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627. REPORT OF LOWER TRIAS FROM PIR PANJAL, NEAR QAZIGUND, KASHMIR, INDIA, WITH DESCRIPTION OF A FEW AMMONOIDS*

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インド国カシミール州 Qazigund 付近の Pir Panjal 地区の下部三畳系：本層は従来ペルム系 Zewan Series の上部と見做されてたが，*Claraia* や *Ophiceras* などの産出により，またカシミールの Srinagar 付近の Guryul Ravine に発達する下部三畳系と層相が極めて類似することから下部三畳系に属することが明らかとなった。この Pir Panjal 地区から産出した特徴的なアンモナイトとして *Lytophiceras* aff. *ptychodes* DIENER, *Hypophiceras* ? sp., *Glyptophiceras* sp., *Ophiceras* sp. を記載報告したが，これらのアンモナイト動物群は同じカシミールの Pastun や Spiti の *Ophiceras* 動物群と対比される。

H. M. KAPOOR, 坂東祐司

Introduction

Kashmir has extensive development of Permian and Triassic formations. Many of the geological sections, confined to the Vihi and Traal valleys of Kashmir, are famous in the annals of Himalayan stratigraphy. A number of modifications, reviews and additions of data have also been done from time to time on these sections by geologists from India and abroad; but for other areas of Kashmir, we still lack lithological and paleontological details. These discrepancies make it difficult to correlate different strata situated apart. Therefore, in the present paper the authors have made an attempt to review one of the areas of Pir Panjal, Kashmir, situated near Qazigund, on the basis of latest data available from type sections.

TEICHERT, KUMMEL and KAPOOR (1970) and NAKAZAWA and his collaborators (1970) in recent years carried out extensive study of the Guryul Ravine section of Vihi Valley. They established that advent of the Lower Trias in Kashmir is marked by the appearance of *Claraia*, and many of the Permian brachiopods continued to survive in the lower part of the Lower Trias. The

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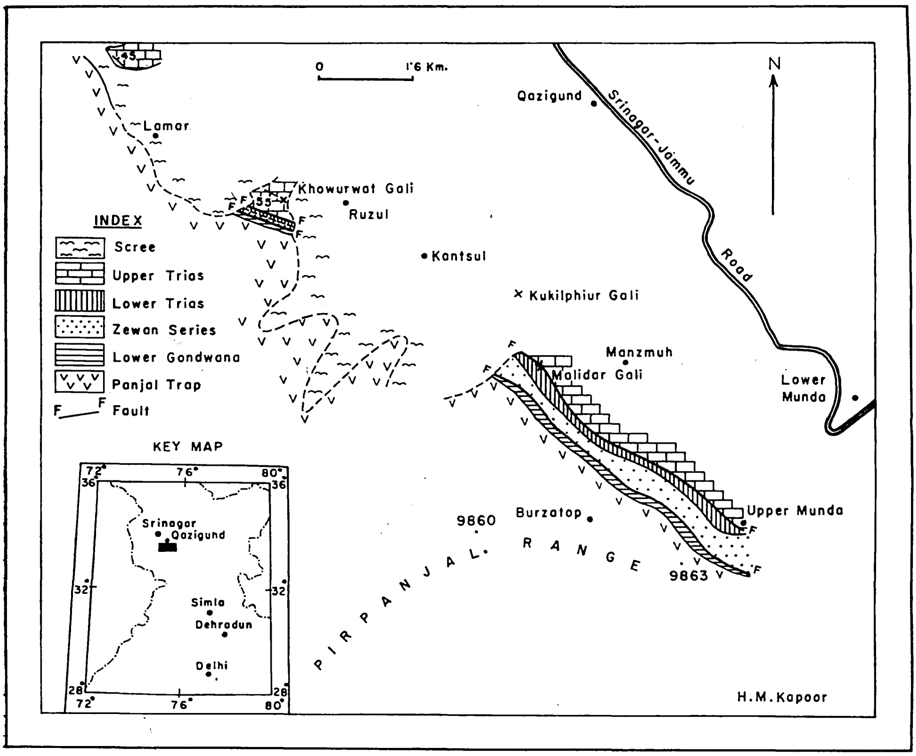
Lower Triassic ammonoid fauna, however, made its first appearance when the typical Permian elements completely vanished. The boundary between Permian and Triassic, considered by TEICHERT *et al.* (1970) and NAKAZAWA *et al.* (1970), is considerably lower than the boundary inferred by MIDDLEMISS (1910) and WADIA (1957); thus reducing the thickness of the Zewan Series and increasing the thickness of the Lower Triassic beds.

Out of the several known sections from Vihi and Traal Valley, the Guryul Ravine section, where maximum details have been worked out by NAKAZAWA and his collaborators, is regarded as the type for comparative study in this paper. TEICHERT *et al.* (1970) and NAKAZAWA *et al.* (1970) considered the Pastun (=Pastannah) section as the type section of Lower Triassic beds in Kashmir. As the above papers revise the contact between Permian and Lower Trias, the position of the boundary is also likely to change at Pastun. The revision of Pastun has already been taken up by KAPOOR, and he found that the boundary is actually quite below the one hitherto considered. The Pir Panjal area, which is far away from Vihi Valley, is compared with the above type section to know the lateral extention and lithological and faunal variations of the Zewan Series and the Lower Triassic beds in Kashmir Himalaya, and also to know the faunas at the Permo-Triassic



Text-fig. 1. The sketch map of Pir Panjal, near Qazigund, Kashmir, showing the Lower Gondwana, the Zewan Series and the Lower Trias. *Inset*: Key Map.

contact. This comparative study also modifies the Zewan Series of Pir Panjal of pioneer workers, as the upper part of it is included now into the Lower Trias.

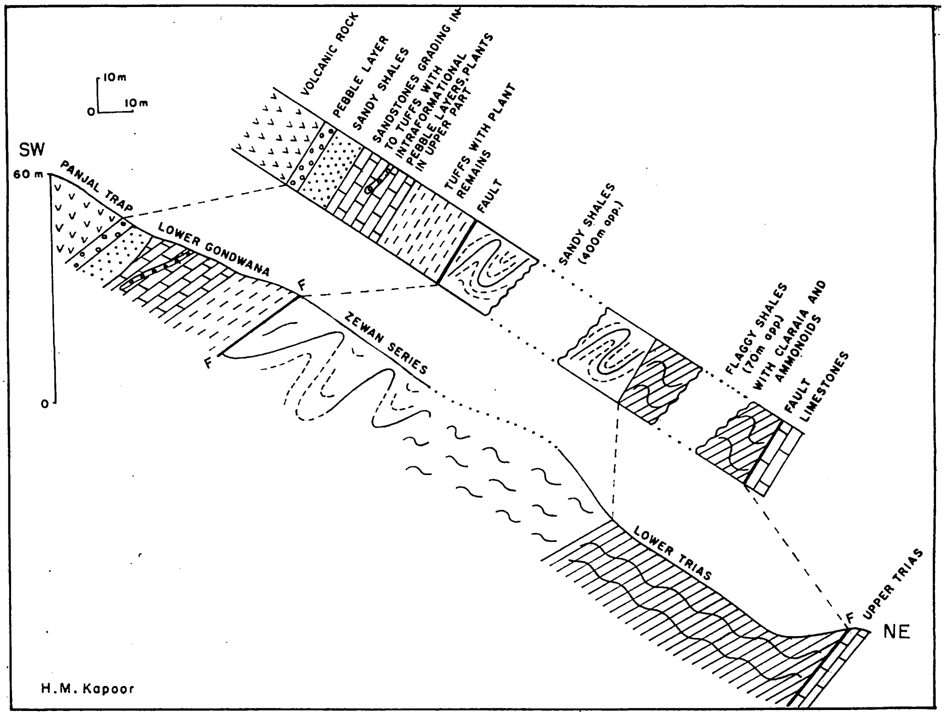
The area dealt with in the present paper, lies north of the Pir Panjal Range between Upper Munda (33°32′ : 75°11′30″) in the east and 1 km west of Lamar (33°35′15″: 75°05′) in the west (Text-fig. 1). Several diagonal sloping ridges emerge from the Pir Panjal Range and finally about on the flat terrain of the Karewa (Pleistocene) formation. The diagonal ridges are separated from each other by the development of a small valley formed due to water courses.

A number of short notes published between 1866 and 1928 by R. LYDEKKER, C. S. MIDDLEMISS, H. S. BION and D. N. WADIA of Geological Survey of India give only an outline of the geology of this region of Pir Panjal. HAZRA and PRASAD (1963), however, reviewed and elaborated the earlier work and supplemented the geology of the region by adding more data observed by them. It will not be out of the way to refer here the work on the western part of the Pir Panjal by WADIA (1928, p. 251), who reports the occurrence of *Pseudomonotis* cf. *aurita* and *Pseudomonotis griesbachi* in the upper part of the Zewan Series. He thinks that the presence of *Pseudomonotis* indicates nearness of the Triassic horizon between which and the Zewan Series of the type area there is a gradual and conformable passage. This zone containing *Pseudomonotis* may be the zone of 'Mixed fauna' (of TEICHERT *et al.*, 1970) of the Lower Trias of the Guryul Ravine and represents the lateral continuity of the Lower Triassic beds of the Guryul Ravine in the Pir Panjal area, near Qazigund.

Geology

The geological sequence given in the Table 1 is modification of HAZRA and PRASAD (1963) as observed by KAPOOR. Text-fig. 1 is a geological map of Pir Panjal near Qazigund showing distribution of Lower Gondwana, Zewan Series and Lower Trias; and Text-fig. 2 shows geological section and column as seen in Upper Munda.

The Lower Permian to Jurassic formations, exposed on the northern ridges emerging from Pir Panjal Range, are part of a broad overfold. The Panjal Trap, the oldest formation in the area of this report, forms high peaks. This is succeeded by the Lower Gondwana beds. A three-meter thick pebble bed above the Panjal Trap is characteristic in this area. It suggests probability of hiatus and change before the sediments of Lower Gondwana were laid. The Zewan Series, the second oldest formation is of marine nature. It is rich in bryozoan and brachiopod fauna (*Linoproductus*, *Spinomarginifera*, *Leptodus*, *Protoretepora*, etc.) of Upper Permian age. The complete succession of this formation is not seen in any of the sections, all along the strike of strata. It is due to a reversed fault running between the Lower Gondwana and this formation; however, summing up all the sections the lithological succession can be established as Limestone (=Basal limestone; rich in crinoids, corals, shells of brachiopods, etc.) succeeded by sandy shales with abundance of brachiopods (equivalent to *Marginifera himalayensis* and *Spirifer rajah* Zones). The Zewan Series are closely folded; therefore it is difficult to estimate the actual thickness of the formation (thickness given in the Text-fig. 2 is the total thickness of folded sediments). The sandy shales pass into



G. S. I. (N.R.) D. O. No. 9067-70-XI

Text-fig. 2. Geological Section and Column, near Upper Munda, Pir Panjal, near Qazigund, Kashmir. Thicknesses of the Zewan Series and the Lower Trias are not actual but sum of the folded strata.

flaggy shales.

The flaggy shale is the important rock unit. It marks the begining of the Lower Trias. This bed contain *Claraia* spp. (*C. concentrica* YABE, *C. stachei* (BITTNER), ammonoids and also a number of Permian brachiopods such as *Lino-productus*, *Derbya* etc.). These shales in this area are purple and very fragile. They split along the bedding planes. The original black colour is rarely seen. The thickness given in the Text-fig. 2 is the total thickness of the folded sediments. These shales were included by HAZRA and PRASAD (1963) in the Zewan Series and appear to represent Bed No. 47 to 59 of the Guryul Ravine described by NAKAZAWA *et al.* (1970) and correspond to the bivalve coquina zone or to the *Claraia* zone of TEICHERT *et al.* (1970).

It is, however, difficult to say whether the upper part of the Lower Trias and the Middle Trias were developed in the area, as the flaggy shales are succeeded by folded Upper Triassic limestones and contact between them is inferred to be a strike fault. In Kashmir, biostratigraphically, the upper part of the Lower Trias is characterised by limestone with *Meekoceras*; while the Middle Trias by shales and limestones with *Ceratite* and *Daonella* fauna. The Upper Triassic limestones are mostly barren of mega-fossils, but there are occassional layers, 10 to 20 cm. thick, rich in *Spiriferina stracheyi* and *Spiriferina haueri*.

Table 1. Showing stratigraphic sequence in Pir Panjal, Kashmir.

Formation	Lithology	Geological age
Holocene	Scree, moraines and alluvium	Holocene
Karewa	Clay, lignite, carbonaceous shales, etc.	Pleistocene
	Unconformity	
Jurassic	Limestones, sandstones, sandy shales with bivalve fossils	Lower Jurassic
	? Unconformity	
Upper Triassic	Limestone with occassional layers of *Spiriferina* spp.	Upper Trias
	Fault	
Lower Triassic	Flaggy shales with thin limestone layers. Layers of *Claraia* and ammonoids in shales	Lower Trias (Lower Scythian)
	Conformity	
Zewan Series	Limestones; argillaceous, calcareous and sandy shales with bryozoa, brachiopoda, etc.	Upper Permian (? Kungurian-Tartarian)
	Reverse Fault	
Lower Gondwana Series	Sandstones, tuffs, pebble layers, sometimes pinkish shales overlying tuffs. Plant fossils present in tuffs.	Lower Permian (Upper Artinskian)
	? Unconformity	
Panjal Trap	Mainly basic lava flows	Lower Permian

In the crests of folded Upper Triassic limestones, three bands of the Jurassic sediments are present. The Jurassic beds are rich in lamellibranch fauna, though a few brachiopods, ammonites (especially *Perisphinctes*) and fish remains are also known.

The Quaternary geology is of less significance for the present work, hence not dealt with here.

Permo-Triassic Boundary

The lithological and faunal comparison of the Pir Panjal near Qazigund and the Guryul Ravine has been indicated in the above paragraphs. The Zewan Series marks the close of Permian in Kashmir, but at both places it has been observed that *Claraia* which is developed in flaggy shales marks the begining of the Lower Trias. These *Claraia*-bearing shales were included in the Zewan Series by pioneer workers. Recent contributions by TEICHERT *et al.* (1970) and NAKAZAWA *et al.* (1970) in the Guryul Ravine have already shown that the upper part of the Zewan Series is actually Lower Trias and there are many Permian survivors in the lowermost part of the Lower Trias. In the Pir Panjal area of Qazigund, though there is a little variation in litho-units of the Zewan Series with that of the Guryul Ravine, almost complete faunal zones are developed and likewise the boundary between the Permian and Triassic beds is between sandy shale and flaggy shale.

In Pir Panjal, only the lower part of the Lower Trias is developed. The characteristic ammonoids of the Lowest Scythian, i. e. *Otoceras* fauna, could not be found in the Pir Panjal. There is, however, possibility of finding *Otoceras* in the thin limestone layers in the flaggy shales.

Many of the Permian forms such as *Linoproductus*, *Spinomarginifera*, *Derbya*, *Eumorphotis*, *Etheripecten* are occasionally seen in the arenaceous limestone layers in flaggy shales. These are associated with *Claraia stachei* (BITTNER) and are restricted only in the lower part of the flaggy shales. The upper part of the shale abounds in *Claraia concentrica* YABE and ammonoids. Such faunal distribution is similar to that of the Guryul Ravine. Ammonoids and pelecypods are usually in separate layers, but layers containing both are not rare. The fossils are collected from Upper Munda (33°32′: 75°11′30″), Malidar Gali (33°33′: 75°09′) and Khowurwat Gali (33°35′: 75°06′), which show good and clear exposures. In other areas these are either highly weathered or concealed under scree.

Reference about the western part of the Pir Panjal has already been made in the Introduction. WADIA (1928, p. 251) considers that the presence of *Pseudomonotis* spp. in the Zewan Series indicates nearness to the Lower Trias, but the present authors feel that the beds containing these are lowermost Lower Trias and are equivalent to the flaggy shale horizon of eastern Pir Panjal. The presence of *Pseudomonotis* spp. in association with Permian forms indicates a mixed Permo-Triassic fauna in the area as is known in Guryul Ravine as well as in the eastern part of the Pir Panjal. The contact between Permian and Trias in both parts of Pir Panjal is gradual and conformable.

It is really a matter of great interest that a thick succession of the upper part of Lower Trias and complete Middle Trias is not known in these parts of the Pir Panjal. It is due to the strike fault which caused elimination of thick strata or due to non deposition of the sediments. The problem is open to the future workers; but the present authors support WADIA's (1928, p. 252) opinion quoted below: "The Triassic development near Mandi and Trekana is restricted to only a small part of the Upper Trias, the whole of the Lower Trias and Muschelkalk stages, which are so completely represented in the Vihi hills, are totally absent. It is however, more probable that the resulting unconformity between these beds and the Permian is not of erosion, but may be really due to non-deposition in this locality, in that the Upper Trias has come to occupy this position by a progressive overlap on all the lower division of the Trias. The Panjal area forms the southern limit of the marine Triassic rocks of the Himalaya and hence this thinning out of both the Permian and Trias is explicable as the natural coastal boundary of marine calcareous sediments at extreme limit of the geosynclinal zone of the central Himalaya."

Faunal Consideration

There is a large collection of ammonoids from the localities mentioned in the above paragraphs. All of them come from flaggy shale member. The preservation is very poor and fossils are friable. From the collection, a few were sorted out and only four were recognized and are described in detail by BANDO in the next chapter. These are:

Lytophiceras aff. *ptychodes* DIENER
Hypophiceras ? (s. str.) sp.
Ophiceras (s. str.) sp.
Glyptophiceras ? sp.

The forms listed above are characteristic of the *Ophiceras* fauna. These are comparable with the fossils of the *Ophiceras* fauna of Pastun (Pastannah in Traal Valley), Guryul Ravine and Spur 3 km north of Barus (both in Vihi Valley). The *Ophiceras* fauna from Pastun was described by DIENER (1897, 1915); who regarded the fauna to be comparable with the *Ophiceras* fauna of Greenland. The fossils of other two localities are still under study by NAKAZAWA and his collaborators.

Besides Kashmir, *Ophiceras* fauna is also known from other parts of Indian Himalayas, with which forms show similarity. Most famous are Spiti (HAYDEN, 1904, VON KRAFFT and DIENER, 1909) and Painkhanda (Kumaon) (DIENER, 1912). DIENER (1912, pp. 30-31) considers that the lowermost Eo-Trias of Painkhanda seems to be similar to that of Spiti, in both lithology and fauna. Also, the difference between Pir Panjal and these localities seems to be very small.

Further east of Kumaon Himalaya there are only a very few records of Eo-Trias. FUCHS (1964, pp. 7-8) reports Lower Triassic limestone in Dolpo region of Nepal Himalaya with *Meekoceras* sp., *Arpadites* sp., *Ophiceras* sp., etc. In the same region, FUCHS (1964, p. 7) has described Upper Permian beds of Barbung Khala; upper part of which appears to correspond to Flaggy shale horizon having the Mixed Permo-Triassic Fauna (Eo-Trias) of Kashmir. BORDET *et al.* (1967, pp. 888-889) have also reported Lower and Middle Scythian sediments in Thakkhola region of Nepal Himalaya. It is difficult, however, to compare them with Kumaon, Spiti or Kashmir Himalaya by the available data. The presence of *Ophiceras*, *Meekoceras* and *Clypeoceras* undoubtedly put them to Lower Trias.

The scanty data at far situated places undoubtedly indicate the development of the Eo-Trias in the eastern Himalaya and suggests that a thorough search of these beds will prove one day its continuity and lateral variations of lithogy and faunas.

The probability of its presence is also supported by the Lower Triassic beds of Burma at Na-Nahkam in the Yunan State. SAHNI (1932, p. 66; 1938, p. 114 and in PASCOE, 1959, pp. 902-3) reports that the interstratified dolomites in a series of thin bedded argillaceous limestones and shales contain a rich fauna apparently ranging from *Otoceras* zone (although this genus itself has not been found) to the Owenitan. Components of the fauna are *Xenaspis carbonaria* WAAGEN, *Glyptophiceras* sp., *Lytophiceras* sp., *Vishnuites* sp., *Owenites* sp., *Kashmirites* sp., etc. with a number of gastropods and bivalves. Many of the forms (such as *Xenaspis*) appear to be the Permian survivors in the Lower Trias. The fauna has affinity with the *Ophiceras* fauna of Kashmir, Spiti and Kumaon.

West of Kashmir, the *Ophiceras* fauna is known from Salt Range, Pakistan (SCHINDEWOLF, 1954; KUMMEL and TEICHERT, 1966; TEICHERT and KUMMEL, 1970). SCHINDEWOLF in his paper included the description of *Ophiceras connectens* SCHINDEWOLF which was later reported by KUMMEL and TEICHERT from a lower bed while working on the details of lower Scythian stratigraphy and palaeontology. They found this species from six inches above the base of the Kathwai member (Lowest Scythian Formation) of the Mianwali Formation. Accordingly, KUMMEL (1966) correlated the Kathwai Member with the Lowest Scythian (*Ophiceras* zone) age.

Further west, in Afghanistan, FISCHER (1971) also collected *Ophiceras* from brown argillaceous limestone beds just above the Permo-Triassic boundary in Kohe Safi District of Eastern Afghanistan. This report was also substantiated by ISHII, FISCHER and BANDO (1971) in their report on the Permo-Triassic boundary problems in Eastern Afghanistan and occurrence of gyronitid ammonoids from the Kohe Safi area. From the study of the nature of lithofacies and presence of numerous vertical burrows made by suspension feeders at the Permo-Triassic boundary, the above authors derived conclusion that the Upper Permian calcium carbonate sediments were exposed to subaerial denudation and quick drying under the intertidal environments, thus causing a break in the Eastern Afghanistan at the boundary zone.

It is not beyond scope to refer here the recent work at Arctic Canada (TOZER, 1961), where *Ophiceras commune* SPATH with *Otoceras boreale* SPATH is reported from the beds near basal part of the Blind Fiord Formation in an island of Queen Elizabeth Islands between Bunde and Bukken Fiords. It is slightly different from Guryul Ravine of Kashmir where *Otoceras* is known at a later stage though within the *Ophiceras* zone.

The biostratigraphic significance of the *Ophiceras* and *Otoceras* faunae from Kashmir is being studied by one of the authors (BANDO) and will be published elsewhere.

Systematic Description

The specimens described in detail were collected by KAPOOR and were studied in the Palaeontological Laboratory of Kagawa University by BANDO. All the specimens are preserved in the Palaeontological Division of the Geological Survey of India in Calcutta. The views expressed in the following pages are of BANDO.

Family Ophiceratidae ARTHABER, 1911

Genus *Ophiceras* GRIESBACH, 1880

Subgenus *Lytophiceras* SPATH, 1930

Type species: *Ophiceras chamunda* DIENER, 1897, p. 123, pl. 12, figs. 3a-b.

Lytophiceras aff. *ptychodes* DIENER

1897. *Ophiceras ptychodes*, DIENER, Pal. Indica, Ser. XV, 11, p. 120, pl. xi, figs. 3, 5, 6.

1915. *Ophiceras ptychodes*, DIENER, Catalogue, p. 213.

1930. *Lytophiceras ptychodes*, SPATH, Med. om Grønland, Bd. 83, 1, p. 21, pl. iv, figs. 4a-b, pl. v, figs. 3a-b.

1934. *Lytophiceras ptychodes*, SPATH, Catalogue of Fossil Cephalopods, p. 78, pl. i, figs. 1a-b.

1935. *Lytophiceras* aff. *ptychodes*, SPATH, Med. om Grønland, Bd. 93, no. 2, p. 21, pl. xix, fig. 9.

Description: — Shell laterally compressed, and also highly deformed laterally, with considerable strong falciradiate ribs. Form of venter unknown due to poor preservation. Ornamentation of shell surface shows characteristic falcoid radial ribs and striations running from umbilical margin and gradually diminishing toward ventral margin. Height of the last whorl about 1/3 of the diameter of shell; and diameter of the umbilicus a little less than half of the diameter of the shell. Width of the shell unknown.

Measurements (in mm):—*

	D	H	W	U	H/D	W/H	U/D
GSI. 18656	42.2	15.6(8.6)	—	19.9(11.5)	0.29	—	0.47
DIENER's Lectotype**	38.8	16.0	8.6	10.9	0.41	0.53	0.28

* D: Diameter of shell, H: Height of last whorl, W: Width of last whorl, U: Diameter of umbilicus.

** DIENER (1897, p. 123, pl. xii, figs. 3a-b), SPATH (1934, p. 77)

Remarks:—The specimen described above is highly deformed and compressed laterally. The ornamentation of the shell and the form of the whorl suggest it belongs to *Lytophiceras* (a subgenus of *Ophiceras*), not to the genus *Glyptophiceras*, which has stronger radial or falcoid ribs from the body whorls to the inner whorls of umbilical portion.

The genus *Lytophiceras* was considered by SPATH (1934, p. 78) as the transitional form from *Ophiceras* to *Glyptophiceras* for the type specimen from the *Ophiceras* bed of Pastun, Kashmir. The author also agrees with SPATH's view.

Lytophiceras ptychodes DIENER from Pastun, Kashmir, resembles with *Lytophiceras sakuntala* DIENER. Both species apparently look alike as remarked by SPATH (1934, p. 78). However, in the opinion of the present author the two species differ in the ornamentation of shell. *Lytophiceras sakuntala* has more feeble and weak falcoid striation than that of *L. ptychodes*.

Geological Horizon:—Flaggy shale.

Geological Age:—Otoceratan or Early Induan stage of Eo-Trias, Scythian.

Locality:—Khowurwat Gali, Pir Panjal Range, near Qazigund, Kashmir, India.

Regist. No.:—GSI (Geological Survey of India) 18651, 18656

Collector:—H. M. KAPOOR.

Subgenus *Ophiceras* SPATH, 1934

Type species: *Ophiceras tibeticum*, GRIESBACH, 1880, p. 109, pl. 5, fig. 4.

Ophiceras sp.

Pl. 33, fig. 1

Description:—Shell rather evolute, laterally compressed, with falcoid radial fine striations. Umbilical shoulders considerably acute angled and their wall shallow. Form of venter and sutures unknown.

Remarks:—In the generic rank the present material may be belonged to the genus *Ophiceras* judging from the shell ornamentation and cross section of the whorls. It is really unfortunate that the shape of the periphery is not clear in this material.

Specifically, the present material is comparable with some specimens of *Ophiceras* (*Discophiceras*). The present specimen, on the other hand, actually shows the same type of ornamentation of *Ophiceras greenlandicum* SPATH (SPATH, 1930, p. 16, pl. 11, figs. 12a-b; 1935, p. 15, pl. 11, figs. 1a-b, pl. 5, figs. 5a-b, pl. 10, figs. 1a-b, pl. 19, figs. 11a-b), but high deformation of this specimen and missing septa unabled the author to identify with the boreal type illustrated by SPATH.

Geological Horizon:—Flaggy shale.
Geological Age:—Otoceratan or Early Induan stage of Eo-Trias, Scythian.
Locality:—Malidar Gali, Pir Panjal, Kashmir, India.
Regist. No.:—GSI 18652
Collector:—H. M. KAPOOR.

Genus *Glyptophiceras* SPATH, 1930

Subgenus *Glyptophiceras* TRÜMPY, 1969

Type species: *Glyptophiceras aequicostatum* (DIENER), DIENER, 1913, p. 6, pl. ii, figs. 10a-b.

Glyptophiceras sp.

Pl. 33, fig. 5

Description:—Whorls evolute, laterally compressed, with wide umbilicus. Shell surface ornamented with widely spaced radial ribs, which are most prominent at one-third height of flanks and diminish toward umbilical and ventral margin. On surface of umbilical whorls ornamentation by faint radial folds become gradually indistinct in the inner whorls. Outer whorl overlaps about one-third height of inner whorl. There are 12-13 radial ribs and faint sigmoidal striations on shell surface of half part of outer whorl. Suture unknown.

Measurements (*in mm*):—

	D	H	W	U	H/D	W/H	U/D
GSI. 18655	38. 0?	12. 5	—	18. 7	0. 33	—	0. 49

Remarks:—The present specimen is completely crushed, so that the specific identification is difficult. As to the characteristic ribbing or shell ornamentation in the outer whorl rather resemble those of the genus *Glyptophiceras* and *Ophiceras* s. str. The present author (BANDO) included subgenus *Metophiceras* (SPATH, 1935, p. 34, type species: *Metophiceras subdemissum* SPATH) in the genus *Ophiceras* s. str. (BANDO, 1973). Essentially, "*Metophiceras*" is a transitional form between the *Glyptophiceras* and *Ophiceras* in the shell form, but it is better to be included in the *Ophiceras* s. str.

HSU (1936-37) has described *Ophiceras* from the *Otoceras* bed of the Chainglung limestone (Lower Trias at Lungtan in Kiangsu) and *Ophiceras* ? sp. from the Teyeh limestone (Lower Trias at Paoan near Teyeh in Hupei), both in South China. These *Ophiceras* ammonoids are considerably crushed and secondarily deformed like the Pir Panjal specimens. The shell ornamentation in the illustration by HSU (1936-37, p. 319, pl. 11, fig. 3, not fig. 4), in comparison with Pir Panjal specimen, suggests that these be included in *Ophiceras* s. str.

Explanation of Plate 32

Ophiceras fauna in the flaggy shale. *Locality*: Khowrwat Goli, Pir Panjal Range, near Qazigund, Kashmir. *Age*: Otoceratan or Lower Induan stage, early Eo-Trias. *Collector*: H. M. Kapoor.
Figured Specimen No. GSI. 18656 ×1.2

TRÜMPY (1969, pp. 93, 94, pl. 1, figs. 4-6), in his descrition of a new species of "*Metophiceras*", i.e. "*M.*" *wegeneri* TRÜMPY (from the Lower Trias of Jameson Land in East Greenland), has stated (op. cit., p. 93) that the genus "*Metophiceras*" is much closer to *Glyptophiceras* than to *Ophiceras* s. str., especially in the shell sculpture of the outer whorl and cross section of the whorl, but the ornamentation of umbilical shell has a remarkable difference from that of *Glyptophiceras*.

Geological Horizon:—Flaggy shale.

Geological Age:—Otoceratan or Lower Induan stages of Early Eo-Trias.

Locality:—Khowurwat Gali, Pir Panjal Range, near Qazigund, Kashmir, India.

Regist. No.:—GSI. 18655

Collector:—H. M. KAPOOR.

Subgenus *Hypophiceras* TRÜMPY, 1969

Type species: *Glyptophiceras triviale* SPATH, 1935, p. 47, pl. 7, fig. 2.

Hypophiceras ? sp.

Pl. 33, figs. 2, 3

Description:—Shell evolute, laterally compressed, with shallow umbilicus and narrow venter. Shell surface ornamented with falcoid radial fine ribs which are finer on body whorl than on inner whorls. Ribs most prominent at middle height portion, on the flanks and gradually diminish toward ventral and umbilical margin. Surface on umbilical whorls ornamented with coarsely radial projections, but not on ribs and more obscure than those of outer volution.

Remarks:—The specimen at hand is incomplete; especially the inner whorls are not clear and the ornamentation is poor; it is also highly deformed laterally. However, generic identification could be made though some dificulty, but nothing could be ascertained on species due to reasons given above.

The ornamentation of the outer whorl and a part of umbilicus of the present specimen shows its similarity to that of *Glyptophiceras* and more closely to subgenus *Hypophiceras* TRÜMPY (1969, p. 89).

Geological Horizon:—Flaggy shale.

Geological Age:—Otoceratan or Early Induan stages of Early Eo-Trias.

Locality:—Khowurwat Gali, Pir Panjal, near Qazigund, Kashmir, India.

Regist. No.:—GSI. 18654, 18655.

Collector:—H. M. KAPOOR.

Acknowledgments

The authors would like to record their sincere gratitude to the Governments of India and Japan, for their kind support, cooperation and collaboration throughout the work; without which this work would not have been successful. The present paper is one of the series of the Indo-Japanese collaboration in Geological Sciences.

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NAKAZAWA, K., KAPOOR, H. M., ISHII, K., BANDO, Y., MAEGOYA, Y., SHIMIZU, D.,

Explanation of Plate 33

All figures ×1.2. Figure 1 from Malidar Gali and figures 2-5 from Khowurwat Gali, Pir Panjal, near Qazigund, Kashmir. Age inferred for all ammonoid bearing horizons is the Otoceratan or Lower Induan stages of early Eo-Trias. *Collector*: H. M. KAPOOR.

Fig. 1. *Ophiceras* sp. GSI. 18652; from *Ophiceras* bed.
Figs. 2, 3. *Hypophiceras* ? sp. GSI. 18654, 18655
Fig. 4. *Lytophiceras* sp. (aff. *L. ptychodes* DIENER) GSI. 18651
Fig. 5. *Glyptophiceras* sp. GSI. 18653
(All specimens preserved in the Palaeontological Division of the Geological Survey of India)

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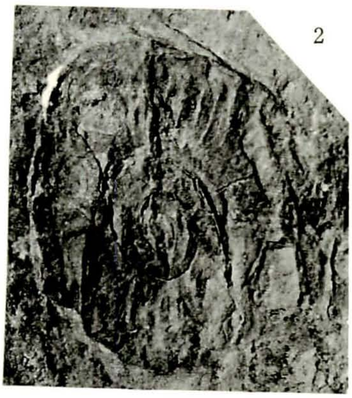

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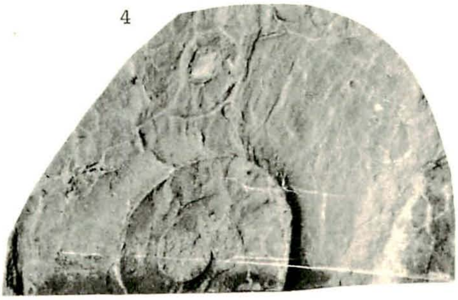

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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 93, pp. 240-248, pl. 34, April 20, 1974

628. A NEW SPECIES OF *INOCERAMUS* FROM THE SHIMANTOGAWA GROUP OF SOUTH SHIKOKU*

MASAYUKI NODA

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四国四万十川累層群より産出したイノセラムスの新種について： 四万十川累層群からは，所々に白亜紀化石が報ぜられているが，なお未だ多くの疑問を残している。その中で中筋地溝帯の西方に発達する御荘層（仮称）から最近幾種かの軟体動物化石が採集され，有効な時代決定の資料が得られたので該層についてその時代を考察する。また，産出したイノセラムスの中には特異な形質をもつものが認められるので，ここに新種として発表し，あわせてその類縁関係を考察する。

野　田　雅　之

Introduction

The apparently thick deposits, generally called the Shimantogawa group, are extensively developed in the southern terrain of the Outer Zone of Southwest Japan. The group consists mainly of shale and sandstone in various grades of thickness and has occasional interbeds or lentils of conglomerate, basaltic lava, tuffite, chert and limestone.

Recently the paleontological study of this group has been carried out on molluscan fossils found at some limited places and offered important biostratigraphical data, as those descrived by MATSUMOTO, KIMURA and KATTO (1952), KATTO and OZAKI (1956), NAGAI, NAKANO, YOSHIDA and OHOTSUKA (1962), NAKAI and HADA (1966), HAYAMI and KAWASAWA (1967), HASHIMOTO (1967), MATSUMOTO and HIRATA (1969) and MOROZUMI (1970).

Since 1969, I have examined the Inoceramids from this group. In this paper, I deal with the geological age of the "Misho formation", one of the Shimantogawa group and the paleontological description on a new species of *Inoceramus* from that formation, and do not intend to give comprehensive comments on the classification of the Inoceramidae. Only a short remark is given in connections with the allied species.

Before going further, I wish to acknowledge my indebtedness to several persons for their supporting of my work. My gratitude is first due to Professor Tatsuro MATSUMOTO of Kyushu University for much valuable advices and kind supervision of this work. Thanks are to Dr. Itaru HAYAMI for his kindness to the laboratory work and the bibliographic survey, to Professor Kozo NAGAI of Ehime University and Professor Michitoshi MIYAHISA of Ehime University for their favours to supply me with a number of specimens and the valuable references. Finally my gratitude is dedicated to Mr. Yasushi YUASA, Mr. Masaharu SEKI and Dr. Hakuyu OKADA who have stimulated through Prof. MATSUMOTO the present study with valuable specimens of their

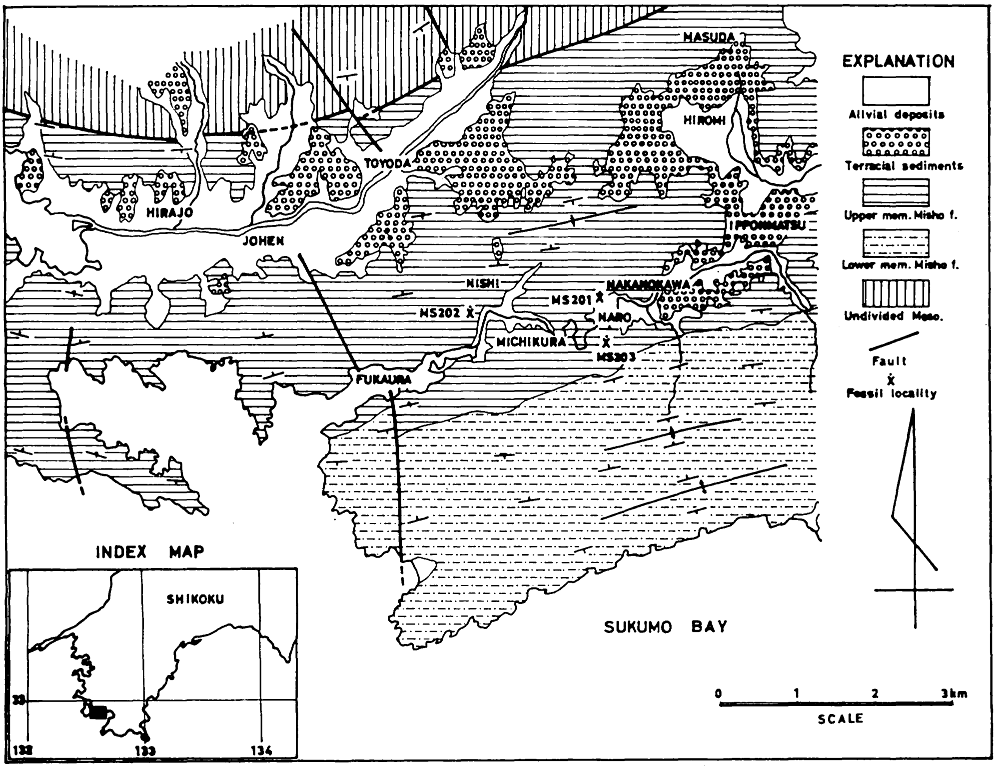
* Received June 8, 1973: read Oct. 28, 1972 at Matsuyama.

collections.

Note on Geology

The "Misho formation" is exposed on the northern coast of Sukumo Bay, which is situated in the southwestern part of the Shimanto belt of South Shikoku. The northern margin is demarcated from another unnamed formation of the Shimantogawa group by fault, and the east area also bounded by fault to the Arioka formation of the Upper Cretaceous developing in the Nakasuji-Rift-Valley. The name of this formation was proposed by NAGAI and others (1962). However, OKADA (1971) disapproves the name of the "Misho formation" by the reason of phonetic confusion that the "undifferentiated Mesozoic" was called "misho Mesozoic" in Japanese.

The geology of this district is shown in Fig. 1. The formation mainly consist of sandstone, shale and their alternation. They are broadly arcuate in strike, showing a trend of NEE-SWW, E-W and NWW-SEE, and divided into several blocks by transverse faults. The geologic structure is generally complicate, with overturned strata and fractured zones. Sandstone in various grades of coarseness is mainly distributed in the southern part of the mapped area. Each sandstone bed is commonly more than 20 cm in thickness, and in some part thin layers of mudstone are frequently inserted. In some other part sandstone



Text-fig. 1. Geological Map of the Johen area.

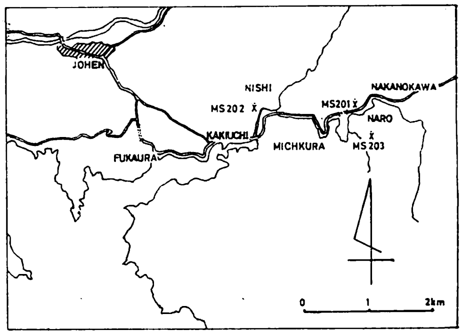
and mudstone are alternated. The northern part is occupied by mudstone with subordinate intercalation of sandstone of various thickness. Although the thickness of this formation is not precisely known, because of complicated structure, it is divided into two members, of which the Lower member is probably represented by the sandstone of the southern part.

Molluscan fossils occur in the mudstone bed near Nishi, Johen Town and Nakanokawa and Naro, Ipponmatsu Town, Minamiuwa County, Ehime Prefecture. The stratigraphic position of the fossiliferous bed is probably assigned to the middle part of the Upper member of this formation.

The faunal list is as follows:

Inoceramus balticus toyajoanus NAGAO and MATSUMOTO
Inoceramus balticus subsp.
Inoceramus schmidti MICHAEL
Iuoceramus yuasai n. sp.
Maolites sp.
Ammonites gen. et sp. indet.

According to MATSUMOTO in TAKAI and MATSUMOTO (1961), *I. balticus toyajoanus* probably indicates the Lower Hetonaian. NAGAI et al. (1962) reported *Inoceramus balticus toyajoanus* from Naro, Ipponmatsu Town, and considered the geological age of this formation as the Upper Urakawan to the Lower Hetonain (approximately Upper Santonian to Campanian), and they referred the flat large specimen (see NAGAI et al. 1962, Pl. 1, fig. 3) to one of *I. balticus* subsp. Now I am examining on the chronological change of morphology of Upper Cretaceous *Inoceramus*. Thus, I put off, at present, the subspecific determination of that specimen, which will be proposed in a separate paper. Furthermore, MATSUMOTO (personal information) identified *I. schmidti*, an effec-



Text-fig. 2. Locality Map.

tive indicator of the Lower Hetonaian, and *Maorites* sp. in the collection of YUASA from the same bed of Ipponmatsu. On the paleontological evidence mentioned above, the fossiliferous bed of this formation is probably referred to the Lower Hetonaian, i. e. Campanian in term of international scale.

Paleontological Description

Family Inoceramidae GIEBEL, 1852

Genus *Inoceramus* J. SOWERBY, 1814

Inoceramus yuasai n. sp.

Pl. 34, figs. 1-10

1962. *Inoceramus* sp., NAGAI et al., *Mem. Ehime Univ., Sec. 2, Ser. D*, vol. 4, no. 3, p. 3, pl. 1, fig. 2.

Material:—Holotype: GK. H6823, (Pl. 34, fig. 1) internal mould of left valve from Nakanokawa, Ipponmatsu Town, Minamiuwa County, Ehime Prefecture (coll. Y. YUASA). Paratypes: GK. H6824, (Pl. 34, fig. 5), internal mould of right valve, in the same rock as the holotype. GK. H6826 (Pl. 34, fig. 3), internal mould of right valve from the type locality (coll. Y. YUASA). GK. H6831 (Pl. 34, fig. 4), external mould of left valve (coll. M. SEKI), GK. H8005 (Pl. 34, fig. 9), internal mould of right valve, GK. H8004 (Pl. 3, fig. 7), and GK. H8006 (Pl. 3, fig. 2a, 2b), internal moulds of left valve from Nishi, Johen Town, Minamiuwa County, Ehime Prefecture (coll. M. NODA). Repository: Department of Geology, Kyushu University. There are many other specimens in NODA's private collection.

Specific Characters:—Shell small to medium in size, probably subequivalve or slightly inequivalve, inequilateral, moderately inflated from anterior to posterior and from umbo to ventral extremity, with an abrupt change in convexity along the growth axis. Antero-dorsal part steep or perpendicular to valve plane, postro-dorsal part abruptly flattened to wing-like area without sharp boundary. Hinge-line straight and fairly long, about two thirds of the shell length. The growth axis gently concave to the anterior. Umbo terminal, considerably inflated; left one more prominent than the right, rising above the hinge-line. Beak angle about 80°, apical angle slightly larger than a right angle. Small individuals, less than 10 mm in growth axis, slightly longer than high, and gradually becoming higher with growth, resulting in the outline slightly higher than long in the left valve and as long as high in the right one.

Antero-dorsal margin moderate in length and straight or slightly concave, anterior margin broadly arcuate passing gradually to the narrowly rounded ventral margin and then to the more broadly curved postero-ventral one, which is in turn bent abruptly to the moderately long and nearly straight posterior margin. The angle between the posterior margin and the hinge-line about 130°.

Surface ornamented with low, narrow and sharp concentric ribs which are regular in strength and distance. Interspaces comparatively broad and concave. Two or three round-topped radial folds run from the umbonal part to the anterior and also to the postero-ventral extremity. They vary in strength and stage of appearance. In some specimens the radial folds are very weakened, only showing abrupt bending in concentric ribs.

Measurements:—

Table 1. Dimension in mm.

Specimen*	H	L	h	l	h/l	HL
GK. H6823* holotype, internal mould of LV.	36	25	30	27	1.1	15
GK. H6826* paratype, internal mould of RV.	27	27	26	26	1.0	20
GK. H6831 paratype, external mould of LV.	58	52	55	49	1.1	29
GK. H8002 paratype, internal mould of LV.	17	11	16	14	1.1	7
GK. H8005* paratype, internal mould of RV.	29	24	28	25	1.1	—
GK. H8006* paratype, internal mould of LV.	34	34	33	33	1.0	—

* Less deformed specimen.
LV: left valve, RV: right valve, H: maximum dimension along the growth axis, L: maximum dimension along a line perpendicular to H, h: height; measured perpendicular to the hinge-line, l: length; measured parallel to the hinge-line, h/l: proportion of height to length, HL: length of the hinge-line.

Table 2. Measurement of angle.

Specimen	α	β	γ	δ
GK. H6823, holotype	95°	80°	130°	60°
GK. H6826, paratype	95°	80°	130°	60°
GK. H8001	95°	80°	130°	55°

α: apical angle between hinge-line and anterior margin.
β: beak angle of umbonal inflation.
γ: postro-dorsal angle between hinge-line and posterior margin.
δ: obliquity, the angle between hinge-line and the line from umbo to ventral extremity.

Table 3. Change of obliquity with growth.

Specimen	length of growth axis in mm.						
	5	10	15	20	25	30	35
GK. H6823	35°	40°	47°	50°	56°	56°	60°
GK. H6831	—	50°	57°	60°	60°	62°	67°
GK. H8007	35°	48°	60°	70°	—	—	—

Remarks:—Only four specimens (GK. H6823, GK. H6826, GK. H8005 and GK. H8006) are fairly well preserved showing the original outline, the shell convexity and the surface ornamentation. Many other specimens are more or less modified by secondary deformation, therefore, the marginal outline, the convexity and the proportion of h/1 are apparently varied. Generally details of the surface ornamentation are better impressed on the external mould (e. g. GK. H6831). The concentric ribs and radial folds are variable in strength and shape of cross-section, although apparently varied state sometimes occurs owing to the secondary deformation.

In spite of the above situation, from the synthetic judgement of available specimens, the distinctive specific characters are recognized as above.

Comparison: — *Inoceramus inconstans* WOODS from the Upper Chalk of England, shows considerable variation in marginal outline, shell convexity, proportion of h/1 and surface ornamentation. The specimen of GK. H8006 is comparable to a certain form of *Inoceramus inconstans* (WOODS, 1912a, p. 285-291, pl. 51, figs. 2a, 4a; 1912b; p. 14, text-figs. 69, 70), in abrupt change of convexity and curvature of concentric ribs, but differs from that form in its less convexity and more clearly developed concentric folds, as well as its radial ornament.

Inoceramus mihoensis MATSUMOTO, from the upper part of the Lower Urakawan (K5α), (approximately Upper Coniacian) of Saghalien, Hokkaido and Kyushu, is also similar to the present species in inequivalveness and abrupt change of convexity along the growth axis but the former is distinguished from the latter in its large size, absence of the posterior wing-like area, curvature of the concentric ribs and absence of the radial ornamentation.

According to WOODS (WOODS, 1917), *Inoceramus australis* WOODS (WOODS, 1917, p. 27, 28, pl. 12, figs. 17-19; pl. 13, figs. 1-3), from the Campanian of the

Amuri group of New Zealand, is allied to *Inoceramus inconstans*. It is also somewhat allied to the present species in abrupt change of convexity but discriminated from the latter in large proportion of h/l and absence of the radial folds.

Inoceramus (*Cordiceramus*) *brancoiformis* SEITZ (SEITZ, 1961, p.15 9-163, pl. 13, fig. 4, pl. 14, figs. 1-3) from the Middle to Upper Santonian of northwest Germany, also closely resembles the present species in abrupt changes of the shell convexity, presence of the posterior wing-like area and also presence of the radial ornamentation, but differ from the latter in larger apical angle, larger obliquity and less proportion of h/l.

NAGAI et al. (1962) regarded that the present species somewhat resembles *Inoceramus balticus* BÖHM and the allies from the Upper Urakawan to the Upper Hetonaian (approximately Santonian to Maestrichitian). Their material, however, as they explained, is a single imperfect specimen, which seems to be specifically indistinguishable from one of the present specimens (GK. H8005).

The present species is apparently similar to *Inoceramus subsulcatus* WILSHIRE (1896) (WOODS, 1911, p. 268, pl. 42, figs. 5, 6), from the Upper Gault of England, in the inequivalveness, development of the radial folds which vary in number, shape of cross-section and stage of appearance, but distinctly differs from the latter in its less prominent umbo, less convexity, presence of wing-like area, more strongly developed concentric ribs and anteriorly curved growth axis.

To sum up, the present species is not identical with any previously described species. Therefore, it is described under a new specific name which is dedicated to Mr. Y. YUASA who provided through Prof. T. MATSUMOTO valuable specimens of his collection for this study.

Consideration:—COX (1969), (in MOORE ed., p. 317) set up subgenus "*Cremnoceramus*" (=*Cephaloceramus* HEINTZ, 1932) for the species which are characterized by subequivalve or inequivalve shell, slight or moderate obliquity, abrupt change of convexity along the growth axis and absence of narrow postero-dorsal wing, and designated *Inoceramus inconstans* WOODS as its type species.

Regardless of the presence or the absence of radial folds, the essential characters of inequivalveness and abrupt change of shell convexity are in common between *Cremnoceramus* spp. and *Inoceramus yuasai*. This may suggest some connections between them. Although *Inoceramus inconstans* is not found in Japan, it is said to be very persistent ranging from the Upper Turonian to the Upper Campanian. Furthermore, as WOODS (1912b) himself has already admitted, the very variable *I. inconstans* has been considered as an ancester which gave rise to many other species. *Inoceramus mihoensis* from the upper part of the Lower Urakawan (K5α) (approximately Upper Coniacian) is regarded by MATSUMOTO as a lateral off-shoot from the main stock of the group of *I. inconstans*. In the essential characteristics mentioned above, *I. mihoensis* is also similar to the present species, but the available specimens, are insufficient for linking stratigraphically these two species.

Inoceramus australis, from the Campanian of New Zealand, is probably allied to *I. inconstans*, as WOODS (1917) has mentioned, but I consider that there is more intimate relation in morphology between *I. mihoensis* and the present species than that of *I. australis* and the present species.

SEITZ (1961) has pointed out that the immature form of *Cremnoceramus* is similar to that of *Heanlainia* (=*Cordiceramus* HEINTZ, 1932) and gradually differentiates from the latter with growth. It seems to suggest the intimate connection between the two subgenera. Regardless of the geographical distance, *Inoceramus* (*Cordiceramus*) *brancoiformis* SEITZ from the Middle to Upper Santonian of northwest Germany, may be possible to link morphologically and stratigraphically the present species with *Inoceramus* (*Cremnoceramus*) *inconstans* WOODS.

To sum up, in view of the above discussions, it is more reasonable to consider that the present species is probably derived from some forms of *I.* (*Cremnoceramus*) *inconstans*.

Occurrence:—Rather crowded in the black shale of the presumably middle part of the Upper member of the "Misho formation". Locality MS201; Nakanokawa, Ipponmatsu Town, Minamiuwa County, Ehime Prefecture, location, Long. 132°37′52″E, Lat. 32°57′04″N. Locality MS202; Nishi, Johen Town, Minamiuwa County, Ehime Pref., location, Long. 132°36′37″E, Lat. 32°56′57″N.

NODA and TASHIRO (1973) reported the present species as *Inoceramus* n. sp. (see NODA and TASHIRO, p. 494) from the basal part of the Izumi group at Dogo-Himezuka, Matsuyama City, associated with *I. schmidti* and numerous species of Campanian pelecypods. Loc. IM101, location, Long. 132°51′00″E, Lat. 33°50′42″N.

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Dogo-Himezuka	道後姫塚
Ipponmatsu	一本松
Johen	城辺
Minamiuwa	南宇和
Nakanokawa	中ノ川
Nakasuji	中筋
Naro	奈路
Nishi	西
Sukumo	宿毛

Explanation of Plate 34

Inoceramus yuasai n. sp.

Fig. 1. GK. H6823, holotype, internal mould of left valve. ×1.3. Loc. MS201, Nakanokawa, Ipponmatsu Town, Minamiuwa County, Ehime Prefecture (coll. Y. YUASA, 1968).

Fig. 2a, 2b. GK. H8006, paratype, internal mould of left valve, 2a, lateral view, 2b, anterior view. ×1.3. Loc. MS202, Nishi, Johen Town, Minamiuwa County, Ehime Prefecture (coll. M. NODA, 1970).

Fig. 3. GK. H6826, paratype, internal mould of right valve. ×1.3. Loc. MS202 (coll. M. SEKI, 1969).

Fig. 4. GK. H6831, paratype, rubber cast of left external mould, natural size. Loc. MS202 (coll. M. SEKI, 1969).

Fig. 5. GK. H6824, paratype, internal mould of right valve. ×1.3. Loc. MS201 (coll. Y. YUASA, 1968).

Fig. 6. JG. H2051, internal mould of left valve, natural size. Loc. MS202 (coll. M. NODA, 1971).

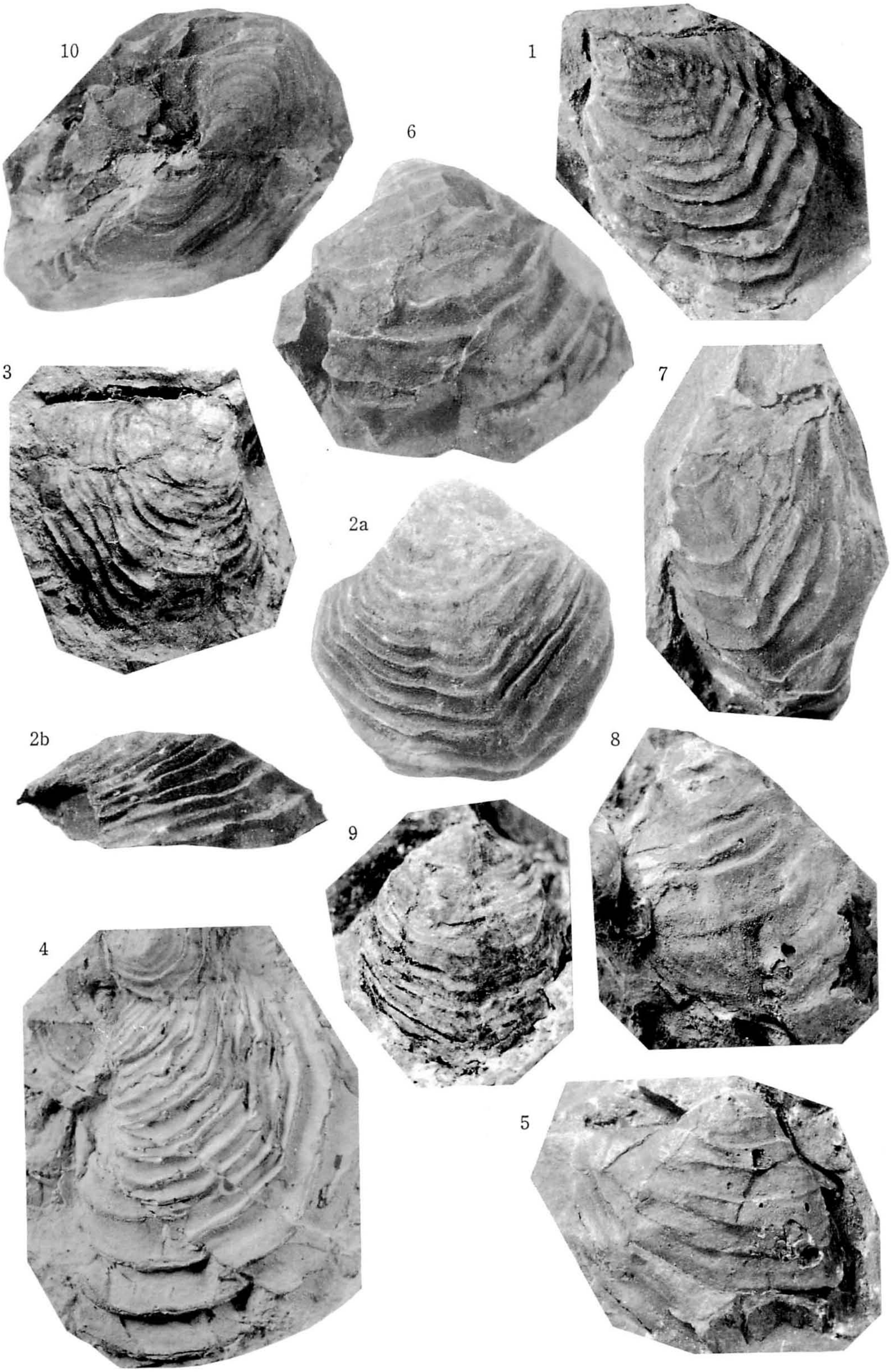
Fig. 7. GK. H8004, paratype, internal mould of left valve. ×1.3. Loc. MS202 (coll. M. NODA, 1970).

Fig. 8. GK. H8002, internal mould of left valve. ×1.3. Loc. MS202 (coll. M. NODA, 1970).

Fig. 9. GK. H8005, internal mould of right valve. ×1.3. Loc. MS202 (coll. M. NODA, 1970).

Fig. 10. GK. H8003, internal mould of both valves. ×1.3. Loc. MS202 (coll. M. NODA, 1971).

JG: Collection of Jonan Geological Association, Oita.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Trans. Proc. Palaeont. Soc. Japan, N. S., No. 93, pp. 249-265, pls. 35, 36, 37, April 20, 1974

629. EARLY AND MIDDLE PENNSYLVANIAN FUSULINIDS FROM SOUTHERN BRITISH COLUMBIA, CANADA AND NORTHWESTERN WASHINGTON, U. S. A.*

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カナダ British Columbia 南部とアメリカ合衆国 Washington 州北西部から産出する Pennsylvanian 初期と中期の紡錘虫類：British Columbia 南部の Kamloops や Keremeos 地域および Vancouver 島，Washington 州の Whatocom 地域や San Juan 諸島に分布する Pennsylvanian 層に含まれる石灰岩レンズなどの中に Pennsylvanian 初期から中期にいたる紡錘虫化石動物群の存在を確認し，ここにその詳報をはじめて記する。Pennsylvanian 初期の紡錘虫化石動物群は *Millerella, Eostaffella, Ozawainella* ? によって特徴づけられ，*Endothyra, Endothyranopsis* ?, *Tetrataxis, Textularia, Climacammina* などの小型有孔虫をも含む。中期の化石動物群は *Nankinella* や *Eoschubertella* ? などによって特徴づけられている。初期のものは THOMPSON (1948) や ROSS & SABINS (1965) らの北米の Pennsylvanian 初期の紡錘虫化石動物群に対比され，また，本邦の福地の *Millerella bigemmicula* 化石動物群（猪郷，1957）や阿哲石灰岩の *Millerella bigemmicula-Eostaffella kanmerai* 化石動物群（佐田，1964, 1965），帝釈石灰岩の *Millerella* 化石動物群（佐田，1967）に酷似している。 佐田公好・W. R. DANNER

Introduction

In southern British Columbia and northwestern Washington there is a widespread sequence of Upper Paleozoic rocks ranging in age from Middle Devonian (in Washington) to Late Permian. A group of limestone lenses and pods within this sequence contains Early to Middle Pennsylvanian fusulinids (DANNER, 1966, 1970a). In some areas these limestones may also contain in part a Late Mississippian (Late Chesterian=Viséan) fauna. This paper is the first description of these fusulinid faunas in southern British Columbia and northwestern Washington and is part of a continuing project on the description of Paleozoic faunas of this area.

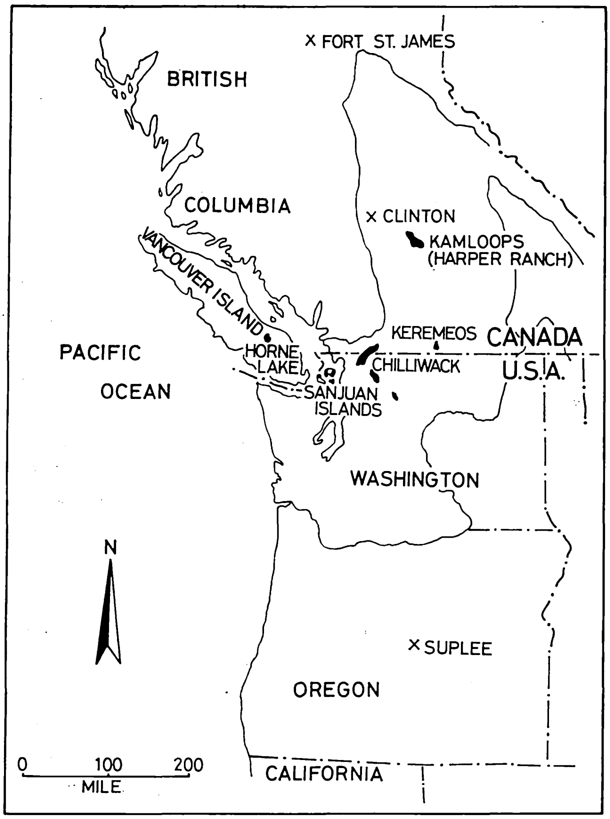
The Early Pennsylvanian fusulinid faunas of southern British Columbia and northwestern Washington are characterized by *Millerella marblensis*, *M.* sp., *Eostaffella columbiana* SADA & DANNER, n. sp., *E.* sp. A, *E.* sp. B, *E.* spp.,

* Received June 18, 1973; read Oct. 28, 1972 at Matsuyama.

Ozawainella ? sp. and *Endothyranopsis* ? sp. Associated microfaunas not described in this paper include *Endothyra* spp., *Climacammina* sp., *Textularia* sp., *Tetrataxis* sp., *Komia* sp., pteropods and algae. These fossils closely resemble the Early Pennsylvanian faunas of North America described by THOMPSON (1948) and ROSS & SABINS (1965), anda lso the Japanese Early Pennsylvanian faunas by IGO (1957) and SADA (1964, 1965, 1967). In the western Cordillera of North America they have been reported in the Fort St. James area (THOMPSON, 1965), northwestern Washington (SKINNER & WILDE, 1966) and northern California (HARBAUGH, 1955; SKINNER & WILDE, 1965).

The Middle Pennsylvanian fusulinid fauna is much rarer and is characterized by *Eoschubertella* ? sp. from Vancouver Island and *Nankinella plummeri* THOMPSON from the Kamloops area of British Columbia and the San Juan Islands of Washington. The genus *Eoschubertella* is a typical representative of early Middle Pennsylvanian age and is abundant in Middle Pennsylvanian rocks of America, Europe and Asia. In the western Cordilleran region it has been reported previously from the Fort St. James area of central British Columbia (THOMPSON, 1965) and from the Ballenas Islands off the east coast of Vancouver Island (J. E. MULLER, personal communication in MONGER & ROSS, 1971). *Nankinella plummeri* was originally described by THOMPSON (1947) from the early Middle Pennsylvanian Marble Falls Limestone, Llano Uplift, Texas. The genus is widespread in rocks ranging in age from Early Pennsylvanian to Late Permian in Europe, Asia and North America but to our knowledge no Early Pennsylvanian species has been described from North America. Unnamed species have been described previously in Middle Pennsylvanian rocks of the western Cordilleran region in the Fort St. James area of central British Columbia (THOMPSON, PITRAT & SANDERSON, 1953) and from southeastern Alaska (DOUGLASS, 1971).

Acknowledgments: Part of the field work by DANNER was conducted under grants of the National Research Council of Canada, the National Advisory Committee of the Geological Survey of Canada and the University of British Columbia. Some of the field work in northwestern Washington was performed while DANNER was employed by the Division of Mines and Geology of the State of Washington Department of Conservation. Re-examination and description of the material were undertaken by SADA while he was at the University of British Columbia under a grant of the National Research Council of Canada. John W. SKINNER aided in preliminary identification of some of the fusulinids and furnished information on the location of one of the Pennsylvanian fusulinid localities east of Kamloops, British Columbia. We wish to thank all of the many property owners who kindly permitted access on their lands and collection of material. We also wish to acknowledge the numerous students of the University of British Columbia and Boy Scouts of the 80th University Hill Troop who served as field assistants over a period of several years in the search for Pennsylvanian fossil localities and who helped pack out a large quantity of limestone samples. We give special thanks to T. NEUFELDT, P. GARVIN, E. HUNTER and F. GLASS who prepared several hundred thin sections in preliminary work on this project. Further work on this project was carried out while DANNER was visiting Professor at Hiroshima University under the aus-



Text-fig. 1. Map showing distribution of Lower Pennsylvanian sequence in southwestern British Columbia and northwestern Washington. Black indicates Pennsylvanian limestone outcrops where fauna was collected and multiplication indicates other Pennsylvanian localities.

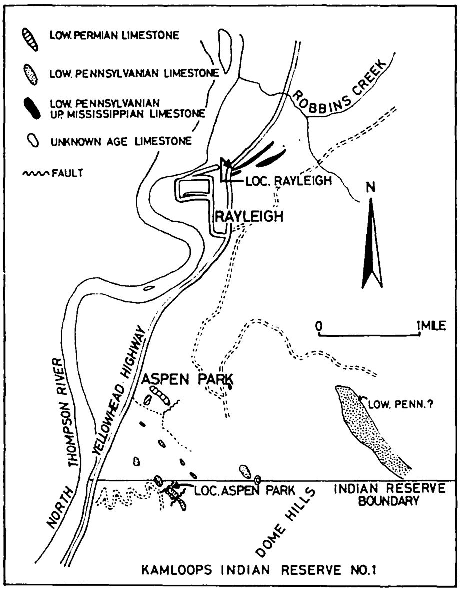
pices of the Japan Society for the Promotion of Science.

Stratigraphy and Discussion of Fauna

The Pennsylvanian limestones studied in this paper are in the lower part of the eastern facies of the Cache Creek Group in south central British Columbia. In southwestern British Columbia and northwestern Washington they are in the middle part of the Chilliwack Group and on the San Juan Islands in northwestern Washington they are in the middle part of an as yet not formally named sequence which is correlative with the British Columbia central "oceanic" facies of the Cache Creek Group. On Vancouver Island the Pennsylvanian limestones are in the lower part of the Sicker Group.

(1) Possible Late Mississippian limestones

Limestones that might be of Late Mississippian age have so far proved to be very rare in the study area. An as yet undescribed species of the Late



Text-fig. 2. Map showing the fossil localities at Rayleigh near north of City of Kamloops in British Columbia.

Mississippian (Viséan) coral *Hexaphyllia* has been found in our collections from the limestones cropping out near the community of Rayleigh north of Kamloops, British Columbia. This form, along with a different species of *Hexaphyllia* from the Late Mississippian Coffee Creek Formation of central Oregon (SADA & DANNER, 1973) is the only known occurrence of *Hexaphyllia* in North America. At the Rayleigh locality we also found *Eostaffella columbiana*, *E. kanmerai*, *Millerella* ? sp. and endothyroid foraminifera which may indicate that part of the limestone is of Early Pennsylvanian age.

Some of the limestones exposed in the Kendall limestone quarries on the west side of Red Mountain in northern Whatcom County, Washington, appear to contain only endothyroid foraminifera and this is also true of a small limestone lens located north of the road to the Devonian limestones of the Red Cross quarry on Orcas Island, Washington. It is possible that these exclusively *Endothyra*-bearing limestones may be of Late Mississippian age.

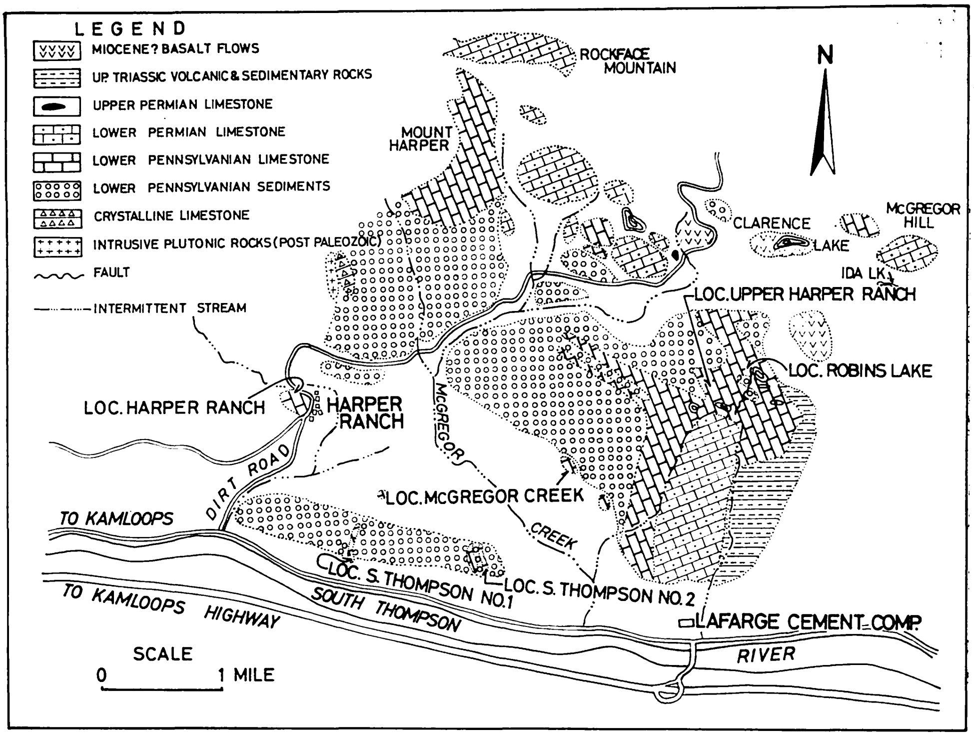
(2) Early Pennsylvanian limestones

Eastern Cache Creek Facies in Southern British Columbia

Limestones containing an Early Pennsylvanian fauna are widespread in the area north and east of the city of Kamloops in south central British Columbia. The first indication of Pennsylvanian age limestone was when M. Y. WILLIAMS (in COCKFIELD, 1948) tentatively identified the Early Pennsylvanian brachiopods, *Neospirifer cameratus* ? and *Rhynchopora magnicosta*, from this area but there is no indication of just where these brachiopods were collected. Later, fusulinids of Early Pennsylvanian age were found in limestone at Harper Ranch (John W. SKINNER, 1965, written communication). Subsequently we have found Pennsylvanian fusulinids in limestones in the cliffs along the South Thompson River, in the hills and meadowlands northeast and above the Harper Ranch, on the eastern side and top of Mount Harper and in numerous limestone lenses in the hills along the east side of the North Thompson River north of the city of Kamloops.

The fauna is typified by *Eostaffella columbiana*, *Eostaffella kanmerai*, *Millerella marblensis*, *Ozawainella* ? sp., *Endothyranopsis* ? sp., numerous endothyroid foraminifera, *Tetrataxis*, *Climacammina*, *Textularia*, pteropods, large crinoid columnals, large brachiopods and rare corals.

Early Permian limestones characterized by large *Pseudoshwagerina* overlie the Early Pennsylvanian limestone in the Kamloops area. However, some of



Text-fig. 3. Locality map of Harper Ranch area near Kamloops, British Columbia.

the smaller Early Pennsylvanian limestone bodies form discrete lenses surrounded by clastic sediments. East of the North Thompson River one of these limestone lenses is inverted with beds containing Early Pennsylvanian fusulinids overlying beds containing Early Permian fusulinids. The contact is a paraconformity and is marked by a layer of chert pebbles and a zone of silicification.

At Keremeos, British Columbia in the Blind Creek Formation we have found very small primitive forms of *Eostaffella*, *E.* sp. B, along with *Endothyra* and *Millerella marblensis*. The Keremeos limestone also contains a coral identified as of Permian or Late Carboniferous age and a coral that resembles a Late Mississippian species (SMITH, 1935). The late Donald ANGOLD (personal communication) stated that there were two divisions of the limestone of the Blind Creek Formation, one with abundant corals and the other containing a few poorly preserved brachiopods. His limestone specimens in which we have found *Eostaffella*, *Millerella* and *Endothyra* came from the non-coral part of the Formation so it is likely that the Blind Creek Formation consists of an Early Pennsylvanian limestone overlain by an Early Permian limestone.

Chilliwack Group in British Columbia and Washington

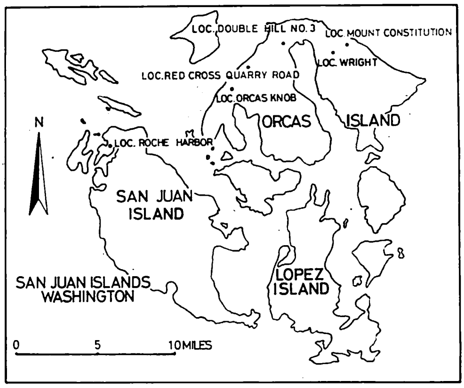
Large and small bodies of well-bedded partly argillaceous limestone of Early Pennsylvanian age are found in the Chilliwack Group in southwestern British Columbia and northwestern Washington.

In the Chilliwack area of British Columbia (MONGER, 1966) they seldom exceed 100 feet in thickness but may be as much as 600 feet thick or more in Washington State (DANNER, 1966) and extend in discontinuous outcrops for at least 65 miles southeastward into the Northern Cascade Mountains. The Pennsylvanian limestones are overlain by coarse- to medium-grained volcanic arenites, greywackes and cobble conglomerates. Some of the clastics contain plant fragments identified as *Lepidodendron* and *Calamites* by G. E. ROUSE and may be of Later Pennsylvanian age. The clastics are in turn overlain by Permian fusulinid limestones of Early Leonardian age.

The Early Pennsylvanian limestones of the Chilliwack Group contain a fauna similar to that of the eastern facies of the Cache Creek Group exposed near Kamloops, British Columbia and it includes *Eostaffella columbiana*, *E. kanmerai*, *Millerella* sp., *Ozawainella* ? sp., *Tetrataxis* sp., *Textularia* sp., *Climacammina* sp., numerous endothyroids, large crinoid columnals, coral, bryozoa and large brachiopods. The puzzling algae or stromatoporoid *Komia* is locally abundant.

San Juan Islands, Washington

On the San Juan Islands in northwestern Washington numerous small limestone bodies contain an Early Pennsylvanian fauna. They are overlain on Orcas Island by a sequence of sedimentary and volcanic rocks containing the Early and Late Permian faunas and on San Juan Island by volcanic and sedimentary rocks containing a Late Permian fauna. The Late Permian faunas on both islands contain *Neoschwagerina* and other Tethyan fusulinids correlative with the middle or "oceanic" facies of the Cache Creek Group (DANNER, 1970b; MONGER & ROSS, 1971). The Early Pennsylvanian limestones contain *Eostaffella* spp., *Millerella* ? sp., *Ozawainella* sp., *Endothyra* spp., *Tetrataxis* sp., *Textularia* sp., *Climacammina* sp., large crinoid columnals and corals. We have not been able to obtain well enough oriented material to identify the species of *Eostaffella*. On San Juan Island at Roche Harbor *Eostaffella* sp. is associated with mats of filamentous algae in limestone interbedded with radiolarian cherts.



Text-fig. 4. Map showing the fossil localities on San Juan Islands in Washington.

(3) Middle Pennsylvanian

Kamloops area and Vancouver Island, British Columbia; Orcas Island, Washington

Nankinella plummeri THOMPSON was found in limestones of the eastern facies of the Cache Creek Group in the hills and meadowland areas above and east of the Harper Ranch near Kamloops, British Columbia. Our collections containing it all come from the largest outcrop area of Pennsylvanian limestone overlain by Early Permian limestone or Triassic volcanic rocks and not from the small lenses of Pennsylvanian limestone in clastic rocks. *Nankinella plum-*

meri is associated with *Endothyra* spp. in these limestones.

On Vancouver Island *Eoschubertella* was collected from a limestone bed on the west side of Horne Lake and *Eostaffella* ? sp. from limestone talus blocks below the limestone cliffs on Mount Mark on the north side of Horne Lake. *Endothyra* sp. also occurs in these limestones. It had been suspected for several years that Pennsylvanian rocks occur on Vancouver Island (DANNER, 1960, 1965) although YOLE (1963) could find only evidence of Early Permian age. More recently the Middle Pennsylvanian fusulinids *Wedekindellina* and *Eoschubertella* have been reported from North Balenas Island just off the east coast of Vancouver Island in Georgia Strait (J. E. MULLER in MONGER & ROSS, 1971). A Pennsylvanian fusulinid fauna is also known to occur in the central "oceanic" facies of the Cache Creek Group in limestones near the town of Clinton in central British Columbia but it will be discussed in a later paper when the study of this area is completed.

On Orcas Island, Washington, our samples containing *Nankinella* came from a small lens of argillaceous limestone on the northeast slopes of Mount Constitution about 550 feet above sea level. The limestone contains a microfauna of *Eostaffella* sp., *Millerella* ? sp.. *Endothyra* sp., and crinoid columnals, bryozoa, corals and one species of trilobite.

The thin sections used in this study are deposited in the stratigraphic-paleontologic collections of the University of British Columbia, Department of

Table 1. Distribution of species of fusulinids and other microfossils by samples from the Pennsylvanian limestone in British Columbia and Washington.

	MICROFAUNA / LOCALITY	*Eostaffella columbiana, n. sp.*	*E. kanmerai*	*E. sp. A*	*E. sp. B*	*E. spp.*	*Millerella marblensis*	*M. sp.*	*Ozawainella ? sp.*	*Nankinella plummeri*	*Eoschubertella ? sp.*	*Endothyranopsis ? sp.*	*Endothyra spp.*	*Tetrataxis sp.*	*Textularia sp.*	*Climacammina sp.*	*Komia sp.*	*Hexaphyllia sp.*
BRITISH COLUMBIA	KEREMEOS				X		X						X					
	RAYLEIGH	X	X				X	X					X					X*
	ASPEN PARK	X					X	X					X	X	X	X		
	HARPER RANCH	X	X	X	X		X	X				X	X	X	X	X		
	SOUTH THOMPSON #1	X	X		X								X	X	X	X		
	SOUTH THOMPSON #2	X	X	X	X		X	X	X			X	X	X	X	X		
	NORTH McGREGOR CREEK		X	X			X	X					X	X	X	X		
	UPPER HARPER RANCH	X						X					X	X	X	X		
	UPPER HARPER RANCH									X			X					
	ROBINS LAKE	X					X	X					X	X	X	X		
	ROBINS LAKE									X			X					
	LJUMPTION RIDGE	X	X					X	X									
	WEST SIDE HORNE LAKE										X		X					
	NORTH SIDE HORNE LAKE					X							X					
WASHINGTON	BLACK MOUNTAIN	X							X				X	X	X	X	X	
	RED MOUNTAIN					X							X					
	UPPER KENDALL QUARRY					X			X				X	X	X	X	X	
	LOWER KENDALL QUARRY												X					
	WRIGHT, ORCAS IS.					X		X	X				X					
	MOUNT CONSTITUTION, ORCAS IS.					X	X	X		X			X					
	DOUBLE HILL #3 ORCAS IS.					X			X				X	X				
	ORCAS KNOB, ORCAS IS.					X							X	X	X	X	X	
	REDCROSS QUARRY ROAD, ORCAS IS.												X					
	ROCHE HARBOR, SAN JUAN IS.					X												

* As the sample containing *Hexaphyllia* sp. from Rayleigh is different from the sample containing Early Pennsylvanian fusulinids, the species is not associated with *Eostaffella columbiana, E. kanmerai, Millerella marblensis* and *M.* sp.

Geological Sciences.

Fossil Localities

British Columbia

Keremeos.—Blind Creek Limestone. Top of hill southeast of the town of Keremeos.

Rayleigh.—Road cut on east side of Yellowhead Highway about 8 miles north of the city of Kamloops and just north of the community of Rayleigh in SW$^1/_4$ section 34, T. 21, R. 17.

Aspen Park.—Several small limestone bodies about 4$^1/_2$ miles north on the Yellowhead Highway from the city of Kamloops. About one mile up hillside between 2000 and 2500 feet in altitude. Near north boundary of Kamloops Indian Reserve No. 1 and southeast for $^1/_2$ mile. Part of these same limestone bodies contain Early Permian fusulinids.

Harper Ranch.—Ridge of limestone in center of north $^1/_2$ section 10, T. 20, R. 16, just west of Harper Ranch buildings on Harper Ranch Road.

South Thompson #1.—Lens of limestone cropping out on south-facing cliff $^1/_4$ mile north of South Thompson River and the river road along east section line of NE$^1/_4$ section 3, T. 20, R. 16.

South Thompson #2.—Breached anticlinal bed of limestone cropping out along east section line of section 2, T. 20, R. 16, on top of terrace above South Thompson River Valley about $^1/_2$ mile north of South Thompson River and the river road.

North McGregor Creek.—Small knob of limestone exposed at base of hills north side of McGregor Creek valley, east end of Harper Ranch in SE $^1/_4$ section 12, T. 20, R. 16 about 1$^1/_2$ miles north of South Thompson River at an altitude of approximately 1700 feet.

Upper Harper Ranch.—NE$^1/_4$ section 7, T. 20, R. 15 in meadowlands in hills above east end of Harper Ranch at an altitude of between 3000 and 3100 feet. Low ridges of limestone north of small alkalie lakes.

Robins Lake.—Limestone outcrops around shores of Robins Lake, an alkalie Lake in the NW$^1/_4$ of section 8, T. 20, R. 15 in the hills above the South Thompson River at an altitude between 3200 and 3300 feet.

Liumption Ridge. — Bedded argillaceous limestone exposed up a stream bed near the base of the steep slope forming the north side of Liumption Ridge. Above the south side of a meadow area used for camping which is about $^1/_2$ mile up and south of Liumption Lake. There was a cabin in the meadow in 1959. Altitude about 4600 feet. Liumption Ridge is the southwestern extension of Church Mountain.

West Side Horne Lake.—Limestone exposed in outcrops along logging road above west side of Horne Lake.

North Side Horne Lake.—Talus blocks of limestone at base of Mount Mark along logging road on north side of Horne Lake.

Washington

Black Mountain.—Limestone cliff near center of section 4, T. 40 N., R. 6 E., on a northwestern spur of Black Mountain. Logging road at base of cliff. Northern Whatcom County.

Red Mountain.—Limestone outcrop on the top of Red Mountain near its northern end in the SW$^1/_4$ section 12, T. 40 N., R. 5 E.

Upper Kendall Quarry.—Top of north end of large limestone quarry used for cement rock. Section 14, T. 40 N., R. 5 E.

Lower Kendall Quarry.—In east wall of abandoned limestone quarry in the SW$^1/_4$ section 14, T. 40 N., R. 5 E.

Wright, Orcas Island.—Small area of limestone outcrop in the NE$^1/_4$ section 19, T. 37 N., R. 1 W., at an estimated altitude of 900 feet on the northwest side of Mount Constitution. Southeast of a large swampy area and about $^1/_8$ mile south of Day Lake Road.

Double Hill #3, Orcas Island.—A 40 foot high limestone knob on a north-facing slope about the center of the SE$^1/_4$ of section 15, T. 37 N., R. 2 W., on the west side of the southern part of Double Hill. It is about 300 feet northwest and downslope from the pass between Double Hill and Lookout Mountain and about 120 feet north of the Double Hill #2 limestone deposit.

Mount Constitution, Orcas Island.—Northeast slope of Mount Constitution in the SW$^1/_4$ section 16, T. 37 N., R. 1 W., just west of the junction of a main logging road with two abandoned spur roads. Knob-like exposure of limestone.

Orcas Knob, Orcas Island.—Small limestone lenses and pods and large limestone clastics in volcanic breccia in cliffs on west side of Orcas Knob in the SE$^1/_4$ section 30, T. 37 N., R. 2 W. between top of knob and Soderberg limestone quarries (Devonian age) at west base of Orcas Knob.

Red Cross Quarry Road, Orcas Island.—Small outcrop of oolitic limestone on vegetation covered ridge north above road into Red Cross limestone quarry (Devonian age) in the NE$^1/_4$, SE$^1/_4$ section 20, T. 37 N., R. 2 W. East of House.

Roche Harbor, San Juan Island.—Southeast side of northernmost limestone quarry at Roche Harbor in the NE$^1/_4$ section 23, T. 36 N., R. 4 W.

Systematic Description

Family Ozawainellidae THOMPSON & FOSTER, 1937

Genus *Millerella* THOMPSON, 1942

Millerella marblensis THOMPSON

Pl. 37, figs. 6-12, 14

1942. *Millerella marblensis* THOMPSON. *Amer. Jour. Sci.*, vol. 240, pp. 405-407, pl. 1, figs. 3-14.
1944. *Millerella marblensis*, THOMPSON. *Kansas Geol. Surv. Bull. 52*, pp. 420-423, pl. 1, figs. 1-9, pl. 2, figs. 1-15.
1948. *Millerella marblensis*, THOMPSON. *Kansas Univ., Paleont. Contr., Protozoa, art. 1*, p. 76, pl. 23, figs. 1-12, pl. 24, figs. 1-9.
1951. *Millerella marblensis*, THOMPSON. *Contr. Cushman Found. Foram. Res.*, vol. 11, pt. 4, p. 118, pl. 13, figs. 14, 17.
1954. *Millerella marblensis*, SKINNER & WILDE. *Jour. Paleont.*, vol. 28, no. 4, p. 449, pl. 49, fig. 3.
1957. *Millerella marblensis*, IGO. *Sci. Rep. Tokyo Kyoiku Daigaku, Sec. C*, vol. 5, nos. 47-48, pp. 178-179, pl. 1, figs. 13-14, 18-19.
1961. *Millerella marblensis*, RICH. *Jour. Paleont.*, vol. 35, no. 6, p. 1159, pl. 142, figs. 1-9.
1964. *Millerella marblensis*, MOORE. *Jour. Paleont.*, vol. 38, no. 2, pp. 295-305, pl. 47, figs. 1-24, pl. 48, figs. 1-23.
1965. *Millerella marblensis*, ROSS & SABINS. *Jour. Paleont.*, vol. 39, no. 2, pp. 183-184, pl. 21, figs. 18-27.
1965. *Millerella marblensis*, ROSS & TYRRELL. *Jour. Paleont.*, vol. 39, no. 4, p. 621, pl. 76, figs. 38-42.
1967. *Millerella marblensis*, SADA. *Trans. Proc. Palaeont. Soc. Japan, N. S.* no. 67, pp. 140-142, pl. 12, figs. 13-14, pl. 13, figs. 1-3, 9.

Description:—The shell of *Millerella marblensis* THOMPSON is discoidal and shows rounded periphery and umbilicated poles. The shell of five volutions illustrated as fig. 8 on Pl. 37 (South Thompson #2-39-a) is 100 microns in length and 400 microns in width, having a form ratio of 0.25. The outer two or three volutions are completely evolute. The spherical proloculus of a specimen measures 20 microns in its outside diameter. The radius vectors of the 1st to the 5th volution of a specimen are 30, 60, 100, 140 and 210 microns, respectively. The spirotheca consists of a tectum and inner and outer tectoria and its thickness of the last volution is about 20 microns. The septa are closely spaced. The chomata are small and primitive.

Remarks:—As pointed out by THOMPSON (1948, p. 76) *Millerella marblensis* has a fairly broad specific variation in its shell-shape and size. In the shell-shape and the internal characteristics, the present specimens are identified with *M. marblensis* described by THOMPSON from the Lower Pennsylvanian rocks of Texas and New Mexico (1942, 1948), Arkansas and Kansas (1944).

Occurrence:—M. marblensis was found at the following localities: South Thompson #2, Harper Ranch, Robins Lake, North McGregor Creek, Rayleigh, Aspen Park, Keremeos and Mount Constitution on Orcas Island.

Genus *Eostaffella* RAUSER-CHERNOUSSOVA, 1948

Eostaffella columbiana SADA & DANNER, n. sp.

Pl. 35, figs. 1-8; Pl. 36, figs. 1-5

Description:—The shell of *Eostaffella columbiana* SADA & DANNER, n. sp. is large for the genus and discoidal in shape with subangular to rounded periphery, slightly umbilicated poles and convex lateral slopes. The mature shells of five to six volutions are 250 to 370 microns in length and 680 to 950 microns in width, giving the form ratios of 0.26 to 0.49. The shell of the holotype is 300 microns in length and 820 microns in width, possessing a form ratio of 0.37. The inner and outer volutions are involute but the last one is partly evolute. The proloculus is large. Its outside diameter ranges from 40 to 60 microns in eight specimens. The radius vectors of the 1st to the 6th volution of eight specimens are 40-60, 60-120, 140-190, 210-310, 340-450 and 520 microns, respectively. The spirotheca is fairly thick and is composed of a tectum and inner and outer tectoria in the inner volution but in the outer ones it consists of a tectum, inner and outer tectoria and a discontinuous thin lighter layer. The thickness of the spirotheca of the 1st to the 2nd volution is less than 10 microns and of the 3rd to the 5th volution is 10 to 30 microns, respectively. The septa are fairly thick and planer throughout the shell. They bend anteriorly. The septal counts of the 1st to the 5th volution of a typical specimen illustrated as fig. 5 on Pl. 36 (South Thompson #2-48-b) are 5, 12, 16, 18 and

Table 2. Measurements of *Eostaffella columbiana* SADA & DANNER, n. sp.

Slide	Pl.	fig.	L.	W.	R.	Prol.	Radius vector					
							1	2	3	4	5	6
Upper Harper Ranch 93-a	35	1	0.30	0.82	0.37	0.06	0.06	0.11	0.19	0.28	0.45	
Upper Harper Ranch 93-b	35	2	0.37	0.80	0.46	0.06	0.05	0.10	0.18	—	0.43	
Harper Ranch 4-c	35	3	0.37	0.76	0.49	0.05	0.06	0.12	0.19	0.31	0.41	
Harper Ranch 1-a	35	6	0.35	0.78	0.45	0.05	0.05	0.10	0.16	0.27	0.45	
Harper Ranch 4-b	35	7	0.36	0.78	0.46	0.06	0.06	0.11	0.16	0.27	0.45	
South Thompson #2-30-a	35	4	0.27	0.68	0.40	0.05	0.05	0.09	0.15	0.24	0.36	
South Thompson #2-26-c	35	5	0.23	0.47	0.49	0.05	0.05	0.06	0.17	0.27		
Harper Ranch 62-66	36	1	0.25	0.95	0.26	0.04	0.04	0.08	0.14	0.21	0.34	0.52

(Measurements in mm)

19, respectively. The chomata are distinctly developed. The tunnel angles of the 1st to the 4th volution are 25, 25, 26 and 27 degrees, respectively, in a specimen illustrated as fig. 3 on Pl. 35 (Harper Ranch 4-c).

Remarks:—A large number of the sectioned specimens are referable to the present new species. They show a fairly wide range of variation in the length of the axis of coiling and the height of the chambers in the outer two or three volutions. In the general shape of the shell *Eostaffella columbiana* SADA & DANNER, n. sp. somewhat resembles *Eostaffella circuli* which was described by THOMPSON (1945, pp. 46-47, pl. 1, figs. 15-18) from the Pennsylvanian Belden formation in Northwest Colorado and East Utah, and by THOMPSON (1948, p. 77, pl. 24, figs. 16-18) from Powwow Canyon, Hueco Mountain, Texas. However, *E. columbiana*, n. sp. is distinguished from *E. circuli* in having larger shell, larger proloculus and more rapid expansion of the shell in the outer volutions. The present species has a close resemblance to *Eostaffella gigantea* (KANMERA) (1952, pp. 172-173, pl. 12, figs. 4-14) from the Kakisako formation of Southwest Japan, but they are easily distinguished by smaller shell of *E. columbiana*, n. sp., larger form ratio, smaller proloculus and thicker spirotheca of the last volution. *E. columbiana*, n. sp. is somewhat allied to *Eostaffella japonica* (KANMERA) (1952, pp. 170-172, pl. 11, figs. 1-19: pl. 12, figs. 1-3) from Japan. However, the more slender shell, smaller form ratio and smaller proloculus of *E. japonica* serve to distinguish it from *E. columbiana*, n. sp. *Eostaffella columbiana*, n. sp. resembles *Eostaffella britishensis* described by ROSS (1967, pp. 715-716, pl. 79, figs. 6-10) from locality 2B-15-63-54, 9 miles south of Trout Lake, British Mountains, Yukon. However, the former species is smaller in size and has smaller proloculus and smaller form ratio. *Eostaffella columbiana* differs from *Eostaffella thompsoni* (ANISGARD & CAMPAU) (1963, p. 102, pl. 9, figs. 1-15, pl. 10, figs. 1-7, pl. 11, figs. 1-4) in that it has a smaller shell, smaller form ratio, smaller tunnel angles and larger number of volutions.

Occurrence: — *Eostaffella columbiana* was found abundantly at many localities including: South Thompson #1, South Thompson #2, Rayleigh, Aspen Park, Harper Ranch, Upper Harper Ranch, Robins Lake #1, Liumption Ridge, in British Columbia and Black Mountain in Washington State.

Eostaffella kanmerai (IGO)

Pl. 37, figs. 1-3, 5, 18-19

1957. *Millerella kanmerai* IGO. *Sci. Rep. Tokyo Kyoiku Daigaku, Ser. C*, vol. 5, nos. 47-48, pp. 175-177, pl. 1, figs. 20-26, pl. 2, fig. 14.

1964. *Eostaffella kanmerai*, SADA. *Jour. Sci. Hiroshima Univ., Ser. C*, vol. 4, no. 3, pp. 230-231, pl. 21, figs. 8, 16-17.

1967. *Eostaffella kanmerai*, SADA. *Trans. Proc. Palaeont. Soc. Japan, N.S.* no. 67, pp. 144-145, pl. 2, figs. 1-10.

1969. *Eostaffella kanmerai*, SADA. *Trans. Proc. Palaeont. Soc. Japan, N.S.* no. 75, pp. 120-121, pl. 12, figs. 1-13; pl. 13, figs. 1-2.

Description:—The shell of *Eostaffella kanmerai* (IGO) is discoidal in shape with subangular to rounded periphery and depressed at the umbilicated poles. The lateral slopes are distinctly convex. Shells with five volutions measure 190 to 230 microns in length and 390 to 680 microns in width, giving the form ratios of 0.29 to 0.43. The inner volutions are involute but the last one or two volutions become partly evolute.

The spherical proloculus measures 30 to 40 microns in the outside diameter. The radius vectors of the 1st to the 5th volution of seven specimens are 40-50, 70-100, 110-130, 190-330 and 280-380 microns, respectively.

The spirotheca is fairly thick in the outer two volutions and consists of a tectum and inner and outer tectoria and its thickness of the 1st to the 5th volution of seven specimens is 10 to 20 microns. The thickness of the proloculus wall ranges from 10 to 15 microns. The septa are thin and slightly bent anteriorly. The chomata are low and slightly asymmetrical. The tunnel angles of the 1st to the 3rd volution of a specimen (Pl. 37, fig. 1: North McGregor Creek 11-a) are 20, 24 and 25 degrees, respectively.

Table 3. Measurements of *Eostaffella kanmerai* (IGO).

Slide	Pl.	fig.	L.	W.	R.	Prol.	Radius vector				
							1	2	3	4	5
North McGregor CK. 11-a	37	1	0. 23	0. 56	0. 41	0. 04	0. 05	0. 08	0. 13	0. 21	0. 30
South Thompson #2-18-b	37	3	0. 19	0. 56	0. 34	0. 04	0. 04	0. 07	0. 11	0. 19	0. 28
South Thompson #2-18-a	37	2	0. 20	0. 68	0. 29	0. 03	0. 05	0. 10	0. 15	0. 24	0. 38
South Thompson #2-26-b	37	19	0. 19	0. 55	0. 34	0. 04	0. 05	0. 09	0. 18	0. 31	
South Thompson #2-27-a	—	—	0. 19	0. 58	0. 33	0. 04	0. 05	0. 09	0. 18	0. 33	

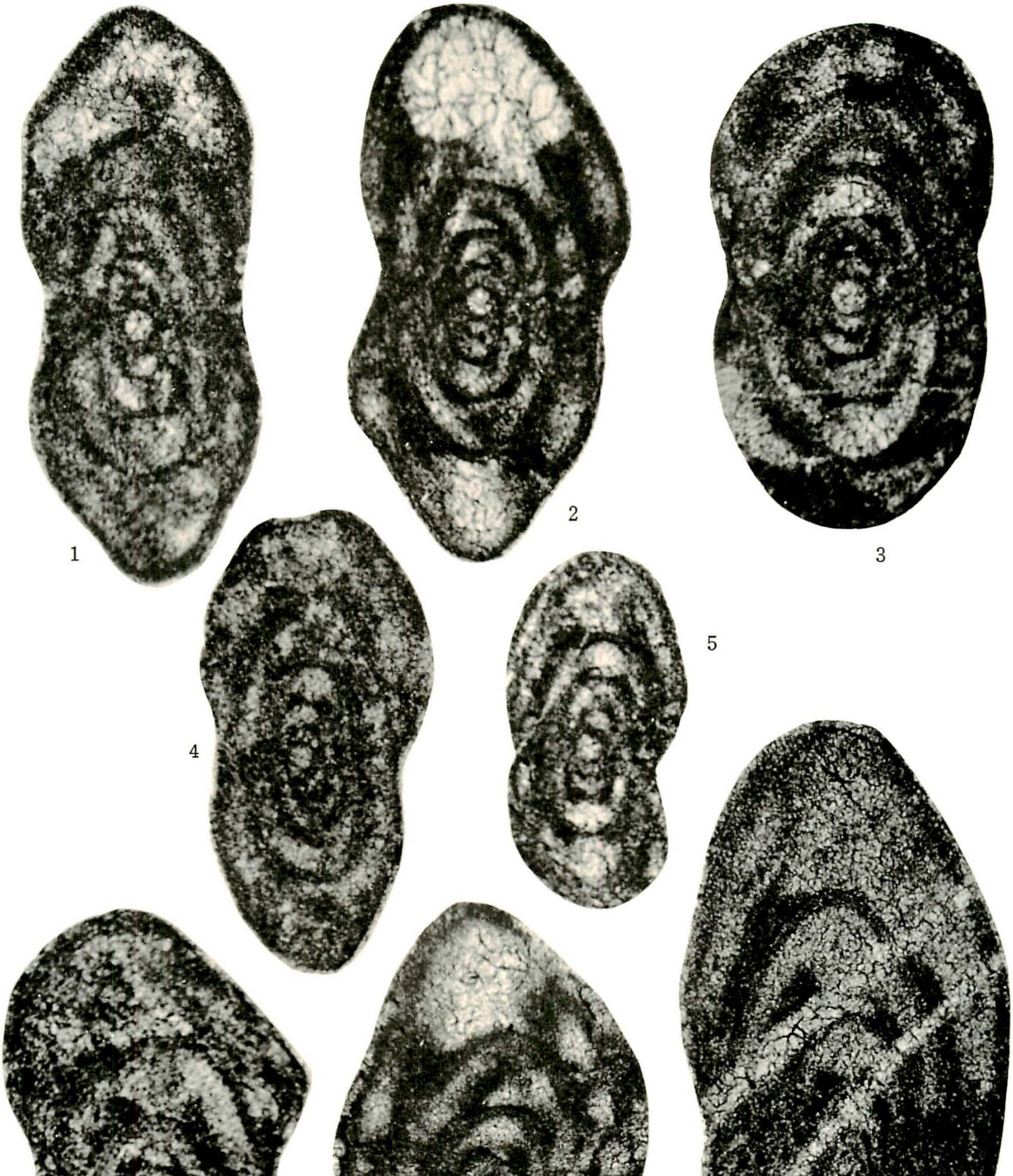
(Measurements in mm)

Remarks:—Eostaffella kanmerai was originally described by IGO (1957) from the Ichinotani formation in Central Japan, and then it was described from the Pennsylvanian limestones of Atetsu (SADA, 1964) and Taishaku (SADA, 1967, 1969) in West Japan. The specimens described above are quite identical with the types and the hypotypes of Japan in the shell-shape, the size, the form ratio, the number of volutions, the expansion of the shell, the spirothecal thickness, the proloculus diameter, the tunnel angles and the septal counts. *Eostaffella kanmerai* somewhat resembles *Eostaffella circuli* described from Utah and Colorado (THOMPSON, 1945, pp. 46-47, pl. 1, figs. 15-18) and from Texas (THOMPSON, 1948, p. 77, pl. 24, figs. 16-18). However, *E. kanmerai* can be easily distinguished from *E. circuli*, for the former species has a shorter axial length, smaller form ratio, smaller proloculus, smaller chomata, higher chambers and fewer septa for corresponding volutions, thinner spirotheca and larger tunnel

Explanation of Plate 35

All figures ×100

Figs. 1-8. *Eostaffella columbiana* SADA & DANNER, n. sp.
1. Axial section of the holotype: Slide-Upper Harper Ranch 93-a.
2-8. Axial sections of paratypes: Slides-Upper Harper Ranch 93-b, Harper Ranch 4-c, South Thompson #2-30-a, South Thompson #2-26-c, Harper Ranch 1-a, Harper Ranch 4-b and Harper Ranch 1-b, respectively.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angle.

Occurrence:—Eostaffella kanmerai was collected at the following localities: Rayleigh, Harper Ranch, South Thompson #1, South Thompson #2, North McGregor Creek and Liumption Ridge.

Eostaffella sp. A

Pl. 37, figs. 15-17

Descriptive remarks: — The shell of *Eostaffella* sp. A is moderate for the genus and discoidal in shape, having a broadly rounded periphery and slightly umbilicated poles. The specimen illustrated as fig. 17 on Pl. 37 (South Thompson #2-34-a) is 250 microns long and 430 microns wide, giving a form ratio of 0.58. The shell is involute in the inner volutions but the last one is partly evolute. The proloculus diameter is uncertain due to secondary mineralization. The spirotheca is composed of a tectum and inner and outer tectoria. The thickness of the spirotheca of the penultimate and the last volutions is about 10 microns. The chomata are obscure.

In the shell-shape, the number of volutions and some internal characteristics of the shell, the present species has a resemblance to *Eostaffella* sp. B described by SADA (1964, pp. 232-233, pl. 21, figs. 18-20; pl. 22, figs. 5-7) from the Pennsylvanian beds of the Atetsu Limestone in West Japan. However, more perfect specimens are necessary for the definite determination of the species.

Occurrence: — *Eostaffella* sp. A was obtained from the following localities: South Thompson #2, Harper Ranch and North McGregor Creek.

Eostaffella sp. B

Pl. 36, figs. 6-7

*Descriptive remarks:—*We have obtained a small species referable to the genus *Eostaffella* from the Pennsylvanian beds of the Blind Creek Limestone at Keremeos, B. C. and from the area around Kamloops, B. C. However, we cannot determine the accurate specific name, because the specimens are very poor in preservation. The shell of *Eostaffella* sp. B is small and discoidal in shape with subangular to rounded periphery and convex lateral slopes. The shell illustrated as fig. 7 on Pl. 36 (Keremeos, B. C. S. W. 2-3-a) is 80 microns in length and 210 microns in width, giving a form ratio of 0.38. The inner volutions are involute but the last one becomes partially evolute. The proloculus diameter and the radius vectors are uncertain due to the poor preservation of the shell. The spirotheca is composed of a tectum and inner and outer tectoria, and the spirothecal thickness of the last volution is about 10 microns. The chomata are indistinctly developed.

Occurrence:—Eostaffella sp. B is common in the following localities: South Thompson #1, South Thompson #2, Harper Ranch and Keremeos Limestone.

Family Staffellidae MIKLUKHO-MAKLAY, 1949

Genus *Nankinella* LEE, 1933

Nankinella plummeri THOMPSON

Pl. 37, fig. 4

1947. *Nankinella plummeri* THOMPSON. *Jour. Paleont.*, vol. 21, pp. 155-157, pl. 32, figs. 11-16; pl. 33, figs. 10-11.

1957. *Nankinella plummeri*, IGO. *Sci. Rep. Tokyo Kyoiku Daigaku, Ser. C*, vol. 5, nos. 47-48, p. 183, pl. 3, fig. 4.

1961. *Nankinella plummeri*, SADA. *Jour. Sci.*

Hiroshima Univ., Ser. C, vol. 4, no. 1, pp. 107-109, pl. 10, figs. 22-25.

Description:—The shell of *Nankinella plummeri* THOMPSON is minute and discoidal in shape, having the angular periphery in maturity, convex lateral slopes and slightly umbilicated poles. The mature shell of six volutions illustrated as fig. 4 on Pl. 37 is 450 microns in length and 1050 microns in width. The form ratio is 0.43. The outside diameter of the proloculus is 50 microns. The radius vectors of the 1st to the 6th volution of the illustrated specimen are 60, 100, 180, 260, 400 and 600 microns, respectively. The spirothecal thickness of the outer volutions is less than 30 microns. The spirotheca is composed of three layers. The chomata are low. Their tunnel sides are steep and poleward slopes are very gentle. The tunnel angles of the 3rd to the 5th volution are 16, 17 and 18 degrees, respectively.

Remarks:—In the shell-shape, the form ratio, the height of the chambers, the features of the chomata, and the number of volutions, the present form closely resembles *Nankinella plummeri* described by THOMPSON (1947) from the Marble Falls limestone, Llano Uplift, Texas. They may be conspecific.

Occurrence:—*Nankinella plummeri* was collected from the following localities: Upper Harper Ranch, Robins Lake and Mount Constitution on Orcas Island.

Subfamily Eoschubertellinae SKINNER, 1931

Genus *Eoschubertella* THOMPSON, 1937

Eoschubertella ? sp.

Pl. 37, fig. 13

Description:—The shell of *Eoschubertella* ? sp. is small for the genus and inflated fusiform in shape and has bluntly pointed polar ends and straight axis of coiling. The shell of the specimen illustrated as fig. 13 on Pl. 37 (Westside of Horne Lake, Vancouver Island 5-16 (V. I.-1)) is 600 microns in length and 450 microns in width. The form ratio is 1.32. The proloculus of the shell is invisible due to the secondary mineralization. The spirotheca is composed of a tectum and inner and outer tectoria. The spirothecal thickness measures about 20 microns in the penultimate and ultimate volutions. The chomata are distinct in all but the last volution. The tunnel sides of the chomata are nearly vertical but the pole-

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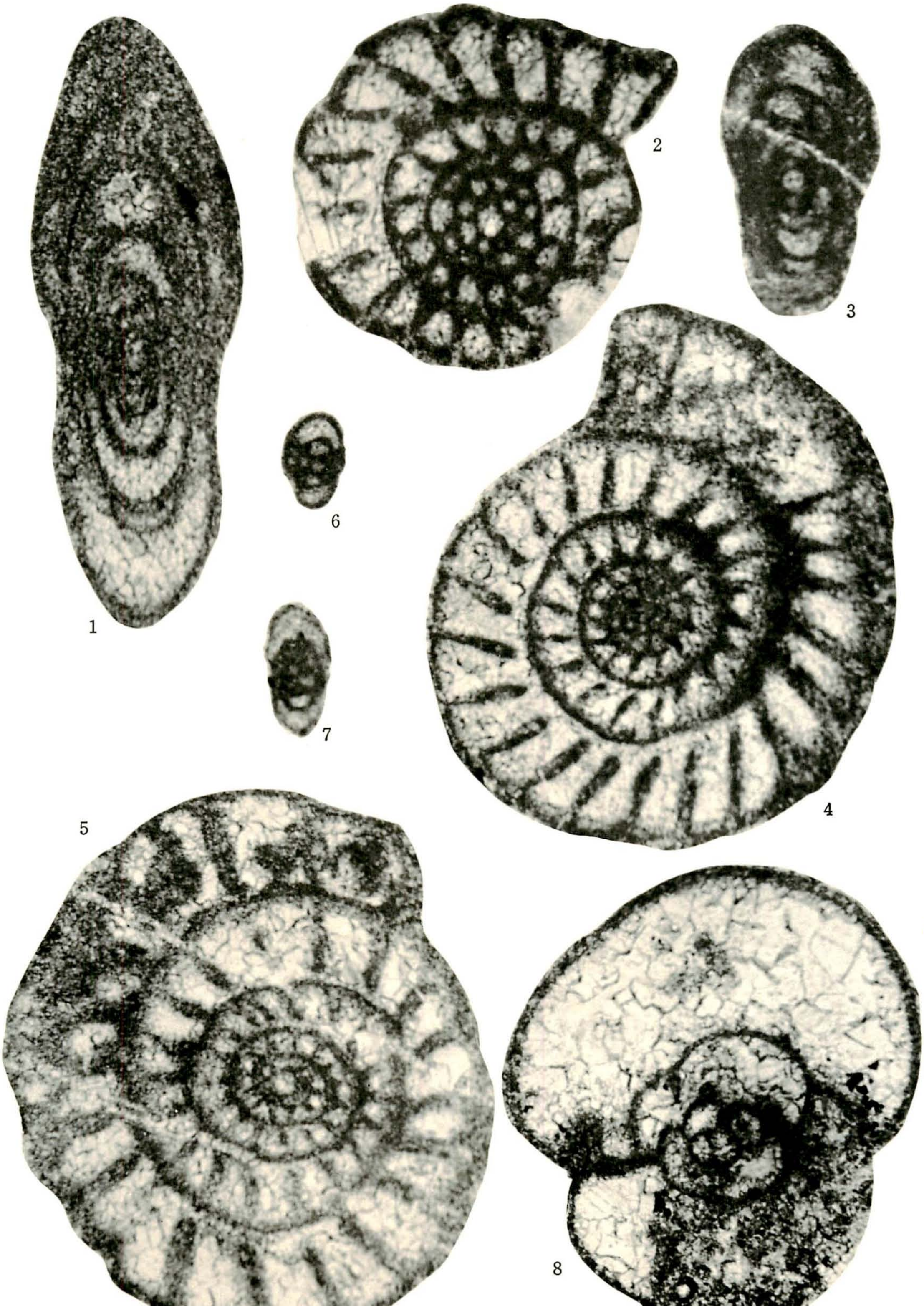
Explanation of Plate 36

All figures ×100

Figs. 1-5. *Eostaffella columbiana* SADA & DANNER, n. sp.
1, 3. Axial sections of paratypes: Slides-Harper Ranch 62-66 and South Thompson #2-54, respectively.
2, 4-5. Sagittal sections of paratypes: Slides-Upper Harper Ranch 93-c, South Thompson #2-26-a and South Thompson #2-48-b, respectively.

Figs. 6-7. *Eostaffella* sp. B
6-7. Axial sections: Slides-Keremeos B. C. S. W. 2-4-a and Keremeos B. C. S. W. 2-3-a, respectively.

Fig. 8. *Endothyranopsis* ? sp.
8. Axial section: Slide-Harper Ranch 25-2-b.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ward slopes are gentle. The tunnel angle is about 20 degrees in the penultimate volution.

Remarks:—The present species is incompletely known owing to the scantiness of the material and it is difficult to determine the generic affinities with certainty. In the general shell-shape and some internal characteristics of the shell, however, the single specimen described above has similarities to species placed in *Eoschubertella.* So we refer it to that genus with question as *Eoschubertella* ? sp. The specific comparison will be postponed until more information is obtained.

Occurrence: — *Eoschubertella* ? sp. is common in the Pennsylvanian rocks at the westside of Horne Lake on Vancouver Island.

Family Endothyridae BRADY, 1884

Subfamily Endothyranopsinae REYTLINGER, 1958

Genus *Endothyranopsis* CUMMINGS, 1955

Endothyranopsis ? sp.

Pl. 36, fig. 8

Description:— The shell of *Endothyranopsis* ? sp. is large and subglobular in shape with broad and rounded periphery and depressed umbilicated poles. The axis of coiling rotates in the inner volutions. The specimen (Harper Ranch 25-2-b) illustrated as fig. 8 on Pl. 36 is 50 microns long and 70 microns wide. The shell is tightly coiled in the inner volutions but rapidly expands in the last volution. The proloculus is small and its outside diameter measures 4 microns. The spirotheca is thin and consists of a tectum and inner and outer layers composed of granules of calcite bounded by calcareous cement.

Remarks:—The present species has similarities to the type species of genus *Endothyranopsis*, *E. crassa* BRADY, in the general shell-shape and some internal characteristics. However, the present species differs from the type species in having three layered wall composed of a distinct tectum and inner and outer layers which consist of granules of calcite bounded by calcareous cements. Therefore, the present species is referred to the genus *Endothyranopsis* with question.

Occurrence:—*Endothyranopsis*? sp. was obtained from the following localities: South Thompson #2 and Harper Ranch.

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Explanation of Plate 37

All figures ×100 except for Figs. 4 and 13

Figs. 1-3, 5, 18-19. *Eostaffella kanmerai* (IGO)

1-3, 18-19. Axial sections: Slides-North McGregor Creek 11-a, South Thompson #2-18-a, South Thompson #2-18-b, South Thompson #2-42-a and South Thompson #2-26-b, respectively.

5. Sagittal section: Slide-Harper Ranch 1-c.

Fig. 4. *Nankinella plummeri* THOMPSON

4. Axial section: Slide-Mount Constitution, Orcas Is. OI-30F. ×50.

Figs. 6-12, 14. *Millerella marblensis* THOMPSON

6-10, 14. Axial sections: Slides-Harper Ranch 67-68, Mount Constitution, Orcas Island OI-30F, South Thompson #2-39-a, Harper Ranch 67-72-b, Harper Ranch 25-2-a and Robins Lake 48-48d, respectively.

11-12. Sagittal sections: Slides-South Thompson #2-52-a and South Thompson #2-48-a, respectively.

Figs. 15-17. *Eostaffella* sp. A

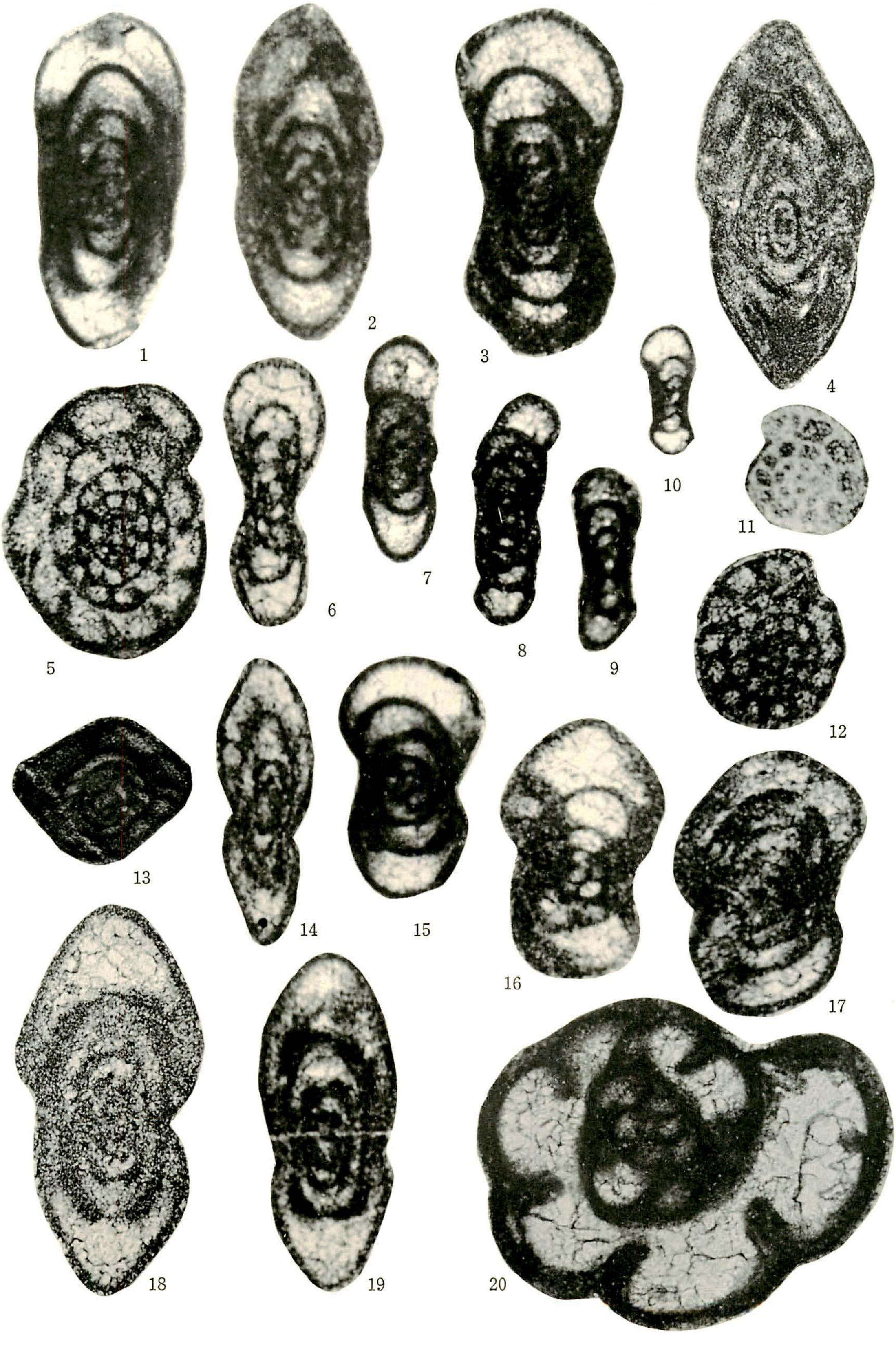
15-17. Axial sections: Slides-North McGregor Creek 11-b, Harper Ranch 67-72-a and South Thompson #2-34-a, respectively.

Fig. 13. *Eoschubertella* ? sp.

13. Axial section: Slide-West Side Horne Lake Vancouver Island 5-16(V. I. -1) ×51. 6.

Fig. 20. *Endothyra* sp.

Slide-North McGregor Creek 11-c.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630. MOLLUSCAN FOSSILS FROM THE MIOCENE EOIL FORMATION, GAMPO AND ULSAN DISTRICTS, SOUTHEASTERN-SIDE OF KOREA*

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韓国東南部甘浦，蔚山地域の中新世魚日層産貝化石について：韓国東南部，慶尚北道甘浦地域および慶尚南道蔚山地域に発達する魚日層産出の貝化石 16 種を識別し，日本の中部中新世特有の Arcid-Potamid fauna と称される群集組成と共通することを認めた。

金　鳳均・野田浩司・尹　銑

Introduction

The Eoil Formation, of which marine molluscs are treated in this article, is distributed in the Gampo and Ulsan districts on south to southwest of Yeongil Bay or the southeastern coast of the Korean Peninsula. This formation and the other Neogene deposits are distributed in small areas of the Korean Peninsula. The record of some plant and marine molluscan fossils are due to TATEIWA (1924), KANEHARA (1936a, b) and KIM (1970). Recently, HUZIOKA (1972) stated that the fossil plants, named by him the Changgi Flora, was collected from the Keumkwandong Shale underlying the Eoil Formation, both of the Changgi Group. According to HUZIOKA (1972) the Changgi Flora corresponds to the Aniai type flora in northeastern Honshu, Japan. Beside the above, some species of molluscan fossil common between Japan and Korea have been known from the paleontological works of TATEIWA (1924), KANEHARA (1936a, b), MAKIYAMA (1926, 1936), HATAI and NISIYAMA (1938), HATAI and KOTAKA (1952), KIM (1970) and HUZIOKA (1972). However, the biostratigraphy, especially of the Neogene molluscs, has remained untouched. The potamid-arcid species herein described for the first time were collected from the Eoil Formation in the Gampo and Ulsan districts. These fossils are significant for the

* Received June 23, 1973: read June 23, 1973 at Niigata.

correlation of the formations distributed in southeastern Korea and also with those in Japan, for their indicating the Early Middle Miocene age in Korea, and also for revealing the paleogeography of the Asiatic borderland at that time.

Acknowledgments

The writers express their hearty thanks to Dr. Kotora HATAI, Professor Emeritus of the Tohoku University for his continuous encouragement and supervision during the present study. Deep appreciation is due to Professor Tamio KOTAKA of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University for his kind suggestions and discussions on the biostratigraphy of Korea and Japan. Thanks are extended to Mr. Kimiji KUMAGAI of the Tohoku University for his photographic work.

Geological notes on the occurrence of molluscan fossils

TATEIWA (1924) seems to have been the first geologist to study the geology around area of the present fossil localities. He classified the rocks stratigraphically into the Chôki (Janggi), Poumgongni (Beomgogri) and Ennichi (Yeonil) groups in ascending order in his geological maps of the Chôyô (Gampo), Kyûryûho (Guryongpo) and Ennichi (Yeonil) sheets in the scale of 1 : 50,000, and their explanation text. The groups were cut into finer stratigraphic units based upon their lithology (Table 1).

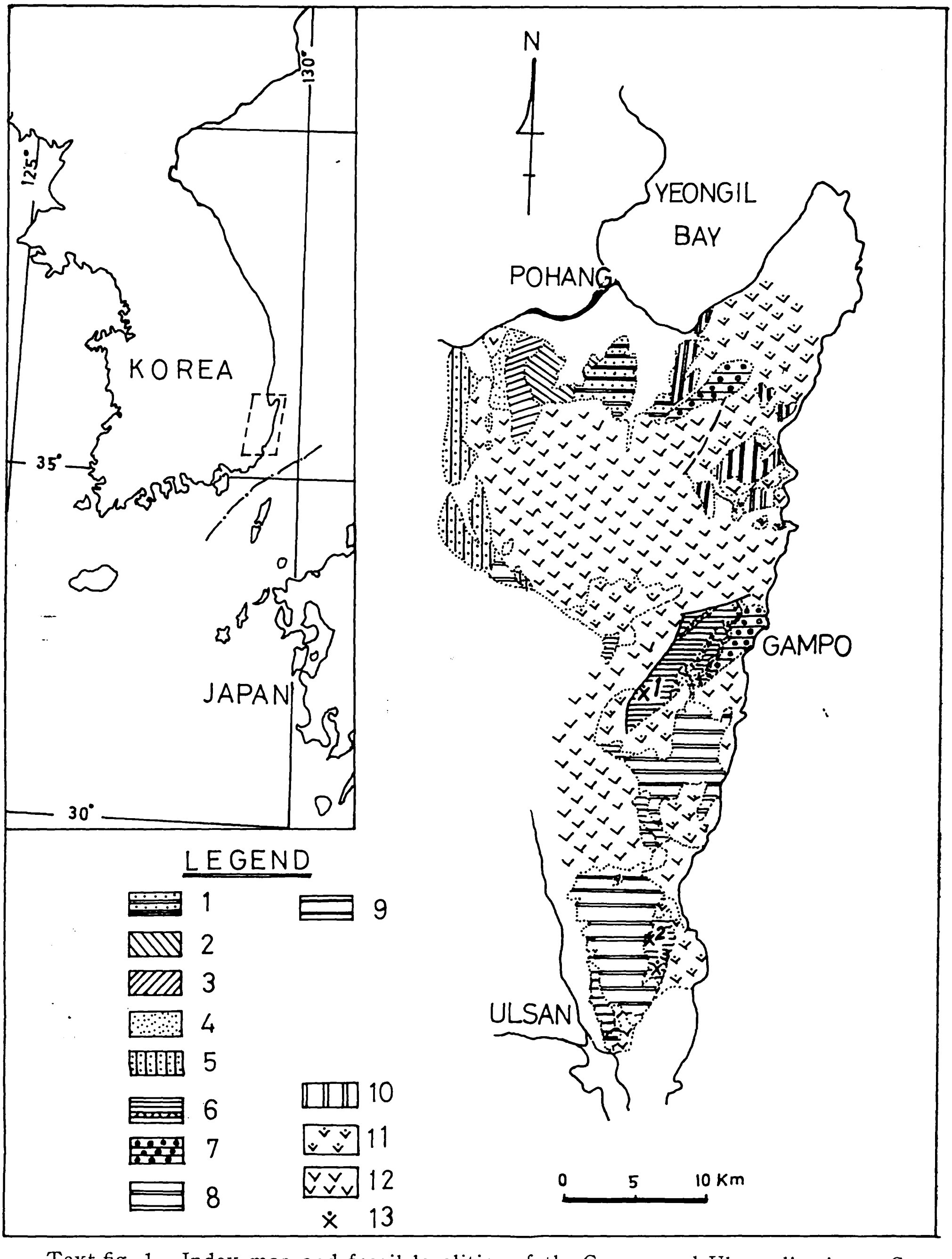
Subsequently, the northern part of Gampo district was restudied by KIM (1970) for the purpose analysing and determining the sequence of the foraminiferal fauna of the Neogene formations. During his geological survey, KIM (1970) collected some interesting fossil molluscs from the Eoil Formation but they were neither described nor discussed. Some of the fossil molluscs listed by TATEIWA (1924) and *Vicarya callosa* recorded by KANEHARA (1936b) were probably from near the locality no. 1 of the writers. To determine the exact horizon of the fossil molluscs and to know their mode of occurrence, therefore, the stratigraphy of the area was made and the geological notes of the Gampo district are given in the following lines.

The stratigraphic succession of the Gampo district can be classified into the Cretaceous Black Shale, Felsophyre, Granite porphyry, Miocene Gampo Conglomerate, Hyodongri Volcanics and Eoil Formation in ascending order. The Miocene formations are included into the Janggi Group which covers the Cretaceous rocks (Bulgugsa Series) with unconformity. The Gampo Conglomerate, the basal part of the Janggi Group, is composed mainly of well rounded pebbles of the basement rocks and of gray coarse- to medium- grained sandstone with thin intercalations of dark gray carbonaceous shale and white tuffs. The Gampo Conglomerate about 600 meters in thickness, resembles in lithology, especially in containing similar kind of gravels, the Janggi Conglomerate which is distributed mainly in the Yeonil district. The shale intercalated in the Gampo Conglomerate has yielded abundant plant fossils as mentioned already by TATEIWA (1924) and KANEHARA (1936a) and the flora according to HUZIOKA is similar to the Aniai type flora distributed in northeastern Honshu, Japan.

Table 1. Stratigraphic relationship between the geological maps of Kyûryûho (Guryongpo), Ennichi (Yeonil) and Chôyô (Gampo) published by TATEIWA (1924).

System	Series	Group	Kyûryûho (Guryongpo)	Ennichi (Yeonil)	Chôyô (Gampo)
Quater-nary			Ennichi Basalt and two Pyroxene Andesite	Ennichi Basalt and two Pyroxene Andesite	Ennichi Basalt
			~~Unconformity~~~	~~~Unconformity~~~	~~~Unconformity~~~
Tertiary System	Ennichi Series			Ennichi Shale	
				Sempoku Conglomerate	Sempoku Conglomerate
			~~	~~~Unconformity~~~	~~~Unconformity~~~
	Choki Series	Poumgongni Group	Changam Andesite and its Tuff	Poumgongni Andesite and its Tuff	Poumgongni Andesite and its Tuff
				Chinjyoundong Andesite and its Tuff	
				Manghaisan Andesite and its Tuff	
			Changam Perlite	Pangsailni Perlite	
				Kalpyoundong Breccia	Kalpyoundong Breccia
				Yongdongni Tuff	Yongdongni Tuff
					Andongni Conglomerate
					Oaeumni andestic Tuff
			~~Unconformity~~~	~~~Unconformity~~~	~~~Unconformity~~~
		Choki Group	Upper basaltic Tuff	Upper basaltic Tuff	
			Keumori andestic Tuff	Keumori andestic Tuff	
			Upper coal bearing Formation	Upper coal bearing Formation	Auil Formation and Auil Basalt
			Lower basaltic Tuff	Lower basaltic Tuff	
			Lower coal bearing Formation	Lower coal bearing Formation	
			Kyûryûho Andesite	Keumgoangdong Shale	Hyotongni Volcanic Rocks
				Sinjyoungdong Andesite	
			Nultairi Trachyte	Nultairi Trachyte	
			Nultairi Trachyte Tuff	Nultairi Trachyte Tuff	
			Chôki Conglomerate	Chôki Conglomerate	Kampo Conglomerate
			~~Unconformity~~~	~~~Unconformity~~~	~~~Unconformity~~~
		Hasouri Group			Hasouri andestic Tuff
					Hasouri Andesite
			~~	~~~~~~	~~~Unconformity~~~
Cretaceous System			Fukkokuji Group	Fukkokuji Group	Fukkokuji Group

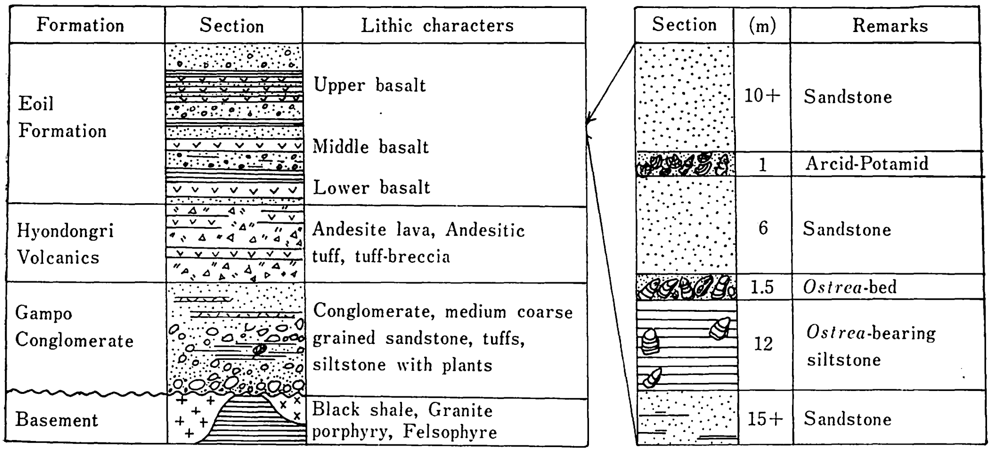
The Hyodongri Volcanics distributed in the southwestern corner of the area studied consists of andesite lava and its tuff or tuff breccia. The Hyodongri Volcanics cover directly the Cretaceous black shale and granite porphyry with unconformity and without the development of the Gampo Conglomerate which thins out towards the southwestern corner of the area mapped. The stratigraphic relationship between the Gampo Conglomerate and the Volcanics is not



Text-fig. 1. Index map and fossil localities of the Gampo and Ulsan districts. Geological map from KIM (1970). 1: Pohang Formation, 2: Idong Formation, 3: Daegog Formation, 4: Songhagdong Formation, 5: Seoam Conglomerate (Cheonbug Conglomerate), 6: Eoil Formation, 7: Janggi Conglomerate, 8: Mesozoic sedimentary rocks, 9: Hwabongri Formation, 10: Coal bearing formation of Eoil Formation, 11: Tertiary igneous rocks, 12: Mesozoic igneous rocks, 13: Fossil locality.

clear because of their being distributed in separated areas. Accordingly, the stratigraphic situation of the Hyodongri Volcanics is due to the relationship between the Janggi Conglomerate and Nuldaeri Volcanics in the neighbouring north of the Yeonil district. The Hyodongri Volcanics lithologically may correspond to the Nuldaeri Volcanics which are superposed on the Janggi Conglomerate with unconformity around Yeongil Bay (TATEIWA, 1924).

The Eoil Formation lies on the Hyodongri Volcanics with conformity and on the Cretaceous granite porphyry with unconformity at the eastern side of the present area, but comes into contact with the Cretaceous rocks and Hyodongri Volcanics with fault trending NE-SW at the southern side. The formation is distributed zonally from the southwest of Jugjeon-ri to the northeast of Eoil (Fig. 1). The formation is composed mainly of coarse-grained sandstone and conglomerate intercalated with three sheets of basalt lava flow, namely at the basal part, in the lower middle part, and in the upper part of the formation (Fig. 2). Except for the basalt lavas, the Eoil Formation is some-



Text-fig. 2. Stratigraphic sequence of the formations in the area of Gampo, showing the stratigraphic horizon of the molluscan fossils.

times intercalated with conglomerates, sandy shales, siltstones, tuffs and some thin lignite beds. The siltstones and tuffs generally contain plant fossils that have been studied by HUZIOKA (1972) and named by him the Changgi Flora. The formation is judged to attain a thickness of more than 800 meters, because its upper part is cut by a fault at eastern part of the field. The molluscan fossils discussed in the present article were collected from the middle part of the Eoil Formation (Figs. 1 and 2). TATEIWA (1924) collected from the conglomerate bed molluscan fossils (KANEHARA, 1936a), such as *Natica* sp., *Cerithium* sp., *Arca* sp., *Pectunclus* sp., *Ostrea* sp., *Dosinia* sp. and *Solen* sp. The stratigraphical position of the newly collected arcid-potamid fauna is just above the second basalt lava sheet exposed in the road cliff between Songjeon-ri and Jugjeon-ri (Loc. no. 1, Fig. 1). As shown in the columnar section

(Fig. 2), the fossils were collected from two different stratigraphic horizons of the same cliff; the lower bed consisted of gray tuffaceous siltstone yielded mainly *Crassostrea gravitesta eoilensis*, n. subsp., and the upper one situated at about 10 meters above the lower bed, consists of hard, massive pale gray, poorly sorted, tuffaceous sandstone with such characteristic species as *Vicarya callosa japonica*, *Cerithium* sp. (cf. *kanpokuensis*), *Anadara kiiensis*, *Anadara kakehataensis*, *Clementia nakamurai*, *Cyclina japonica* and others (Table 2). The sandstone bed of about 10 meters in thickness inserted between the fossiliferous siltstone and sandstone mentioned above is non-fossiliferous.

The characteristic marine molluscan fossils mentioned above have been found commonly in the Middle Miocene deposits distributed along the borderland of the Japan Sea (NODA, 1973).

Since the above stated characteristic molluscs bearing formations are distributed in separated sedimentary basins in Korea (KIM, 1970) (Fig. 1), they have been given different formation names. But from the similar lithostratigraphic order of succession and yield of the same arcid-potamid fauna such as *Vicarya callosa japonica*, *Vicaryella ishiiana*, *Anadara kakehataensis*, *Dosinia nomurai*, *Cyclina japonica*, *Clementia nakamurai*, *Soletellina minoensis* and others (Table 2), the Eoil Formation in the north and the Jeongjari Conglomerate in the south should be correlated

Table 2. Molluscan fossils from the Eoil Formation.

Species \ Localities	no. 1	no. 1-1	no. 2	no. 3
Anadara (*Anadara*) *kiiensis* MIZUNO	+			
Anadara (*Hataiarca*) *daitokudoensis* (MAKIYAMA)	+			
Anadara (*Hataiarca*) *kakehataensis* HATAI and NISIYAMA	+		+	+
Glycymeris sp.				+
Crassostrea gravitesta eoilensis KIM, NODA and YOON, n. subsp.		+		
"*Ostrea*" sp.		+		
Thyasira sp.	+			
Dosinia (*Phacosoma*) *nomurai* OTUKA			+	+
Cyclina (*Cyclina*) *japonica* KAMADA	+		+	+
Clementia (*Clementia*) *nakamurai* OTUKA	+		+	+
Soletellina minoensis YOKOYAMA	+		+	+
Panope cf. *nomurae* KAMADA				+
Vicarya (*Shoshiroia*) *callosa japonica* YABE and HATAI	+		+	+
Vicaryella ishiiana (YOKOYAMA)				+
Vicaryella sp.	+			
Cerithidea sp. (cf. *kanpokuensis* MAKIYAMA)	+			

Loc. no. 1: South of Songjeon-ri, Yangbug-myeon, Weolseong-gun, Gyeongsangbug-do.
Loc. no. 1-1: About 6 meters below at the same locality of no. 1.
Loc. no. 2: About 3 km west of Jeongja-ri, Gangdong-myeon, Ulju-gun, Gyeongsangbug-do.
Loc. no. 3: About 1 km east of Jangmyeong-gol, Sinhyeon-ri, Gangdong-myeon, Ulju-gun, Gyeongsangbug-do.

with each other (Loc. nos. 2 and 3 in Fig. 1). This correlation will contribute to the interpretation of the geological problems of the Tertiary System in Korea and also serve to make clear the relation between the Tertiary deposits distributed on opposite sides of the Japan Sea.

Remarks on the molluscan fauna of the Eoil Formation

The molluscan fauna collected from three isolated localities (Fig. 1) of the Eoil Formation consists of 9 pelecypod and 4 gastropod species. The preservation of the fossils are rather good even though they were collected from a pale gray, poorly sorted, tuffaceous sandstone with plant fragments. The molluscan fauna although a small one, is important for the age determination and correlation of the formation with other areas, and the assemblage serves for the interpretation of the paleoecological conditions under which the formation was deposited.

The fauna of the Eoil Formation is characterized by *Vicarya-Anadara* species (Potamid-Arcid Fauna of TSUDA, 1965) and the assemblage resembles that of the formations which yielded the *Vicarya-Anadara* species in the Japanese Islands (NODA, 1973), namely the Yoshino Formation in Okayama Prefecture, Kunimi Formation in Fukui Prefecture, Higashi-Innai Formation in Ishikawa Prefecture, Kurosedani Formation in Toyama Prefecture, Tsugawa and Orito formations in Niigata Prefecture, Oyama Formation in Yamagata Prefecture, Asagawa Formation in Ibaraki Prefecture, Tanosawa Formation in Aomori Prefecture and Tsurikake Formation in Hokkaido. All of these stratigraphic units are distributed along the eastern borderland of the Japan Sea except the Yoshino and Asagawa formations. Among the molluscan species of the Eoil Formation, *Anadara kiiensis*, *Anadara kakehataensis* and *Anadara daitokudoensis* are particularly important because they are the representative forms of the Natorian of HATAI (1962) and also because they usually occur in association with the *Vicarya-Vicaryella* species which have equal biostratigraphical value. Those *Anadara* species like the two gastropod genera just mentioned are restricted in their geological distributions. The occurrence of *Anadara kakehataensis*, *Anadara kiiensis* and *Anadara daitokudoensis* refer them to the zone of *Anadara kakehataensis-Anadara makiyamai* of NODA (1966) in terms of anadaran biostratigraphy. The anadarid zone was correlated by NODA (1966) with the stage II of KITAMURA (1959), *Nanaochlamys notoensis* Assemblage zone of MASUDA (1962a), *Turritella s-hataii* zone of KOTAKA (1959) and the Natorian of HATAI (1962).

Beside the anadarids, *Cyclina japonica*, *Clementia nakamurai*, *Dosinia nomurai*, *Soletellina minoensis*, *Vicarya callosa japonica*, *Vicaryella ishiiana*, *Cerithium kanpokuensis* usually occur in association with the arcid-potamid fauna in Japan (NODA, 1973). The vicaryan gastropods from the Eoil Formation are identified with *Vicarya callosa japonica* YABE and HATAI and *Vicaryella ishiiana* (YOKOYAMA), species that are known from the Natorian formations cited in earlier lines. From the assemblage of the Eoil Fauna, the Eoil Formation is inferred to belong to the same paleogeographical province as the formations mentioned above.

Some species such as *Anadara daitokudoensis*, *Clementia nakamurai*, *Cyclina* *japonica* and *Soletellina minoensis* were found with conjoined valves in natural position and some specimens of *Vicarya* and *Vicaryella* are provided with well preserved tubercles. From the state of preservation of the fossils in the Gampo and Ulsan districts, the Eoil fauna may be considered to have been autochthonous and probably the molluscs lived under a rather warm water embaymental condition.

The present description is the first of the *Vicarya-Anadara* fauna from the Eoil Formation from the Gampo district, though KIM (1970) recorded some species of the arcid-potamid without discussion or description. The present writers discriminated an arcid-potamid fauna such as *Vicarya callosa japonica*, *Vicaryella ishiiana*, *Anadara kakehataensis*, *Cyclina japonica*, *Dosinia japonica*, *Clementia nakamurai*, *Soletellina minoensis* from a formation that corresponds to the Eoil Formation at Jeongjari in the northeastern part of Ulsan (Fig. 1). Thus the geographical distribution of the arcid-potamid fauna along the eastern side of the Korean Peninsula seems to form a key to the geological correlation, paleogeography and paleooceanography.

And here it should be added that the biostratigraphic relationship between the Neogene of the northern and southern parts of the Korean Peninsula still remain to be worked out.

Descriptions of species

Genus *Anadara* GRAY, 1846

Subgenus *Anadara* s. s.

Anadara (*Anadara*) *kiiensis* MIZUNO, 1953

Pl. 38, figs. 1a, 1b, 11

Arca cf. *camuloensis*, YOKOYAMA, 1929, p. 368, pl. 70, figs. 5a-c.
Anadara (*Pectinarca*) *kiiensis* MIZUNO, 1953, p. 16, figs. 5a, 5b.
Anadara (*Anadara*) *kiiensis* MIZUNO, NODA, 1966, p. 92-93, pl. 6, figs. 13-15.

The present species was originally described from the Miocene Mitsuno Formation in Wakayama Prefecture by MIZUNO in 1953 based upon immature forms. Subsequently NODA (1966) reported on the adult forms from the Miocene Yoshino Formation in Okayama Prefecture.

The present species is characterized by having 28 non-dichotomous radial ribs, squarish in cross section with granules on the anterior side, without a posterior depressed area, convex and swollen umbonal area, incurved beak and narrow triangular ligamental area with chevron-shaped grooves.

Kiiensis resembles *Anadara* (*Hataiarca*) *kakehataensis* HATAI and NISIYAMA (1949) originally described from the Miocene Kurosedani Formation in Toyama Prefecture in the swollen form and characteristic radial ribs but the latter has strongly depressed area along the posterior side. *Anadara makiyamai* HATAI and NISIYAMA (1938) from the Miocene Heiroku Formation in North Korea resembles the present species but the former differs from the latter by having 24-25 radial ribs and flatly narrow umbonal area. *Anadara ninohensis* (OTUKA, 1934) is similar to the present species in the non-dichotomous radial ribs and rather squarish, 28-30 radial ribs, but the latter has wider swollen, convex umbonal area and inclined beak.

Locality and Formation:—Loc. no. 1, Eoil Formation.

Subgenus *Hataiarca* NODA, 1966

Anadara (*Hataiarca*) *daitokudoensis* (MAKIYAMA, 1926)

Pl. 38, figs. 8a, 8b, 12

Arca (*Anadara*) *daitokudoensis* MAKIYAMA, 1926, p. 153-154, pl. 12, figs. 10, 14, 15.
Anadara daitokudoensis MAKIYAMA, MAKIYAMA, 1936, p. 205; OTUKA, 1938b, p. 25, pl. 1, figs. 3-4.
Anadara (*Hataiarca*) *daitokudoensis* (MAKIYAMA), NODA, 1966, p. 115-116, pl. 7, fig. 13.

The present species was originally described from Miocene Heiroku Formation in North Korea by MAKIYAMA in 1926. It is characterized by the depressed area along the posterior side of the shell extending from near the beak to the ventral margin, 27-28 strongly elevated, non-dichotomous radial ribs and rather narrow triangular ligamental area with chevron-shaped grooves.

Daitokudoensis resembles *Anadara* (*Hataiarca*) *kakehataensis* in having depressed area and granules on the anterior ribs and also in the shell form, but the former has a larger number of the radial ribs than the latter.

Locality and Formation:—Loc. no. 1, Eoil Formation.

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

Pl. 38, figs. 10, 13, 14

Anadara (*Anadara*) *kakehataensis* HATAI and NISIYAMA, 1949, p. 88-89, pl. 23, figs. 8-10; MASUDA, 1955, pl. 19, figs. 2a-b (no description).
Anadara kakehataensis HATAI and NISIYAMA, KASENO, 1956, p. 5, pl. 1, fig. 2; IWAI, 1960, p. 204, pl. 24, fig. 4; FUJII, 1961, p. 496-497, pl. 27, figs. 1a-c, 3a-b; KITAMURA and IWAI, 1963, pl. 2, figs. 4, 6a-b (no description).
Anadara (*Hataiarca*) *kakehataensis* HATAI and NISIYAMA, NODA, 1966, p. 116, pl. 2, fig. 17, pl. 13, figs. 7-8, 10-15, 21; NODA, 1973, pl. 18, figs. 1, 3-16.
Anadara sp., KASENO, 1956, pl. 1, figs. 4a-b; IWAI, 1960, pl. 24, figs. 6a-b.

The present species was originally described from the Miocene Kurosedani Formation in Toyama Prefecture by HATAI and NISIYAMA in 1949. The species is characterized by the depressed area along the posterior side extending from the beak to the ventral margin, wide triangular ligamental area with rather sharp chevron shaped grooves, 24-26 strongly elevated radial ribs with granules on their anterior part.

Kakehataensis resembles *Anadara* (*Hataiarca*) *shimonakaensis* HAYASAKA (1969) from the Miocene Kawachi Formation in Kagoshima Prefecture in shell form and number of the radial ribs, but the former differs from the latter in having more radial ribs, smaller shell height and more elongated shell. The differences from the Pliocene species, *Anadara* (*Hataiarca*) *kogachiensis* from Okinawa Prefecture were already mentioned by NODA (1971).

Locality and Formation:—Loc. nos. 1, 2, 3, Eoil Formation.

Genus *Crassostrea* SACCO, 1897

Crassostrea gravitesta eoilensis, n. subsp.

Pl. 38, fig. 15, Pl. 39, figs. 1a-1c

Shell very heavy, stout and thick, inequilateral, much higher than long. Right valve somewhat convex, external surface smooth with fine concentric growth lines. Younger shell somewhat roundly quadrate with strongly incurved and inclined anterior beak. Umbonal area flat. Anterior and posterior margins rather straight and nearly parallel with each other. Ligamental pit rather wide and deep. Inner surface smooth. Muscle scar large, rounded in form. Growth lamellae oblique in lateral view. Young shell lamellae highly inclined against height of shell. Left valve rather flat, roundly quadrate. Surface smooth with fine concentric growth lines. Beak near central part of hinge, umbonal area flat. Both anterior and posterior margins long, nearly straight and nearly parallel, ventral margin narrowly and somewhat arcuated, anterior and posterior corners rather angular. Ligamental pit narrowly elevated with distinct grooves on both sides. Inner surface smooth, muscle scar rounded in form.

The specimens at hand are somewhat incomplete but the right valve (Holotype) measures 31 cm in height and 9.5 cm in length and the left valve (Paratype) 28.8 cm in height and 10.4 cm in length.

Comparison and Affinities:—The present new subspecies is characterized by the very high, large and thick shell. The young shell form resembles that of *Ostrea gravitesta* YOKOYAMA (1926b) which was originally described from the Miocene Takasaka Bed in Akita Prefecture. YOKOYAMA's species seems to be restricted to shallow and brackish warm water facies of Early Miocene formations. *Ostrea gravitesta* is distinguishable from the present subspecies by the stout, thick rather flatly rounded shell form at the adult stage. *Ostrea gravitesta* and the present new subspecies have different shell form at the young and adult stages with each other. *Ostrea gigas* THUNBERG is allied with the present subspecies. Some *Ostrea gigas* with very long and enlarged shell form have been recorded from the Miocene (NOMURA and HATAI, 1937), Pleistocene (HAYASAKA, 1960; ARAKI, 1959) and Recent (WAKIYA, 1929; HIRASE, 1930 and others). However, the present subspecies differs from the above cited species in having roundly-quadrate shell form in the young stage and enlarged shell form at the adult stage, with incurved, flat beak, and series of growth lamellae. The characteristic of the present subspecies resembles the young stage of *Ostrea gravitesta* and the adult form of *Ostrea gigas*.

Ostrea gigas from the Shigarami Formation (KURODA, 1931) and *Ostrea gravitesta* from the Tatsunokuchi Formation (NOMURA, 1938), both of Miyagian age, occurred in crowded form but not as banks; they resemble the present subspecies in shell form and growth form in the adult stage but differ in shell form at the immature stage. They rather resemble *Ostrea gravitesta* in shell form. Both of these species were once considered to be synonymous with *Ostrea gigas* by HAYASAKA (1960) and others. Such data are important to trace the phylogenetical trend of *Ostrea gravitesta* to such Recent forms as *Ostrea gigas* and its allied species.

From the ecological point of view concerning the mode of occurrence and shell form, by HAYASAKA (1960) and OHSHIMA (1971), it is of interest to note the following. HAYASAKA (1960) pointed out that the large sized *Ostrea gravitesta* has been usually recorded sporadically in occurrence but not as bank-builder and is a representative form seems to have resulted from the high sea water temperature of the Early Miocene. The elongated *Ostrea gigas* found to occur as bank in the Pleistocene is considered to be a rather cool water form. WAKIYA (1929) stated in his study of the Japanese food oyster "the shell (*Ostrea laperousii*) also varies according to environment as much as with age. Those that live on a soft bottom have a much more elongated shell than those living on a harder bottom".

Considering the above cited researches, the present specimens seem to have a different mode of shell growth as compared with *Ostrea gravitesta* and *Ostrea gigas* though the elongated shell form might be caused by the crowded occurrence as pointed out by HAYASAKA (1960). The associated fauna and sedimentary facies of the present new subspecies are similar with those of the formations which yielded *Ostrea gravitesta* in Japan.

Locality and Formation:—Loc. no. 1-1, Eoil Formation.

Genus *Thyasira* LEACH in LAMARCK, 1818

Subgenus *Thyasira* s. s.

Thyasira (s. s.) sp.

Pl. 38, fig. 7

The present species is characterized by its small trapezoidal form with narrow depressed area along the posterior side of the shell. The shell surface is sculptured with concentric growth lines. The inner surface is smooth with very fine striations. The beak is small, incurved and situated anteriorly. The species is not identified because of its ill-preservation.

The genus *Thyasira* is a rather common genus in the northern part of the Pacific Ocean, although it is distributed to southern areas of warm water. From the Miocene Oidawara Formation in Gifu Prefecture, ITOIGAWA (1960) described *Thyasira* (s. s.) *minoensis* as a new species. This species resembles the present species in the shell form but ITOIGAWA's species has a stepped depressed area along the posterior side of the shell. Though many species of the genera *Thyasira* and *Conchocele* have been recorded in Japan and the adjacent countries by many paleontologists, it is difficult to identify immature forms because the species sometimes shows varied forms in the growth series. The record of the genus from the present formation is significant so far as the paleoecology of the fauna is concerned.

Locality and Formation:—Loc. no. 1, Eoil Formation.

Genus *Dosinia* SCOPOLI, 1777

Subgenus *Phacosoma* JUKES-BROWNE, 1912

Dosinia (*Phacosoma*) *nomurai* OTUKA, 1934

Pl. 38, figs. 3a, 3b

Dosinia japonica nomurai OTUKA, 1934, p. 618, pl. 48, fig. 54; OTUKA, 1937, p. 29, pl. 3, figs. 3-4.

Dosinia nagaii OTUKA, 1934, p. 618, pl. 48, fig. 55.

Dosinia nomurai, NOMURA, 1935, p. 217, pl. 17, fig. 7; NOMURA, 1940, p. 26-27; ITOIGAWA, 1956, pl. 2, fig. 3; UOZUMI and FUJIE, 1966, p. 151-152, pl. 12, figs. 3-11; TANAKA, 1967, p. 58, pl. 6, figs. 6-7.

Dosinia chikuzenensis NAGAO, HIRAYAMA, 1956, pl. 7, figs. 14-15 (Reproduction of OTUKA, 1934).

Dosinia (*Phacosoma*) *chikuzenensis nomurai* OTUKA, KAMADA, 1962, p. 112-113, pl. 12, figs. 4, 5, 7-10.

Dosinia (*Phacosoma*) *chikuzenensis nagaii* OTUKA, KAMADA, 1962, p. 113-114, pl. 12, fig. 6.

Dosinia (*Phacosoma*) *nomurai* OTUKA, MASUDA, 1962b, p. 30-32, pl. 1, figs. 1-9;

OGASAWARA, 1973, p. 149-150, pl. 12, figs. 17, 20-21; HIRAYAMA, 1973, p. 176, pl. 15, fig. 14.

The specific characteristics were already discussed by HATAI (1938), HIRAYAMA (1956) and MASUDA (1962b). The Korean species has rather swollen shell, fine concentric growth lines, small lunule and defined pallial line; these features characterize the named species.

Locality and Formation:—Loc. nos. 2, 3, Eoil Formation.

Genus *Cyclina* DESHAYES, 1850

Subgenus *Cyclina* s. s.

Cyclina (*Cyclina*) *japonica* KAMADA, 1952

Pl. 38, fig. 9

Cyclina chinensis, YOKOYAMA, 1926a, p. 222, pl. 28, fig. 7.
Cyclina (*Cyclina*) *japonica* KAMADA, 1952, p. 168-169, pl. 15, figs. 1-2; KAMADA, 1962, p. 115-116, pl. 13, fig. 4.
Cyclina japonica KAMADA, KASENO, 1956, p. 6, pl. 2, figs. 8a-d; IWAI, 1965, p. 41-42, pl. 13, figs. 3, 4.

The present species was originally described from the Miocene Higashi-Innai Formation in Ishikawa Prefecture by KAMADA in 1952. The species is characterized by the higher than long, inequilateral shell, inclined beak, convex posterior side, sculpture of narrow longitudinal ribs crossed with very fine growth lines and triangular sinuated pallial line.

The present species resembles *Cyclina* (*Cyclina*) *orientalis* (SOWERBY), a Recent shell, in form and shape of sinuated pallial line but the latter species has rather more distinct striations than the former.

Locality and Formation:—Loc. nos. 1, 2, 3, Eoil Formation.

Genus *Clementia* GRAY, 1842

Subgenus *Clementia* s. s.

Clementia (*Clementia*) *nakamurai* OTUKA, 1938

Pl. 38, figs. 5, 6a, 6b

Clementia speciosa, YOKOYAMA, 1925b, p. 119, pl. 14, fig. 7.
Clementia nakamurai OTUKA, 1938a, p. 14-15, pl. 1, figs. 7, 11; ARAKI, 1960, p. 97, pl. 7, figs. 7a-c.

The present species was originally described from the Miocene Shiroyama Sandstone in Shizuoka Prefecture by OTUKA in 1938a. The species is characterized by its rough concentric growth lines and folds with nearly straight posterior margin and narrow anterior one.

In the original description, OTUKA mentioned the difficulty of the identification of *Clementia* species based upon the external morphology. The present species is allied to *Clementia japonica* MASUDA (1955) which was described from the Miocene Higashi-Innai Formation but the latter differs from the former in not having so strong wavy concentric growth lines and elongated shell. *Clementia vatheleti* MABILLE resembles the present species but differs from the latter in having more convex shell and rounded form. *Clementia papyracea* (GRAY) shows more variation in shape as already mentioned by SHUTO (1960) but can be distinguished from the present species by the short dorsal margin.

Locality and Formation:—Loc. nos. 1, 2, 3, Eoil Formation.

Genus *Soletellina* DE BLAINVILLE, 1924

Soletellina minoensis YOKOYAMA, 1926

Pl. 38, fig. 4

Soletellina minoensis YOKOYAMA, 1926a, p. 221, pl. 28, figs. 13-16; MASUDA, 1955, pl. 19, fig. 9; KAMADA, 1962, p. 126-127, pl. 14, fig. 7; UOZUMI and FUJIE, 1966, pl. 12, fig. 12.

Sanguinolaria (Soletellina) minoensis (YOKOYAMA), OTUKA, 1934, p. 619, pl. 49, figs. 65a-b; OYAMA and SAKA, 1944, p. 141, pl. 15, figs. 17-18.

Soletellina cf. *minoensis* YOKOYAMA, KASENO, 1956, p. 6, pl. 3, figs. 14a-c.

Some conjoined shells were examined. The species is characterized by its elongated form, short anterior side and elongated posterior side. Both sides are rounded and the ventral margin is broadly curved. A small beak is situated anteriorly. Inner characteristics are not known. The named species was originally described from the Tsukiyoshi Formation in Gifu Prefecture by YOKOYAMA in 1926a.

Locality and Formation:—Loc. nos. 1, 2, 3, Eoil Formation.

Genus *Panope* MENARD, 1807

Panope cf. *nomurae* KAMADA, 1962

Pl. 38, fig. 2

Compared with:—*Panope nomurae* KAMADA, KAMADA, 1962, p. 135-136, pl. 16, figs. 9-12.

The present specimen is characterized by its transversely elongated form; both extremities rather narrowly rounded, anterior and posterior dorsal margins slender and surface with wavy concentric growth lines. *Panope nomurae*, according to KAMADA (1962) is distinguishable from *Panope japonica* ADAMS, a common species in the seas around northeastern Japan and in the Pliocene to Pleistocene of Japan by the proportion of shell length to height. However, as already mentioned by NOMURA (1938), KAMADA (1962), AKUTSU (1964) and HATAI (1964), considerable morphological changes can be recognized in "*Panope japonica*" from the Miocene to Recent of Japan. Accordingly, some species, *Panope kanomatazawaensis*, *Panope kanomatazawaensis fudoensis* and also *Panope nomurae* were discriminated. The present specimen in this connection resembles *Panope japonica* of KANNO (1960) described from the Miocene Nagura Formation in Saitama Prefecture and which is clearly distinguishable from *Panope japonica* A. ADAMS, a Recent species. The specimen described under the names of *Panope japonica*, *Panope generosa* and also *Panope estrellana* should be re-examined.

The usage of the generic name *Panope* has been subjected to discussion but from the International code of zoological nomenclature, STOLICZKA (1871), DALL (1912), OLDROYD (1924), STEWART (1930), GRANT and GALE (1931), KANNO (1957, 1960) all favor to use the generic name and it seems at present *Panope* of MENARD, 1807.

Locality and Formation:—Loc. no. 3, Eoil Formation.

Genus *Vicarya* D'ARCHIAE and HEIME, 1954

Subgenus *Shoshiroia* KAMADA, 1960

Vicarya (Shoshiroia) callosa japonica YABE and HATAI, 1938

Pl. 39, figs. 4, 5

Vicarya baculum YOKOYAMA, 1926a, p. 219, pl. 28, figs. 4-6.

Vicarya vernuili, MAKIYAMA, 1932, pl. 1, fig. 5.

Vicarya callosa JENKINS, TAKEYAMA, 1933, p. 137-140, pl. 13, fig. 3.

Vicarya callosa japonica SAGA (MS), YABE and HATAI, 1938, p. 156-157, pl. 21, figs. 12-13, 21-22, 28, 31.

Vicarya callosa japonica YABE and HATAI, MASUDA, 1955, p. 125; MASUDA, 1956, pl. 26, figs. 1a-b; YAMANA, 1966, p. 34, pl. 1, figs. 1a-b.

Vicarya cf. *callosa japonica* YABE and HATAI, IWAI, 1960, p. 206-207, pl. 24, figs. 1a-b, 2; KITAMURA and IWAI, 1963, pl. 2, figs. 1-2.

Vicarya callosa forma *japonica* SAGA (MS), OTATUME, 1943, p. 314, fig. 1.

Vicarya (*Shoshiroia*) *callosa japonica* YABE and HATAI, KAMADA, 1960, pl. 30, figs. 2a-b, 7, 8, pl. 31, figs. 2a-b; KAMADA, 1967, pl. 7, figs. 3-5; HAYASAKA, 1969, p. 48-49, pl. 3, figs. 7-8.

Several specimens were examined. The species is characterized by 9-10 distinct subsutural tubercles on the penultimate whorl, flat on upper side and inclined on the lower side with spiral lines on a suture and somewhat conical shape of suture. YABE and HATAI (1938) recognized two subspecies among *Vicarya callosa*; one is *callosa* s. s, and other is *callosa japonica* based upon the shape of the tubercles and development of grooves over the tips of the tubercles. This classification has been accepted by MATSUO (1951), MASUDA (1955, 1956), IWAI (1960), KAMADA (1960, 1967), YAMANA (1966) and HAYASAKA (1969). Whereas IKEBE (1939) questioned the differences between *Vicarya callosa* and *Vicarya callosa japonica* and concluded (IKEBE, 1952) that *Vicarya callosa* should not be separated into subspecies by the shape of the tubercles. Although he examined the tubercles of *Vicarya callosa* from Java, he did not figure the species. IWASAKI (1970) stated that "the morphological differences among the Japanese species seem to be not significant", and he wrote that the species from the Pitogo Formation in the Philippines is closer in shell form and surface ornamentation to *Vicarya callosa* from the type locality of Java than that from Japan. From the many literatures and specimens preserved in the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, the specimens from South Korea are identified to *Vicarya callosa japanica* described by YABE and HATAI in 1938.

Locality and Formation:—Loc. nos. 1, 2, 3, Eoil Formation.

Genus *Vicaryella* YABE and HATAI, 1938

Vicaryella ishiiana (YOKOYAMA, 1926)

Pl. 39, fig. 2

Cerithium baculum YOKOYAMA, 1925a, p. 12, pl. 2, fig. 6.

Cerithium ishiianum YOKOYAMA, 1926a, p. 218, pl. 28, figs. 11, 12.

Cerithium (*Proclava*) *otukai* NOMURA, 1935, p. 227, pl. 17, fig. 7.

"*Vicaryella*" *ishiiana* (YOKOYAMA), YABE and HATAI, 1938, p. 169.

Vicaryella ishiiana (YOKOYAMA), OYAMA and SAKA, 1944, p. 139-140, pl. 14, figs. 7a-8b; KAMADA, 1960, pl. 31, figs. 4a-b; KAMADA, 1962, p. 152, pl. 18, figs. 15-16; MASUDA, 1967, p. 1-2, pl. 1, figs. 1a, 2b.

The present species is distinguished from *Vicaryella notoensis* MASUDA (1956), which was originally described from the Miocene Higashi-Innai Formation in Ishikawa Prefecture, in having more tubercles on the fine spiral cords. *Vicaryella tyosenica* YABE and HATAI, 1938, the type species of the genus, which was originally described from the Miocene Heiroku Formation in North Korea, is another species allied to the present one but the species is characterized by conspicuous tubercles and four or five spiral cords with small beads.

Locality and Formation:—Loc. no. 3, Eoil Formation.

Vicaryella sp.

Pl. 39, fig. 3

The poorly preserved specimens at hand show no distinct tubercles on the subsutural area. The specimens possess the vicaryellid aperture and spiral cords but lack such beaded tubercles as seen on *Vicaryella tyosenica* YABE and HATAI, *V. ishiiana* and *V. jobanica*. In this respect the present specimens are rather more similar to *V. notoensis* MASUDA (1956). MASUDA's species is characterized by having many small beaded spiral cords. Unfortunately the specimens from the Eoil Formation can not be named until additional and better material is obtained.

Locality and Formation:—Loc. no. 1, Eoil Formation.

Genus *Cerithidea* SWAINSON, 1840

Subgenus *Cerithidea* s. s.

Cerithidea (s. s.) sp.

Pl. 39, fig. 6

Compared with:—Potamides (*Cerithidea*) *kanpokuensis* MAKIYAMA, 1926, p. 149, pl. 12, figs. 2, 3.

The specimen (unnamed) is characterized by its high conical shell with 9-11 longitudinal folds and rather distinct spiral cords on the sutures; the apertural part is broken. *Cerithidea kanpokuensis* (MAKIYAMA), comparable with the present specimen was originally described from the Miocene Heiroku Formation in North Korea by MAKIYAMA in 1926. That species has been recorded from the Miocene Higashi-Innai Formation in Ishikawa Prefecture (MASUDA, 1967), and Kawachi Formation in Kagoshima Prefecture (HAYASAKA, 1969) but the specimens from the recorded formations are all small in size compared with the specimen from the Eoil Formation.

Locality and Formation:—Loc. no. 1, Eoil Formation.

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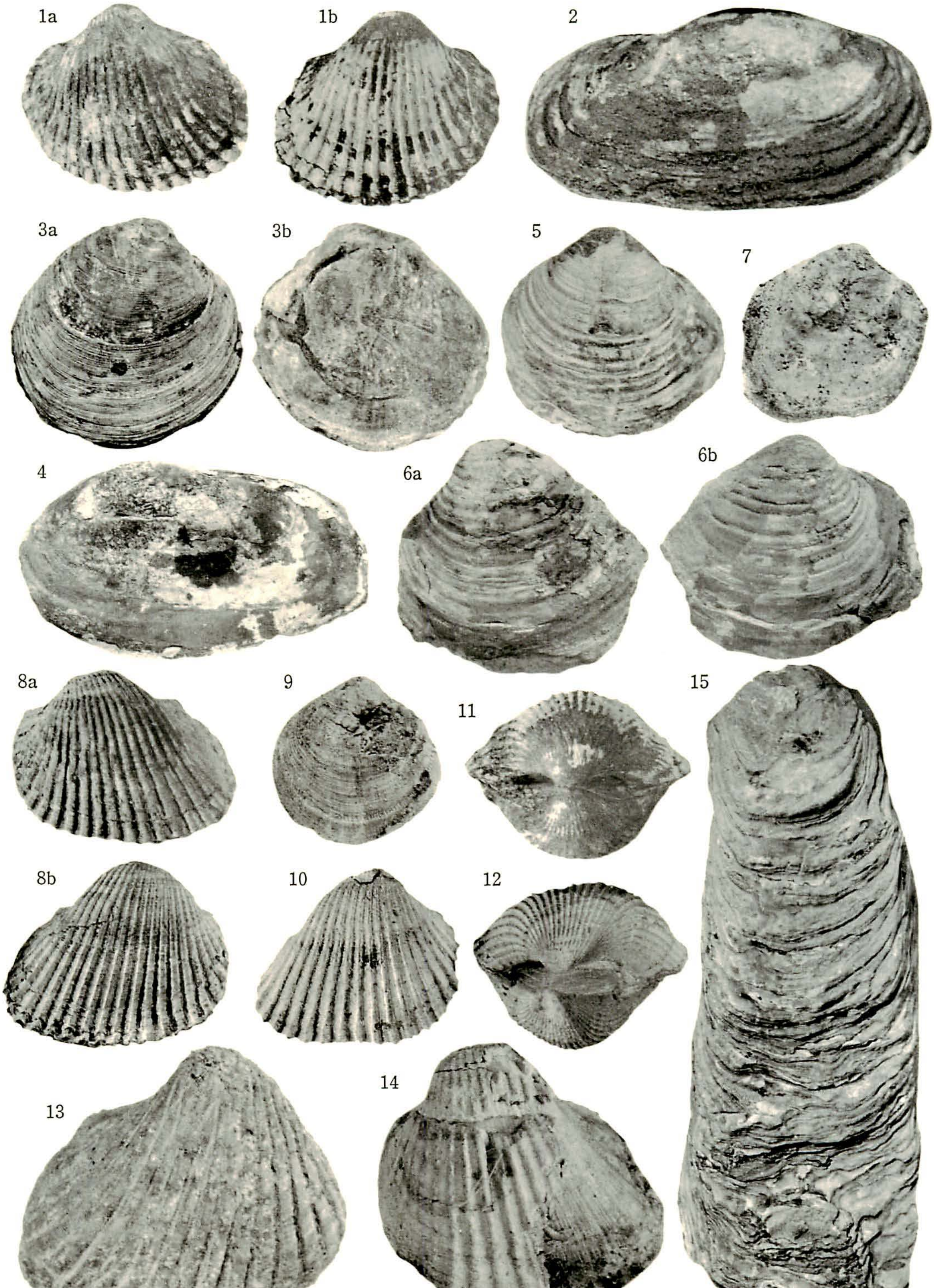

KUMAGAI photo.

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Explanation of Plate 38

(All figures in natural size unless stated otherwise)

Figs. 1a, 1b, 11. *Anadara* (*Anadara*) *kiiensis* MIZUNO, p. 273, Loc. no. 1, IGPS coll. cat. no. 92933.

Fig. 2. *Panope* cf. *nomurae* KAMADA, p. 278, Loc. no. 3, preserved in Busan National Univ.

Figs. 3a, 3b. *Dosinia* (*Phacosoma*) *nomurai* OTUKA, p. 276, Loc. no. 3, IGPS coll. cat. no. 92939.

Fig. 4. *Soletellina minoensis* YOKOYAMA, p. 278, Loc. no. 1, IGPS coll. cat. no. 92940.

Fig. 5. *Clementia* (*Clementia*) *nakamurai* OTUKA, p. 277, Loc. no. 3, IGPS coll. cat. no. 92941.

Figs. 6a-6b. *Clementia* (*Clementia*) *nakamurai* OTUKA, p. 277, Loc. no. 1, IGPS coll. cat. no. 92942.

Fig. 7. *Thyasira* sp., p. 276, Loc. no. 1, IGPS coll. cat. no. 92943.

Figs. 8a, 8b, 12. *Anadara* (*Hataiarca*) *daitokudoensis* (MAKIYAMA), p. 274, Loc. no. 1, IGPS coll. cat. no. 92934.

Fig. 9. *Cyclina* (*Cyclina*) *japonica* KAMADA, p. 277, Loc. no. 1, IGPS coll. cat. no. 92958.

Fig. 13. *Anadara* (*Hataiarca*) *kakehataensis* HATAI and NISIYAMA, p. 274, Loc. no. 3, IGPS coll. cat. no. 92935.

Figs. 10, 14. *Anadara* (*Hataiarca*) *kakehataensis* HATAI and NISIYAMA, p. 274, Loc. no. 1, IGPS coll. cat. no. 92936.

Fig. 15. *Crassostrea gravitesta eoilensis* KIM, NODA and YOON, n. subsp., (Paratype) p. 274, Loc. no. 1-1, IGPS coll. cat. no. 92937, ×1/3.

IGPS coll. cat. no. = collection catalogued number of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, Sendai, Japan.

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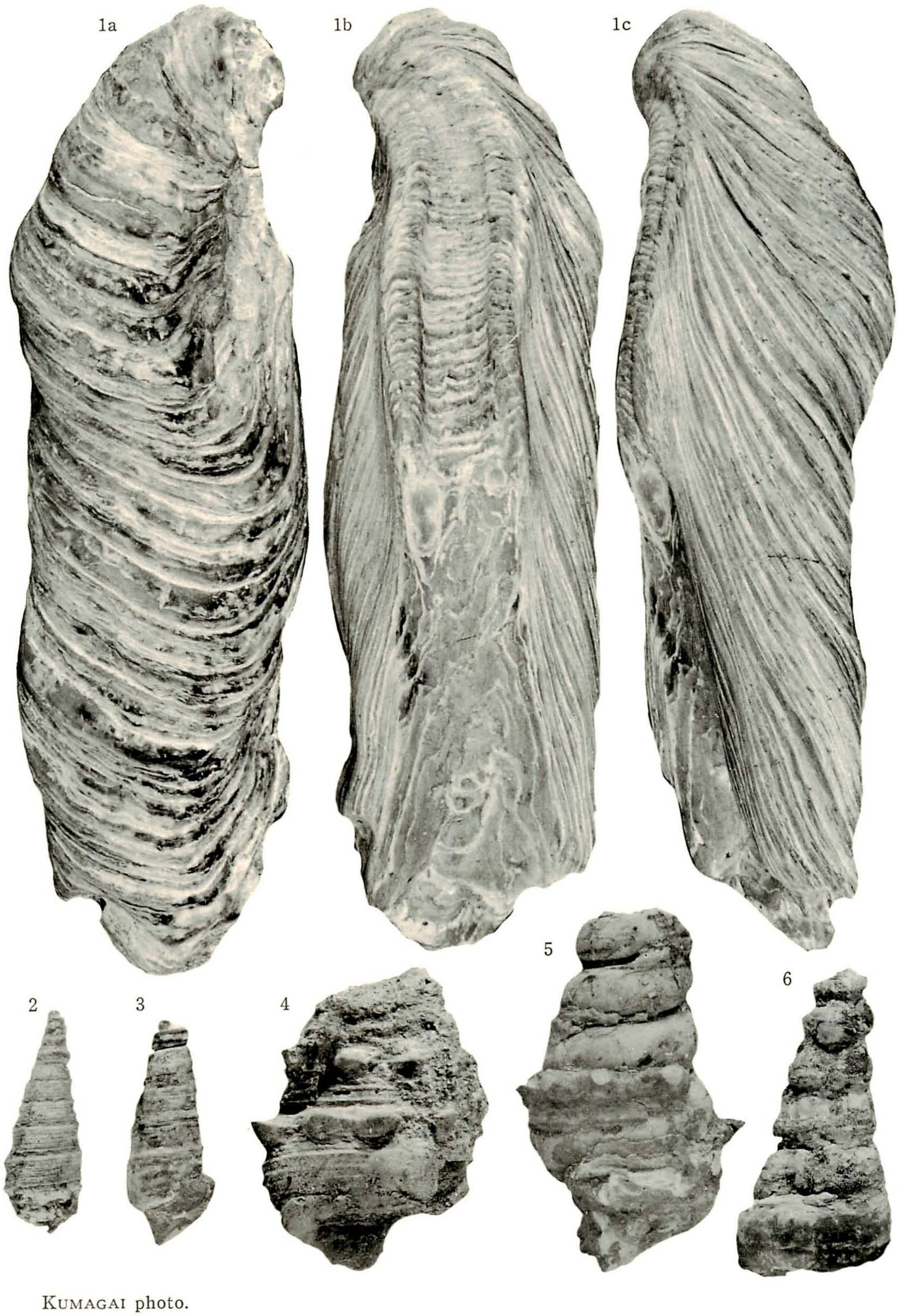

KUMAGAI photo.

Andong-ri*	安洞里
Aniai+	阿仁合
Asagawa+	浅川
Auil** = Eoil*	魚日
Bangsan-ri*	芳山里
Beomgog-ri*	凡谷里
Bulgugsa* = Fukkokuji**	佛国寺
Changam*	倉右
Changgi* = Janggi* = Chôki**	長鬐
Cheonbug* = Sempoku**	川北
Chôki** = Changgi* = Janggi*	長鬐
Chôyô* = Gampo*	朝陽＝甘浦
Daegog*	大谷
Ennichi** = Yeonil*	延日
Eoil* = Auil**	魚日
Fukkokuji** = Bulgugsa*	佛国寺
Galpyeong-dong*	葛坪洞
Gampo* = Kampo**	甘浦
Geumo-ri*	金吾里
Guryongpo* = Kyûryûho**	九龍浦
Haseo-ri** = Hasouri**	下西里
Heiroku* = Pyeongryug*	坪六
Higashi-Innai+	東印内
Hyodong-ri* = Hyotongni**	孝洞里
Hwabong-ri*	華峰里
Idong*	梨洞
Janggi* = Chôki** = Changgi*	長鬐
Jangmyeong-gol*	新峴里
Jeongja-ri*	享子里
Jinjeon-dong*	陳田洞
Jugjeon-ri*	竹田里
Kampo** = Gampo*	甘浦
Keumgoangdong** =	
Gumgwan-dong*	金光洞
Kunimi+	国見
Kurosedani+	黒瀬谷
Manghaesan* = Manghaisan**	望海山
Nuldae-ri* = Nultairi**	訥台里
Oidawara+	生俵
Orito+	折戸
Oyama+	大山
Pohang*	浦項
Sempoku** = Cheonbug*	川北
Shigarami+	柵
Shiroyama+	城山
Sinjeong-dong*	新享洞
Songhag-dong*	松鶴洞
Songjeon-ri*	松田里
Seoam*	西庵
Tanosawa+	田の沢
Tatsunokuchi+	竜の口
Tsugawa+	津川
Tsukiyoshi+	月吉
Tsurikake+	釣懸
Ulsan*	蔚山
Waeum-ri*	臥邑里
Yeonil* = Ennichi**	延日
Yeongil*	迎日
Yongdong-ri*	龍洞里
Yoshino+	吉野

* = Geographical name in Korea.
** = Geographical name used for the stratigraphic units by TATEIWA (1924).
+ = Geographical name in Japan.

Explanation of Plate 39

(All figures in natural size, unless stated otherwise)

Figs. 1a, 1b, 1c. *Crassostrea gravitesta eoilensis* KIM, NODA and YOON, n. subsp., p. 274, Loc. no. 1-1, IGPS coll. cat. no. 92938. (Holotype), ×2/3.

Fig. 2. *Vicaryella ishiiana* (YOKOYAMA), p. 279, Loc. no. 3, IGPS coll. cat. no. 92944.

Fig. 3. *Vicaryella* sp., p. 280, Loc. no. 1, IGPS coll. cat. no. 92945.

Figs. 4, 5. *Vicarya* (*Shoshiroia*) *callosa japonica* YABE and HATAI, p. 278, Loc. no. 1, IGPS coll. cat. no. 92946.

Fig. 6. *Cerithidea* sp., p. 280, Loc. no. 1, IGPS coll. cat. no. 92947.

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会 1974 年総会・年会は 1974 年 1 月 11 日（金）・12 日（土）に九州大学理学部において開催された（参加者 72 名）。

海外学会出席報告

三葉虫及び三葉虫形類，腿口類の分類と進化に関する会議 ……………………浜田隆士
第二回珊瑚礁国際会議 ……………小西健二

総　会

特別講演

登米層 ……………………………村田正文
北太平洋地域における新生代軟体動物のマイグレーションに関する二・三の問題について ……………………………………菅野三郎

個人講演

Lower Cretaceous flora from the Akaiwa Formation, the Tetori Supergroup, Central Japan ....KIMURA, T. & SEKIDO, S.
A new cycadophyte from the Liassic Iwamuro Formation, Gumma Prefecture, Japan ....KIMURA, T.
壱岐層産の植物化石について‥林 徳衛・鈴木順雄
チリー，キリキナ島上部白亜紀の花粉群集 ……………………………………高橋 清
日本海海底から採取したピストン・コアにおける現世—後期中新世珪藻群集について ……………………………………小泉 格
石灰質ナンノプランクトンにおける現生群集と現世底質群集（予報）……………西田史郎
Microbiostratigraphy of some middle Miocene sequence in northern Japan.... ....TAKAYANAGI, Y., TAKAYAMA, T., SAKAI, T., ODA, M. & KITAZATO, H.
Foraminiferal research in the Geodynamic Project, the First Cruise, 1972 (GDP-1) .... KONDA, I.
Globorotalia (*Turborotalia*) *humerosa praehumerosa*, n. subsp. and its stratigraphic significance...................NATORI, H.
Foraminifera from the Tachigase Formation along the Arakawa River, Saitama Prefecture, Japan ....FUKUTA, O.
Pliocene planktonic foraminiferal fauna from northern Mindanao, Philippines .. ..UJIIÉ, H. & SAMATA, T.
Lower Pleistocene to Upper Miocene planktonic foraminifera from the Shimajiri Group of the Island of Miyako, Ryukyu ....UJIIÉ, H. & OKI, K.
岐阜県揖斐郡石山石灰岩層の紡錘虫について ‥ ……………………………………千坂武志
Biostratigraphical Zonation of the Rat Buri Limestone in the Khao Phlong Phrab area, Sara Buri, Central Thailand ....TORIYAMA, R., KAMMERA, K., KAEWBAIDHOAM, S. & HONGNUSONTHI, A.
Correlation of the Silurian stromatoporoid reefs in Shropshire (England) and Gotland (Sweden) ....MORI, K.
現生の眼を通して福地クサリサンゴを論ずる ‥ ……………………………………岡村長之助
Gaudryceras の constriction について …… ……………………………………平野弘道
Otoscaphites puerculus の形態の時間的変化とその機能形態学的意味について ……棚部一成
Cretaceous patelliform gastropods from Japan and adjacent areas ......KANIE, Y.
The differentiation of the species of *Inoceramus* in the Lower Urakawan (Coniacian) ....NODA, M.
On the type-species of *Trigonioides* (Studies on the Cretaceous non-marine mollusca from Korea. Part 1) ....梁 承栄
On a new veneroid pelecypod genus "*Mesochione*" from the Himenoura Group ....TASHIRO, M.
Associated occurrence of *Adulomya* and "*Akebiconcha*" from the Taishu Group of Tsushima, Nagasaki Prefecture ....KAMADA, Y. & TAKAHASHI, K.
Some interesting taxodontid bivalves from the Miocene Osozawa Formation, Yamanashi Prefecture ....OMORI, M., AKIYAMA, M. & MANO, K.

シンポジウム

「古無脊椎動物の系統分類にかんする最近の進歩」

(世話人：高柳洋吉・速水 格)

学会記事

◎ 1974年総会によって，会費等の変更および会計監査設置を主とする会則変更が承認された(詳細は290ページ所載の会則を参照)。

◎ 1974年1月10日の評議員会において，1974年度庶務担当常務委員として速水 格が選ばれた。それに伴い幹事に若干の異動が生じた(表紙うら参照)。

◎ 同上評議員会において，賞の委員会委員の半数改選を行なった結果，花井哲郎，氏家 宏の2名と決った。1974年度の同委員は，他に会長，首藤次男，棚井敏雅の3名である。

◎ 同上評議員会において，1974年度より次の7法人が賛助会員として推薦され承諾された(ABC順)。中東石油株式会社，出光日本海石油開発株式会社，インドネシア石油開発株式会社，イラン石油株式会社，三菱石油開発株式会社，石油開発公団石油開発技術センター，エス・ジー技研。

◎ 同上評議員会の議に従い，1974年度より，次の15名の諸君が特別会員となった(敬称略，ABC順。以下同様)。新井重三，藤井昭二，橋本 勇，平山勝美，池谷仙之，石田志朗，河野通弘，桑野幸夫，岡田博有，太田正道，奈須紀幸，斉藤登志雄，山崎達雄，吉田三郎，渡部景隆。

◎ 同上評議員会により，次の19名の諸君の入会が承認された。藤島泰隆，針生真也，長谷川淳一，本田博巳，井上雅夫，生路幸生，川上 広，神田 要，光井 久，根本修行，野村律夫，大越 章，岡田 豊，下山正一，菅谷政司，富永振作，冨田幸光，Jens RICKMEYER，矢島道子。

◎ また次の3君の退会も認められた。斉藤林次，佐藤達治，山田静雄。

◎ 以上により1974年2月15日現在の会員総数は，名誉会員6名，賛助会員11社，特別会員140名，普通会員299名，在外会員58名となった。

◎ 1974年1月の評議員会により，日本古生物学会特別号第18号として，小林貞一・浜田隆士君の Silurian trilobite from Japan の出版が承諾された。

◎ 日本古生物学会報告・記事1973年度最優秀論文賞は，平野弘道君の「Biostratigraphic study of the Jurassic Toyora Group. Pt. 3」に授与された。

◎ 1974年学術奨励金は，小西建二君(化石硬組織の研究)および氏家 宏君(有孔虫の層位・古生物学的研究)に授与された。

◎ 雑誌「化石」は諸般の事情により，1974年度以降，当分の間，不定期刊行物として出版されることになった。

1973年度最優秀論文賞推薦文

平野弘道君，1973年6月20日発行日本古生物学会報告紀事904号45〜71頁収載論文「Biostratigraphic study of the Jurassic Toyora Group. Pt. III.」

本研究は，日本の中生界に重要な位置を占めるジュラ系豊浦層群について，詳細な層序学的検討に加え，多産するアンモナイト類23属42種の分類学的研究を進めることによって，その時代論，古動物地理論に大きな成果をあげている。すなわち，豊浦層群はアンモナイト等の化石にもとづき Sinemurian から Bathonian にわたることを明かにし，とくに同層群中部にはアンモナイトによる帯を識別して，それらと欧州標準地域のアンモナイト帯との詳しい対比に成功した。そして岩相層序区分の境界がかなり顕著に時代面と斜交することをも明かにした。これは，ヨーロッパで普遍的にみられるような岩相と生相とのよい一致を生じる環境とはちがった古環境を反映していることを示す。事実，シンプソン公式の適用による同時代の他地域の動物群との類似度の比較から判断して，一般的には地中海系の特徴をそなえ，Whitbian 亜階には他の欧州地区とも類似を示す豊浦層群のアンモナイトが，いわゆるボレアル型の堆積物より産するものであるという興味ある結論を得ている。

このような研究は，正確な分類学的基礎知識に加えて，精力的な野外調査ならびに慎重な資料解析のうえに立ってはじめてなり立つものであり，生層序学的方法による規範的業績として高く評価される。よって日本古生物学会は，本研究に対して論文賞を贈り，同君の今後の一層の発展を期待するものである。

1974年度学術奨励金推薦文

小西健二君：化石硬組織の研究

化石硬組織には，それをつくった生活時の履歴あるいは生活の環境を示すさまざまな記録が残されており．これを正しく読みとることは，古生物の研究に極めて重要な情報を提供することになる。小西健二君は，多くの共同研究者とともに主として南西諸島の第四系化石および現生の石サンゴ類を主とする造礁生物の骨格を材料とし，この分野の研究に重要な貢献をしてきた。硬組織中の酸素同位体比を用いる古水温測定法は古環境解析の重要な手段となっているが，小西君は共同研究者と共に酸素及び炭素同位体について，測定の方法，いわゆる vital effect の問題，続成作用にともなう同位体比の変化などを調べ，この古水温測定法およびそれに関連する生物学的・地質学的な問題の基礎的研究を進めてきた。また，サンゴ・シャコガイなどに初生的に含まれる U，Na などの微量成分や上記同位体比が生長とともに周期的に変動していることを詳細に示し，またこれらが化石化に伴なって変化する様子を明らかにした。これは，このような同位体比や微量元素量の変動を生物時計として利用する際の方法と問題点を指摘したものである。放射性同位体についても，化石中に含まれる ^{230}Th に初生的なものがあることを示し，その結果補正された年代値を用いて地殻変動の記録とともに更新世後期の海水準の位置を明らかにした。

これらの例からわかるように，小西健二君は，化石の硬組織を構成する安定ないし放射性同位体や微量元素を用いて，古生物の生活履歴や生息環境を研究する際の，多くの基礎的な問題点を指摘し，これを解決してきた。これによって我が国におけるこの分野の研究を著しく進歩させた功績はまことに大なるものがある。よって日本古生物学会はここに学術奨励金を贈り，今後の一層の発展を期待する。

氏家　宏君：有孔虫の層位・古生物学的研究

氏家宏君は20年にわたって有孔虫の研究を精力的に進めて大きな成果をあげた。有孔虫研究は対象や取扱い方によって多様に分化しているが，同君は自然分類の確立を第一の基礎におき，統計的手法を取入れて層序，群集，生態，形態，構造など多方面の問題に取組んできた。第一に底生有孔虫種の時代分布についての知識に基づく赤平層（1959），幌内層（1960）などの生層序的研究から進んで，種個体の出現頻度頻度に基づく HOLZINGER の因子分析を行ない，化石群集の分帯と現生群集の区分が可能なことを列証した（1962）。さらにこの方法を長沼層の浮遊性有孔虫群集に適用し，同層堆積時の古環境・古地理について従来の知見を改めた。第二に国際対比に有力な手段とされる浮遊性有孔虫分帯を西太平洋地域に適用するにあたって生態的見地から適用方法に工夫を加えた（1959. 1970. 1971 など）。また分帯の重要な鍵である種の変異性を現生種で検討した。第三に Elphidiidae (1956)，*Ammonia tochigieksis* (1965)，*Pararotalia nipponica* (1966) などの堆構造の研究は形態・構造の知識を加えただけでなく，自然分類に寄与する所が大きい。第四に *Miogypsina* に見られる Nepionic acceleration の吟味により，系統分類，進化系列を明らかにし，精密な生層序への道を確実にした。

これらの研究は相良 — 掛川堆積盆地の層序的研究（1962）で示されているような層序・堆積についての精密な観察に裏付けられており，総合的な視野のもとで推進されている。このような意味で氏家宏君の研究は常に古生物学研究に力強い牽引の役割を果しており，その功績は大きい。日本古生物学会はここに学術奨励金を贈り，今後の一層の発展を期待する。

日本古生物学会特別号の原稿募集

PALAEONTOLOGICAL SOCIETY OF JAPAN, SPECIAL, PAPERS NUMBER 19 を 1975 年度に刊行したく，その原稿を公募します。適当な原稿をお持ちの方は，次の事項に合わせて申込書を作成し，〒812 福岡市東区箱崎町 九州大学理学部地質学教室気付，日本古生物学会特別号編集委員会（代表者勘米良亀齢）宛に申し込んで下さい。

(1) 古生物学に関する論文で，欧文の特別出版にふさわしい内容のもの。同一の大題目の下に数篇の論文を集めたもの（例えばシンポジュウムの欧文論文集）でもよい。分量は従来発行の特別号に経費上ほぼ匹敵すること。学会から支出できる経費は 40 万円程度です。学会以外からも経費が支出される見込のある場合には，その金額に応じて上記よりも分量が多くてよい。

(2) 内容・文章ともに十分検討済の完成した原稿（または完成間近い原稿）で，印刷所に依頼して正確な見積りを算出できる状態にあること。なるべく原稿の写しを申込書とともに提出して下さい。（用済の上は返却致します）。

(3) 申込用紙は自由ですが，次の事項を明記し，〔 〕内の注意を守って下さい。

(a) 申込者氏名；所属機関または連絡住所・電話番号。〔本会会員であること〕。

(b) 著者名；論文題目。〔和訳を付記すること〕。

(c) 研究内容の要旨。〔800～1200 字程度，和文で可〕。

(d) 内容ならびに欧文が十分検討済であることの証明。〔校閲者の手紙の写しでもよい〕。

(e) 本文の頁数（刷上り見込頁数または原稿で欧文タイプ 25 行詰の場合の枚数 — ただし，パイカーかエリート字体かを添記すること）；また本文中小活字（8 ポ組み）に指定すべき部分があるときは，そのおよその内訳（総頁に対するパーセント）；挿図・表の各々の数と刷上り所要頁数；写真図版の枚数。

(f) 他からの経費支出の見込の有無，その予算額，支出源。〔その見込の証明となる書類またはその写しを添えて下さい〕。〔1975 年度の文部省の刊行助成金を申請希望の場合も，その旨を上記の準じて添記して下さい〕。

(g) その他参考事項。原稿が未完成の場合には，申込時における進行状況ならびに完成確約年月日を必ず記して下さい。

(4) 申込締切 1974 年 10 月 15 日（消印有効）。採否は 1975 年 1 月の評議員会で審議決定の上申込者に回答の予定です。ただしその前または後に，申込者との細部の交渉を，編集委員から求めることがあるかもしれません。

(5) 印刷予定論文が完全な場合には，決定後できるだけ早く印刷にとりかかる予定です。文部省の刊行助成金（「研究成果刊行費補助金」）を申請希望の場合には，学会から申請（例年は 11 月中旬中に申請締切）し，その採否・金額など決定後印刷にとりかかります。その場合は文部省との約束により，その年の秋（前例では 10 月 20 日）までに初校が全部出なければ，補助金の交付が中止されることになっています。

(6) 特別号の投稿規定はとくにありません。会誌に準じ，前例を参考とし，不明の点は編集委員会に問い合わせて下さい。経費がかかるので，特別な場合を除き，別刷は作成せず，本刷 25 部を著者に無料進呈します。それ以上は購入（但し著者には割引）ということになります。いくつかの論文を集めて 1 冊にするときには，世話人の方から指示して，体裁上の不統一のないようにして下さい。印刷上の指示事項が記入できるよう，原稿の左右両側・上下に十分空白をとって，タイプで浄書して下さい。

日本古生物学会会則　(1974, 1, 11改訂)

第1条　本会は日本古生物学会という。

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

第3条　本会は第2条の目的を達するため次の事業を行なう。
1. 会誌そのほかの出版物の発行。2. 学術講演会の開催。3. 普及のための採集会・講演会そのほかの開催。4. 研究の援助・奨励および研究業績ならびに会務に対する功労の表彰その他第2条の目的達成に資すること。

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

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

第6条　会員を分けて普通会員・特別会員・賛助会員および名誉会員とする。

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

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

第9条　賛助会員は第2条の目的を賛助する法人で評議員会の推薦による。

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

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

第12条　会費の金額は総会に計って定める。会費は普通会員年3,000円，特別会員年4,200円．賛助会員年1口10,000円以上とする。名誉会員は会費納入の義務がない。在外の会員は年 U.S.$16とする。

第13条　本会の経費は会費・寄付金・補助金などによる。

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

第15条　本会の役員は会長1名，評議員15名とし，うち若干名を常務委員とする。任期は総て2年とし再選を妨げない。
会長の委嘱により本会に幹事および書記若干名を置くことができる。
常務委員は評議員会において互選される。評議員は特別会員の中から会員の通信選挙によって選出される。

第16条　会長は特別会員の中から評議員会において選出され，本会を代表し会務を管理する。
会長に事故ある場合は会長が臨時に代理を委嘱する。

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

第18条　本会は毎年1回定例総会を開く。その議長には会長が当たり本会運営の基本方針を決定する。
総会の議案は評議員会が決定する。
会長は必要があると認める時は臨時総会を召集する。総会は会員の十分の一以上の出席をもつて成立する。会長は会員の三分の一以上の者から会議の目的たる事項および召集の理由を記載した書面をもつて総会召集の請求を受けた場合は臨時総会を召集する。

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

第20条　総会の議決は多数決により，可否同数の時は議長がこれを決める。

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

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

第23条　会計監査1名をおく。監査は評議員会において評議員および幹事をのぞく特別会員の中から選出される。任期は2年とし再選を妨げない。

第24条　本会の会計年度は毎年1月1日に始まり12月31日に終る。

第25条　本会会則を変更するには総会に付議し，その出席会員の三分の二以上の同意を得なければならない。

付　則　1）評議員会の議決は総て無記名投票による。

CONSTITUTION
of the
PALAEONTOLOGICAL SOCIETY OF JAPAN

(Jan. 11, 1974)

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

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

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

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

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

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

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

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

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

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

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

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

Article 12. The rates for annual dues shall be decided by the General Meeting. Rates for annual dues are: Regular Members, Yen 3,000; Fellows, Yen 4,200; and Foreign Members, U.S.$16.00; Patrons are organizations donating more than a share (Yen 10,000) annually; Honorary Members are free from obligations.

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

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

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

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

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

Article 18. The Society shall hold regularly one General Meeting a year. The President shall be Chairman and preside over the administrative affairs. The program for the General Meeting shall be decided by the Council. The President may call a Special Meeting when he deems it necessary. The General Meeting requires the attendance of more than one-tenth of the members. The President shall call a Special Meeting at the written request of more than one-third of the members. The request shall be granted only if the written statement fully explains the reasons for assembly and items for discussion.

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

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

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

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

Article 23. An auditor shall be elected by the Council from Fellows excluding Councillors and Secretaries. The term of office is two years and he may be eligible for re-election.

Article 24. The fiscal year of the Society shall begin on the first of January each year and end on the thirty-first of December of the same year.

Article 25. The amendments to the Constitution of the Society shall be decided at the General Meeting and must be approved by more than two-thirds of those members who are in attendance.

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

例 会 等 の 通 知

	開　催　地	開　催　日	講演申込締切日
113 回　例　会	大阪市立 自然史博物館	1974年 6 月15-16日	1974年 4 月 10日
114 回　例　会	名古屋大学	1974年10月19-20日	1974年 8 月 20日
1975年　総会・年会	国立科学博物館	1975年 1 月 下 旬	未　定

◎ 113回例会では，16日に討論会「古生物学と博物館」（世話人・千地万造）が予定されている。

◎ 114回例会では，20日に瑞浪地方巡検（ガイド・森下　晶）が予定されている。

お 知 ら せ

◎ 1974年9月発行予定の **英文会員名簿作製** のため，異動のあった会員は，東京都新宿区百人町3-23-1 国立科学博物館分館（〒160）浅間一男あて6月末までに通知されたい。

◎ **化石，Nos. 25・26 の発行**（特集・古植物の分布とその問題点）浅間一男：古生代における植物分布と問題点，木村達明：三畳紀－下部白亜紀の植物群，大山年次：中植代植物から新植代植物への転換について，棚井敏雅：北半球における温帯林の起源と発展，岡崎由夫・鈴木順雄：北海道東・北部の新第三紀後期以後の植物群の変遷，高橋　清：上部白亜紀および古第三紀の花粉・胞子の分布と変遷ならびに問題点。その他に寄稿・テクニック・トピックス・国際ニュース。1部1,400円，購入申込は仙台市青葉山東北大学理学部地質学古生物学教室・高柳洋吉。

◎ 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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