of the Nakaminato Formation, IGPS coll. cat. no. 91765.

K. KUMAGAI photo.

the present worm trail with other species was given above and here it is to be said that its similarity with the species of the genus *Arenicola* suggests that it may have led a similar life. It is judged that the fine-grained somewhat muddy sandstone of the upper part of the Hiraiso-machi Member in which the present worm trail was found, and where some ammonite and pelecypod fossils have been found, was deposited under a shallow water, open sea environment, and further it is inferred that the water temperature was moderate to warm.

It is also thought that the Hiraiso-machi Member just mentioned which is in conformable stratigraphic relation with the underlying terrestrial Oarai Formation, represents an early phase in marine transgression and an environment transitional from terrestrial to shallow marine conditions.

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——, 1962. Ditto, (Part 2). *Ibid.*, no. 13, p. 51-87, 8 pls.

Chikko	築　港	Muroto	室　戸
Hiraiso	平　磯	Nakaminato	那珂湊
Isoai	磯　合	Oarai	大　洗

Trans. Proc. Palaeont, Soc. Japan, N.S., No. 88, pp. 462-471, pl. 56 December 20, 1972

609. AMMONITES FROM THE MESOZOIC YAMABU FORMATION, KYUSHU

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九州山部層から産出したアンモナイトについて：九州の秩父帯に断片的に露出する白亜系堆積物の一つである山部層はこれまで非海成の領石統とみなされてきたが，このたびその基底部より二種のアンモナイトが採集された。一つはヨーロッパ標準地域のベリアシアンを指示する *Berriasella* で，他はバランギニアン上部を特徴づける *Pseudoosterella* に比較しうるものである。これによって西南日本外帯にも北上山地の長崎，磯草層や阿武隈山地の小山田層に対比しうるジュラ系にひきつづく海成白亜系の存在することが確認された。本論では，これらアンモナイト類の記載に加えて，山部層の地質時代について再吟味し，その問題点を将来の課題としてうきぼりにするとともに，長崎，磯草層ならびに小山田層をも含めて，このたびの発見がジュラ系白亜系の境界に関する国際的問題に対して占める意義について予察的に論及する。

野田雅之

Introductoin

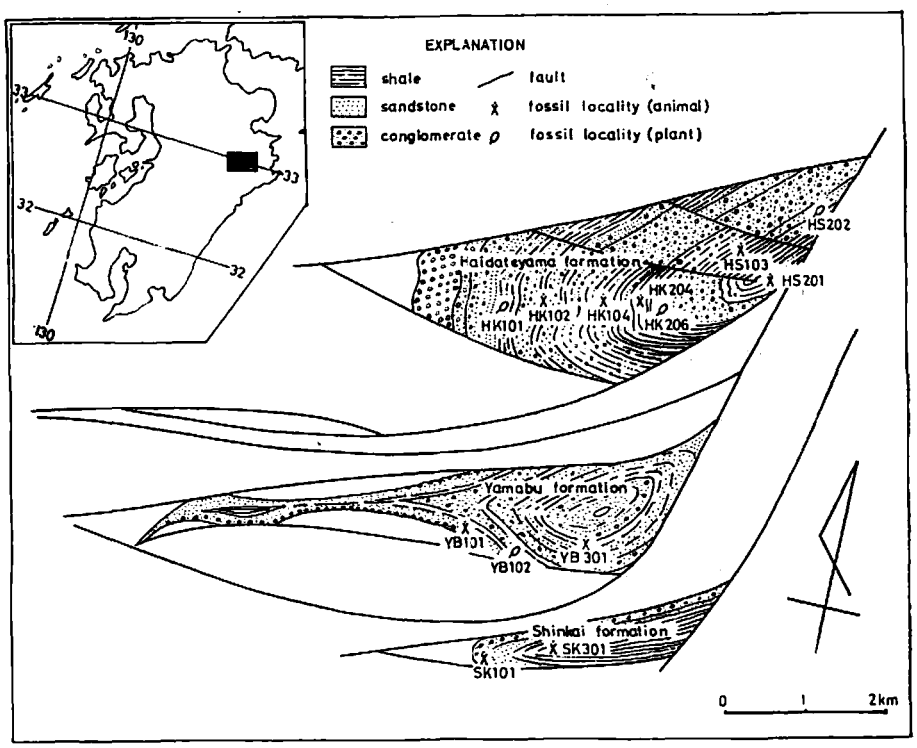
The Mesozoic Yamabu formation is exposed in a narrow area of eastern Kyushu, which belongs to the Chichibu belt of the Outer Zone of Southwest Japan. It lies unconformably on the Paleozoic strata in the western part of the southern margin and is demarcated by faults in the other sides, occupying the area of about 6 km from east to west and about 1.2 km from north to south. Its sequence is about 450 m in thickness.

The stratigraphy and the structure of this formation were previously reported by FUJII (1954) and TERAOKA (1970). FUJII considered that the basal to middle member of the Yamabu formation might be correlated to the Ryoseki formation of south Shikoku, and also to the Kawaguchi formation of the Yatsushiro area, western Kyushu, for the reasons of the resemblance in fossils and lithofacies, and assigned the sequence to the Lower Cretaceous Ryoseki Series. Furthermore, he pointed out that the formations described above were all of brackish water or non-marine environment. Since then, MATSUMOTO (1954, 1967) regarded this formation as the Ryoseki Group, and he and TERAOKA (1970) assigned it to the Kochian Series.

Anyhow, the Ryoseki Group thus understood was assigned to the lowest part of the Cretaceous deposits of Japan, and approximately correlated to the Wealden of Europe.

On December 29th, 1970, the author unexpectedly collected several specimens of ammonites from the black shale intercalated in the basal conglomerate, of which the one is referable to a species closely allied to *Berriasella patula* from the various localities of France. There is furthermore another species.

This paper deals with the paleontological descriptions of the two species of



Text-fig. 1. Geological map of the Yamabu area, showing lithostratigraphic division and distribution (adopted from TERAOKA, 1970).

ammonites from the Yamabu formation with a remark on the geological age and also some discussions on the problem of Jurassic-Cretaceous boundary in Japan.

Before going further, I express my sincere thanks to Professor Tatsuro MATSUMOTO of Kyushu University for his kind guidance and supervision of this study and also to Dr. Tadashi SATO of the University of Tokyo for his useful suggestion about the identification of the species. Acknowledgements are also due to Dr. Yoji TERAOKA of the Geological Survey of Japan for his kindness of permission to adopt his geological map in this paper.

Stratigraphy of the Yamabu formation

The Yamabu formation structurally shows the syncline with axial trend from east to west. In its sequence four minor sedimentary cycles are distinguished.

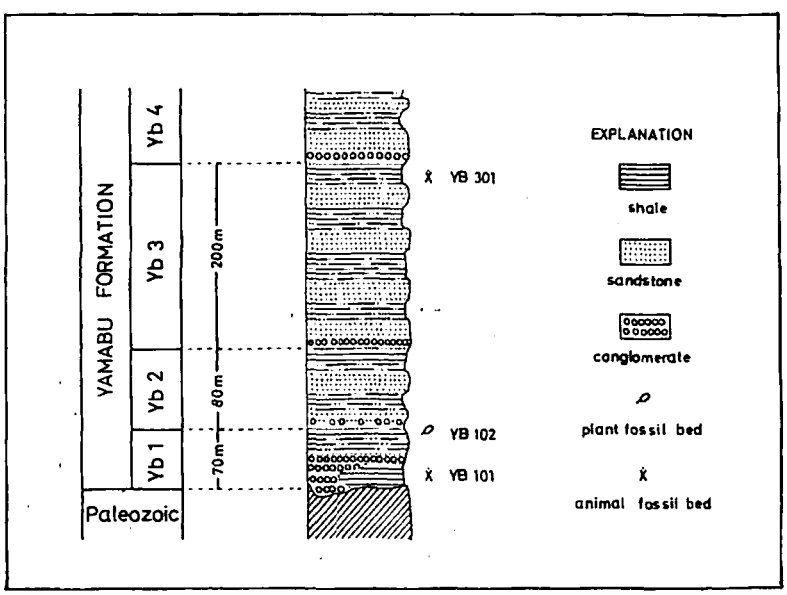
(1) Basal member. About 20 m-90 m in thickness. Mainly exposed on the southern synclinal wing and partly in the northern area, generally thickened westwards and northwards. Its lower part consists of ill-sorted conglomerate with intercalation of black shale about 20 m in thickness near Shinkai, Honjo Village, Minamiamabe County, Oita Pre-

fecture, and generally becoming rich in sandstone upwards. The upper part consists of thin bedded and moderately thickened alternation of sandstone and shale. The conglomerate is made up of well-rounded boulders, cobbles and pebbles of granite, granite-porphyry, aplite, diorite, quartz-porphyry, porphyrite, sandstone, slate, chert and green-schist, commonly with sandy matrix and partly with muddy one. Sandstone is well-sorted and medium-grained. Thin bedded shale inserted in sandstone bears carbonaceous or poorly preserved plant fossils.

(2) Lower member. About 80 m in thickness. Its lower part consists of white or grayish white feldspathic-quartz-sandstone, well-bedded about 1 m in thickness. The main part consists of hard, fine to medium-grained sandstone, occasionally inserted with thin layers of shale, and gradually becoming more fine-grained upwards.

(3) Middle member. About 200 m in thickness. Its lower part consists of conglomerate about 10-15 m in thickness. The main, middle part is fine to medium-grained sandstone and shale; the upper part, sandy shale. The features of this conglomerate is similar to those of the basal one in grading, and kinds of gravel but distinguishable in its more muddy matrix. Occasionally it is so rich in matrix that it can be called the pebbly mudstone. In the main part, the following brackish water mollusks of the Ryoseki type are contained in the black shale inserted in feldspathic-quartz-sandstone (FUJII, 1954; TERAOKA, 1970).

Brotiopsis kobayashii SUZUKI
Polymesoda (*Isodomella*) *otsukai* (YABE and NAGAO)
Protocyprina cf. *naumanni* (NEUMAYR)
Eomiodon cf. *sakawanus* (KOBAYASHI and SUZUKI)



Text-fig. 2. Schematic columnar section of the Yamabu formation.

Ostrea ryosekiensis KOBAYASHI and SUZUKI
Aloides sp.

(4) Upper member. More than 100 m in thickness, mainly occupying the axial area of the syncline. Its lower part consists of conglomerate. The main part is dark gray coarse-grained sandstone and thin bedded alternation of sandstone and shale. Upper limit is uncertain because of the synclinal structure. Sandstone is commonly graywacke with hard matrix of aphanitic silica.

The geological map and stratigraphic column of this formation are shown in Text-figs. 1 and 2.

Paleontological descriptions

Family Berriasellidae SPATH, 1922

Subfamily Berriasellinae SPATH, 1922

Genus *Berriasella* UHLIG, 1905

Berriasella sp. aff. *B. patula* SCHNEID

Pl. 56, Fig. 1a, b.

Compare—
1915. *Berriasella patula* SCHNEID, *Geol. Palaeont. Abh.* 13, (5), p. 66, pl. 7, fig. 5
1939. *Berriasella patula*, MAZENOT, *Mem. Soc. Géol. France*, N.S.N°. 41, pp. 60, 61, pl. 4, fig. 5a, 5b.
1962. *Berriasella* sp. aff. *patula*, COLLIGNON, *Atlas des fossils Caracteristiques de Madagascar*, p. 6, pl. 117, fig. 772

Material.—One specimen from loc. YB101, the basal member of the Yamabu formation, Oita Prefecture, Kyushu, collected by M. NODA (1970) is concerned with the description.

Descriptive remarks.—The specimen is so crushed secondarily that the original proportion of breadth and height is uncertain. The umbilical wall is probably steep, forming a rounded shoulder with the flank. The whorl is fairly evolute, probably less than one fourth of inner whorl being embraced by the outer one, increasing comparatively slowly in height. The original proportion of the umbilicus and the diameter is not precisely known owing to the effect of deformation, but it is probably larger than the measured value. The flanks are rather flat, on which, especially on the outer two whorls, the ornamentation is fairly well-preserved. On inner whorls the ornamentation is unfortunately indiscernible because of the poor preservation. In later stages more than 33 mm in diameter, the whorls are ornamented with sharp, distinct and somewhat sigmoidal ribs. They begin at the umbilical margin with conspicuous elevation and bifurcate at the middle or at the point a little below the middle of the flank, curving considerably forward on the ventrolateral part. There are 41 ribs in the last whorl which is more than 116 mm in diameter. On the last whorl, the ribs are as wide as interspaces and on the inner half of the flank, the interspaces are fairly wide

Measurements.—

	Diameter	Umbilicus	U/D
(1)	105.1 mm	41.4 mm	0.40
(2)	85.4 mm	37.1 mm	0.42

(1) At the end of visible whorl.
(2) About 65° back from (1).

Table 1.

species	material	diameter	umbilicus	U/D
B. priversensis	MAZENOT pl. 2, fig. 3	58 mm	21 mm	0.36
B. priversensis	MAZENOT pl. 2, fig. 4	56 mm	23 mm	0.40
B. priversensis	MAZENOT pl. 2, fig. 6	42 mm	16 mm	0.38
B. sp. aff. *B. priversensis*	MAZENOT pl. 2, fig. 5	38 mm	12 mm	0.32
B. collistoides	MAZENOT pl. 7, fig. 1	76 mm	22 mm	0.29
B. callistoides	MAZENOT pl. 7, fig. 2	81 mm	24 mm	0.30
B. patula	MAZENOT pl. 5, fig. 5	73 mm	33 mm	0.45
B. patula	SCHNEID pl. 7, fig. 5	74 mm	36 mm	0.48
present specimen		93.5 mm	38.8 mm	0.42

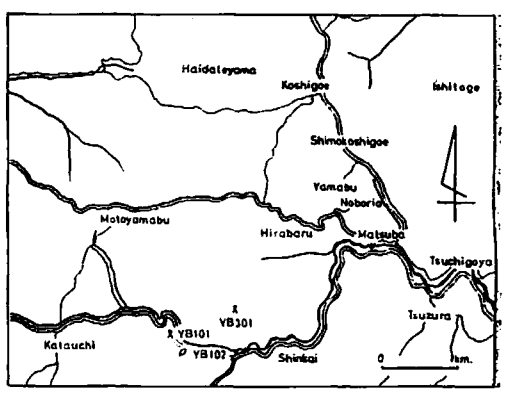
and flat or broadly concave. The suture lines are indiscernible.

These characteristics are comparable with those of *Berriasella patula* SCHNEID, 1915 from the Upper Tithonian of Neûburg and the Berriasian of Saint-Julien-en Bochaine, Berrias and Bournet, France. But there are some differences between the specimens concerned with the SCHNEID's original description (1915) and the photograph of the same species by MAZENOT (1939). That is, the MAZENOT's specimen has more rapidly enlarging whorls and a less wide umbilicus than the SCHNEID's. The Yamabu specimen is rather closer to the MAZENOT's in this respect, if the effect of deformation is taken into consideration.

The present specimen also resembles *B. priversensis* (PICTET, 1867) and *B. callistoides* (BEHRENDSEN, 1891), but differs from them in the following characters. (1) The umbilicus of the present specimen as shown in Table 1, is fairly wide in proportion to diameter. (2) The ribs are flexuous in the present species but nearly straight in *B. priversensis*. (3) The ribs bifurcate near the middle of the flank in the present species but at much higher point up about a fourth of the flank in *B. priversensis*.

B. morti MAZENOT, 1939 from the Upper Tithonian of Vogüe, also resembles this specimen but differs from the latter in more crowded ribs which bifurcate at somewhat higher point than the middle of the flank, and absence of the conspicuous elevation at the starting point of the ribs.

Occurrence.—Locality YB101, at Yamabu, Honjo Village, Minamiamabe County, Oita Prefecture. Location: Long. 131°38′33″8E, Lat. 32°55′5″7N. The specimen occurred in the black shale inserted in the basal conglomerate of the Yamabu formation.



Text-fig. 3. Locality map.

Family Oosterellidae BREISTROFFER, 1940

Genus *Pseudoosterella* SPATH, 1924

Pseudoosterella sp.

Pl. 56, Figs. 2-4

Material.—Three specimens from loc. YB101, the basal member of the Yamabu formation, Oita Prefecture, Kyushu, (coll. M. NODA) are concerned with the description.

Descriptive remarks.—Although the specimens are all very incomplete fragments, the original characteristics are preserved in the convexity of whorl and ornamentation. The specimen of NODA collection JG. H1003 is an adult individual about one sixth of whorl with 19.3 mm in height and other two specimens (JG. H1004 and JG. H1005) are both immature, of which the one, JG. H1004, is about one fourth of whorl and the other is about one sixth of whorl.

The umbilical wall is fairly steep, forming a round shoulder with the flank. The whorl is compressed probably increasing slowly in height. The flank is broadly convex and forms a subangular shoulder at the ventrolateral part. There is a finely serrate keel at the mid-venter.

The simple ribs bigin at the umbilical margin, running rectiradially on the flank, and sharply projected at the ventrolateral shoulder. They are as wide as the concave interspaces, and regular in strength and distance. The rib density ranges from 8 to 9 per one sixth of whorl and 10 per one fourth of whorl.

In these features, this species is referable to *Pseudoosterella*. The specific identification remains uncertain because of the incomplete materials.

Occurrence.—Locality, YB101, at Yamabu, Honjo Village, Minamiamabe County, Oita Prefecture. The specimen is associated with *Berriasella* aff. *patula*.

On the geological age of the Yamabu formation

The Yamabu formation has been considered as the non-marine deposits, because of the occurrence of *Protocyprina* cf. *naumanni* in its middle member. It has been set to the lowest part of the Lower Cretaceous in Japan, probable correlative of the Wealden of England (see remarks in the introduction). The discovery of ammonites from the basal member, however, indicates that the early stage of sedimentation of the Yamabu formation is probably of marine origin and the occurrence of *Berriasella* probably indicates Berriasian age. According to MAZENOT (1939), *Berriasella patula* occurs not only in the Lower Tithonian of Neûburg (SCHNEID regarded the same locality as the Upper Tithonian) but also from the Berriasian of Saint-Julien-en-Bôhain, Berrias and Bournet of Southeast France. Although there are some questions about the range of that species described in MAZENOT, the occurrence of *Berriasella* aff. *patula* from the Yamabu formation, at least, indicates the geological age corresponding to the Berriasian.

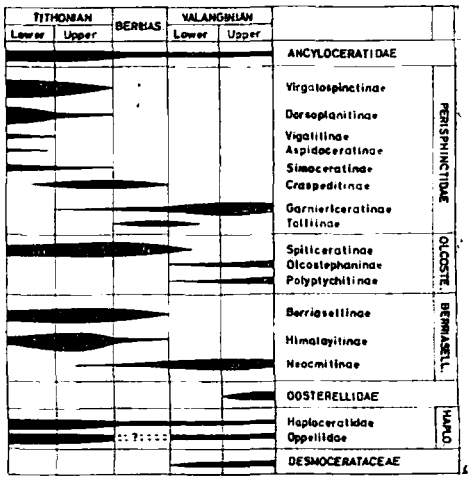
SATO (1958, 1961) previously described some Berriasian and Valanginian ammonites from the Lower Cretaceous deposits which comformably overlie the Jurassic strata in the Kitakami and the Abukuma massifs. They are *Berriasella akiyamae* SATO, *Thurmanniceras isokusensis* KOBAYASHI and FUKADA from the Isokusa formation, *Berriasella* sp. ex gr. *B. berthei* TOUCAS, *Spiticeras* (*Spiticeras*) cf. *binodiger* UHLIG, *Olcostephanus* sp. and *Kilianella* juv. sp. from the Nagasaki formation and *Parakilianella umazawensis* SATO, *Thurmanniceras* sp. and

Berriasella sp. from the Koyamada formation. Based on the assemblage of species he considered that there are some marine deposits in Japan which are contemporaneous with or somewhat older than the non-marine Ryoseki Series and that they probably correspond to the Berriasian in the international scale, regardless the occurrence of *Olcostephanus* sp., the genus from the Upper Valanginian of Europe, South Africa, Madagascar, Pakistan, Mexico and Peru, being later than *Berriasella* in these areas.

The basal member of the Yamabu formation, therefore, may be correlated to those formations of Northeast Japan. But there is a question that *Pseudooosterella* sp. which should normally characterize the Upper Valanginian occurs from the same bed with *B.* aff. *patula*. This is similar to the case of the Nagasaki formation.

At present, it is uncertain whether or not the association of the Berriasian and the Valanginian species is the exceptional case found only in Japan. The solution of this problem is important for more precise world-wide correlation.

The upper part of the middle member of the Yamabu formation is characterized by brackish water mollusks listed in p. 464, common in various localities of the Ryoseki Series in Japan. The similar examples in the Lower Cretacous, i. e. the marine deposits under the non-marine ones are also found in the Uminoura formation, Kumamoto Prefecture (TAMURA, 1960b ; SATO, 1961 and MATSUMOTO, 1962) and the Kawaguchi formation, Kumamoto Pref. (MATSUMOTO, personal information, 1971). However, due to the insufficient data, more precise correlation of the Yamabu formation and those of Kumamoto Pref. is left unsolved. I must investigate it as a further problem.



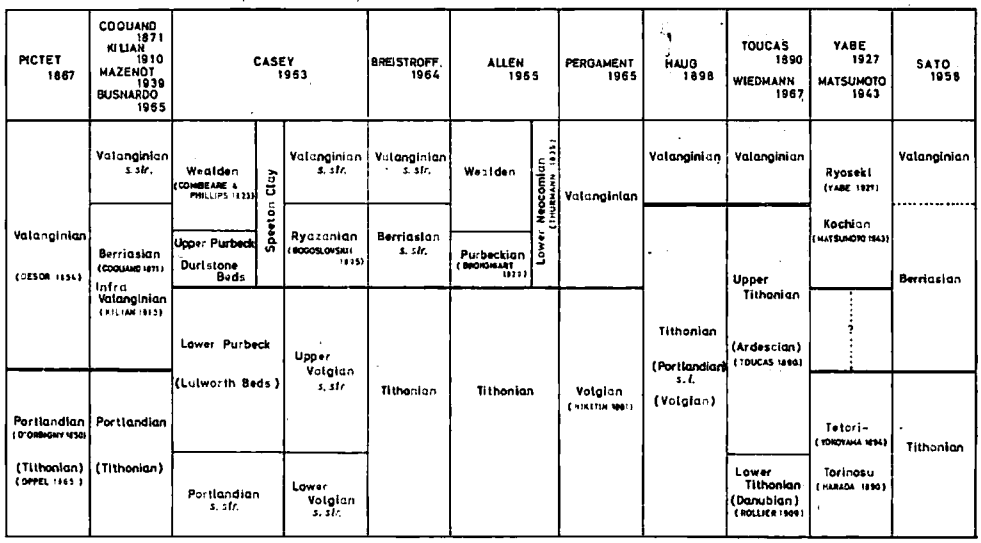
Text-fig. 4. Range chart of ammonites at Jr/Cr boundary (after WIEDMANN, 1967).

The international problem of the Jr/Cr boundary

The geological age of the Yamabu formation has some relations to the international problem of the Jr/Cr boundary, because there is no agreed opinion, at present, for the border-line by means of paleontological evidence and sedimentary structure. The geological divisions of the Upper Jurassic and the Lower Cretaceous are interpreted differently by various researchers as shown in Table 2.

The PERGAMENT's division is based on paleontological evidence, notwithstanding it differs from that of HAUG, TOUCAS and WIEDMANN. He has regarded the zones of *Subthurmannia boissieri* and *Riasanites rjasanensis* as the lowest limit of the Cretaceous, under the name of Valanginian and he excluded the name of Berriasian in his division. In other words, the zones characterized by *Berriasella* spp. are included into the

Table 2. Geological division of the Upper Jurassic and the Lower Cretaceous (thickness not to scale).



Volgian. While, TOUCAS and others included the two zones in the Tithonian, hence the top of the Tithonian in their definition corresponds to the border-line of Berriasian and Valanginian of MAZENOT, BUSNARDO, BREISTOROFFER and KILIAN.

WIEDMANN's division is based on a range chart of ammonites (Text-fig. 4).

For the Cretaceous of Japan the division proposed by YABE (1927) had been used. He intended to use the term Ryoseki Series as a time-stratigraphic unit but gave a definition that it is a series, mostly of fresh and brackish water deposits, which is the product of a time of marine regresssion and that it is approximately correlated with the Wealden, the time of transition from the Jurassic Period to the Cretaceous in the European standard. Actually, what had been recognized as the Ryoseki in various areas of Japan was rather a facies-stratigraphic unit and accordingly MATSUMOTO (1943, 1954) proposed the Kochian [=Kotian] for the lower series of the tripartite Lower Cretaceous in Japan. He attempted to define it by the available marine fossils (trigonians), but our knowledge of the taxonomy and stratigraphic occurrence of the trigonians at that time was not sufficient. SATO's (1958, 1961) discovery of ammonites from the Isokusa and the Nagasaki formations has made it possible to correlate the Japanese scale with the international one. From the fact that the ammonites of Upper Valanginian aspect are associated with Berriasian species, it is better to ascribe these formations to the Lower Cretaceous Berriasian as defined by MAZENOT and BUSNARDO rather than to the Tithonian. The facts newly observed in the Yamabu formation also support this.

The apparent intermingling of Valanginian aspect ammonites with the undoubtedly Berriassian ones at several

Table 2. Geological division of the Upper Jurassic and the Lower Cretaceous (thickness not to scale).

PICTET 1867	COQUAND 1871 KILIAN 1910 MAZENOT 1939 BUSNARDO 1965	CASEY 1963			BREISTROFF 1964	ALLEN 1965		PERGAMENT 1965	HAUG 1898	TOUCAS 1890 WIEDMANN 1967	YABE 1927 MATSUMOTO 1943	SATO 1958
Valanginian (DESOR 1854)	Valanginian s. str.	Wealden (COMBEARE & PHILLIPS 1822)	Speeton Clay	Valanginian s. str.	Valanginian s. str.	Wealden	Lower Neocomian (THURMANN 1835)	Valanginian	Valanginian	Valanginian	Ryoseki (YABE 1927)	Valanginian
	Berriasian (COQUAND 1871) Infra Valanginian (KILIAN 1910)	Upper Purbeck Durlstone Beds		Ryazanian (BOGOSLOVSKII 1895)	Berriasian s. str.	Purbeckian (BRONGNIART 1829)			Tithonian (Portlandian s. l. (Volgian)	Upper Tithonian (Ardescian) (TOUCAS 1890)	Kochian (MATSUMOTO 1943) ?	Berriasian
Portlandian (D'ORBIGNY 1850) (Tithonian) (OPPEL 1865)	Portlandian (Tithonian)	Lower Purbeck (Lulworth Beds)		Upper Volgian s. str.	Tithonian	Tithonian		Volgian (MIKLUTHO 1881)			Tetori- (YOKOYAMA 1894)	Tithonian
		Portlandian s. str.		Lower Volgian s. str.						Lower Tithonian (Danubian) (HOLLIER 1909)	Torinosu (HARADA 1896)	

Volgian. While, TOUCAS and others included the two zones in the Tithonian, hence the top of the Tithonian in their definition corresponds to the border-line of Berriasian and Valanginian of MAZENOT, BUSNARDO, BREISTOROFFER and KILIAN.

WIEDMANN's division is based on a range chart of ammonites (Text-fig. 4).

For the Cretaceous of Japan the division proposed by YABE (1927) had been used. He intended to use the term Ryoseki Series as a time-stratigraphic unit but gave a definition that it is a series, mostly of fresh and brackish water deposits, which is the product of a time of marine regresssion and that it is approximately correlated with the Wealden, the time of transition from the Jurassic Period to the Cretaceous in the European standard. Actually, what had been recognized as the Ryoseki in various areas of Japan was rather a facies-stratigraphic unit and accordingly MATSUMOTO (1943, 1954) proposed the Kochian [=Kotian] for the lower series of the tripartite Lower Cretaceous in Japan. He attempted to define it by the available marine fossils (trigonians), but our knowledge of the taxonomy and stratigraphic occurrence of the trigonians at that time was not sufficient. SATO's (1958, 1961) discovery of ammonites from the Isokusa and the Nagasaki formations has made it possible to correlate the Japanese scale with the international one. From the fact that the ammonites of Upper Valanginian aspect are associated with Berriasian species, it is better to ascribe these formations to the Lower Cretaceous Berriasian as defined by MAZENOT and BUSNARDO rather than to the Tithonian. The facts newly observed in the Yamabu formation also support this.

The apparent intermingling of Valanginian aspect ammonites with the undoubtedly Berriassian ones at several

localities in Japan is unusual and left to be solved in the future.

To sum up, the discovery of new data in Japan as described in this paper, not only enables us to attempt the world-wide correlation but also may give some contribution to the international problem of the Jr/Cr boundary.

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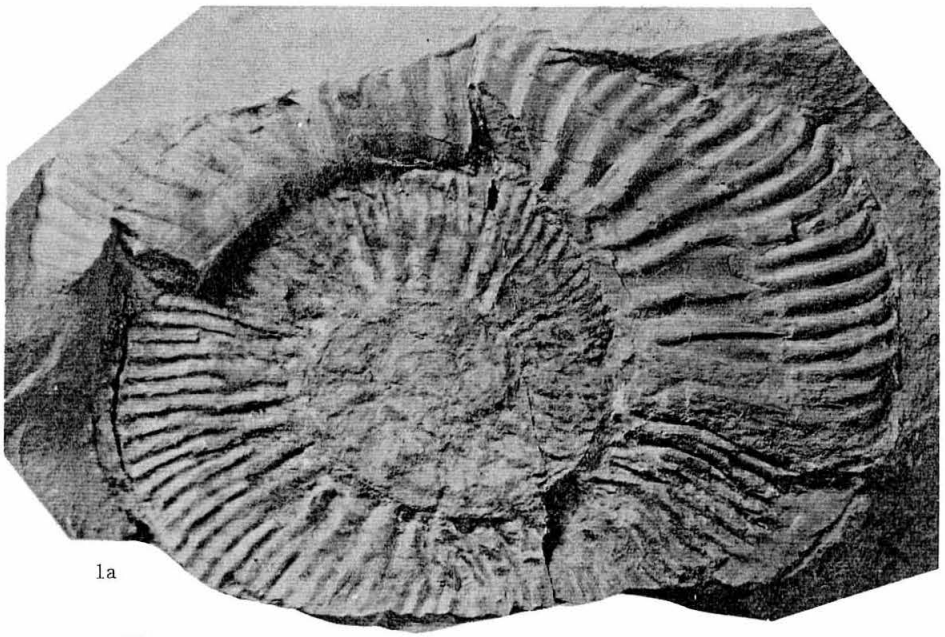
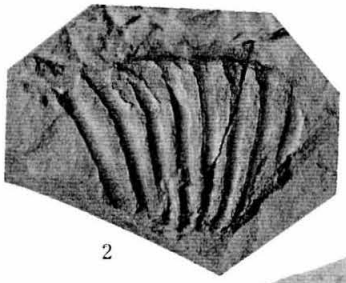
Explanation of Plate 56

Fig. 1a, b. *Berriasella* sp. aff. *B. patula* SCHNEID, natural size. Loc. YB101, Shinkai, Honjo Village, Minamiamabe County, Oita Prefecture. (Coll. NODA, 1970)

Figs. 2-4. *Pseudoosterella* sp. 2. natural size, 3, 4. ×1.5. Loc. YB101. (Coll. NODA, 1971)



1a



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3

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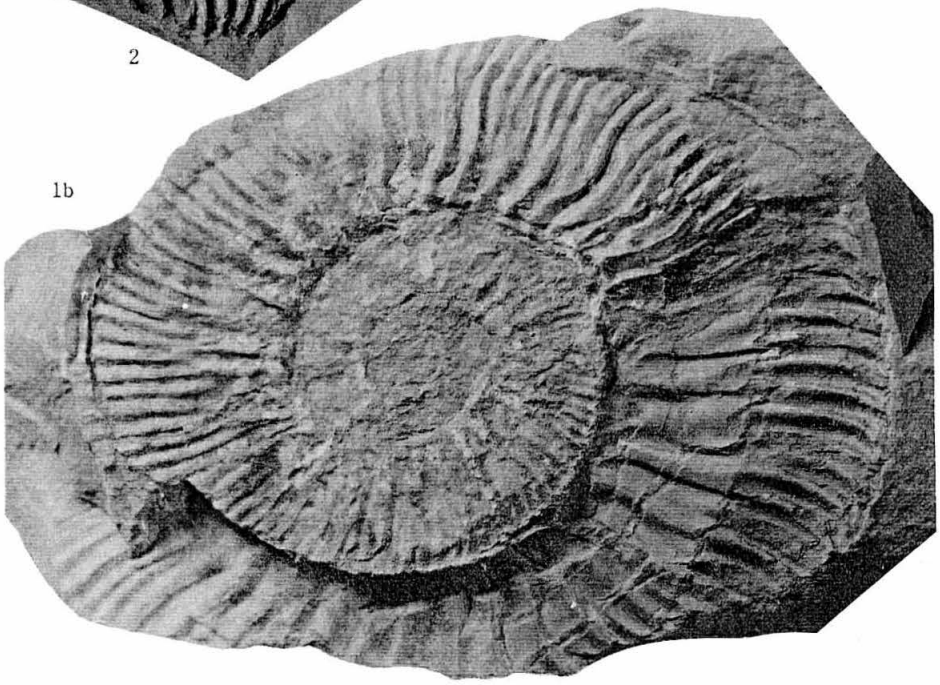
1b



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Honjo	本匠	Ryoseki	領石
Isokusa	磯草	Shinkai	新開
Kawaguchi	川口	Uminoura	海ノ浦
Kitakami	北上	Yamabu	山部
Koyamada	小山田	Yatsushiro	八代
Minamiamabe	南海部		

Trans. Proc. Palaeont, Soc. Japan, N.S., No. 88, pp. 472-484, pl. 57, December 20, 1972

610. SOME FOSSIL PTEROPODA FROM MIYAZAKI AND OKINAWA PREFECTURES, SOUTHWEST JAPAN*

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西南日本沖縄および宮崎県産翼足類化石について：沖縄本島中南部に発達する上部中新世与那原層と下部鮮新世新里層および宮崎県中部に分布する中部中新世児湯層下部の川原部層産出の翼足類化石を検討した。児湯層川原部層から *Cleodora hataii*, 新里層より *Cleodora okinawana*, *Cavolinia okinawana*, *Atlanta okinawana* の四新種を含む7属8種の記載を行なった。

野田浩司

Introduction

There are only few studies on the fossil pteropods in and outside Japan, probably because of their rare occurrence due to thin and fragile shell.

Although the Pteropoda range from the Paleogene (HARRIS, 1894; CURRY, 1965) to Recent, in Japan the oldest record is a Miocene species, *Cavolina raritatis* NOMURA and ZINBO, 1935, from the Yanagawa Shell Bed in Fukushima Prefecture and several Pleistocene species from the Semata Shell Bed by YAMAKAWA and ISHIKAWA (1912a, b), NOMURA and HATAI (1936) and KOBAYASHI (1956), whereas there are no records from the Pliocene in Japan. The systematic classification of the shell bearing pteropods has been based mainly on the soft parts (RANG, 1825; PELSENEER, 1888b; TESCH, 1904; WENZ, 1960; TAYLOR and SOHL, 1962; SPOEL, 1967; HYMAN, 1967; BOLTOBSKOY, 1971 and others). According to the authorities just mentioned the Pteropoda are cosmopolitan in distribution.

Fortunately the writer collected some Miocene and Pliocene species from Miyazaki and Okinawa Prefectures, Southwest Japan. These records are important for regional correlation and reconstruction of the paleo-environment of the deposits.

* Received June 20, 1972; read June 3, 1972, at Utsunomiya.

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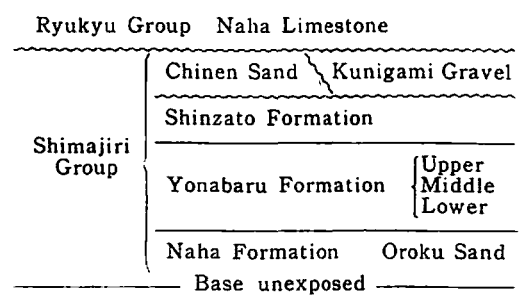
tions on the stratigraphy of Okinawa-jima. Thanks are also due to the members of the Research Group of Cenozoic Molluscs (Profs. Koichiro MASUDA, Miyagi University, Kotora HATAI, Tohoku University, Tokio SHIKAMA, Yokohama University, Shozo HAYASAKA, Kagoshima University, Associate Professors Tamio KOTAKA, Tohoku University, Takehiko IWAI, Hirosaki University, Taisuke TAKAYASU, Akita University, Saburo KANNO, Tokyo University of Education, Kiyotaka CHINZEI, Tokyo University, Hiroyuki OTSUKA, Kagoshima University, Junji ITOIGAWA, Nagoya University, Sakae OJIARA, Chiba University, Drs. Yasuhide IWASAKI, Tokyo University, Kazuo OKAMOTO, Hiroshima University, Messrs. Kimihiko OKI, Kagoshima University, and Kenshiro OGASAHARA, Tohoku University) for their kind information on the biostratigraphy of the Miyazaki Basin and discussions in the field. Thanks are expressed to Mr. Michio KATO, Tohoku University for picking up the fossil pteropods under the microscope and to Mr. Kimiji KUMAGAI for the photographic work.

Stratigraphic occurrence of fossil Pteropoda

The fossil pteropods treated in this article were collected from the two isolated areas (Miyazaki and Okinawa) as described below.

A. Okinawa District.

The fossil pteropods were collected from some localities in the area of distribution of the Shinzato and Yonabaru formations (Text-fig. 2) of the Shimajiri Group (HANZAWA, 1935). The classification of the Neogene stratigraphy of the Okinawa-jima proposed by HANZAWA (1935) and MACNEIL (1960). has recently been revised by KONISHI *et al.* (1970, 1971) and FUKUDA *et al.* (1970). According to them, the stratigraphical sequence of the south to central parts of Okinawa-jima is:



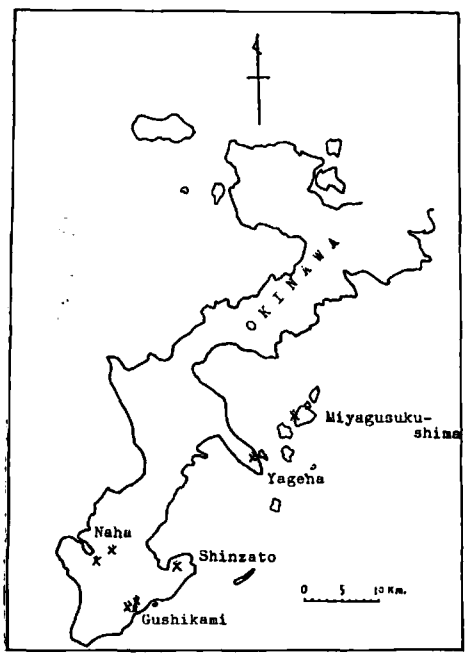
The lower part of the Yonabaru Formation (FUKUDA *et al.*, 1969, 1970) is nearly the same as the lower part of the Yonabaru Clay of MACNEIL (1960) in the western part of island. The formation dips eastwards with low dips and is composed mainly of massive dark gray to brownish gray clayey siltstone sometimes intercalated with fine-grained tuffaceous sandstone layers which yielded *Cavolinia telemus* LINNAEUS, *Cleodora okinawana* n. sp., and *Creseis acicula* RANG. The first mentioned species is rather common but the other two are rather rare in occurrence. These pteropods are sometimes associated with molluscs, foraminifers and fish otoliths.

The Shinzato Formation, first proposed by MACNEIL (1960) for the white acidic tuffs intercalated in the massive clayey siltstone around Shinzato, Sashiki-son in the eastern part of island under the name of the Shinzato Tuff Member, also yielded fossil pteropods. The formation was revised by FUKUDA *et al.* (1970), and stated to be composed mainly of massive dark gray to brownish gray siltstone intercalated with very fine, layered acidic tuffs and partly

sandy siltstone. The formation is distributed mainly on the eastern side of the island and in a small isolated area of the Katsuren Peninsula (HAYAMI, 1971) and Miyagusuku-shima (Text-fig. 1).

The Shinzato Formation near the type locality yielded *Cavolinia telemus*, *Cleodora okinawana* and *Creseis acicula*. The same formation around Yagena and Tobaru, composed mainly of massive tuffaceous sandy siltstone intercalated with white very fine acidic tuffs, yielded *Atlanta okinawana*, *Hyalocylix striata*, *Cleodora okinawana* and *Diacrina bisulcata* commonly. There is another isolated area around Yonagusuku where the Shinzato Formation yielded some pteropods.

The Shinzato Formation, according to FUKUDA *et al.* (1970) and the field survey by the writer, changes gradually from the Yonabaru Clay (MACNEIL, 1960) and Yonabaru Formation (FUKUDA *et al.*, 1970).



Text-fig. 1. Map showing fossil localities.

B. Miyazaki District.

Only one new species *Cleodora hataii*, n. sp. was found from the bluntly laminated pale gray to brownish gray, hard, medium to fine-grained sandstone of the Kawabaru Member of the Koyu Formation (SHUTO, 1961). The fossil locality is near to the localities nos. 46 and 47 of SHUTO (1961). According to SHUTO (1961), the Kawabaru Member occupies the lowest part of the Koyu Formation. The formation was subdivided by SHUTO (1961) into three members in his area of Aoshima Facies, which is distributed mainly along the western part of the Miyazaki Basin. SHUTO (1961) stated that the formation is Middle Miocene in age based upon the molluscan and planktonic foraminiferal fossils. *Cleodora hataii* is noteworthy for occupying a lower stratigraphic position in Japan. An allied species was described from the type Langhian Cessole Formation (Italy) by ROBBA (1971).

Remarks on the Pteropoda records

As already stated by PELSENEER (1888b) the Pteropoda differ from the Cephalopoda, *Tentaculites*, *Conularia* and *Hyolithes* though the external sculptures and morphology are somewhat similar. PELSENEER (1888b), TESCH (1904), CHEN and BÉ (1964), HYMAN (1967) and others have made a historical review of the Pteropoda and further reworks are not necessary. At this place, remarks are given on the first records from the Miyazaki and Okinawa Prefectures, southwest Japan because of their being first from the Japanese Pliocene and the second from the Miocene. As known at present the earliest record of the shell-

bearing Pteropoda is from the Eocene of England (HARRIS, 1894; CURRY, 1965). The Koyu Formation in Miyazaki Prefecture is Middle Miocene in age according to SHUTO (1961), who studied the marine molluscan fossils from the formation. SHUTO (1961) subdivided the formation into three members, among which the lowest or the Kawabaru Member yielded *Cleodora hataii*, n. sp., a species resembling *Clio pulcherrina* reported from the Cessole Formation (Langhian), Italy by ROBBA (1971). This Middle Miocene record is the oldest in the Japanese Neogene.

The Shimajiri Group originally described by HANZAWA (1935) was revised by MACNEIL in 1960. Recently, FUKUDA *et al.* (1969, 70) published a geological map of the Shimajiri Group distributed in the central southern part of the Okinawajima from the view point of the natural gas resources. The Yonabaru Formation, the middle part of the group, according to FUKUDA *et al.* (1969, 1970) underlies the Shinzato Formation with conformity and yielded *Amussiopecten praesignis*, *Hawaiarca uwaensis*, *Limopsis tajimae*, *L. tokaiensis*, *Glycymeris pilsbryi* and many other molluscan species besides *Cavolinia telemus* which was originally described from the Mediterranean Sea and also reported from the Miocene Bowden and Pliocene Manchioneal beds of Jamaica and Jacnel Pliocene Formation in Tahiti. The geological age of the Yonabaru Formation may be Upper Miocene from the macrofossils cited above. The Shinzato Formation yielded seven pteropod species among which three are new species, and *Diacrina bisulcata*, *Cavolinia telemus* and *Creseis acicula* have been recorded from the Middle Miocene Bowden of Jamaica, Santa Rosa, Vera Cruz, Mexico and Virginia. All of the species mentioned above are known to be distributed in the subtropical to temperate seas as stated by PELSENEER (1888a, b), TESCH (1904), PILSBRY (1922) TOKIOKA (1955, 1960 in OKADA *et al.*), CHEN and BÉ (1964) and others. From the occurrence of the pteropod species the Shinzato Formation is inferred to have been deposited under an open sea condition but whether of rather deep water analogous to the depth of pteropod ooze may be questionable. The correlation of separated geological formations by the pteropod fossils is at present difficult owing to the few occurrences, but should their records be increased their value in biostratigraphic correlation and paleobiogeographic analysis may become important.

Systematic description

Family Cavolinidae FISCHER, 1833

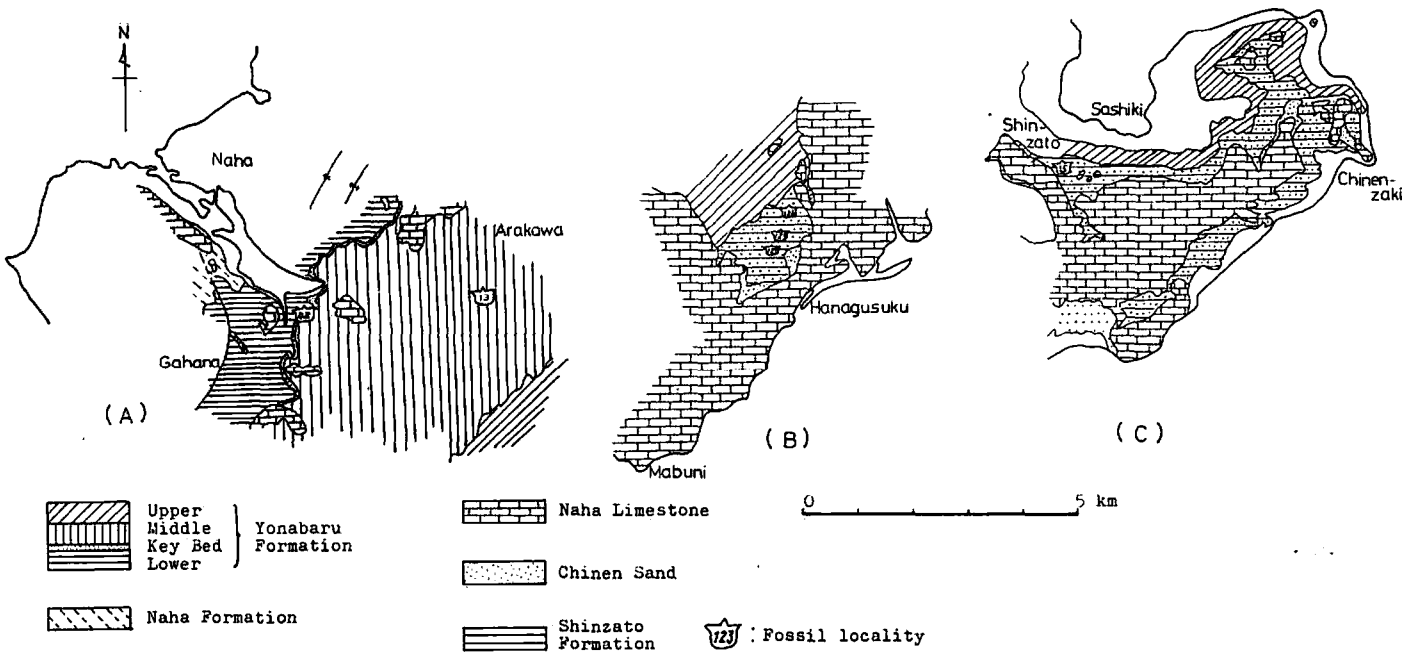
Genus *Cleodora* PERON and LESUEUR, 1810

Cleodora hataii NODA, n. sp.

Pl. 57, figs. 9-11

Type locality:—Road side cliff, east of the tunnel northeast of Yamaji, Saito City, Miyazaki Prefecture, Kawabaru Member of the Koyu Formation, Miocene. IGPS coll. cat. no. 92579.

Description:—Shell very thin, rather large for the genus, triangular, somewhat inequilateral in form. Ventral side convex with a single broad, slightly elevated median ridge with concentric equi-spaced growth bands. Dorsal side slightly convex with medium rib near apex, branching into three longitudinal ribs; middle rib narrower than the others with concentric growth lines. Both sides of radial ridge on both sides



Text-fig. 2. Fossil localities of three separated areas (A; Naha district, B; Gushikami district, C; Chinen Peninsula district). Geological map from FUKUDA *et al.*, 1970.

Dimension:—

Length	19.0 mm	Width	12.0 mm	Height	4.2 mm (92579)
Length	20.6 mm	Width	17.9 mm	Height	— mm (92580)

of shell become very flat. Apex very small, pointed. Aperture wide, narrow, middle part rather wide, both ends of aperture narrowly flat.

Comparison and affinities:—The present species resembles *Cleodora bowdenensis* COLLINS originally described from the Middle Miocene of Jamaica (COLLINS, 1934) in having radial ridge on the shell surface and in shell form but differs from the latter by the small width for shell length, distinct radial ridges from near apex to aperture and rather distinct concentric growth lines on the external surface. *Cleodora balantium* RANG illustrated by DALL (1878) under the name of *Balantinum recurvum* CHILDREN from the Recent sea of Australia resembles the present species in the undulated ridged growth lines, and three longitudinal ridges but the former differs from the latter in the U-shaped shell except for the sharp apical spine. The latter species has a V-shaped trigonal shell form. *Clio pulcherrina* (MAYER) described recently by ROBBA (1971) from the Langhian Cessole Formation in Italy resembles the present new species in the shell form and undulated growth lines crossing the longitudinal ridges but the former differs from the latter by having five longitudinal ridges.

Remarks:—At present, the present species is the earliest record of Pteropoda in Japan.

Cleodora okinawana NODA, n. sp.

Pl. 57, figs. 6, 12, 13

Type locality:—Near the type locality of the Shinzato Formation, south cliff of Shinzato, Sashiki-son, Okinawa Prefecture, Shinzato Formation, Pliocene. IGPS coll. cat. no. 92581.

Description:—Shell very fragile, moderate in size, and of lozenge-form. Dorsal side of shell sculptured with medium rather narrowly elevated, longitudinal rib which becomes divided into three similar longitudinal ribs. Interstices flat, wider than longitudinal ribs sculptured with very fine concentric growth striations. Aperture sharply triangular in form. Lateral sides of shell very thin rather flat. Lateral corner also sharp. Apical end prominent and spinose.

Dimension:—(Holotype) Height 12.8 mm, width 6.0 mm.

Comparison and affinities:—The species is characterized by its rather distinct three longitudinal ridges on the apertural margin and its lozenge-form. *Cleodora bowdenensis* COLLINS, 1934 originally described from the Middle Miocene Lower Zone at Bowden in Jamaica by COLLINS (1934), resembles the present new species but the former differs from the latter in having straight, very prominent spinose apical end, and three distinct radial ridges on the dorsal side of the shell. The latter species is characterized by its wider apertural length, rather slight lateral elevation of medial ridge and recurved apex. *Cleodora pyramidata* LINNAEUS (*fide* COLLINS, 1934, p. 201) is another species allied with the present one but differs in having rather inflated shell and distinct median ridge. *Cleodora hataii*, n. sp. from the Miocene Koyu Formation in Miyazaki Prefecture resembles the present new species but

differs in the large size, inflated shell, elevated medial part with three distinct longitudinal ridges on the dorsal side and distinct growth lines. *Cleodora australis* D'ORBIGNY illustrated by DALL (1878) resembles the present species in the pyramidal shell form but the former differs from the latter in having no interstitial folds between the central costae.

Locality and formation:—Loc. no. 13, prefectural road (Route 44) side cliff near Kamima, Haebaru-son, Okinawa Prefecture, Middle Part of Yonabaru Formation, Miocene, IGPS coll. cat. no. 92582; Loc. no. 15, south of Shinzato, Sashiki-son, Okinawa Prefecture, Shinzato Formation, Pliocene. IGPS coll. cat. nos. 92581, 92582; Loc. no. 12-06, sea side cliff, west of Tobaru, Yonagusuku-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS coll. cat. no. 92596.

Genus *Hyalocylix* H. FOLKSKAL, 1875

Hyalocylix striata (RANG, 1828)

Pl. 57, figs. 7, 8

Creseis striata RANG, 1828, *Ann. Sci. Nat.*, Tom. 13, p. 315, pl. 17, fig. 7 (*fide* LAMARCK, 1836).

Cleodora striata RANG: LAMARCK, 1836, *Hist. Nat. Animaux, Verteb.*, Tom. 7, p. 433.

Creseis striata RANG: DALL, 1878, pl. 5, figs. 30a, b. (*non vidi*).

Clio (*Hyalocylix*) *striata* (RANG): PELSENEER, 1888a, *Rept. Sci., Voy. H.M.S. Challenger*, vol. 23, p. 54, pl. 2, fig. 3.

Clio (*Hyalocylix*) *striata* (RANG): TESCH, 1904, *Siboga Exped. Monogr.*, vol. 52, p. 27, 28, pl. 1, figs. 16-17.

Hyalocylix striata (RANG): TOKIOKA, 1955, *Publ. Seto Mar. Biol. Lab.*, vol. 5, no. 1, p. 65, pl. 9, fig. 21.

Hyalocylix striata (RANG): TOKIOKA in OKADA *et al.*, 1960, *Encyclop. Zool. Illust. Col.*, Vol. 3, p. 171, fig. 642.

Hyalocylix striata (RANG): CHEN and BÉ, 1964, *Bull. Mar. Sci. Gulf. Carrib.*, vol. 14, no. 2, p. 193, fig. 3g.

Hyalocylis striata (RANG): KEEN, 1971, p. 805, fig. 2285.

Description:—Shell very thin, fragile, small, conical tube, nearly straight but slightly curved at end of apex. Aperture round in cross section. Apex narrow and rather spinose. Shell surface sculptured with equispaced distinct annulations.

Dimension:—Length 6.2mm and width 2.5 mm.

Comparison and affinities:—The present species is characterized by its slightly curved apex and distinct external annulations. This species resembles *Hyalocylix haitensis* COLLINS, 1934 in having similar external annulations but the former has finer and denser crenulations on the external surface and the apical end is more spinose, compared with the latter.

Remarks:—The present species, known as a Recent form of wide distribution in the warm to subtropical sea realm, has no previous record as fossil. The present discovery extends the geological range of this species back to the Pliocene.

Locality and formation:—Loc. no. 12-06, sea side cliff, west of Tobaru, Miyagusuku-shima, Yonagusuku-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS coll. cat. no. 92583.

Genus *Diacria* GRAY, 1847

Diacria bisulcata GABB, 1873

Pl. 57, fig. 18.

Diacria bisulcata GABB, 1873, *Trans. Amer. Philos. Soc., n.s.*, vol. 15, p. 200. (*non vidi*)

Cavolina (Diacria) bisulcata (GABB): DALL, 1892, *Trans. Wagner Insl. Philad.*, vol. 3, pt. 2, p. 430. (*non vidi*).

Diacria bisulcata GABB: PILSBRY, 1922, *Proc. Acad. Nat. Sci., Phila*, vol. 73, p. 309, fig. 4.

Diacria bisulcata GABB: WOODRING, 1928, *Carnegie Inst. Washington*, no. 385, p. 116, pl. 1, figs. 14-17.

Diacrina bisulcata (GABB): COLLINS, 1934, *John Hopkins Univ. Geol.*, no. 11, p. 197-200, pl. 10, figs. 1-3, pl. 9, figs. 13-20.

Description:—Shell small, equilateral, somewhat lozenge in form. Aperture smoothly rounded, both sides broadly angulated, its external ends rather sharp, not spinose, apical area narrow and long. External sculpture with slightly elevated longitudinal ridge (medial) and secondary ridges, outer sides become flat, without striations beside growth lines. Ventral side unexamined at present. Height 4.8 mm and width 3.8 mm.

Comparison and affinities:—The present species, only one shell showing the dorsal side, resembles *Diacria mbaensis* LADD originally described by LADD (1934) from the Miocene Suva Formation, Fiji Island in the external shell form but the latter is characterized by five subequal rounded longitudinal ribs on the dorsal surface, a character different from the present species. *Diacrina trispinosa* (BLAINVILLE) illustrated by KURODA, HABE and OYAMA (1971) from Sagami Bay, Kanagawa Prefecture (1971 *in* Biol. Lab. Imp. Household) resembles the present species by having rounded aperture, sharply spinose ends and longitudinal ridges on the dorsal surface but the present species differs from the former by its low apertural margin, narrow concaved sides and distinct longitudinal ridges on the dorsal surface. Some specimens identified as *Diacrina bisulcata* by WOODRING (1928, pl. 1, figs. 16-17) and COLLINS (1934, pl. 10, figs. 1-3) resemble *Diacrina trispinosa* s. s. by possessing five longitudinal ridges on the dorsal surface. For this reason the species group should be re-examined.

Locality and formation:—Loc. no. 12-06, sea side cliff, west of Tobaru, Miyagusuku-shima, Yonagusuku-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS coll. cat. no. 92584.

Genus *Cavolinia* ABILDGAAD, 1791

Cavolinia telemus LINNAEUS, 1758

Pl. 57, figs. 14-17, 19-20, 22-26, 29-31

Cavolinia telemus LINNAEUS, 1758, *Syst. Nat.* ed. 10, p. 365, (*fide* COLLINS, 1934).

Cavolina telemus (LINNÉ): WOODRING, 1928, *Carnegie Inst. Washington*, no. 385, p. 10, p. 113, pl. 1, figs. 6-7.

Cavolina telemus (LINNÉ): COLLINS, 1934, *John Hopkins Univ., Stud. Geol.*, no. 11, p. 188-190, pl. 8, figs. 4-7.

Cavolina (Cavolina) telemus (LINNÉ): WENZ, 1959, p. 52, fig. 174.

Cavolinia telemus (LINNÉ): KURODA, HABE and OYAMA *in Biol. Lab. Imp. Household*, p. 300, pl. 64, fig. 12.

Description:—Shell rather large, fragile, inequivalve and equilateral. Ventral valve much swollen, particularly on apertural margin. External surface rather smooth, with very fine concentric striations conspicuous near aperture and slightly bent backward medially. Dorsal valve rather flat, external surface sculptured with three distinct elevated longitudinal ribs; one of them distinct and situated on middle part of shell, other two slightly weaker. Apertural margin with elevated rim, overhanging ventral part of shell, rather smoothly rounded. Posterior horn spinose, lateral ends not spinose but shouldered. Best preserved

and largest specimen is 12.9 mm in length and 10.5 mm in width.

Comparison and affinities:—The present species resembles *Cavolinia globulosa* (GRAY) and *Cavolinia uncinata* (RANG) in having similar shell form and growth lines but the latter two differ from the present species by their short and slightly incurved posterior horn and wide apertural side. *Cavolinia tridentata* which was described from the Semata Pleistocene Formation by YAMAKAWA and ISHIKAWA (1912b) may be identified with the present species in being characterized by one medial longitudinal ridge with two on the dorsal shell, the shell form and posterior and lateral ends.

Remarks:—The present species is very common in tuffaceous medium to fine grained sandstone and tuffaceous siltstone of the Shinzato Formation. The species has been discussed in detail by COLLINS (1934) who listed its many synonyms. The generic names *Cavolinia* and *Cavolina* were treated by PELSENEER (1888a) who used *Cavolinia* in same sense as *Cavolina*. Many previous authorities used the generic name *Cavolina* but recently SPOEL (1967) and KURODA, HABE and OYAMA (1971) used *Cavolinia* for *Cavolina*. The nomenclature of the generic name should be subjected to further consideration.

Locality and formation:—Loc. no. 42, east of Nesabe, Tomigusuku-son, Okinawa Prefecture, lower part of Yonabaru Formation, Miocene, IGPS, coll. cat. no. 92585: Loc. no. 15, south of Shinzato, Sashiki-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS, coll. cat. no. 92586; Loc. no. 123, small road side cliff, north of Hanagusuku, Gushikami-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS, coll. cat. not. 92587; Loc. no. 126, small road side cliff, north of Hanagusuku, Gushikami-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS, coll. cat. no. 92588; Loc. no. 129, west side cliff of Route 46 (prefectural road), north of Gushikami, Gushikami-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS, coll. cat. no. 92589; Loc. no. 12-06, sea side cliff, west of Tobaru, Miyagusuku-shima, Yonagusuku-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS, coll. cat. no. 92590.

Cavolinia okinawana NODA, n. sp.

Pl. 57, figs. 27-28

Type locality:—Loc. no. 12-06, sea side cliff, west of Tobaru, Miyagusuku-shima, Yonagusuku-son, Okinawa Prefecture, Shinzato Formation, Pliocene.

Description:—Shell fragile, rather small in size, subrounded, inequivalve, equilateral in shell form. Ventral shell inflated, external surface smooth, covered with dorsal aperture. Dorsal valve not so swollen, sculptured with faint, elevated radial fold on apertural margin and indistinct on middle to posterior side., Both sides narrowly depressed with small elevated ridge. Aperture narrow, quadrate, apertural plate obliquely positioned with smooth surface. Lateral sides quadrate but not spinose. Posterior end small and spinose.

Dimension:—Height 5.9 mm and width 5.9 mm.

Comparison and affinities:—The present species resembles *Cavolinia tridentata* (FORKSKAL) which is characterized by faint radial ribs on the dorsal surface but differs from the latter in having narrow radial depressed area, and small elevated ridge on the lateral side, and faint radial fold at the apertural margin on dorsal surface. *Cavolinia telemus* LINNAEUS is considered a synonym of

Cavolinia tridentata by KURODA, HABE and OYAMA (in Biol. Lab. Imp. Household, 1971) but the present writer considers that both species are valid because the characteristics of the dorsal surface are different from each other as mentioned by TOKIOKA (1960) and YAMAKAWA and ISHIKAWA (1912b). *Cavolinia telemus* differs from the present species in having only one mid-radial ridge on the apertural margin and narrow apertural shell band.

Locality and formation:—Loc. no. 12-06, sea side cliff, west of Tobaru, Miyagusuku-shima, Yonagusuku-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS coll. cat. no. 92591.

Genus *Creseis* RANG, 1828

Creseis acicula (RANG, 1828)

Pl. 57, figs. 1-5.

Clio acicula RANG, 1828, *Ann. Sci. Nat. Ser.*, vol. 13, p. 318, pl. 17, fig. 6, (*fide* PELSENEER, 1888a)

Clio acicula RANG: PELSENEER, 1888a, *Challenger Rep.*, vol. 23, p. 51-53.

Clio (Creseis) acicula RANG: YAMAKAWA and ISHIKAWA, 1912a, *Jour. Geol. Soc. Tokyo*, vol. 19, p. 2-3, pl. 1, figs. 1a-b.

Creseis acicula (RANG): COLLINS, 1934, *John Hopkins Univ. Geol.*, no. 11, p. 207-208, pl. 9, figs. 6-7, pl. 13, figs. 7-8.

Creseis acicula (RANG): ABBOTT, 1954, p. 294, fig. 64-n.

Creseis acicula (RANG): TOKIOKA, 1955, *Seto Mar. Biol. Lab., Publ.*, vol. 5, p. 64.

Creseis acicula (RANG): TOKIOKA, 1960, *in* OKADA *et al.*, p. 170, fig. 1.

Creseis acicula (RANG): CHEN and BÉ, 1964, *Bull. Mar. Sci., Gulf Carrib.*, vol. 14, no. 2, p. 216, fig. 3-e.

Creseis acicula (RANG): KEEN, 1971, p. 805, fig. 2281.

Description:—Shell very small, long tuberous in form and circular in cross section. Apertural part widest, posterior end spinose but not curved. Shell surface smooth but with transverse striation.

Comparison and affinity:—The present species resembles *Creseis virgula* RANG. Both *Creseis acicula* and *C. virgula* are subdivided into subspecies, the former into two and the latter into four subspecies according to the morphological features of the posterior end and transverse striation (s). The present species differs from the *Creseis virgula* group in having straight posterior end without expansion near the posterior end like a knob. A subspecies, *Creseis acicula clava* RANG, has a shorter tuberous shell but resembles the species.

Locality and formation:—Loc. no. 12, west of Yagena Harbour, Yagena, Yonagusuku-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS, coll. cat. no. 92592; Loc. no. 15, south of Shinzato, Sashiki-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS, coll. cat. no. 92593.

Family Atlantidae

Genus *Atlanta* LESUEUR, 1817

Atlanta okinawana NODA, n. sp.

Pl. 57, fig. 21

Type locality:—Loc. no. 12-06, sea side cliff, west of Tobaru Miyagusuku-shima, Yonagusuku-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS, coll. cat. no. 92594.

Description:—Shell small, fragile and plainly spiral. Three spirals with very thin, fragile plate on outer margin of shell, distinct on outer whorl and faint on inner. Shell surface smooth except

for fine growth lines. Shell characterized by similar sculpture and height. Aperture elongated fusiform, apertural slit not observable.

Dimension:—Width 3.4 mm and thickness 0.3 mm.

Comparison and affinities:—The present species is characterized by its flat shell with thin marginal plate without apertural slit. *Atlanta lesueur* SOULEYET resembles the present new species in outer view of the shell but the former has the apertural slit not so deep. *Atlanta peroni* LESUEUR differs from the present species in having distinct keel on the marginal whorl.

TOKIOKA (1960, *in* OKADA *et al.*) illustrated some species allied to the present species. Among them, *Atlanta lesueri* of TOKIOKA resembles the new species except for the apertural slit. *Atlanta gaudichaudi* SOULEYET is another allied species in having low-spiral whorls with marginal keel but has a relatively higher shell compared with the present new species. The present species resembles the American fossil species *Atlanta diamesa* WOODRING originally described from the Miocene Bowden Formation (WOODRING, 1928, p. 133, pl. 2, figs. 23-25) in having similar number of coiled whorls and marginal keel, but the former differs from the latter in having low-elongated profile of apertural form (latter one is trigonal) and the keel appears from inside of the suture.

Remarks:—Only two specimens of this species were collected from the Shinzato Formation. This is the first record of the genus as fossil.

Locality and formation:—Loc. no. 12-06, sea side cliff, west of Tobaru, Miyagusuku-shima, Yonagusuku-son, Okinawa Prefecture, Shinzato Formation, Pliocene, IGPS, coll. cat. no. 92594.

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Gushikami	具志頭	Sashiki	佐敷
Haebaru	南風原	Semata	瀬又
Hanagusuku	花城	Shimajiri	島尻
Katsuren	勝連	Shinzato	新里
Kawabaru	川原	Tobaru	桃原
Koyu	児湯	Tomigusuku	豊見城
Miyagusuku	宮城	Urazoe	浦添
Miyazaki	宮崎	Yamaji	山路
Naha	那覇	Yonabaru	与那原
Okinawa	沖縄	Yonagusuku	与那城

Explanation of Plate 57

Figs. 1-5, *Creseis acicula* RANG, ×20, Loc. no. 15, Pliocene Shinzato Formation, IGPS coll. cat. no. 92593.

Figs. 6, 12, 13, *Cleodora okinawana* NODA, n. sp., ×3, figs. 6, 12, Loc. 15, IGPS coll. cat. nos. 92582, and 92581, Fig. 13, Loc. 12-06, Pliocene Shinzato Formation, IGPS coll. cat. no. 92596.

Figs. 7, 8, *Hyalocylix striata* (RANG), ×5, Loc. no. 12-06, Pliocene Shinzato Formation, IGPS coll. cat. no. 92583.

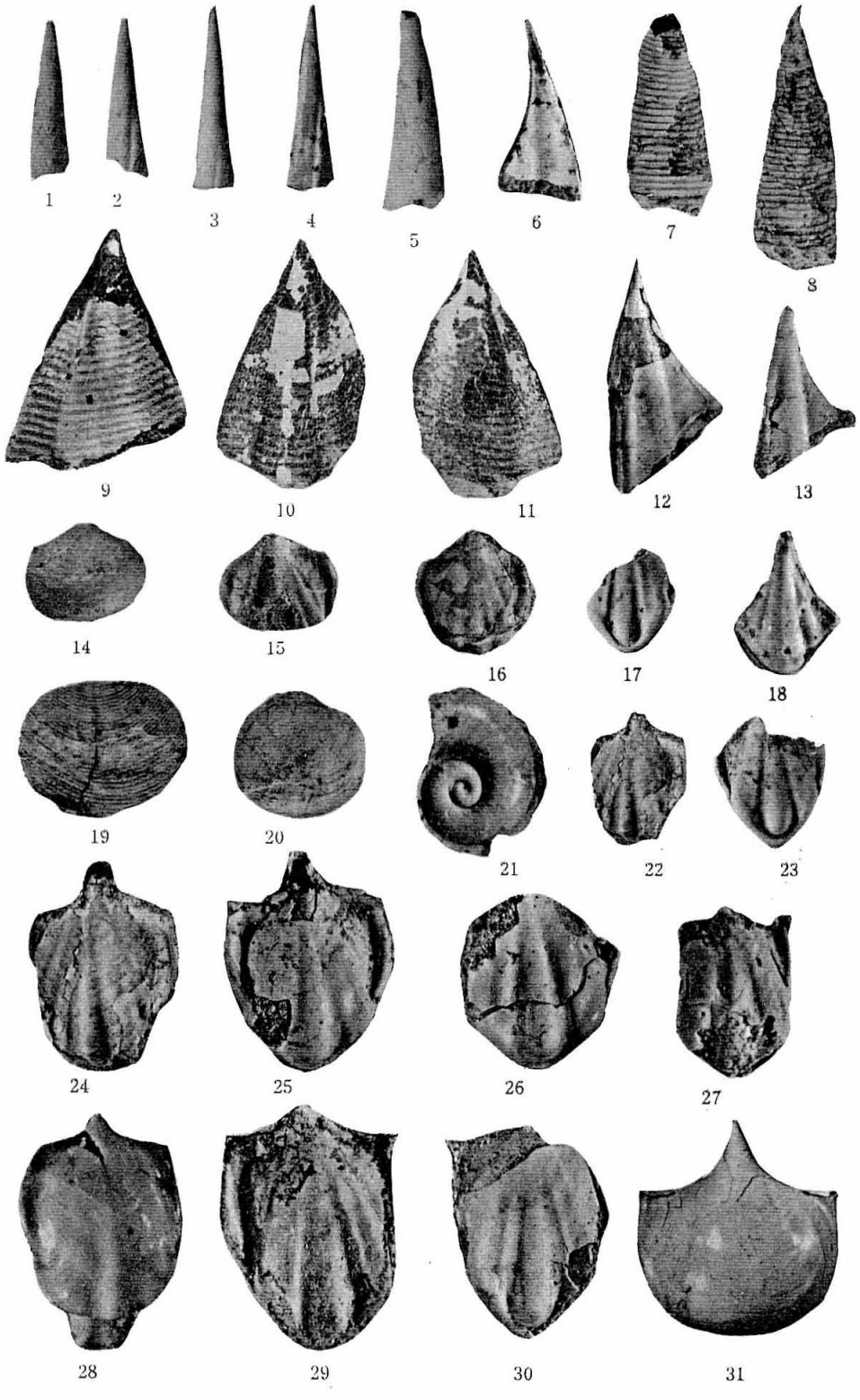
Figs. 9-11, *Cleodora hataii* NODA, n. sp., ×2, Miocene Kawabaru Member of the Koyu Formation, IGPS coll. cat. no. 92579.

Figs. 14-17, 19-20, 22-26, 29-31, *Cavolinia telemus* LINNAEUS, Figs. 14-16, 19-20, Loc. 123, ×2, IGPS coll. cat. no. 92587; fig. 17, Loc. 129, ×3, IGPS coll. cat. no. 92589,; fig. 22, Loc. 123, ×2, IGPS coll. cat. no. 92587; fig. 24, Loc. 123, ×3, IGPS coll. cat. no. 92789; fig. 23, ×2, Loc. 15, IGPS coll. cat. no. 92586; figs. 25, 26, ×3, fig. 27, ×5, fig. 30-31, ×3, all from Loc. 12-06, IGPS coll. cat. no. 92590; fig. 29, Loc. no. 126, IGPS coll. cat. no. 92588. All, Pliocene Shinzato Formation.

Fig. 18, *Diacrina bisulcata* GABB, ×5, Loc. 1206, Pliocene Shinzato Formation, IGPS coll. cat. no. 92584.

Fig. 21, *Atlanta okinawana* NODA, n. sp., ×8, Loc. 12-06, Pliocene Shinzato Formation, IGPS coll. cat. no. 92594.

Fig. 28, *Cavolinia okinawana* NODA, n. sp., ×3, Loc. 12-06, Pliocene Shinzato Formation, IGPS coll. cat. no. 92591.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PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第 110 回例会は，1972 年 10 月 28 日（土）愛媛大学理学部において開催された。（参加者 50 名）。尚翌 29 日（日）には，下記の通りの巡検を行った。（参加者 35 名）。

特別講演

Paleontologic potpourri of the Pacific Coast of North America .....DANNER, W. R. (British Columbia Univ.)

個人講演

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Upper Devonian plants from Yokokura-yama, Kôchi Prefecture, Japan ....ASAMA, K. & HIRATA, M.

Coniopteris (Dicksoniaceae) species from the Itoshiro Sub-group, the Tetori Group, Central Honshu, Japan .....KIMURA, T.

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Early Permian *Parafusulina* and *Pseudofusulinella* from the Chilliwack Group, southwestern British Columbia ....SADA, K. & DANNER, W. R.

Late Lower Carboniferous *Eostaffella* and *Hexaphyllia* from Central Oregon, U.S.A. .....SADA, K. & DANNER, W. R.

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相対生長解析からみた *Inoceramus* (*Sphenoceramus*) *naumanni* 個体群の生活様式の時間的変化 .....棚部一成

Miocene molluscs from the Bihoku Group at Miyauchi (Shinchiku)-cho, Shobara city, Southwest Japan..... .....OKAMOTO, K. & TERAUCHI, M.

化石からみた水溶型ヨウ素鉱床 .....福田 理

〔巡検，10 月 29 日（日）〕西南日本中央構造線，久万層群（始新統）模式地の検討と二名層化石採集　　案内者 永井浩三

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日本古生物学會報告・紀事

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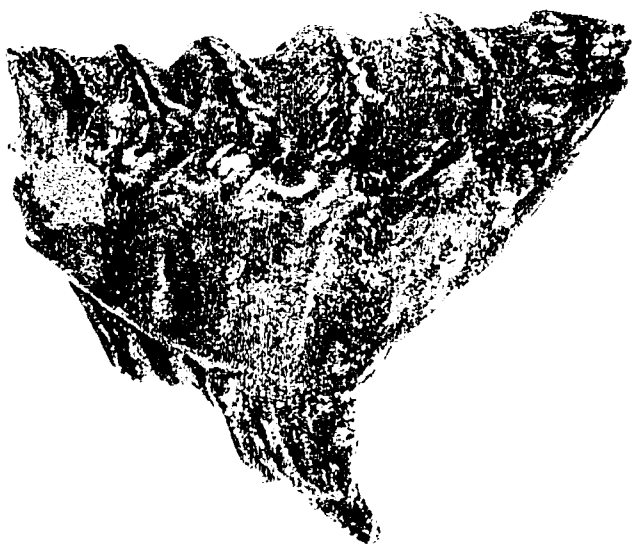

日本古生物学会

Palaeontological Society of Japan

The heading in Japanese commemorates the handwriting of Prof. Matajiro YOKOYAMA, father of Japanese palaeontology, who was a professor of stratigraphy and palaeontology at the Geological Institute, Imperial University of Tokyo.

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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例　会　通　知

	開　催　地	開　催　日	講演申込締切日
1973年 総会·年会	東　北　大　学	1973 年 1 月 16·17 日	締　　切
111 回 例　会	新　潟　大　学	1973 年 6 月 23·24 日 (予定)	1973年 4 月 20 日*

* 申込締切日は，プログラム印刷の都合で今後とも開催の約 2 ケ月前にいたします。御諒承下さい。

○ 1973 年々会・シンポジウム「古植物の分布と問題点」(1 月 17 日)　世話人・高橋　清。

国　際　会　議

○ IUGS の Commission on Stratigraphy では，1975 年に第 1 回太平洋地域新第三系国際会議を日本で開催することを決定した。これに関連して，国内では組織委員会をつくる準備が進められている。連絡先は池辺展生 (大阪市大) および高柳洋吉 (東北大)。

国　際　学　会

○ 1973 年 7 月 1 日～8 日に，Oslo において NATO Advanced Study Institute の一環として，「Evolution and Morphology of the Trilobita, Trilobitoidea and Merostomata」の講演・討論会が開かれる。連絡先は

Dr. D. L. BRUTON
Paleontologisk Museum,
Sars gate 1, Oslo 5,
Norway.

● 本会誌の出版費の一部は文部省研究成果刊行費による。

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