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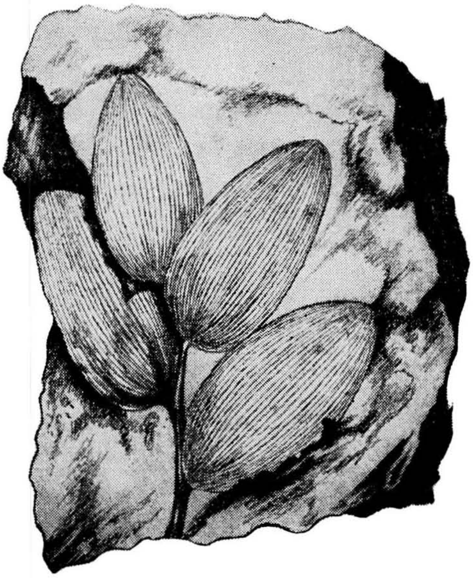

日本古生物学会

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The fossil on the cover: Original figure of *Podozamites Reinii* GEYLER, 1877, from the Tetori group. GEYLER's description marked the onset of modern palaeontology in Japan.

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672. SOME CONSIDERATIONS ON THE ANCESTOR OF THE FAMILY VERBEEKINIDAE (FUSULINACEA)

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Verbeekinidaeの祖先型に関する若干の考察：従来多くの紡錘虫研究者により，Verbeekinidaeの祖先型はStaffellidaeと考えられてきた。しかしLEVEN (1970)は西南ダルバスより*Pamirina*属を提唱し，OzawainellidaeがVerbeekinidaeの先祖であると考えた。本属の特記すべき特徴は外殻でalveolar keriothecaを有すること，二次的なmineralizationをうけていないこと，パラコマータをもたないことなどである。本属の模式種*P. darvasica* LEVENはパラコマータを考慮に入れないと原始的な*Misellina*属，特に*M. dyhrenfurthi* (DUTKEVICH)に酷似するが，後者は個体発生のより初期の段階でalveolar keriothecaが出現する。筆者は最近関東山地の数地より本属を採集したのをきっかけに本属の系統発達ならびに個体発生の段階における旋回壁構造の変遷について考察した。その結果，模式種よりもさらに下等と考えられる*Pamirina tethydis*, *P. leveni*の二新種を認めた。これらは旋回壁構造の系統発生上，*Misellina*属と緊密な関係があり，同一進化系列上に位置づけられることを認め，明確にOzawainellidaeに属すること，Verbeekinidaeの祖先型はOzawainellidaeであることを確認した。本論ではこれらを中心に考察し，*Pamirina*の3種を記載した。さらに従来報告された種についても若干の検討を加えた。　小林文夫

Introduction

From the beginning of this century, various classifications of the fusulinaceans have been proposed by many authors. Currently, fusulinacean foraminifers were classified into six families by ROSS (1967). Russian authorities, such as RAUSER-CHERNOUSOVA (1963a, b) established seven families and ROZOVSKAYA (1969) recognized eight ones, namely, Ozawainellidae, Staffellidae, Fusulinidae, Schwagerinidae, Verbeekinidae, Neoschwagerinidae, Schubertellidae, and Boultonidae. Phylogenetic relationships among these families were also discussed by these authors.

Concerning the family Verbeekinidae, many previous authors treated that the family Staffellidae are the direct ascendants. In his detailed investigation on the Verbeekinidae and Neoschwagerinidae, however, OZAWA (1970, p. 38, 44) came to a conclusion that the Verbeekinidae was not derived from the Staffellidae but possibly from the Ozawainellidae. In the same year, LEVEN (1970) proposed a new genus *Pamirina*, *P. darvasica* LEVEN as its type species, and also described a primitive species of *Misellina*, *M. dyhrenfurthi* (DUTKEVICH) from the Artinskian Safetdadonski Limestone, southwest Darvas. Furthermore, he pointed out that the Family Verbeekinidae is the descendant of the Ozawainellidae. CHOI (1972) discussed the classification and phylogeny of the genus *Misellina*. Although his conclusion is very inter-

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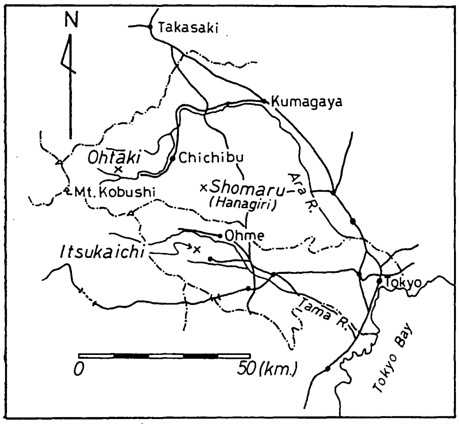
* Received Feb. 23, 1976: read Jan. 26, 1975, in Tokyo.

esting, it seems to be insufficient to settle the origin of *Misellina*, because he treated only single material from the Kitakami Massif.

Recently, I have obtained three species of *Pamirina* from the Kwanto Mountainlands, Central Japan. In this paper, I will describe these species and discuss their ontogenetic and phylogenetic aspects considering of several biocharacters and stratigraphic position of *Pamirina*. Furthermore, for clarifying the evolutionary trend from the Ozawainellidae to the Verbeekinidae, phylogenetic and ontogenetic relationship between *Pamirina* and *Misellina* is discussed. Three species of *Misellina* collected from the Kwanto Mountainlands and the Akiyoshi Limestone of west Japan, are also illustrated in this paper.

All of the figured specimens are stored in the Institute of Geology and Mineralogy, Tokyo University of Education.

Acknowledgements: I would like to thank Dr. Hisayoshi IGO, Associate Professor of the University of Tsukuba, for his continuous guidance and critical reading of this manuscript. Dr. T. KOIKE, Associate Professor of Yokohama National University and Mr. K. WATANABE of Noda Senior Highschool helpfully advised me. Mr. M. MATSUKAWA of Tokyo Gakugei University helped my field survey and sampling. A part of the expense of this study was supported by the Scientific Research Fund from the Ministry of Education.



Text-fig. 1. Index map showing the sample localities.

Geologic Setting of the Localities of *Pamirina*

The present material was collected from several localities and their brief geologic setting are summarized below.

A. Itsukaichi: Upper Paleozoic and Mesozoic strata are widely distributed as several narrow belts trending northwest to southeast in Itsukaichi, southern part of the Kwanto Mountainlands. From the beginning of 1970, I have been engaged in the geological survey of this area and brief summary of geology was presented by IGO and KOBAYASHI (1974). *Pamirina darvasica* LEVEN was collected from Nishihosoo and Fukazawa, 4 km north and 2 km northwest of Itsukaichi, respectively. This species occurred from the micritic partly sparitic limestone pebbles of the Triassic intraformational conglomerate. *Pamirina darvasica* is associated with *Misellina dyhrenfurthi* (DUTKEVICH), *Misellina* sp. A and others. Accordingly, its geologic age is approximately equivalent to early Artinskian of the Tethys region.

B. Hanagiri: Hanagiri, near Kamikutsu, at the southeast foot of Shomaru Pass (617 m), is situated about 60 km northwest of Tokyo. According to MORIKAWA (1955), the Upper Paleozoic formations are typically exposed at Kutsuzawa (valley) and subdivided into the following seven members in descending order, 1: grey chert (more than 100 m thick), 2: Kami-kutsu Limestone Conglomerate (about 30 m thick), 3: red chert (about 200 m thick), 4: Shimo-kutsu Conglomerate (about 40 m thick), 5: alternation of sandstone and slate (about 100 m thick), 6: Hanagiri Limestone (about 30 m thick), and 7: alternation of sandstone and slate (about 100 m thick). The fourth Shimo-kutsu Conglomerate and the sixth Hanagiri Limestone members bear some Lower Permian Schwagerinidae. The second Kami-kutsu Limestone Conglomerate yields some upper Middle Permian Neoschwagerinidae. Based on my observation, the Hanagiri Limestone Member attains about 40 m in thickness at the type section and is almost barren in megafossils except for calcareous algae and small fragments of crinoid and shells. The lower part of this limestone frequently intercalates thin red to brown tuff and is highly crystalline. Fusulinaceans in this part are ill-preserved and deformed. The middle part of the limestone is grey micrudite and also frequently intercalates red to brown tuff bands. It yields many fusulinaceans, such as *Pseudofusulina fusiformis* (SCHELLWIEN and DYHRENFURTH), *P.* spp., *Biwaella* sp., *Toriyamaia* sp., *Schubertella* sp., *Pamirina tethydis* KOBAYASHI, sp. nov., *P. leveni* KOBAYASHI, sp. nov. and others. The upper part of the limestone is massive, partly bedded, mainly light grey to grey micrudite and yields the similar fossils with the middle part. The occurrence of *Pamirina* seems to be restricted to some part of particular lithology in the limestone. The specimens are crowded in the algal bio-sparudite, and they abruptly disappear vertically as well as horizontally. From the mentioned fusulinaceans, the Hanagiri Limestone Member is correlated to the upper Sakmarian and also to the upper Sakamotozawan.

C. Ohtaki: Carboniferous and Permian rocks composed of limestone, green rocks, chert, sandstone, slate and conglomerate, are distributed in the Ohtaki area, west of Chichibu. These rocks are trending WNW to ESE and bounded by the faults with the Cretaceous formations at northern margin and with the Jurassic Ohtaki Group at the southern margin. FUJIMOTO (1936), ISHII (1962) and others contributed to the geology and paleontology of this area. I collected some specimens of *Pamirina* sp., *Misellina* cfr. *dyhrenfurthi* (DUTKEVICH), *M.* sp. A, *M.* spp., *Nagatoella* sp., *Pseudofusulina* sp. and *Pseudoendothyra* sp. from the limestone lenses cropped out near Uzuradaira, Ohtaki village. Geologic age of this limestone is approximately early Artinskian in the Tethys standard.

Previously described species referable to the genus *Pamirina*

Paramillerella, Millerella, Staffella, Nankinella, Pseudoendothyra and others frequently occur from the Lower Permian rocks associated with many schwagerinids. These fusulinids have been ignored by many authors because of their rare occurrence, small size and rather long stratigraphic ranges. The following species reported from Japan are thought to be assigned to the genus *Pamirina*.

(1) *Paramillerella*? sp.:- This unidentified species was described by TAKAOKA (1966, Pl. 5, Figs. 1-5) from the Futagoyama Limestone, Kwanto Mountainlands. TAKAOKA did not describe any detailed character of shell, but this species is apparently assigned to *Pamirina*. This species coexists with *Pseudofusulina kraffti* (SCHELLWIEN and DYHRENFURTH).

(2) *Staffella* sp.:- This unidentified species was described by KANUMA (1960, Pl. 12, Figs. 29-31) from the Lower Permian Shimadani Formation, Mino Mountain-

lands, Central Japan. It has 4 to 5 volutions, 0.34 to 0.40 mm in the length, 0.65 to 0.75 mm in the width, 0.032 mm in the outside diameter of proloculus, low chomata, thin spirotheca and scarcely recrystallized shell. Associated fusulinids are *Pseudofusulina* sp. The above-mentioned characters of this species are entirely identical with those of *Pamirina*.

(3) *Pseudostaffella*? *tamanouchiensis* SAKAGAMI :- This species was described by SAKAGAMI (1956, Pl. 37, Figs. 1-3) from the limestone pebbles of the Tamanouchi Conglomerate in the vicinity of Itsukaichi, west of Tokyo. According to SAKAGAMI, the important characters of shell are as follows. Shell composed of 7 volutions, 0.67 mm in the axial length, 1.11 mm in the median width and 1 : 0.6 in the form ratio. The spirotheca composed of a tectum, diaphanotheca and a thin lower tectorium. Associated fusulinaceans with this species are *Nankinella* sp., *Staffella moelleri* OZAWA, *Mesoschubertella thompsoni* (SAKAGAMI), *Pseudofusulina vulgaris* (SCHELLWIEN and DYHRENFURTH), *P. vulgaris globosa* (SCHELLWIEN and DYHRENFURTH) and *P.* sp.. From the above-mentioned respects, SAKAGAMI inclined to propose a new genus or new subgenus, but he postponed his conclusion. In my opinion, diaphanotheca of this species is different from that of the Fusulinidae and may represent rather thick translucent layer corresponding to "protheca". Thus, *Pseudostaffella*? *tamanouchiensis* may be assigned to *Pamirina*.

(4) *Millerella hataii* SUYARI :- This species was described from the Lower Permian Kameiwa Formation, Kochi Prefecture, Shikoku, by SUYARI (1962, Pl. 1, Figs. 5, 6). The spirothecal structure, general shape of shell and number of volutions of this species are similar to *Pamirina*. However, this species shows partly evolute one or two whorls and has rather larger shell than *Pamirina*. From the above mentioned biocharacters of this species, I tentatively treat it as a member of *Pamirina* with a query.

In conclusion, at least the above mentioned four species in addition to the three species are referred to *Pamirina* in Japan.

They are :-

Pamirina tamanouchiensis (SAKAGAMI), by SAKAGAMI (1956)
Pamirina sp., by KANUMA (1960)
Pamirina (?) *hataii* (SUYARI), by SUYARI (1962)
Pamirina sp., by TAKAOKA (1966)
Pamirina tethydis KOBAYASHI, sp. nov.
Pamirina leveni KOBAYASHI, sp. nov.
Pamirina darvasica LEVEN
} by the present author (1977)

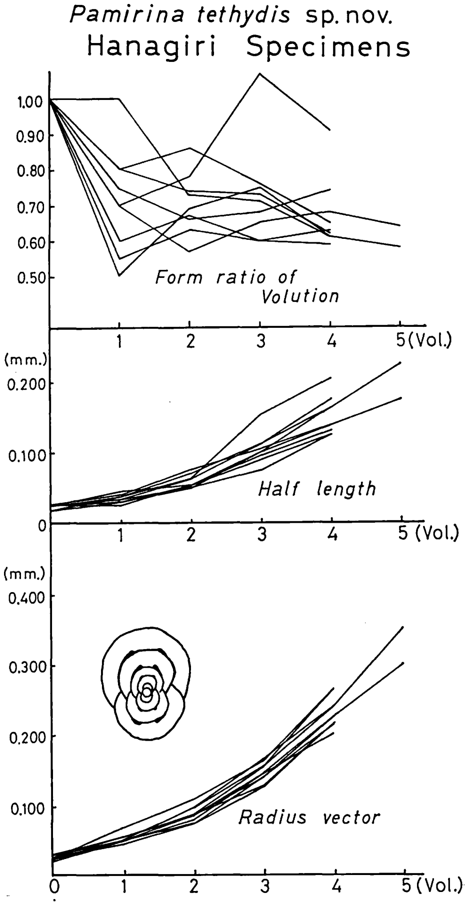
Based on the associated fusulinaceans, stratigraphic occurrences of these species of *Pamirina* in Japan are from the upper *Pseudoschwagerina* Zone to *Misellina* Zone, or from the upper Sakamotozawan to the lowest (?) Nabeyaman of Japan. *Pamirina darvasica* is known from the Artinskian of Darvas. Judging from our up-to-date knowledge, this genus has comparatively short stratigraphic ranges, limited within Lower Permian, and it represents an excellent stratigraphic indicator.

Consideration of the Ancestor of the Verbeekinidae

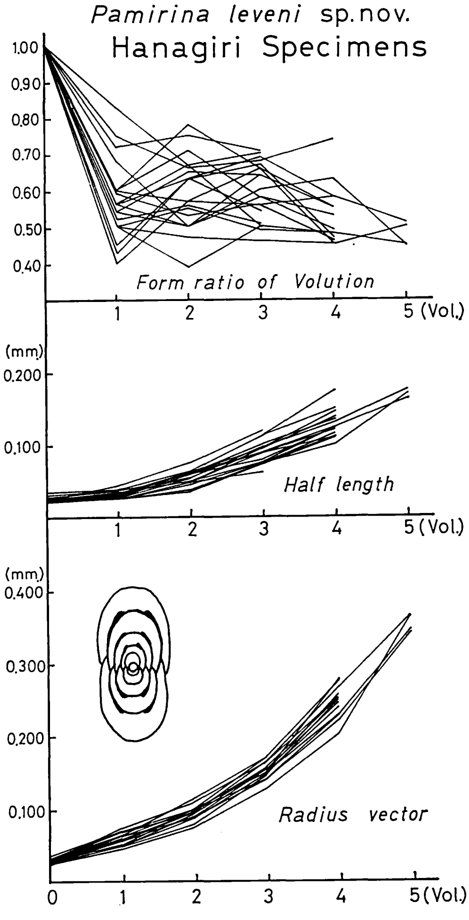
There are many difficulties to discuss the evolution of some groups of fusulinaceans which have less conspicuous morphological differentiation and long stratigraphic ranges. Concerning the evolution and phylogeny among the genera of the Ozawainellidae, several biocharacters are utilized for the taxonomic subdivision, such as, the size and shape of shell, number of whorls, structure and thickness of spirotheca, coiling pattern of shell, growth curve of shell and others. Furthermore, the ontogenetical transition of these biocharacters during the ontogeny and the biostratigraphic data of these fusulinids should be also considered.

In this chapter, I deal with the consideration of evolution from the Ozawainellidae to the Verbeekinidae with special reference to the spirothecal structure and growth curve of *Pamirina* and also certain species of *Misellina*.

〔Spirothecal structure〕 As will be mentioned in the later chapter, there are two types of the spirothecal structure in *Pamirina*. One type is recognized in *Pamirina tethydis* and *P. leveni*, namely, the proloculus and the first to third volutions are composed of structureless single layer. The fourth to last volutions consist of a tectum and protheca. These two species are morphologically more primitive and occupy a slightly lower stratigraphic position than *P. darvasica*.



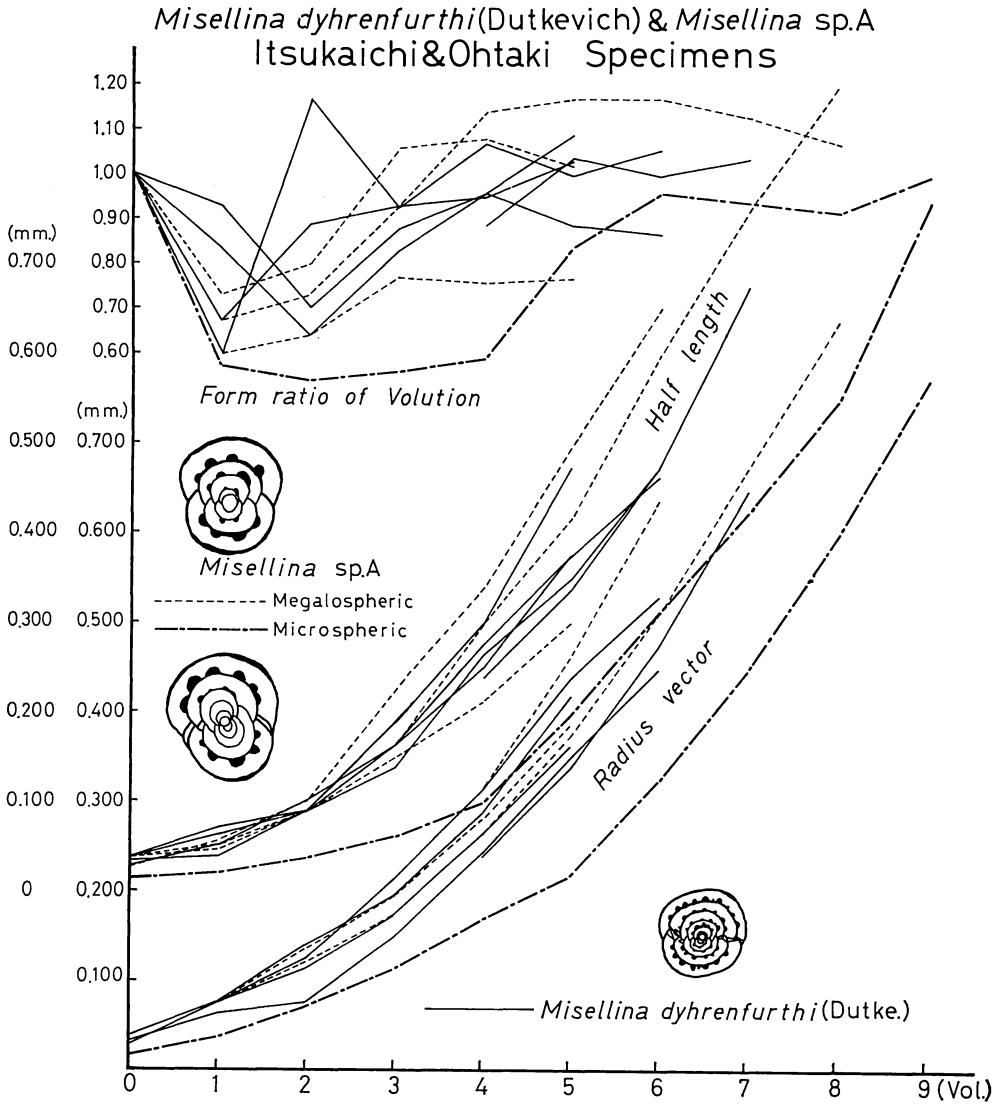
Text-fig. 2. Variations in relative growth of shells of *Pamirina tethydis* KOBAYASHI, sp. nov.



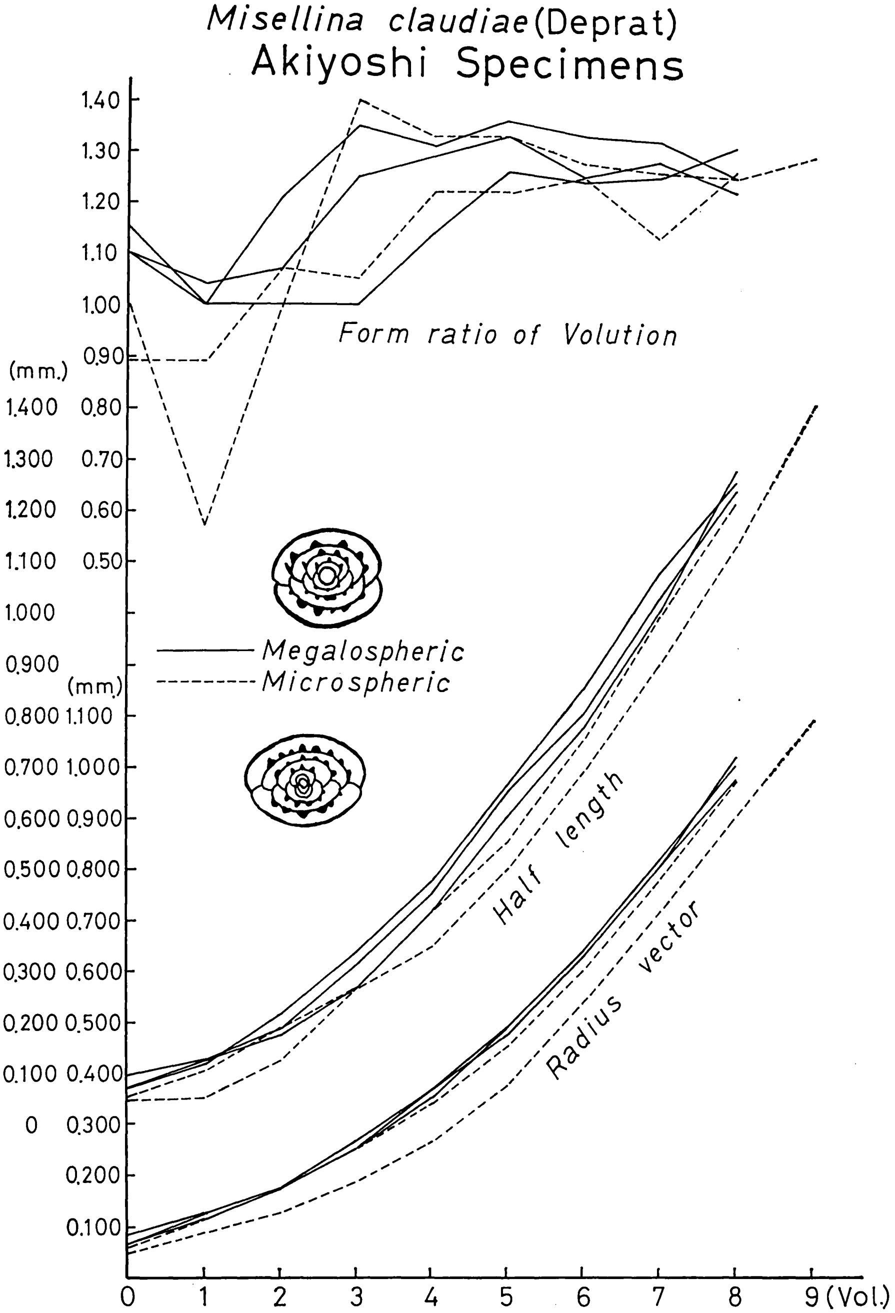
Text-fig. 3. Variations in relative growth of shells of *Pamirina leveni* KOBAYASHI, sp. nov.

The other type of spirotheca is recognized in *P. darvasica.* The prolocular wall and succeeding one to two and a half volutions are composed of structureless single layer. The spirotheca consisting of a tectum and protheca is developed in two and a half to four and a half volutions. Outer four and a half to the last volutions consist of a tectum and fine alveolar keriotheca. This species has morphologically more advanced biocharacters and occupies a slightly higher stratigraphic position than *P. tethydis* and *P. leveni.*

The spirotheca of *Misellina dyhrenfurthi* and *M.* sp. A are composed of

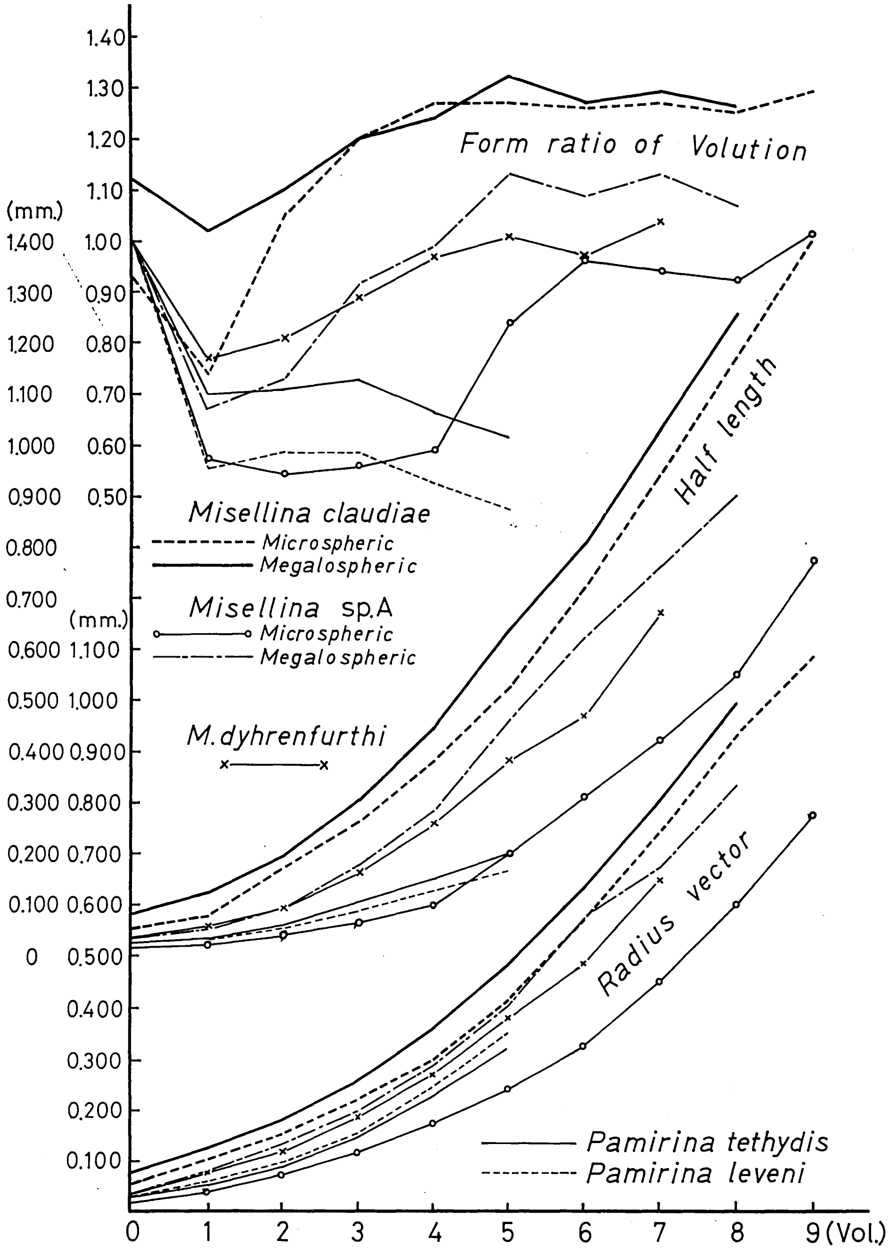


Text-fig. 4. Variations in relative growth of shells of *Misellina dyhrenfurthi* (DUTKEVICH) and *Misellina* sp. A.



Text-fig. 5. Variations in relative growth of megalospheric and microspheric shells of *Misellina claudiae* (DEPRAT).

structureless single layer in proloculus and inner onn or two volutions. A tectum and protheca developed in the second to fourth volutions, and a tectum and alveolar keriotheca recognized in the third or fourth to last volutions in the megalospheric specimens. However, the first appearances of protheca and keriotheca



Text-fig. 6. Average relative growth of shell.

started in later ontogenetic stage in the microspheric specimens than those of megalospheric form. These two species of *Misellina* are associated with *Pamirina darvasica* in Itsukaichi and with *Nagatoella* sp. in Ohtaki.

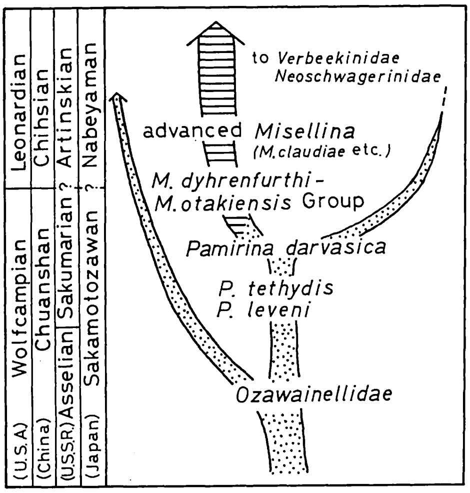
The spirothecal structure of *Misellina claudiae* from Kaerimizu of the Akiyoshi Limestone is composed of structureless single layer in proloculus and inner one volution, tectum and protheca in one and two volutions, and a tectum and thick layer of alveolar keriotheca in three to the last volutions in the megalospheric specimen. However, as in the same case of the above *Misellina* sp. A, protheca and keriotheca first appear also in later ontogenetic stage in the microspheric specimen. Associated fusulinaceans with *M. claudiae* are *Nagatoella orientis* (OZAWA) and others. *Parafusulina kaerimizensis* (OZAWA) appears at stratigraphically several meters high from this level. Therefore, *Misellina claudiae* is morphologically more advanced and occurs from a slightly higher stratigraphic position than *Misellina dyhrenfurthi* and *M.* sp. A.

Summarizing the above-mentioned evidences, a keriotheca is not visible in *Pamirina tethydis* and *P. leveni.* The first appearances of protheca and keriotheca are recognized in their earlier ontogenetic stages in *Misellina dyhrenfurthi* and *M.* sp. A than *Pamirina darvasica.* The development of these layers is the earliest in *Misellina claudiae* (Text-fig. 8).

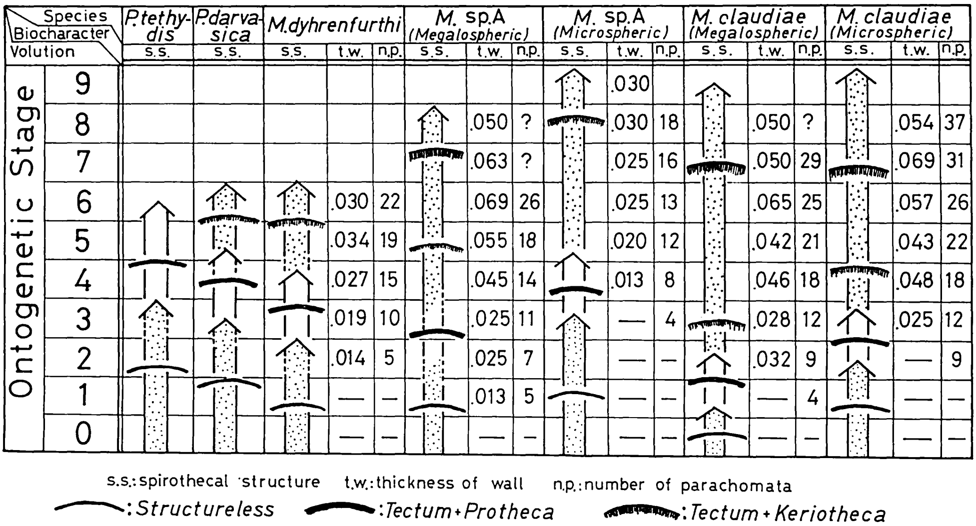
As discussed and noticed by many fusulinacean paleontologists, the change of spirothecal structure through the ontogeny and phylogeny is one of the most important phenomena to discuss the evolution of this superfamily.

[Growth curve] Relative growth of fusulinid shell is graphically expressed by plotting the values of radius vector, half length and form ratio at various ontogenetic stages. All of the measured values in *Pamirina tethydis, P. leveni, Misellina dyhrenfurthi, M.* sp. A and *M. claudiae* are graphically shown in Text-Figs. 2 to 5, and mean values of them are also shown in Text-fig. 6. *Pamirina darvasica* from Itsukaichi is omitted because of its poor data. As evidently shown in Text-fig. 6, the gradational changes of the growth curve of shell from *Pamirina* to *Misellina* are recognized.

In conclusion, the above considerations on the spirothecal structure and growth curve and on the spirothecal differentiation into two types in the Permian Ozawainellidae, as later given in the discussion on the diagnosis of *Pamirina,* suggest that *Pamirina* and *Misellina* have the same evolutionary series and that the Verbeekinidae are the direct descendants of the Ozawainellidae (Text-fig. 7).



Text-fig. 7. Phylogenetic position of *Pamirina*; Dotted branches belong to the Ozawainellidae, and crossed one is the Verbeekinidae.



Species / Biocharacter / Volution	P. tethydis	P. darvasica	M. dyhrenfurthi			M. sp.A (Megalospheric)			M. sp.A (Microspheric)			M. claudiae (Megalospheric)			M. claudiae (Microspheric)		
	s.s.	s.s.	s.s.	t.w.	n.p.	s.s.	t.w.	n.p.	s.s.	t.w.	n.p.	s.s.	t.w.	n.p.	s.s.	t.w.	n.p.
9										.030							
8							.050	?		.030	18		.050	?		.054	37
7							.063	?		.025	16		.050	29		.069	31
6				.030	22		.069	26		.025	13		.065	25		.057	26
5				.034	19		.055	18		.020	12		.042	21		.043	22
4				.027	15		.045	14		.013	8		.046	18		.048	18
3				.019	10		.025	11		—	4		.028	12		.025	12
2				.014	5		.025	7		—	–		.032	9		—	9
1				—	–		.013	5		—	–		—	4		—	–
0				—	–		—	–		—	–		—	–		—	–

s.s.: spirothecal structure t.w.: thickness of wall n.p.: number of parachomata

⌒: *Structureless* ⌒: *Tectum+Protheca* ⌒: *Tectum+Keriotheca*

Text-fig. 8. Diagram showing the transition of each spirothecal structure, thickness of wall (in mm.) and number of parachomata at each ontogenetic stage. The latter two biocharacters are shown with the mean values.

Description of Species

Family Ozawainellidae THOMPSON and FOSTER, 1937

Genus *Pamirina* LEVEN, 1970

[Type species]: *Pamirina darvasica* LEVEN, 1970

[Revised diagnosis]: Small and subspherical to thickly lenticular shell with arched to broadly arched periphery and involute volutions throughout growth, more or less depressed along the axis of coiling, a slight rotated coiling in juvenile stage in some specimens. Shell not secondarily recrystallized, of 4 to 6 whorls, rarely 6.5 to 7 in mature stage. Axial length ranges from 0.2 to 0.9 mm, and median width from 0.3 to 1.2 mm, giving form ratio of 0.4 to 1.0. Proloculus spherical, small and its outside diameter varies from 0.04 to 0.07 mm. Shell expands gradually. Spirotheca smooth, thin (0.01 to 0.05 mm) and has two types in their structure. One type is composed of structureless single layer in proloculus and one to two and a half volutions, tectum and protheca in two and a half volutions, and tectum and fine alveolar keriotheca in four and a half to the last volutions, in advanced species, such as *Pamirina darvasica*. The other is composed of structureless single layer in proloculus and succeeding one to three volutions and tectum and protheca in three to the last volutions, in such primitive species as *P. tethydis* and *P. leveni*. Chomata weak but distinctly developed. Tunnel low and the path rather regular. Parachomata lacking.

[Discussion]: In typical Ozawainellidae, spirotheca is composed of thin three layered structure, tectum, lower and upper tectoria, as represented by the most genera of the Carboniferous Ozawainellidae. However, there are at least two types of the spirothecal structure in Permian species of the Ozawainellidae. One consists of relatively thick, tectum and less dense structureless lower layer which sometimes accompany fine alveolar keriotheca, as clearly shown at the mature stage of *Toriyamaia* KANMERA. It is also imagined that *Leella* DUNBAR and SKINNER and *Rauserella* DUNBAR may have similar spirothecal structures to *Toriyamaia*. The other type of spirotheca is found in *Reichelina* ERK. According to my observation of the latest Permian *Reichelina cribroseptata* ERK and *R.* cfr. *tennuissima* M. MACLAY from Itsukaichi (KOBAYASHI, 1975), the spirotheca is composed of three-layered structure as found in the Carboniferous Ozawainellidae, and diaphanotheca is invisible.

From the above mentioned, *Pamirina darvasica* has the former type of spirothecal structure. However, no alveolar structure is visible in *P. tethydis* and *P. leveni*. Thus, I consider that the genus *Pamirina* occupies the transitional stage of evolutionary lineage from the Ozawainellidae to the Verbeekinidae and also that *P. tethydis* and *P. leveni* are more primitive than *P. darvasica* in view of the transition of spirothecal structure and the stratigraphic position. Similar transition of spirothecal structure is also discriminated in the genus *Triticites* GIRTY by ROZOVSKAYA (1948, 1949, 1950).

Pamirina tethydis KOBAYASHI, sp. nov.

Pl. 1, Figs. 1-12

Shell small, scarcely recrystallized, subspherical in shape and with convex lateral sides. Polar regions flat or with shallow umbilical depressions. Periphery broadly arched throughout growth. Shell coiled involute and planispiral throughout. Mature shell with 4.5 to 5 whorls. Axial length 0.338 to 0.425 mm and median width 0.525 to 0.650 mm. Form ratio of mature specimens varies from 0.57 to 0.76 in nine specimens. Shell expands gradually. Proloculus minute, spherical and its outside diameter ranges from 0.038 to 0.060 mm in nine specimens. Spirotheca thin, composed of structureless single layer in the inner two and one half to three and a half volutions, tectum and protheca in the succeeding ones. Septa numerous, plane and unfluted throughout. Septal counts from the first to the fourth whorls 7, 10, 12 and 16, respectively. Chomata distinct, weakly developed, but indistinct or almost lacking in the outer whorls of some specimens. Tunnel low and its path regular.

Remarks:- This species is closely similar to *Pamirina leveni* KOBAYASHI in the size of shell, number of whorls, spirothecal structure and others. However, the former has longer axis of coiling, more broadly arched periphery and larger form ratio of volutions throughout the growth than the latter, and is easily distinguished from *Pamirina darvasica* LEVEN in the spirothecal structure and size of shell.

Occurrence:- Abundant to common from two levels in the Hanagiri Limestone, associated with *P. leveni*, *Pseudofusulina fusiformis* (SCHELLWIEN and DYHRENFURTH), *Pseudofusulina* spp., *Schubertella* sp. and others.

Reg. nos.:- 2676-13 (Holotype), 2676-1 A, 1B, 2A, 2B, 11 and 13, 2775-2A, 6A and 7 (Paratypes).

Pamirina leveni KOBAYASHI, sp. nov.

Pl. 1, Figs. 13-38

Shell small, scarcely recrystallized, thickly lenticular in shape and convex lateral sides. Polar regions flat or with

Measurements of *Pamirina tethydis*

Reg. no. of specimen	L.	W.	R.	P.	Half length 1	2	3	4	5
2775-2A	.425	.650	.65	.045(?)	.035	.050	.100	.163	.225
2676-11	.338	.588	.57	.060	.040	.070	.113	.163	—
2676-13	.400	.525	.76	.050	.035	.063	.155	.205	—
2775-7	.345	.575	.60	.050	.045	.055	.100	.138	.175
2676-2A	.235	.380	.62	.038	.030	.050	.075	.125	—
2775-6A	.325	.450	.72	?	.038	.063	.113	.175	—
2676-1A	.263	.513	.51	.038	.038	.075	.105	.138	—
2676-2B	.250	.400	.63	.055	.025	.055	.095	.130	—
2676-1B	.238	.400	.59	.050	.030	.055	.088	.125	—

slight umbilical depressions. Periphery arched throughout. Shell coiled involute throughout growth and slightly rotated axis of coiling observed in inner one or two whorls. Mature shells with 4.5 to 5 volutions. Axial length ranges from 0.225 to 0.350 mm, median width from 0.538 to 0.650 mm, giving from ratio of 0.39 to 0.57 in eighteen mature specimens. Height of volutions gradually increased. Proloculus minute, spherical and its outside diameter varies from 0.045 to 0.070 mm. Spirotheca composed of structureless single layer in inner two and a half volutions, tectum and protheca in the succeeding outer volutions. Septa nume-

Measurements of *Pamirina leveni*

Reg. no. of specimen	L.	W.	R.	P.	Half length 1	2	3	4	5
2676-2C	.313	.650	.48	.055	.038	.060	.080	.125	.163
2676-2D	.350(?)	.613	.57	.045	.025	.055	.095	.130	.175(?)
2676-4	.300	.625	.48	.050	.025	.035	.075	.125	.163
2775-6B	.325	.650	.50	?	.023	.050	.075	.120	.175
2676-2E	.270	.600	.45	.055	.035	.060	.100	.130	—
2775-2B	.225(?)	.575	.39	.063	.033	.050	.088	.113	—
2775-1	.325	.638	.51	.055	.030	.050	.075	.100	.170
2775-2C	.250	.575	.43	.050	.030	.063	.095	.138	—
2676-9A	.275	.538	.51	.045	.025	.050	.088	.145	—
2775-3*	.300	?	—	.070	.038	.065	.113	.150	—
2676-8A	.230	.550	.42	.050	.025	.045	.075	.113	—
2775-8A	.238	?	—	.055	.030	.063	.088	.120	—
2676-3*	.238	.500	.48	.050(?)	.038	.050	.088	.125	—
2676-12A*	.225	.439	.51	.050	.025	.038	.075	.115	—
2775-4A*	.200	.400	.50	.063	.038	.050	.088	—	—
2676-2F*	.225	.313	.72	.050(?)	.045	.075	.120	—	—
2676-12B*	.110	.225	.49	.050	.025	.050	.063	—	—
2775-4B*	.163	.300	.54	.063	.033	.063	.088	—	—
2676-9B*	.180	.313	.58	.050	.038	.050	.088	—	—
2676-6*	.175	.388	.45	.055	.030	.060	.088	—	—

*: immature specimen

Kobayashi, sp. nov. in mm.

Radius veoctor					Form ratio of vol.					Fig. in Pl.
1	2	3	4	5	1	2	3	4	5	
.050	.088	.155	.238	.350	.70	.57	.65	.68	.64	Pl. 1, Fig. 1
.050	.095	.155	.263	—	.80	.74	.73	.62	—	Pl. 1, Fig. 2
.050	.080	.145	.225	—	.70	.78	1.07	.91	—	Pl. 1, Fig. 3
.045	.075	.140	.225	.300	1.00	.73	.71	.61	.58	Pl. 1, Fig. 4
.050	.075	.125	.213	—	.60	.67	.60	.59	—	Pl. 1, Fig. 7
.050	.095	.165	.238	—	.75	.66	.68	.74	—	Pl. 1, Fig. 8
.050	.088	.138	.213	—	.75	.86	.76	.65	—	Pl. 1, Fig. 9
.050	.080	.128	.213	—	.50	.69	.75	.61	—	Pl. 1, Fig. 10
.055	.088	.145	.200	—	.55	.63	.60	.63	—	Pl. 1, Fig. 12

rous, plane and unfluted throughout growth. Septal counts of the first to the fourth whorls 8, 11, 13 and 15, respectively. Chomata weakly developed or almost lacking in the outer whorls of some specimens. Tunnel low and path regular.

Remarks:- The present species is similar to *Pamirina tethydis* in the spirothecal structure, number of whorls, chomata and others. *P. leveni* differs from the latter by more slender shell, shorter axis of coiling and smaller form ratio of volutions throughout the growth. It is also easily distinguished from *P. darvasica* by the shape of shell

Kobayashi, sp. nov. in mm.

Radius vector					Form ratio of vol.					Fig. in Pl.
1	2	3	4	5	1	2	3	4	5	
.075	.110	.163	.263	.363	.50	.55	.49	.48	.45	Pl. 1, Fig. 13
.055	.088	.138	.225	.345	.45	.63	.69	.58	.51(?)	Pl. 1, Fig. 14
.045	.075	.125	.200	.363	.56	.50	.60	.63	.45	Pl. 1, Fig. 15
.063	.100	.150	.245	.375	.37	.50	.50	.49	.47	Pl. 1, Fig. 16
.063	.095	.150	.275	—	.56	.63	.67	.47	—	Pl. 1, Fig. 18
.055	.095	.155	.245	—	.59	.53	.56	.46	—	Pl. 1, Fig. 19
.050	.088	.140	.220	.338	.60	.57	.54	.45	.50	Pl. 1, Fig. 20
.050	.080	.145	.250	—	.60	.78	.66	.55	—	Pl. 1, Fig. 21
.063	.088	.155	.250	—	.40	.57	.56	.58	—	Pl. 1, Fig. 22
.070	.100	.170	.275	—	.54	.65	.64	.55	—	Pl. 1, Fig. 23
.050	.095	.163	.250	—	.50	.47	.46	.45	—	Pl. 1, Fig. 27
.050	.088	.150	.225	—	.60	.71	.58	.53	—	Pl. 1, Fig. 28
.055	.100	.150	.255	—	.68	.50	.58	.49	—	Pl. 1, Fig. 29
.050	.095	.150	.238	—	.50	.39	.50	.48	—	Pl. 1, Fig. 30
.070	.100	.138	—	—	.54	.50	.64	—	—	Pl. 1, Fig. 31
.063	.100	.170	—	—	.72	.75	.71	—	—	Pl. 1, Fig. 32
.045	.075	.125	—	—	.56	.67	.50	—	—	Pl. 1, Fig. 33
.063	.113	.170	—	—	.52	.56	.51	—	—	Pl. 1, Fig. 34
.045	.075	.125	—	—	.83	.67	.70	—	—	Pl. 1, Fig. 37
.070	.095	.163	—	—	.43	.63	.54	—	—	Pl. 1, Fig. 38

and spirothecal structure. This species resembles many species of *Eostaffella*, but it differs from them by the spirothecal structure, thicker spirotheca and slightly larger shell. It is also similar to some species of *Pseudoendothyra* which have weakly recrystallized spirotheca and shell. The present genus is however, not subjected to the secondary mineralization. The specific name is dedicated to E.Y. LEVEN who proposed the present genus for his extensive paleontological study on fusulinaceans.

Occurrence:- Abundant in two levels of the Hanagiri Limestone, associated with *Pamirina tethydis*. Rarely found from Ohtaki associated with *Misellina dyhrenfurthi* (DUTKEVICH), *M.* sp. A and others.

Reg. nos.: 2676-2C (Holotype), 2676-2 D, 2E, 2F, 3, 4, 6, 8, 9A 9B and 12, 2775-1, 2B, 2C, 3, 4A, 4B, 6B and 8 (Paratypes).

Pamirina darvasica LEVEN

Pl. 2, Figs. 1a, 1b, 2-3

1970. *Pamirina darvasica* LEVEN, *Palaeont. Jour.*, No. 3, pp. 23-24, Pl. 1, Figs. 1-12, 21-24.

Small shell with six whorls, subspherical in shape and with convex lateral sides, flat or weakly depressed polar regions and broadly arched periphery. Rotation of axis of coiling slightly observed in juvenile stage. Axial length reaches 0.825 mm, median width 1.088 mm and giving a form ratio of 0.76. Shell expands gradually. Spirotheca composed of structureless single layer in proloculus and succeeding one to two and a half volutions, tectum and protheca in two and a half to four and a half volutions, and tectum and fine alveolar keriotheca in four and a half to the last volutions. Septa plain and unfluted. Chomata weakly developed. Tunnel low and path regular.

Remarks:- The present material is specifically identical with the original specimens by LEVEN, but the former has slightly larger shell and weaker chomata. More detailed comparison with the original materials are postponed until more numerous specimens are accumulated.

Occurrence:- Rarely found in the limestone pebbles of the Triassic intraformational conglomerate distributed in north of Itsukaichi, west of Tokyo. Associated fusulinids are *Misellina dyhrenfurthi*

Explanation of Plate 1

(All figures are ×65)

Figs. 1-12. *Pamirina tethydis* KOBAYASHI, sp. nov.

1-2, 4, 6-10, 12: Axial sections of the paratypes; 3: Axial section of the holotype; 5: Sagittal section of the paratype; 11: Tangential section of the paratype.

Loc.: All from the Hanagiri Limestone, Shomaru Pass. Reg. nos.: Figs. 1-12, 2775-2A, 2676-11, 2676-13, 2775-7, 2676-8B, 2775-2D, 2676-2A, 2775-6A, 2676-1A, 2676-2B, 2775-4C and 2676-1B, respectively.

Figs. 13-38. *Pamirina leveni* KOBAYASHI, sp. nov.

13: Axial section of the holotype; 14-23, 27-34, 37-38: Axial sections of the paratypes; 24, 35-36: Sagittal sections of the paratypes; 25-26: Tangential sections of the paratypes.

Loc.: All from the Hanagiri Limestone, Shomaru Pass. Reg. nos.: Figs. 13-38. 2676-2C, 2676-2D, 2676-4, 2775-6B, 2676-2G, 2676-2E, 2775-2B, 2775-1, 2775-2C, 2676-9A, 2775-3, 2676-3A, 2775-8B, 2676-3B, 2676-8A, 2775-8A, 2676-3, 2676-12A, 2775-4A, 2676-2F, 2676-12B, 2775-4B, 2676-10A, 2676-10B, 2676-9B and 2676-6, respectively.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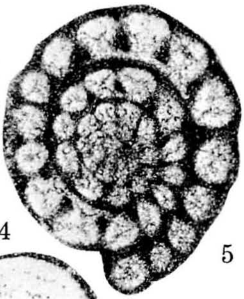
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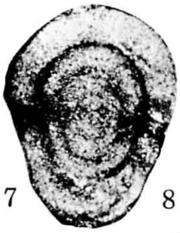
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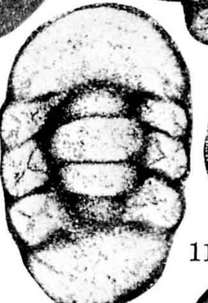
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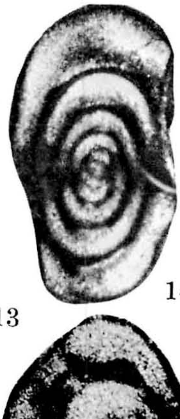
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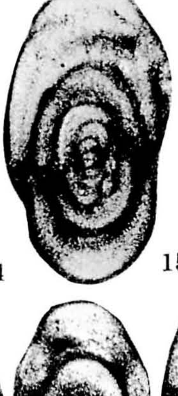
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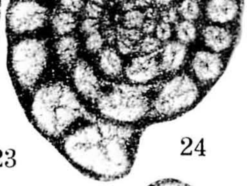
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(DUTKEVICH), *M.* sp. A and others.
Reg. nos.: 2448-1, 2377C-1, 2448-4.

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Explanation of Plate 2

Figs. 1-3. *Pamirina darvasica* LEVEN

1, 3: Axial (slightly tangential) sections; 2: Oblique section. Loc.: All from Itsukaichi. 1a, 2-3: ×20, 1b (the same specimen as 1a): ×65. Reg. nos.: 1; 2448-1, 2: 2377C-1, 3: 2448-4.

Figs. 4-7, 12-13. *Misellina dyhrenfurthi* (DUTKEVICH)

4-7, 12: Axial sections; 13: Sagittal section. 4a, 5-6, 12-13: ×20, 7: ×25, 4b (the same specimen as 4a): ×65. Loc.: All from Itsukaichi, except for 7 from Ohtaki. Reg. nos.: 4: 2448-3, 5: 2448-2, 6: 2448-5, 7: 2715-6, 12: 2448-7, 13: 2448-12.

Figs. 8-11, 14. *Misellina* sp. A

8, 10-11, 14: Axial sections; 9: Sagittal section. 8a: ×25, 9-11, 14a: ×20, 8b, 14b (the same specimens as 8a, 14a): ×65. Loc.: All from Itsukaichi, except for 8 from Ohtaki. Reg. nos.: 8: 2715-4, 9: 2377C-5, 10: 2399-2-8, 11: 2399-2-9, 14: 2377d-1.

Figs. 15-16. *Misellina claudiae* (DEPRAT)

15: microspheric axial section; 16: megalospheric axial section, both are ×65. Loc.: Akiyoshi (Kaerimizu). Reg. nos.: 15: Ak-2, 16: Ak-3

Fig. 17. Thin section of limestone containing many specimens of *Pamirina leveni* KOBAYASHI, sp. nov. and others. ×25. Reg. no.: 2676-2.


1a


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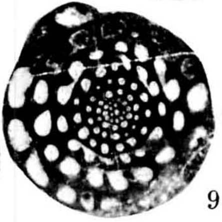
8a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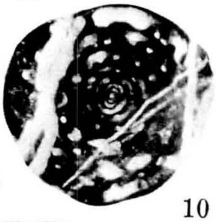
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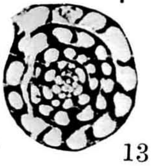
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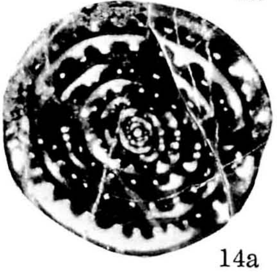
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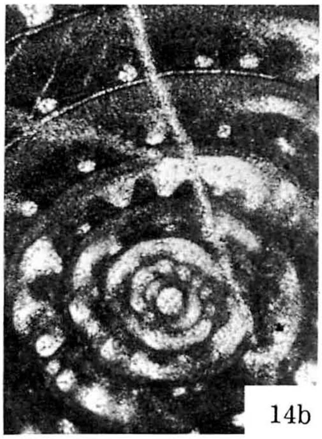
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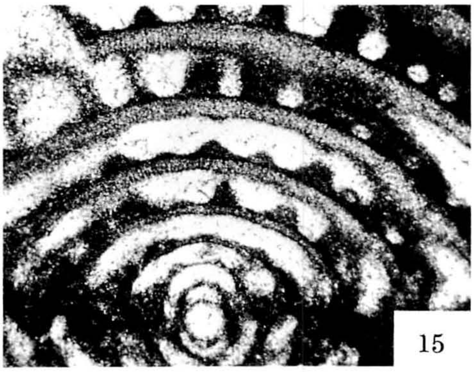
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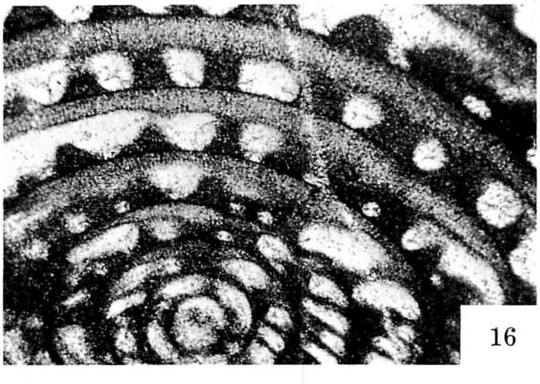
4b


1b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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 105, pp. 17-26, pls. 3, 4, April 30, 1977

673. *MANCHUROCERAS* FOUND IN SOUTH KOREA WITH NOTES ON THE MANCHUROCERATIDAE AND THE *MANCHUROCERAS* PROVINCE

To the Memory of Takuji SHIRAKI, 1891-1971**

TEIICHI KOBAYASHI

Japan Academy, Tokyo

南鮮産 *Manchuroceras* と *Manchuroceras* 区および Manchuroceratidae について：素木卓二の採集品のうちに *Manchuroceras* を含んでいるので記載する。その中に2新種がある。本資料は南鮮の稷洞石灰岩中の新たな層準を示すものと考えられる。Manchuroceratinae は本属の外に *Kerkoceras*, *Parapiloceras* および恐らく *Coreanoceras* を包括する。*Manchuroceras* は下部奥陶紀後半には東アジアからヒマラヤまで分布し，16種以上を擁している。更にタスマニアに2種があり当時の西太平洋に特徴的な頭足類である。これと時を同じくして，北大西洋から北米には Piloceratidae が広く分布し，*Piloceras*, *Allopiloceras* はタスマニア・オーストリアに及び，この地で両頭足類区が会合していた。　小林貞一

In South Korea Middle Ordovician cephalopods are well represented, but little has been known of Lower Ordovician ones, notwithstanding that piloceroids are so common in the Hwangho basin that the Wolungian was the so-called piloceroid age. Therefore I called attention to the presence of *Manchuroceras* in South Korea about ten years ago (KOBAYASHI, 1966), because some specimens of the genus were contained in SHIRAKI's collection. Although their localities should be allocated in the Ordovician sequence exactly by field observation in future, it can be judged that they are somewhere in the middle part of the Jikdong (or Chiktong) limestone or the Maggol (or Makkol) limestone s. l., unless South Korea is an exception in the *Manchuroceras* province. Because *Manchuroceras* is a key to the Wolungian fauna, the *Mauchuroceras* horizon must be below the Maggol limestone s. str, or the upper Jikdong limestone containing Chazyan *Sigmorthoceras* and above the upper Tomkolian or upper Tremadocian *Protopliomerops* zone yielding a few minute endoceroids and ellesmereoceroids. It is probably higher than the *Clarkella* zone in the basal Jikdong limestone which apparently lacks cephalopods.

The Wolungian cephalopods found in South Korea are determined here as follows:

1. *Manchuroceras* cf. *platyventrum* (GRABAU)

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* Received Jan. 13, 1977; read Jan 22, 1977, in Tokyo.

** The late Takuji SHIRAKI was the first to discover graptolites in Korea at Hwangji-ri, Samcheok-gun, Kangweon-do. It was during his field work for the graduation thesis from the University of Tokyo, 1921. Since then he has done distinguished contributions to the geology of the coal-fields in Korea and their exploitation. He was very helpful for me to provide a large amount of Cambrian and Ordovician fossils including those here described. Now I take a pleasure to dedicate this paper to him.

2. *Manchuroceras kobayashii* OBATA
3. *Manchuroceras tenuise* sp. nov.
4. *Manchuroceras hanense* sp. nov.
5. *Mancnuroceras*? sp.

Manchuroceras has long been thought to be indigenous to the eastern part of the Hwangho basin, namely in Hopei (or Chihli), Shantung, Liaoning (South Manchuria) and North Korea. Now it is known from the Kilienshan in the west. To the south it is distributed as far as the Himalayan and Tasman troughs through the Yangtze basin (Central China to Viet Nam). In short, it is a Wolungian genus characteristic of the late or middle Canadian cephalopod faunas on the western Pacific side, ignoring *Liaotungoceras* sp. listed in an Arenigian fauna of Argentina by HARRINGTON and LEANZA (1957).

Beside this genus the family Manchuroceratidae comprises *Kerkoceras, Parapiloceras* and probably *Coreanoceras.* The first of them is the closest ally to *Manchuroceras* which was recently proposed with *Kerkoceras bicostatum* from Central China. The second is a highly specialized genus known of monotypic *Parapiloceras shimizui* from North China. The third genus is represented by several species in North Korea and North China (Hopei, Shantung, CHEN, 1976). Recently it was found in Central China where *Coreanoceras trapezoidum* and *C. reniforme* were described from Szechuan (CHEN and LIU, 1974). In addition *Coreanoceras lunatum* FLOWER, 1956 is known from the Canadian of Maryland, North America.

Of the genus *Manchuroceras* an isolate occurrence is *M. asiaticum* BALASHOV, 1962 from the Krivolusky formation in the central Siberian platform which may be an early Middle Ordovician survivor. Its cross section, however, reveals a different outline of its endosiphocone. *Emmonsoceras aristos* (FLOWER, 1955) from Lake Champlain, eastern North America may be another Chazyan derivative from the Manchuroceratidae stock as considered by FLOWER (1958). Thus it is probable that the related genera were survived in Siberia and North America until the early Middle Ordovician times, but in the Canadian epoch the distribution of the family was restricted to the western Pacific regions exept for a stranger, *Corenoceras lunatum.*

In the same epoch the Piloceratidae were distributed extensively on the Atlantic side, from Spitzbergen to the Appalachian geosyncline through the Bear islands, Smøla island of Norway, Scotland and Newfoundland and further to the west into Colorado and Texas through the Ozark hills. *Allopilloceras baylorense* and *Piloceras* sp. in the El Paso limestone, Texas and several species of *Kirkoceras* and *Utoceras* in the Manitou limestone, Colorado (ULRICH et al. 1943) are the representatives of the family in southwestern North America.

Furthermore, *Piloceras tasmaniense* TEICHERT, 1947 occurs in the upper Canadian of Tasmania in association with two species of *Manchuroceras* beside *Utoceras* ? sp. *Allopiloceras calmus* TEICHERT and GLENISTER, 1954 is described from the Emanuel limestone in Kimberley, western Australia. The last is accompanied by *Hardmannoceras lobatum,* while in the Langkawi islands, Malay *Discoceras*(*Hardmanoceras*?) *chrysanthimum* KOBAYASHI, 1959 and *Teiichispira kobayashii* YOCHELSON and JONES, 1968 are contained in the same limestone of Pulao Langgon, but neither piloceroid nor manchuroceroid. *Teiichispira* is a very distinctive Macluritacean type of gastropod operculum contained in limestones of upper Canadian to lower Chazyan or basal Middle Ordovician age. It is known now to be widely distributed from Malay to Newfoundland through northern Australia (Kimberley and Toko range), Tasmania, Utah and Alabama (GILBERT-TOMLINSON, 1973).

On the basis of the above mentioned facts it can be concluded that there were two cephalopod provinces in the late Lower Ordovician period. The *Manchuroceras* province on the western Pacific side was connected with the Piloceratidae province at Tasmania. Additional evidences on *Teiichispira* and *Allopiloceras* show that the connection between the Atlantic and Pacific faunas were maintained further through northern Australia. Neither manchuroceroids nor piloceroids are, however, known from western Asia, Europe exclusive of the Atlantic margin and the Mediterranean region (TEICHERT, 1964). It is interesting to see that the leading trend of evolution was just opposed to each other between the two groups. Namely, the manchuroceroids are mostly orthoconic and invariably circular to dorso-ventrally depressed, whereas piloceroids are laterally compressed and commonly cyrtoconic.

Family Manchuroceratidae
KOBAYASHI, 1935

Diagnosis:- Siphuncle orthoconic, commonly moderate in length, but rarely very breviconic or strongly cyrtoconic, large in comparison with conch and located marginally on ventral side, subcircular or more commonly dorso-ventrally depressed in section, but never compressed laterally; endocone thickened on ventral side, accordingly endosiphocone shifted dorsally; septa slanting dorsally; septal neck shorter than septal distance which is relatively short. Apical projection often present.

Remarks:- The camerate portion of the conch is largely destroyed probably because the shell and septa were thin and camera had no deposit. Septa are, however, preserved in some specimens near the siphuncle in *Manchuroceras* and *Coreanoceras* with which the large size of the siphuncle and its marginal position in the conch can be ascertained. Septal sutures are completely or almost completely effaced on the ventral side in some forms of these two genera.

When I have instituted this family for *Manchuroceras*, I pointed out as the distinctions of the genus from *Piloceras*, the siphuncle's straightness or weak curvature, marginal position, dorso-ventral depression and its endocone's ventral thickening where a median endosiphoblade exists.

Kerkoceras founded on *Kerkoceras bicostatum* CHEN and LIU, 1974 from the Lower Ordovician of Szechuan is a very close ally to *Manchuroceras*, both having the same kind of apical projection (KOBAYASHI, 1937). *Kerkoceras*' siphuncle is breviconic, dorsoventrally depressed, straight and flattened ventrally; its endocone so strongly thickened medially to form a ventral ridge; septal suture strongly slanting dorsally. The second species is *Kerkoceras magnum* CHEN, 1976 from Chingshueiho, Inner Mongolia.

Of *Parapiloceras* the apical end is unknown, but the genus is well represented by some siphuncles of monotypic *Parapiloceras shimizui* which are breviconic cyrtocones resembling *Piloceras* and *Cassinoceras*. The cross section of *Parapiloceras*' siphuncle is subcircular, but slightly depressed and its endcone is strongly thickened on the concave side as seen in figs, 1-2, pl. 17, OBATA, 1940. Because *Kerkoceras* is breviconic and because the cyrtoconic aspect is seen also in *Manchuroceras* ex. *M. manchuriense* in fig. 14, pl. 33, ENDO, 1932, it is reasonable to consider that *Parapiloceras* is a member of the Manchuroceratidae rather than an isolate member of the Piloceratidae.

Coreanoceras (KOBAYASHI, 1936) may be an additional genus to the family. It agrees with *Manchuroceras* in the relatively long orthocone, depressed cross section of the siphuncle, presense of apical projection, the ventral thickening of the endocone and the presence of endosiphoblades, but it is distinct from *Manchuroceras* in the longer apical projection, zigzag pattern of the septal suture on the ventral flattening, the prominent ventral ridge of the endocone and paired endoshiphoblades, instead of a median one in *Manchuroceras.* A ventral alveolus which appears in the siphuncle of the former genus in a certain stage of growth is a matter of discussion, whether it is an original or a secondary structure. If it be original, it shows the evolutionary trend of siphuncular compartment which introduced the Chihlioceratidae and the Allotricoceratidae. *Chihlioceras* also has an apical projection which is, however, quite diffferent from those of the Manchuroceratidae, if compared to GRABAU's model in his text-figures 4-5, 1922. Until more will be known of *Chihlioceras* any further comparison is unable.

Finally, the apical projection is seen in *Allopiloceras coarctum* in figs. 1-2, pl. 18, though less prominent, and in *Cassinoceras triton* in figs. 1-2, pl. 5, though much less so. These are two exceptions for the Piloceratidae in ULRICH and others' monograph, 1943.

The Piloceratidae and Manchuroceratidae are two branches which were derived from an unknown common stock, and developed respectively on the Atlantic and Pacific side. The presence or absence of the apical projection and the depressed or compressed conch and siphuncle are two morphological differences between the two families. The third difference is the commonness of the orthocones or cyrtocones respectively in the latter and former family. Because *Allopiloceras* has the siphuncle nearly straight and slowly tapering, in the Piloceratidae, it may be the nearest to the *Manchuroceras.*

Genus *Manchuroceras* (OZAKI), KOBAYASHI, 1935

1927. *Manchuroceras* OZAKI, *Jour. Geol. Soc. Tokyo*, v. 34, p. 45.
1935. *Manchuroceras* KOBAYASHI, *Ibid.* v. 42, p. 743.

Diagnosis:- Breviconic orthoceracone; siphuncle large, cylindrical, straight or slightly curved, ventrally marginal, subcircular, subelliptical or ovate and dorsoventrally depressed in various degrees in cross section; its ventral side commonly flattened; septal neck long; septal suture oblique to the axis of the siphuncle, ascending from dorsum to venter; apical part of siphuncle conical, provided with a mammilary projection in some forms; endocone thickened on ventral side to form moderate elevation where a median endosiphoblade is often present; endosiphocone off-center, shifted to dorsum.

Type-species:—*Piloceras wolungense* KOBAYASHI, 1931.

Remarks:- When OZAKI (1927) proposed *Manchuroceras* with a specimen from Yenchoucheng, east of Liaoyang, South Manchuria, Northeast China, he described no species of the new genus, although he made its comparison with *Chihlioceras.* Subsequently in 1935 when I examined his specimen, I found his interpretation of its internal structure erroneous in that his tubular alveolus is nothing but a recrystallized part in the ventral side of the endocone. Because his specimen was identifiable with *Piloceras wolungense*, I wrote a new generic diagnosis on the basis of this species. By the way the endosiphuncular segments were unusually well preserved in OZAKI's specimen. The same kind of structure was, however, so better preserved in *Penhsioceras*? sp. that it showed the change of the endosiphucle and the segments through growth (KOBAYASHI, 1947).

Independently from this type-revision SHIMIZU and OBATA (1935) proposed two new names, *Grabauoceras* and *Liaotungoceras* assigning *Piloceras platyventrum* GRABAU and *Piloceras manchuriense* ENDO as the respective type-species. Their generic description, however, did not appear until next year when they accepted the synonymy of their *Grabauoceras* with *Manchuroceras*. Of the distinction of *Liaotungoceras* from *Grabauoceras*, i. e. *Manchuroceras*, they noted *its* (i. e. *Liaotungoceras*') *curved siphuncle and different shape of endosiphocone in dorso-ventral section*. But the difference has since been neither described nor illustrated by them and no mention was given of *Liaotungoceras* in OBATA's paper on the genus *Manchuroceras* (1939).

ULRICH et al. (1943) on the other hand accepted the validity of *Liaotungoceras*, but saying that the siphuncle is *straight or nearly so*, instead of curved. They pointed out its distinction from *Allopiloceras*, but not from *Manchuroceras* and included *Manchuroceras endoi* in that genus. Precisely speaking, *Piloceras manchuriense* ENDO, 1932 comprises two distinct forms, namely one is straight and circular in cross section and the other curved and dorso-ventrally depressed in section. Because the latter is the holotype, *Manchuroceras endoi* KOBAYASHI, 1935, must be its synonym, as pointed out by ULRICH et al. (1943). This means that *Liaotungoceras* founded on *Piloceras manchuriense* s. str. should be a synonym of *Manchuroceras*, because *Piloceras manchuriense* s. str. is inseparable from *Manchuroceras compressum* at least generically.

Distribution :- In adding GRABAU's species of *Piloceras*, there were four valid species in the genus as follows:

Manchuroceras platyventrum (GRABAU, 1922) Hopei, Shantung
Manchuroceras wolungense (KOBAYASHI, 1931) Liaoning
Manchuroceras compressum (KOBAYASHI, 1931) Liaoning
Manchuroceras manchuriense (ENDO, 1938) Liaoning

Later OBATA (1939) described five new species of *Manchuroceras* (*ozakii, ishidai, yenchouchengense, kobayashii* and *katsunumai*) with the specimens obtained from the Liangchia-shan and equivalent formations in Hopei and Liaoning.

CHANG and SHENG (1958) reported an occurrence of *Manchuroceras* cf. *wolungense* in the Hunghauyuan limestone on the Szechuan-Kweichou border and recently CHEN and LIU (1974) described *Manchuroceras badongense* nov. from the same limestone in Hupeh. In Northwest China CHANG (1965) found a new species *Manchuroceras tochuanshanense* in the Duoquanshan limestone, south Kilienshan. Recently CHEN (1975, 1976) found *Manchuroceras* sp. in the Lower Ordovician of the Himalayas, and *Manchuroceras qingshueiheense* in the Liangchiashan formation, Inner Mongolia.

Incidentally, CHANG (1965) described *Wutinoceras shihuigoense*, *Armenoceras* sp. and *Manchuroceras tochuanshanense* from the upper part of the Lower Ordovician Tochuanshan limestone at Shihuigou, Chinghai. Because the first and second species look two Toufangian armenoceroids, as pointed out already (KOBAYASHI, 1969) and because such armenoceroids have been unknown from the

Canadian or Lower Ordovician not only in Eastern Asia but also in the Arcto-American region or elsewhere, it is quite probable that they were derived from higher part than the *Manchuroceras* horizon, and the part of the Tochuanshan limestone must be already Middle Ordovician in age.

In North Korea I found *Manchuroceras* sp. in Deogcheon district (KOBAYASHI, 1931a). In South Korea this genus is now represented by four or more species two of which are probably new species. Thus the Korea-Chinese species attain more than sixteen species.

Prior to these recent discoveries TEICHERT (1947) and TEICHERT and GLENISTER (1953) described two new species of *Manchuroceras* (*steani* and *exaratum*) from the upper Canadian of Tasmania, while BALASHOV (1962) named *Manchuroceras asiaticum* for a new form from the early Middle Ordovician Krivolusky formation in Central Siberia. The last would be a solitary survivor of the genus, but its endosiphocone shows a sharp angle at the point of an endosiphoblade as seen in its cross section in fig. 2b, pl. 10, BALASHOV, 1962, the difference suggesting the corresponding time-displacement.

Leaving this species for future confirmation, it can be concluded that *Manchuroceras* is widely distributed in the Wolungian or the upper or upper-middle Canadian formations in Korea, China and Tasmania on the western Pacific side.

Manchuroceras cf. *platyventrum* (GRABAU, 1922)

Plate 3, Figures 1a-b

1922. cf. *Piloceras platyventrum* GRABAU, *Pal. Sinica, ser. B*, v. 1, fasc. 1, p. 42, pl. 4, figs. 12a-c (a form), ? figs. 1a-c (b form), ? text-figs. 1a-e.

Description:- The Korean specimen is a straight siphuncle about 58 mm long and 36mm across, slowly tapering toward the apex, subcircular in cross section, but more or less broadly rounded on the ventral than the other side. In the longitudinal section the breadth of the siphuncle increases from 28 mm to 33 mm in the apical 41 mm. The endosiphocone expands more abruptly, attaining 22 mm in breadth at the adoral end. The siphuncular wall is almost the same in thickness all around it and composed of numerous very thin endosheathes. The apical portion of the siphuncle is unpreserved. The adapical end of the specimen is not polished through the endosiphuncle, but the ventral endosiphoblade can be seen on the broken surface to cross the endocone.

On the left side of the longitudinal section from the observer 5 septa and 4 camerae are distributed in the length of 20 mm. The septum forms an angle of about 35 degrees with the siphuncular wall. Its funnel is geniculated at the neck of the preceding septum and invaginated into the latter's funnel for about two-thirds or three-fourths the septal distance.

This siphuncle is almost identical with GRABAU's type specimen in figs. 12a-c on pl. 4. This endosiphocone looks somewhat more conical and slender, but such a difference easily appears by the difference of orientation.

Discussion:- GRABAU (1922) proposed this species with three specimens, but for the third one in text-figs. 1a-e from the Peilintze limestone he stated that "the specimen in question may represent a distinct species", because the annulations are finer, the cross section is subelliptical and the endosiphocone subcentral.

His diagnosis is evidently based on

the two other specimens from the Liangchiashan limestone. Assuming these two to be the syntypes, the siphuncle is straight and conical in apical part, but it becomes subcylindrical on the adoral side; cross section subcircular with endosiphocone either circular and subcentral (a form) or excentric and remarkably flattened ventrally (b form); mammilary projection present (in b form).

Like *M. wolungense* it is known that the b form in figs. a-c, GRABAU, 1922 possesses a mammilary projection, but it differs from *M. wolungense* in the cross section. As OBATA (1939) excluded this form from *M. platyventrum*, it represents a distinct subspecies. Accepting that a form in figs. 12a-c, GRABAU, 1922 as the lectotype, it is certainly remarkable that the Korean specimen fits nicely with it.

Occurrences:- Geasan-chon, Sangjang-myeon, Samcheok-gun, Gangweon-do.

Manchuroceras kobayashii OBATA

Plate 4, Figures 1a-c

1939a. *Manchuroceras kobayashii* OBATA, *Jour. Shanghai Sci. Inst.* vol. 9, p. 105, pl. 9, figs. 2, 3 & 5.

1965. *Manchuroceras kobayashii* CHAO, Chin-Kê et al. Chinese cephalopod fossils, p. 29, pl. 4, figs. 12-13.

Description:- A Korean specimen is an adoral part of an orthoconic sipnuncle which is rapidly expanding with a similar rate as in the holotype. Its ventral side is remarkably flattend and smooth; 4 to 5 annuli distributed in 20 mm gradually descending dorsally from venter. Where the two diameters of the siphuncle measure 28 mm and 38 mm, its wall is as thick as 4 mm and 7.5 mm respectively on the dorsal and ventral side, but no ventral elevation is recognizable on this cross section.

In the ventral view of this specimen the smooth thin shell of the conch is seen directly contact with the siphuncular wall along the broad flattened band which is gradually broadened adorally. Starting from the lateral margin of this band, septal annulations are inclined laterally. They are fairly prominent and about 4 mm apart from one another.

Comparison:- This species is well characterized by the straight siphuncle whose lateral diameter is expanding in a greater rate than any other species of this genus. The OZAKI's holotype from Shihmenchai, Hopei, China measures 133 mm in length and 76 mm and 34 mm in the major and minor diameters respectively at the adoral end, but the two diameters are almost equal in the part 30 to 40 mm apart from the apex where they are 29 to 34 mm. In the apical 15 mm the siphuncle expands very rapidly and the mammilary projection is unknown. Septal annulations are countable about 10 near the apex, but 6 in the adoral part in a distance of 30 mm. They ascend from dorsum to venter gradually where in the latter they die out. The smooth ventral flattening attains 25 mm in width. The siphuncular wall is thickened and more swollen inwardly on the ventral side.

The Chinese and Korean forms resemble *M. compressum* in the transverse section so closely that the outlines of their siphuncles and endosiphocones look almost identical, although *M. compressum* has the ventral elevation and endosiphoblade. Their distinction is quite evident in the expansion of the siphuncle which is incomparably rapid in this species.

Occurrence:- Yongyeon-chon, Sangjang-myeon, Samcheok-gun, Gangweon-do.

Manchuroceras tenuise sp. nov.

Plate 4, Figures 2a-b

A specimen from Guemdae-chon is a straight longiconic siphuncle regularly tapering with the rate of 1 mm of breadth in every 5 mm or so of length; endosiphocone tapering more abruptly to form an angle of about 20 degrees at apex and distinctly ovate and flattened on the ventral side in cross section, although the lateral diameter scarcely exceeds the dorso-ventral one; endocone twice or three times thicker on the ventral than the other side; thickened part crossed by median endosiphoblade; endosiphocone located closer to the dorsal margin, subtriangular in cross section, but its ventral wall is also somewhat angulated at the middle point where the endosiphoblade opens. Endosheathes are recrystallized and camerate portion is unpreserved.

This species can be distinguished from other species of this genus by its slender siphuncle and ovate and subtriangular cross sections respectively of the siphuncle and endosiphocone. The great thickening of the endocone on the ventral side and the distinct endosiphoblade which crosses this part are two characteristics commonly seen in this genus.

Occurrence:- Guemdae-chon, Sanjang-myeon, Samcheok-gun, Gangweon-do.

Manchuroceras hanense sp. nov.

Plate 3, Figures 2a-c

Siphuncle 6 cm long, tapering slowly, approximate 1 mm in 5 mm; 4 weak septal angulations and 3 shallow depressed intervals discernible in the length of 15 mm; endosiphuncle excentric, located at three-fifths the diameter from venter; endosiphocone expanding rapidly, with an apical angle of 20 degrees; endocone thickened more on the ventral side than the other, forming a moderate median elevation. The cross sections of the siphuncle and endosiphuncle are subcircular at the adapical end, but the former is elliptical at the adoral end.

This siphuncle is closely allied to that of *Manchuroceras compressum* in the rate of expansion and the ventral elevation of the endocone, but the endocone thickening is not so much as in that species, as it is evident if compared in the same stage of growth. In this species the siphuncle and endosiphuncle are subcircular at the adapical end, but the former is ovate and the latter broad and arcuate in that species as seen in fig. 3 e, pl. 17, KOBAYASHI, 1931b. If compared with the section in fig. 3c, pl. 17, the cross section of the other end is quite different in the outlines of the siphuncle and endosiphocone and the thickening of the endocone.

Occurrence:- Godoo-am, Gurae-ri, Sangdong-myeon, Yeongweol-gun, Gangweon-do.

Manchuroceras? sp. indet.

Plate 3, Figures 3a-b

An imperfect siphuncle resembles that of *Manchuroceras tenuise* sp. nov. A but

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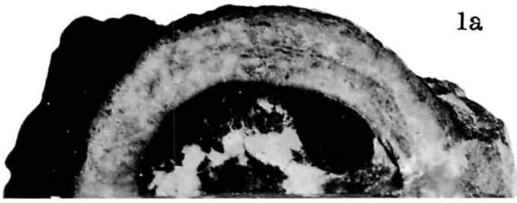
Explanation of Plate 3

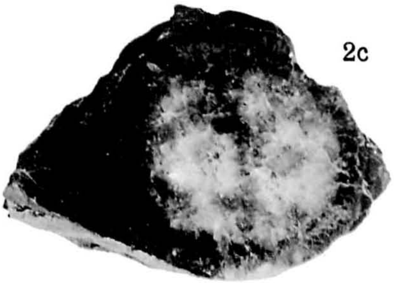
Figures 1a-b. *Manchuroceras* cf. *platyventrum* (GRABAU)
Transverse (a) and longitudinal (b) sections of siphuncle. ×1.5 Geasan-chon.
Figures 2a-c. *Manchuroceras hanense* sp. nov.
Transverse (a, c) and longitudinal (b) sections of siphuncle. ×1.5 Godoo-am.
Figures 3a-b. *Manchuroceras*? sp. indet.
Transverse (a) and longitudinal (b) sections of siphuncle. ×1.5 Godoo-am


1a


1b


2a


2b


2c


3a


3b

tapers more rapidly. The apical angles of this siphuncle and endosiphocone are about 30 and 40 degrees respectively. In cross section the siphuncle is circular and the endosiphocone also subcircular and apparently excentric, although it is difficult to say the excentricity exactly. The endocone has a low ventral elevation where an endosiphoblade exists.

Occurrence :- Godoo-am, Gurae-ri, Sangdong-myeon, Yeongweol-gun, Gangweon-do.

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Place Names in China (C) and Korea (K)

Chinghai 青海 (C), Chingshueiho 清水河 (C), Chumulangmafeng 珠穆朗瑪峰 (C), Deogcheon, Teokcheon 徳州 (K), Gangweon-do, Kangweon-do 江原道 (K), Geasan-chon, Kyesan-mal 鶏山村 (K), Geumdae-chon, Kuntae-chon 金台村 (K), Godoo-am, Kotuoam 高頭巌 (K), Gurae-ri, Kurae-ri 九来里 (K), Hualienshal 火連寨 (C), Hunghuayuan 紅花園 (C), Hwangji-ri 黄池里 (K), Jikdong, Chiktong 稷洞 (K), Kilienshan, Qilienshan 祁連山 (C), Liangchia-shan 亮家山 (C), Maggol, Makkol 莫洞 (K), Niuhsintai 牛心台 (C), Samcheok-gun 三陟郡 (K), Sangdong-myeon 上東面 (K), Sangjang-myeon 上長面 (K), Shihmenchai 石門寨 (C), Yenchoucheng 燕州城 (C), Yeongweol-gun 寧越郡 (K), Yongyeon-chon 竜満村 (K)

The author's thanks are due to Ass. Prof. OH Geunwhan of Masan College of Education for assistance in modern romanization of Korean place names.

Explanation of Plate 4

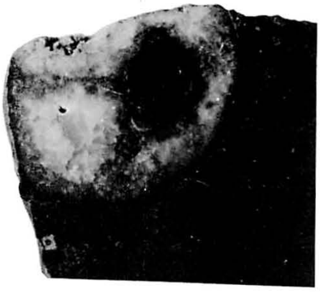
Figures 1a-c. *Manchuroceras kobayashii* OBATA

Longitudinal (a) and transverse (b) sections and ventro-lateral view (c) of siphuncle. ×1.5 Yongyeon-chon.

Figures 2a-b. *Manchuroceras tenuise* sp. nov.

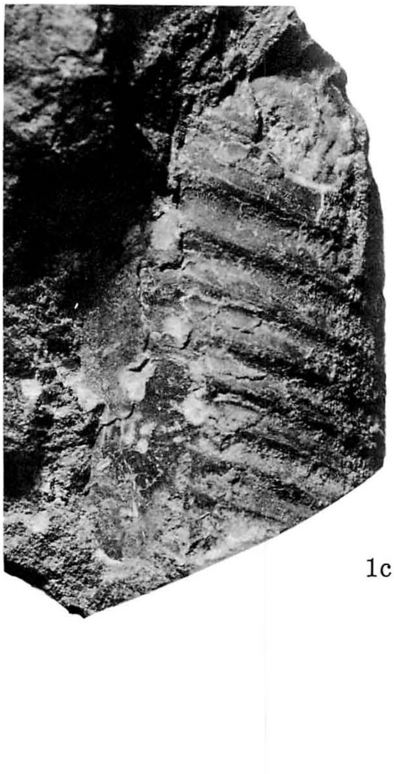
Transverse (a) and longitudinal (b) sections of siphuncle. ×1.5 Guemdae-chon

1a



2a

1b



1c

2b

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 105, pp. 27-54, pls. 5, 6, April 30, 1977

674. NOTES ON THE MORPHOLOGY OF *NEITHEA* (CRETACEOUS PECTINIDS) WITH TAXONOMIC REVISION OF JAPANESE SPECIES*

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and

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白亜紀二枚貝 *Neithea* の形態と本邦産種の分類学的再検討：*Neithea* は特徴ある規則的な放射肋と現生の *Pecten* に比較される形状を持ち，放射肋の系統的発達と適応形態を考察する上に興味深い素材である。また，その内層は現生の Pectinidae と異なりアラレ石から形成されていたと考えられ，同科の殻構造の進化を理解する上に重要と考えられる。日本各地の下部白亜系に産する *Neithea* について，ヨーロッパの種との比較研究にもとづいて分類学的特徴を再検討し，一部の種の分類名の改訂を行なった。牡鹿半島の鮎川層に産した新種 *N. alta* はおそらく本属最古の種で，二つのオーダーの放射肋が分化する過程を示している。*N. atava* は世界的に広く分布する種で，日本では *N. kanmerai* と呼ばれていた種がこれに相当するが，最近大分県の佩楯山層と和歌山県の有田層から良好な標本が得られたので再記載する。

速水　格・野田雅之

Introduction

Neithea DROUET, 1825, is a well-known pectinid genus for its lovely and readily distinguishable morphology and its common occurrence in Cretaceous marine beds. A large number of representatives have been described from various areas of the world, and the known generic range extends from the Berriasian to the Maastrichtian, although in eastern Asia and northern Pacific region the occurrence seems to be restricted to the Lower Cretaceous.

Through the efforts of some Japanese stratigraphers and paleontologists the stratigraphic distribution and diagnostic characters of several domestic species of *Neithea* have been much clarified in recent years, but there are still many doubts and unsolved problems as to their affinity and nomenclature. Evidently much confusion has been arisen from the ambiguous definition of early described European species. For example, D'ORBIGNY (1847) described many species of this genus with fine but highly synthetic illustrations, and his type specimens had long been unstudied. Consequently, many synonymous and doubt-

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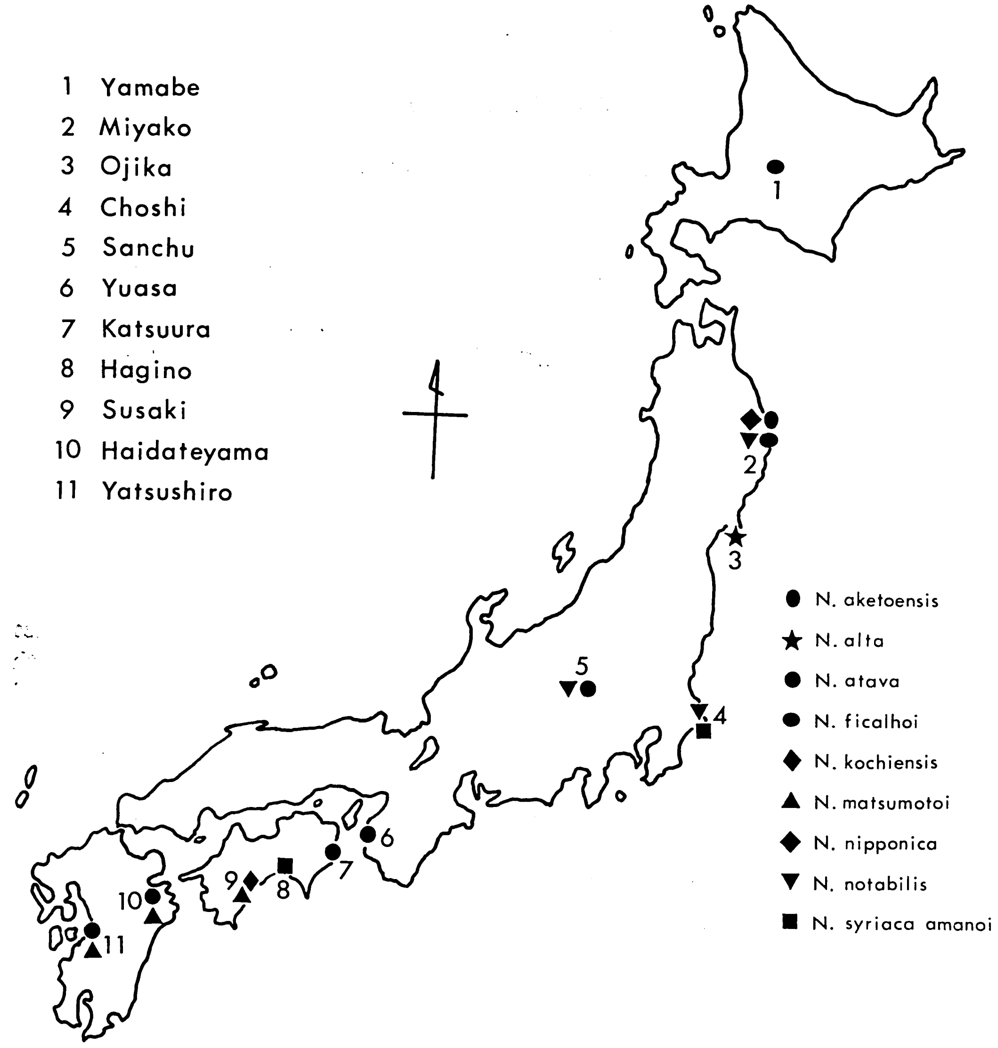
* Received Feb. 4, 1977; read Jan. 22, 1977, in Tokyo.

ful names were proposed and used. Almost all the hitherto published works on *Neithea* by Japanese authors, including Hayami (1965), followed the scheme of classification and nomenclature by Woods (1903) which is now regarded as partly inadequate.

Recently Dhondt (1973) accomplished a comprehensive revision on all the European species of *Neithea*, and the classification of this genus was much improved. Since she observed many original specimens of European species, her revision seems to be generally reliable. She also discussed the taxonomic position of Japanese specimens, suggesting that many of them are specifically identifiable or comparable with formerly



Text-fig. 1. Map showing the occurrences of Early Cretaceous species of *Neithea* in Japan.

described European species.

Although the peculiarly designed morphology of *Neithea* is also interesting from other viewpoint than taxonomic, little studies have actually been made on its adaptive significance and paleoecology. In 1975, one of us (I. H.) had an opportunity to observe numerous well preserved specimens of *Neithea* at the British Museum (Natural History), Sedgwick Museum of Cambridge, Paleontologisk Institutionen of Uppsala University and some other institutions in western Europe. The result of this comparative study, though already reflected in the systematic catalogue of the Mesozoic Bivalvia from Japan (HAYAMI, 1975, pp. 74-77), is shown in this paper, and on this ground we intend to summarize the classification and nomenclature of the Japanese species and to describe some newly obtained material. Two of us are responsible for the description of *Neithea* (*Neithea*) *atava*, and other discussions on the radial ribs, shell structure, adaptive morphology and taxonomic revision are mostly written by one of us (I. H.).

Previous studies on Japanese species of *Neithea*

In Japan nine species of *Neithea* have been discriminated and described. Before entering the description and discussion, we are going to review the history of taxonomic investigations on these species.

About 50 years ago, YABE and NAGAO *in* YABE, NAGAO and SHIMIZU (1926) recorded the first occurrence of this genus from the upper Neocomian Ishido Formation of central Honshu, describing two small specimens under the name of *Pecten* (*Neithea*) cf. *atavus* ROEMER. Subsequently NAGAO (1934) described two species from the Aptian-Albian Miyako Group of north Honshu and called them *Pecten* (*Neithea*) *morrisi* PICTET and RENEVIER and *Pecten* (*Neithea*) sp. An Aptian bivalve fauna from the Hagino Formation of south Shikoku reported by AMANO (1957) also contains two species of *Neithea*, which were compared by him with *Pecten* (*Neithea*) *morrisi* PICTET and RENEVIER and *Pecten* (*Neithea*) *quadricostatus* SOWERBY.

One of us (HAYAMI, 1965) described the majority of Early Cretaceous marine bivalves from Japan with taxonomic revision of hitherto known species. On that occasion seven species of *Neithea* were named and described, and a classification scheme of this genus, though nowadays partly invalid, was presented with a synoptic list of species in the world. In the same work *P.* (*N.*) *morrisi* by NAGAO (1934), *P.* (*N.*) sp. by NAGAO and *P.* (*N.*) cf. *morrisi* by AMANO (1957) were renamed *Neithea* (*Neithea*) *ficalhoi* (CHOFFAT), *Neithea* (*Neithea*) *nipponica* sp. nov. and *Neithea* (*Neithea*) *amanoi* sp. nov., respectively. *P.* (*N.*) cf. *atavus* [*sensu* WOODS, 1903, and YABE and NAGAO, 1926] was recorded also from the Aptian of Miyako and regarded as a member of a newly proposed subgenus *Neithella* HAYAMI, 1965 [type-species: *Janira wrightii* SHUMARD, 1860]. In addition to these species *Neithea* (?) *aketoensis* from the Albian of Miyako, *Neithea* (*Neithea*) *matsumotoi* from the Albian of central Kyushu and *Neithea* (*Neithea*) *kanmerai* from the Aptian of the same area were described as new species. Owing to a misunderstanding of the type-species of *Neithea*, an invalid subgeneric name, *Aequineithea* HAYAMI, 1965, was proposed in this paper: it is actually an objective synonym of *Neithea*, as pointed out by COX et al. (1969) and DHONDT (1973). HAYAMI *in* HAYAMI and KAWASAWA (1967)

Table 1. Synopsis of the classification of the Japanese species of *Neithea*

YABE and NAGAO 1926	NAGAO 1934	AMANO 1957	HAYAMI 1965	HAYAMI and KAWASAWA 1967	SHIKAMA and SUZUKI 1972	DHONDT 1973	HAYAMI 1975 em. here
			N. (s. l.) *aketoensis**				*N.* (*N.*) *aketoensis*
			N. (*N.*) *kanmerai**			*N.* (*N.*) *atava*	*N.* (*N.*) *atava*
	P. (*N.*) *morrisi*		*N.* (*N.*) *ficalhoi*			*N.* (*N.*) *alpina*	*N.* (*N.*) *ficalhoi*
				N. (*Nl.* ?) *kochiensis**			*N.* (*N.*) *kochiensis*
			N. (*N.*) *matsumotoi**	*N.* (*N.*) *matsumotoi*			*N.* (*N.*) *matsumotoi*
	P. (*N.*) sp.		*N.* (*N.*) *nipponica**			*N.* (*N.*) *quinquecostata*	*N.* (*N.*) *nipponica*
P. (*N.*) cf. *atavus*			*N.* (*Nl.*) cf. *atava*		*N.* (*Nl.*) cf. *atava*	*N.* (*Nl.*) *notabilis*	*N.* (*Nl.*) *notabilis*
		P. (*N.*) cf. *morrisi*	*N.* (*N.*) *amanoi**		*N.* (*N.*) *amanoi*	*N.* (*N.*) *syriaca*	*N.* (*N.*) *syriaca amanoi*
		P. (*N.*) aff. *quadricostatus*					*N.* sp.

P: *Pecten* *N*: *Neithea* *Nl*: *Neithella* * new species supplementarily described *Neithea kochiensis* sp. nov. and *N.* (*N.*) *matsumotoi* from the basal part of the Shimantogawa Group of south Shikoku. Furthermore, several specimens comparable with some of these species were reported to occur from the core of test boring in central Taiwan (MATSUMOTO, HAYAMI and HASHIMOTO, 1965), the Choshi Group of central Honshu (SHIKAMA and SUZUKI, 1972), the Lower (or Middle) Yezo Group of central Hokkaido (MATSUMOTO and OKADA, 1973) and the Arida Formation of Kii peninsula (OBATA and OGAWA, 1976).

DHONDT's (1973) monograph on the European species of *Neithea* may also exert a great influence on the classification and nomenclature of Japanese species, because there are some common or closely related species between the two regions. She is of the opinion that *Janira ficalhoi* CHOFFAT, 1888, is a junior synonym of *Janira alpina* D'ORBIGNY, 1847, and the name of *Neithea* (*Neithella*) *notabilis* (MÜNSTER *in* GOLDFUSS) is generally applicable for the small specimens which were interpreted as belonging to *Neithea atava* by WOODS (1903) and Japanese authors. As to Japanese specimens, *N.* (*N.*) *nipponica* HAYAMI, 1965, and *N.* (*N.*) *kanmerai* HAYAMI, 1965, were regarded as synonymous with *Neithea quinquecostata* (SOWERBY, 1814) and *Neithea atava* (ROEMER, 1839), respectively. *Pecten* (*Neithea*) cf. *morrisi* by AMANO (1957) was referred to *Neithea syriaca* (CONRAD, 1852), while *N.* (*N.*) *amanoi* HAYAMI, 1965, which is decidedly conspecific with AMANO's, was compared with *Neithea coquandi* (PERON, 1877). Our opinion on her suggestions will be found in the taxonomic revision of this article.

Because the synonymic and homonymic relation among the taxonomic names in these works may be complicated, the synopsis is shown in Table 1. Since the full synonymic references were listed in the separate paper (HAYAMI, 1975, pp. 74-77), they are not repeated here.

Nature of radial ornaments in *Neithea*

The radial ornamentation on the disk, which is commonly composed of ribs of two orders, has been regarded as important for the distinction and classification of the genus *Neithea*. Actually, the number of primary radial ribs of this genus is invariably six, although the first and sixth ones are sometimes obsolete in the subgenus *Neithella*. The number of secondary ribs on five interspaces also seems to be nearly constant within one fossil population (or one species), being commonly regarded as a taxonomic criterion. The left (or flat) valves of *Neithea* have not been so carefully studied as the right (or convex) valves in hitherto published taxonomic works, but, properly speaking, the same importance should be attached to the two valves.

In ordinary species of the Pectinidae the radial ribs interlock with the corresponding grooves of the counter valve at the ventral margin. It is the same with *Neithea* (*Neithea*) *aequicostata* (LAMARCK, 1819) and a few other species of *Neithea* which have radial ribs of almost a single order of prominence. In many other species of *Neithea* with clearly differentiated radial ribs, on the contrary, the primary ribs of right valve commonly corrrespond with the radial elevations (not depressions) of left valve to give digitations or angulations to the ventral margin, whereas the ribs of secondary order always interlock with the grooves of counter valve. Such a mode of radial ornaments is clearly observed in *N.* (*N.*) *atava* [=*N.* (*N.*) *kanmerai*] and *N.* (*N.*) *matsumotoi* as well as many other species having primary ribs (Text-fig. 5). Yet, in such species there is a narrow groove on the top of each radial elevation in the left valve. Consequently, six bipartite ribs or six pairs of contiguous ribs are commonly developed in the left valve. In *N.* (*N.*) *ficalhoi* and *N.* (*N.*) *syriaca amanoi* the surface of left valve is nearly flat or broadly concave without conspicuous radial elevations, but the six pairs of ribs are clearly distinguishable from other ribs. In such a species the ventral margin is usually not so strongly digitate.

The total number of radial ribs, therefore, can be expressed as follows: $6+5n$ for the right valve, and $12+5(n-1)$ for the left valve. Although there may be, of course, some minor modifications by occasional irregular bifurcation or insertion of secondary ribs, the following number of n appears to be basically maintained in the Japanese species.

$n=1$ *Neithea* (*Neithea*) *alta* sp. nov.
$n=2$ *Neithea* (*Neithea*) *ficalhoi* (CHOFFAT)
$n=3$ *Neithea* (*Neithea*) *atava* (ROEMER), *Neithea* (*Neithea*) *syriaca amanoi* HAYAMI
$n=4$ *Neithea* (*Neithea*) *matsumotoi* HAYAMI, *Neithea* (*Neithea*) *nipponica* HAYAMI, *Neithea* (*Neithea*) *aketoensis* HAYAMI

We presume that this grouping by the number of n also can be applied for various foreign species, since the number of secondary ribs generally seems to be constant within one species. It is interesting to see that *Neithea* (*Neithea*) *regularis* (VON SCHLOTHEIM, 1813) from the Upper Cretaceous of western Europe shows a considerable variation in the differentiation of radial ribs into two orders (DHONDT, 1973). Six primaries are discriminated from secondaries in some specimens but not at all in other ones. Nevertheless, the total number of radial ribs is almost constant in that species, and *N.* (*N.*) *regularis* clearly belongs to the group of $n=3$. It is suggested that the species, even if showing phenotypically monotonous radial ribs of a single order, potentially have six primary ribs. The radial ribbing of an early species, *N.* (*N.*) *alta* sp. nov. also indicates this potentiality. Anyhow, the *six* primary ribs of *Neithea* are, actually or potentially, a quite stable character which seems to have controlled by some phylogenetic (or historical) factor rather than functional.

Such a regularity is scarcely known in other Late Mesozoic and later pectinaceans, but somewhat similarly digitate ventral margin and corresponding radial ribbing are seen in the genus *Amphijanira* BITTNER, 1901, from the Triassic. The mode and number of radial ribs in *Neithea* attract our evolutionary interest, because our knowledge about the biological background and taxonomic evaluation of such shell characters remains quite insufficient.

Origin and shell structure of *Neithea*

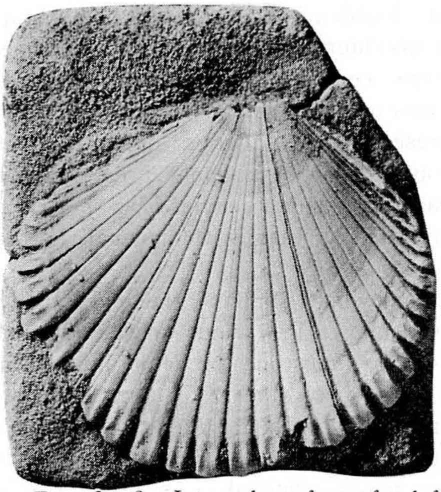
There are several different opinions as to the ancestry of the genus *Neithea* and its phylogenetic relation with other genera of the Pectinidae. As reviewed by DHONDT (1973, p. 9), certain authors assumed iterative evolution of such plano-convex pectinids from some stock of the family at different ages, but some others expected its intimate relation to Recent *Pecten* and also to the genus *Weyla* BOEHM, 1920, which occurs commonly in the Lower Jurassic of South America.

In fact, the flat or rather concave left valve, subequilateral outline and some other external characters of *Weyla alata* (VON BUCH, 1835) and its allies are considerably similar to those of *Neithea*, though the radial ribs of *Weyla* are never differentiated into two orders. It is also interesting to see barely differentiated radial ribs and slightly digitate ventral margin in an early species, *Neithea* (*Neithea*) *alta* sp. nov., from the Lowest Cretaceous of north Japan, because the morphology seems to be primitive for *Neithea* and possibly transitional between this genus and *Weyla*. Yet, nothing is actually known about the Middle and Late Jurassic representatives of the presumed lineage which could link *Neithea* with *Weyla*.

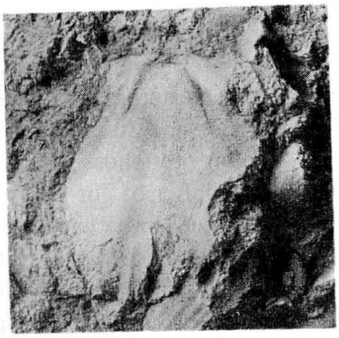
On the other hand, *Neithea* is characterized by the development of a pair of strong isodont crural teeth, which is so far unknown in *Weyla*. DHONDT (1973) appears to have recognized this difference of hinge structure on the basis of a silicified specimen of *Weyla* taken out by dissolving the calcareous matrix with some acid. She attached importance to this difference and almost denied the possibility of direct relationship between the two genera. In this connection, however, some question arises. In 1973, one of us (I. H.) joined to a party of the Expedition of Chiba University to the Middle Andes conducted by Professor MAEDA and collected a lot of silicified specimens of *Weyla alata* or its allied species from the Liassic limestones (Pucará Group) in the Tarma, Huancayo and Lircay areas of central Peru. At many localities the umbonal areas of two valves are rather rarely preserved, notwithstanding that the external surface of the middle and ventral areas of disc is well exhibited and scarcely water-worn. As the result of dissolving the matrix with diluted hydrochloric acid, several silicified shells were completely extracted from the limestone blocks. The shell so far as preserved are always quite thin and fragile in the umbonal area but comparatively much heavier near the ventral margin, provided with unusually strong " internal ribs ".

Somewhat similar phenomena have been known in various fossils from the Eocene limestone of Hahajima, Bonin islands (IWASAKI, 1975) and also from the Chalk of England (HALL and KENNEDY, 1967; CARTER, 1972), though they are never silicified. As observed and interpreted by IWASAKI, every specimen of *Meotolima* from Bonin, which is actually not a limid but a small spondylid, is represented only by the outer foliated calcite layer, and the inner layer of original shell is not preserved at all. During his stay in western Europe, one of us (I. H.) could observe numerous well preserved specimens of *Spondylus* and *Neithea* from the Upper Cretaceous of Scania, Holland and England. In almost all the specimens from the Chalk the umbonal part is unusually thin and apt to be damaged, and only the outer layer of their original test seems to have been fossilized. They have generally well preserved surface ornamentation but neither hinge teeth nor muscle impressions are shown on the internal surface, as pointed out by CARTER (1972). Unlike the shells of living pectinids the thickness of the preserved test of *Neithea* from the Chalk is nearly isometrically increased towards the ventral margin in proportion to the distance from the umbo. Moreover, the radial ornament is too sharply impressed on the internal surface even near the umbo to be interpreted as an original feature (Text-fig. 2).

In all the species of Recent pectinids,



Text-fig. 2. Internal surface of a left valve of "*Neithea quadricostata*" (UMUT 849a, specimen for comparative studies). Loc. Maastricht, Netherland. The thin and damaged umbonal area and sharply impressed radial sculpture indicate the inner layer of original shell was lost in the course of fossilization. [×1]



Text-fig. 3. Internal surface of a left valve of *Neithea ficalhoi* [GK. H6281]. Loc. Hiraiga Formation of the Miyako Group at south of Hiraiga, Tanohata-mura, Iwate Pref. The inner layer is, though has already been replaced by calcite, completely preserved. Isodont teeth and adductor muscle scar are observable. [×2]

on the contrary, the shell is almost entirely composed of foliated calcite except for a thin layer of myostracum (BøGGILD, 1930; TAYLOR, KENNEDY and HALL, 1969, etc.); the umbonal area is much thickened and radial ornament on the internal surface is covered and obscured by successively deposited calcite. Therefore, such a state of preservation as seen in *Neithea* from the Chalk and *Weyla* from the Peruvian Lias would be difficult to explain, if they were similar to living pectinids in the shell structure.

The Miyako Group of north Japan yield various well preserved molluscan fossils at numerous localities. In the upper part of the Hiraiga Formation (especially, the facies of *Orbitolina* Sandstone) and the Aketo Formation aragonitic shells are not necessarily preserved, and some specimens of *Neithea* (*Neithea*) *nipponica* show also sharply sculptured internal surface (HAYAMI, 1965, pl. 40, figs. 3, 4). However, entire original shells seem to be preserved in the lower part of the Hiraiga Formation, although originally aragonitic shells and layers seem to have been replaced by sparry calcite. A left valve of *Neithea* (*Neithea*) *ficalhoi* therefrom reveals notably smoothish internal surface and distinct crural teeth (Text-fig. 3).

Anyhow, it is worthy of notice that the presence of inner aragonitic layer is strongly suggested both in *Weyla* and *Neithea*. In such cases as the Chalk *Neithea* and the Peruvian *Weyla* it is probably impossible to determine whether isodont teeth are developed or not, because they, if originally present, had to be composed of the inner layer. This is presumably the reason why the isodont teeth and muscle impressions of *Neithea* are so rarely met with in European specimens. If the material of *Weyla* dealt with by DHONDT (1973) were of the same state in preservation, the difference of hinge structure between *Neithea* and *Weyla* would not be firmly conclusive.

Since any other type of shell structure than foliated calcite and myostracum aragonite is scarcely known in the living Pectinidae (exclusive of *Propeamussium* and its relatives), the traditional reference of *Weyla* and *Neithea* to this family is open to discussion. So far as the presumed shell structure is concerned, the two genera are probably more similar to *Spondylus* and *Plicatula* rather than many living genera of the Pectinidae. Actually, somewhat similarly inequivalve shell, radial sculpture of two orders and strong isodont teeth are commonly seen in *Spondylus*, although the outline of shell is considerably irregular probably owing to the sessile life.

The shell structure of the Bivalvia is generally evaluated as an important and stable taxonomic character. Some Late Paleozoic pectinaceans as the Aviculopectinidae are said to be different from the living Pectinidae in having inner layers of nacreous or crossed-lamellar aragonite (NEWELL, 1938; etc.). Yet, little has been known about the mode of shell structure evolution from the aviculopectinids to pectinids, though it is almost certain that the former is as a whole ancestral to the latter. BØGGILD (1930) actually studied the shell structure of some Mesozoic pectinids: Jurassic and Cretaceous *Chlamys*, "*Aequipecten*", *Radulopecten* and *Entolium* as well as two species of *Neithea* from the Upper Cretaceous. He pointed out the presence of peculiar zigzag structure in many of those species (but not in *Neithea*), although it is open to doubt whether the structure is original or not. Because aragonitic shell is totally absent in the Chalk and, if preserved, usually replaced by sparry calcite in other Mesozoic rocks, the shell structure of Mesozoic pectinids should be carefully restudied. For the time being, *Neithea* and *Weyla* are regarded as belonging to a particular group of the Pectinidae, for which at least a subfamilial name, Neitheinae SOBETSKI, 1960, is applicable.

The plano-convex outline of *Neithea* is at a glance comparable with that of living *Pecten*, suggesting the same adaptive significance. However, the resemblance is probably superficial and does not seem to indicate any direct phylogenetic relationship, since the shell structure, hinge apparatus and some other important characters are quite different.

Adaptive morphology of *Neithea*

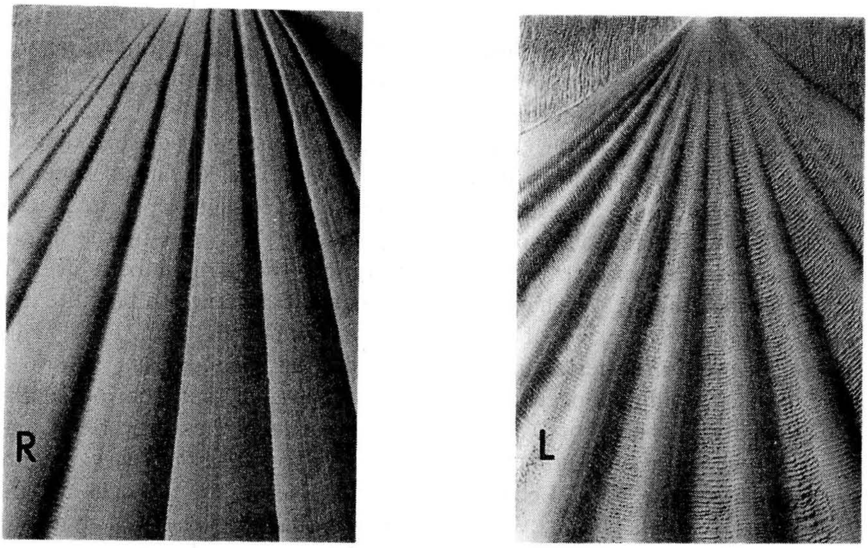
The peculiarly designed morphology of *Neithea* arouses our interest in its functional significance and mode of life. Putting aside the unlikeliness of any direct phylogenetic relation, the plano-convex form of *Neithea* is notably analogous to that of *Pecten* in the modern seas. Judging from the occurrences in Japan, western Europe and some other regions, *Neithea* probably inhabited on sandy or chalky substrate of shallow clean seas and is commonly accompanied by other pectinids, limids, spondylids, belemnites, brachiopods and echinoids. Thus it possibly occupied a similar ecological niche to Cenozoic *Pecten* (s. s.) and *Pecten* (*Notovola*) which are decidedly good swimmers. Could *Neithea* also swim well? Since this genus probably became extinct near the end of Cretaceous without leaving any descendants, only indirect evidences are available to solve this problem.

THAYER (1970) pointed out that the striated (or quick) muscle of the adductor is considerably oblique to the surface of valves in swimming scallops and that this is an adaptive structure to increase the velocity of clapping motion.

GOULD (1971) also studied the allometric change of muscular size and position through the growth of some living and fossil pectinids; the striated muscle is proportionally enlarged and moves from the postero-dorsal portion to the central, so that the swimming ability is maintained against the accelerating increase of shell weight. The orientation and ontogenetic allometry of muscles can be used as important criteria for the estimation of swimming ability in extinct pectinids. Studies on the relative growth of shell thickness to shell size would be also informative, since its negative allometry may be more advantageous for swimming habit. Unfortunately, however, these characteristics are very difficult to observe, chiefly because the inner layer of *Neithea* was frequently dissolved away in the course of fossilization. Here only some remarks will be given about the paleoecology mainly on the basis of a comparative study with living pectinids.

Actively swimming pectinids in the modern seas seem in general to be characterized by 1) subequilateral shells with subequal auricles, 2) shallow or obsolete byssal notch in adult stage, 3) relatively light shells, 4) considerably wide gapes along the anterior and posterior margins of disc to allow the ejection of propulsive jet current, 5) large umbonal angle, and 6) the development of a flange along the dorsal margin of right valve which is effective to the force of oblique striated muscle.

Except for a few species of subgenus *Neithella*, the two valves of *Neithea* are nearly equilateral and the byssal notch, if present, is very shallow. This can be regarded as a suitable morphological character for swimming straight ahead. Yet, the external morphology of *Neithea* does not show any of other attributes. For instance, the umbonal angle of *Neithea* (90-110° in LV) is somewhat smaller than that of *Pecten* (110-120°), *Placopecten* (ca. 120°) and *Amusium* (115-140°). Anterior and posterior gapes and a dorsal flange of right valve are undevelopped in *Neithea*, so far as several conjoined specimens from Europe and Gulf Coast region were examined. The lower-convex shells are not considered as a necessary condition for swimming, because such very actively swimming pectinids as *Placopecten* and *Amusium* have biconvex or even upper-convex shells. The strongly convex right valve of *Pecten* is rather regarded as a kind of gryphaeate morphology, which is advantageous in preventing the commissure from sinking into soupy substrate, as interpreted by some authors (KAUFFMAN *in* COX et al., 1969; STANLEY, 1970; CARTER, 1972). The flat or even concave left valve must be effective to hold a layer of sediment grains, which were once suspended in the sea water by means of jet current and settled on its surface, and consequently to conceal itself from predators. Very interesting is the fact that the surface of left valve is frequently more squarrose than that of right valve of the same individual (Text-fig. 4). It is owing to the more erect growth lamellae in many species of *Pecten* and because of peculiarly meshed ornaments in *Mizuhopecten*. Such plano-convex shells and different sculpture of two valves must have been formed by certain selective advantage. *Neithea* evidently shares such an inequivalve morphology with *Pecten*, and similar living position is strongly suggested. In the newly obtained material of *Neithea* (*Neithea*) *atava*, serpulids attach themselves more frequently to the surface of left valve than right (Pl. 5, Fig. 4b). This phenomenon seems to be coincident with the tendency in living shells of



Text-fig. 4. Difference of surface squarrosity between two valves (the same individual) of *Pecten* (*Notovola*) *albicans*. Recent, Tsuyazaki near Fukuoka. R: right valve, L: left valve. [×2, under the same lighting]

Pecten.

Judging from the thickness of the outer layer so far preserved in Chalk and Gulf Coast specimens as well as Miyako ones, the original shells of *Neithea* are generally thicker than that of living *Pecten*. The silicified specimens of *Weyla* from the Peruvian Lias also show proportionally much heavier outer layer. Most species of *Neithea* and also *Weyla*, we suppose, lived freely on soft substrates, keeping their commissure nearly horizontal. They probably camouflaged themselves with sediments on the flat valves like living *Pecten*, but they were probably not so excellent swimmers.

Repository of specimens

The following abbreviations are used for the indication of the institutes where the specimens studied are preserved:

UMUT: University Museum, University of Tokyo
NSM: Department of Earth Science, National Science Museum, Tokyo
GK: Department of Geology, Kyushu University, Fukuoka
BMNH: British Museum (Natural History), London

Systematic descriptions of Japanese species

In many respects DHONDT's (1973) suggestions on the taxonomic position of Japanese specimens are pertinent and agreeable. However, as the result of our comparative study between Japanese and European specimens of each related species, slight but clear differences are often found in such morphological characters as the shell size, mode of radial ribbing, outline and convexity of two valves. Curiously enough, the vertical ranges of some common or closely related species are not always coincident between the two regions, notwithstanding that the chronology of the fossil beds are generally reliable as documented by ammonites and other indices. In Europe, according to DHONDT (1973), many species of *Neithea* survived from Early to Late Cretaceous, whereas in Japan all the Lower Cretaceous species seem to have become extinct by the beginning of Cenomanian. We have no Late Cretaceous representative of *Neithea* in Japan in spite of other abundant molluscan fossils. Common occurrence of Aptian and Albian species of *Neithea* has been known in Caucasus (DRUSCHIZA and KUDRJAVTSEVA, 1960), Lebanon (VOKES, 1947, etc.), Angola (DARTEVELLE and FRENEIX, 1957, etc.) and some other areas of Western Asia and Africa, but reliable information on the marine bivalve faunas of this age in the midway areas between Japan and India is too deficient to recognize the actual geographic distribution of each species. Moreover, several species of *Neithea* from the Comanche Group of the Gulf Coast region (STANTON, 1947, etc.) and its correlatives in Mexico (BÖSE, 1910; ALENCASTER, 1956) are, if not identical with, closely related to some European and Japanese species. Therefore, it may be dangerous to draw a hasty conclusion about the route of migration.

Although the following taxonomic treatment and consideration on the affinities are not always conclusive, in most cases we are at least convincing the specific discrimination and identity among the fossil populations from Japan in view of the morphology and distribution.

Neithea (Neithea) aketoensis HAYAMI, 1965

Synonymy and type.—See HAYAMI, 1975, p. 77.

Remarks.—This is imperfectly known species, because only one right valve has ever been known. It was collected from the basal part of the Aketo Formation of the Miyako Group together with several specimens of *Neithea (Neithea) nipponica*. As noted in the original description, the arrangement of radial ribs appears at a glance to be quite irregular, and primary ribs can hardly discriminated from secondaries. DHONDT (1973, p. 13) pointed out the possibility that the present species may be synonymous with *Neithea (Neithea) aequicostata* (LAMARCK, 1819), but the two must be unrelated, because the ribs of the present specimen are generally much stronger and more irregular in prominence. Owing to this irregularity this species was referred to *Neithea* with some doubt (HAYAMI, 1965, 1975). Nevertheless, if we trace the weakly impressed growth lamellae on the surface at several ontogenetic stages, the ventral margin of this right valve proves to be polygonally angulated, as commonly seen in ordinary six-ribbed species. Moreover, an unusually strong or bipartite ribs radiates from the umbo to each angle of ventral margin. If we interpret such an unusual rib as primary and other ribs as secondary, the disposition of radial ribs is not essentially different from that of coexistent *N. (N.) nipponica*. Incidentally, in an European species, *Neithea (Neithea) regularis* (VON SCHLOTHEIM, 1813) from the Upper Cretaceous, according to DHONDT (1973), there is a great variability in the extent of differentiation of radial ribs into two orders: primary ribs may or may not be discriminated from other ribs. At present, therefore, we cannot completely restrain the doubt if the holotype of *N. (N.) aketoensis* might be an aberrant individual of *N. (N.) nip-*

ponica. Anyhow, it is needed to examine further the intrapopulational variation of *N.* (*N.*) *nipponica* on the basis of more plentiful material in order to confirm the taxonomic validity of the present species.

Neithea (*Neithea*) *alta* HAYAMI, sp. nov.

Plate 5, Figures 1-3

1970. *Neithea* n. sp.: TAKIZAWA, *Bull. Geol. Surv. Japan*, vol. 21, no. 10, p. 6, listed.
1974. *Neithea* n. sp.: TAKIZAWA, ISSHIKI and KATADA, Geology of the Kinkazan district, p. 21, listed.
1975. *Neithea* sp.: TAKIZAWA, *Bull. Geol. Surv. Japan*, vol. 26, no. 6, p. 18, listed.

Types.—Holotype (UMUT MM 5698), right internal mould, and four paratypes (UMUT MM5699-5702), left external moulds, all collected by Takizawa from the Kobitawatashi Member of the Ayukawa Formation at Yokone, south coast of Ajishima island, Ojika-cho, Ojika-gun, Miyagi Prefecture.

Diagnosis.—Small *Weyla*-like species of *Neithea*, characterized by the moderately convex right valve with 11 radial ribs of almost one order of prominence and remarkably concave left valve provided with 12 angular and highly elevated radial ribs forming six contiguous pairs.

Description.—Shell small for the genus, scarcely exceeding 20 mm in height, highly inequivalve, nearly equilateral, a little higher than long. Right valve moderately convex, subtriangular with slightly concave antero- and postero-dorsal margins of disc, ornamented with 11 highly raised and simple radial ribs which are almost equal in prominence; intercalary ribs seemingly absent. Left valve remarkably concave even at the very early and later stages, provided with 12 highly elevated and angular radial ribs which are at a glance similar to those of *Weyla* but seem to form six contiguous pairs; numerous concentric scales crossing the ribs and their interspaces. Posterior auricle of left valve obtusely truncated and comparatively small, while other auricles are not actually observable owing to the incomplete material. Apical angle of two valves apparently small for *Neithea*, though it may be due to the secondary deformation.

Remarks.—Several years ago one of us (I. H.) had an opportunity to observe various Jurassic and Early Cretaceous molluscan fossils from Ojika Peninsula of north Honshu collected by Takizawa of the Geological Survey of Japan. Although many of them are secondarily deformed and poorly preserved, several specimens of a pectinid attracted our attention, because it appeared to be one of the earliest representatives of *Neithea*.

This species is now proposed on the basis of five specimens from one and the same locality: one is a right internal mould with partly preserved shell and four are incomplete left external moulds. The detailed surface characters of right valve and auricles are actually unknown. Nevertheless, the present species is clearly distinguishable from hitherto described species of *Neithea* by the

Table 2. Measurements in mm [*Neithea* (*Neithea*?) *alta* sp. nov.]

Specimen		Length	Height	Thickness
UMUT MM5698	Right in. mould (holotype)	17.5	18.5	ca. 4.5
UMUT MM5699	Left ex. mould (paratype)	14.0+	15.0+	?

fewer and scarcely differentiated radial ribs in right valve and remarkably concave left valve with well developed concentric scales and only six pairs of angular ribs. *Neithea* (*Neithea*) *aequicostata* (LAMARCK, 1819) and a few other species from the European Cretaceous have also radial ribs of only a single order, but the number of ribs are much more numerous. In the mode of radial ribbing the present species is more similar to *Neithea biangulata* IMLAY, 1940, from the Hauterivian of Mexico, particularly to its young specimen. Although the left valve of that Mexican species has not come to science, the principal ribs of the right valve are almost uniform in prominence, numbering 11 to 13. In *N. biangulata*, however, the shell becomes much larger and one or two weaker riblets occur on each interspace after the middle stage. Such riblets are hardly expected in the present species, judging from the impression of ornaments on the right internal mould and the radial ribs impressed on the left external moulds.

Although the radial ribs in the holotype (right internal mould) are apparently equal in strength, the six contiguous pairs of ribs on the left valve seem to foretell the characters of six-ribbed species of *Neithea* (s. s.). Moreover, the orientation of concentric scales on the left valve strongly suggests a more or less digitated ventral margin in accordance with the six pairs. The number of radial ribs on the right valve, which is 11, may be also meaningful, if one regards the ribs as homologous with the primary ribs plus median secondary ribs in ordinary six-ribbed species. As noted before, in almost all the species of *Neithea* (s. s.) radial ribs are basically composed of six primaries plus a multiple of five for the secondaries. Anyhow, the surface ornamentation of the present species is interpreted as representing an early stage of differentiation of radial ribs into two orders. Taxonomically, the present species is tentatively referred to *Neithea* (s. s.) with a query, since it possibly constitutes an infrageneric group together with *N. biangulata.*

Occurrence.—This species is known only from the above mentioned type locality. All the specimens were obtained from the middle part of the Ayukawa Formation, where *Berriasella* sp. was found in association (SATO and TAKIZAWA *in* TAKIZAWA, 1970). Most of the associated species of Bivalvia, such as *Limatula akiyamae*, *Astarte* cf. *spitiensis*, *Parallelodon* (*Cosmetodon*) *kesennumensis* and *Parallelodon* (*Torinosucatella*) *kobayashii* are the elements of the Late Jurassic Kogoshio fauna, which actually survived until the earliest Cretaceous (HAYAMI, 1961). As suggested by TAKIZAWA, the age of this fossil bed is almost certainly Berriasian. According to DHONDT (1973) the first appearance of *Neithea* in Europe is also from the Berriasian but it becomes common after the Valanginian. In North America, the above cited Hauterivian species, *N. biangulata*, is probably the earliest. In Japan, a small pectinid from the Upper Jurassic Torinosu Group was once referred to *Neithea* (KIMURA, 1951), but, as restudied by TAMURA (1959), it probably belongs to "*Aequipecten*". The present specimens, though poorly preserved, seem to be an interesting material for the consideration about the origin and phylogeny of the genus *Neithea* as well as the process of differentiation of radial ribs into two orders.

Neithea (*Neithea*) *atava* (ROEMER, 1839)

Table 3. Measurements in mm and degrees [*Neithea* (*Neithea*) *atava*]

Specimen	Length	Height	Thickness	Hinge length	Apical angle
NSM MM7348 Right in. mould	103.0	86.5+	25.5+	53.0	81°
UMUT MM5703 Right in. mould	90.9	93.8	21.3	56.5	82°
UMUT MM5704 Right ex. mould	81.0	88.9	30.1	?	77°
UMUT MM5706 Right valve	92.4+	96.0+	30.4	?	77°
GK. H10295 Right in. mould	94.4	98.2	32.4	?	75°
GK. H10298 Right in. mould	24.0	30.0	11.6	?	78°
UMUT MM5703 Left in. mould	90.9	88.6	—	56.5	104°
UMUT MM5705 Left ex. mould	81.0	79.3	—	?	101°
UMUT MM5706 Left valve	92.4+	91.0+	—	?	97°
GK. H10291 Left ex. mould	90.0	95.0	—	?	102°
GK. H10292 Left in. mould	92.6	107.0	—	?	98°
GK. H10294 Left ex. mould	63.6	70.5	—	40.8	105°
GK. H10297 Left ex. mould	115.0	118.2	—	40.0+	106°

Plate 5, Figures 4, 5; Plate 6,
Figures 1, 2

non 1926. *Pecten* (*Neithea*) cf. *atavus* ROEMER: YABE, NAGAO and SHIMIZU, *Sci. Rept. Tohoku Imp. Univ.*, ser. 2, vol. 9, no. 2, p. 61, pl. 13, figs. 18, 19. [=*N.* (*Neithella*) *notabilis*]

1952. *Neithea atava* (RÖMER): MATSUMOTO and KANMERA, Guide books of the geological excursions. The lower valley of the Kuma, p. 45 (non p. 49), listed.

1954. *Neithea atava* (ROEMER): COX, *Jour. Paleontology*, vol. 28, no. 5, p. 627, pl. 64, figs. 1, 4.

1954. *Neithea atava* (ROEMER): FUJII, *Jour. Geol. Soc. Japan*, vol. 60, no. 707, p. 418, listed (pars).

1954. *Neithea atava* (RÖMER): MATSUMOTO, Cret. System, Japan. Islands, p. 113 (non p. 114), listed.

1956. *Neithea* (*Neitheops*) *atava* (ROEMER): ALENCASTER, *Paleont. Mexicana*, no. 2, p. 12, pl. 2, figs. 5-7.

1960. *Neithea atava* ROEMER: DRUSCHIZA and KUDRJAVTSEVA, Low. Cret. Fauna from Caucasus and Crimea, p. 190, pl. 11 figs. 4-6.

1964. *Neithea* cf. *quinquecostata* (SOWERBY): MATSUMOTO and KANMERA, Expl. Text. Geol. Map of Japan, Hinagu, p. 99, listed.

non 1964. *Neithea atava* (RÖMER): MATSUMOTO and KANMERA, Expl. Text, Geol. Map of Japan, Hinagu, p. 106, listed. [=*N.* (*N.*) *matsumotoi*]

1965. *Neithea* (*Neithea*) *kanmerai* HAYAMI, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, vol. 15, no. 2, p. 305, pl. 43, figs. 1-5, pl. 52, fig. 3.

non 1965. *Neithea* (*Neithella*) sp. cf. *N.* (*N.*) *atava* (RÖMER): HAYAMI, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, vol. 15, no. 2, p. 307, pl. 44, figs. 1-4, pl. 52, fig. 4. [=*N.* (*Neithella*) *notabilis*]

1970. *Neithea* (*Neithea*) sp.: TERAOKA, *Rept. Geol. Surv. Japan*, no. 237, p. 10, listed.

non 1972. *Neithea* (*Neithella*) sp. cf. *N.* (*N.*) *atava* RÖMER: SHIKAMA and SUZUKI, *Sci. Rept. Yokohama Nat. Univ.*, sec. 2, no. 19, pl. 4, fig. 14. [=*N.* (*Neithella*) *notabilis*]

1973. *Neithea* (*Neithea*) *atava* (ROEMER): DHONDT, *Mém. Inst. roy. Sci. Nat. Belgique*, no. 176, p. 40, pl. 1, figs. 2a, b [Complete synonymy and occurrences about European specimens were given.]

1975. *Neithea* (*Neithea*) *atava* (RÖMER): HAYAMI, *Bull. Univ. Mus. Univ. Tokyo*, no. 10, p. 74.

1976. *Neithea kanmerai* HAYAMI: OBATA and OGAWA, *Bull. Nat. Sci. Mus.* [*Tokyo*], sec. C, vol. 2, no. 2, p. 101, listed, pl. 4, fig. 11.

Material.—A specimen (NSM MM7348) from the middle part of the Arida Formation at loc. 1908 (see OBATA and OGAWA, 1976, p. 99), Hozudo, Yuasa-cho, Arida-gun, Wakayama Prefecture (Y. OGAWA coll.) and ten specimens (UMUT MM 5703-5706, GK. H10291, 10292, 10294, 10295, 10297, 10298) from the lower member of the Haidateyama Formation at loc. Hk204 southern slope of Mt. Haidateyama, Honjo-mura, Minamiamabe-gun, Oita Prefecture (M. NODA coll.).

Description.—Shell very large, sometimes exceeding 100 mm in length and height, plano-convex, subequilateral. Right valve strongly inflated in young stage but moderately in adult, higher than long; antero- and postero-dorsal margins of disc slightly concave; ventral margin strongly digitate in accordance with six primary ribs; apical angle about 80 degrees, gradually increased with growth; primary ribs invariably six in number, strong, roof-shaped in transverse section (see Text-fig. 5), commonly tripartite, more or less curved outwards; 1st and 6th primary ribs somewhat weaker than other ribs; secondary ribs variable in prominence, round-topped, commonly three on each interspace; both lateral areas weakly striated; radial ribs and interspaces marked with fine growth-lamellae. Left valve nearly flat or a little convex in adult stage, though markedly concave in early stage; antero- and postero-dorsal margins nearly straight, forming an apical angle of about 100 degrees; primary ribs six in number, bipartite, highly elevated, corresponding with the tripartite primary

Table 4. Main diagnostic characters

species	size (max. height)	radial ribs (RV)	primary ribs (RV)	primary ribs (LV)
N. (*N.*) *aketoensis*	medium 51 mm	seemingly irregular	not clearly differentiated	?
N. (*N?*) *alta* sp. nov.	very small 19 mm	P-1-P	not clearly differentiated	recognized as pairs of ribs
N. (*N.*) *atava*	very large 120 mm	P-3-P	roof-shaped tripartite	highly elevated bipartite
N. (*N.*) *ficalhoi*	small 31 mm	P-2-P	round-topped tripartite	flattened bipartite
N. (*N.*) *kochiensis*	large 78 mm	P-0-P	round-topped simple	?
N. (*N.*) *matsumotoi*	small 29 mm	P-4-P	round-topped simple	elevated bipartite
N. (*N.*) *nipponica*	medium 42 mm	P-4-P	not very strong simple	not clearly differentiated
N. (*Nl.*) *notabilis*	very small 15 mm	P-0-P	strengthened with growth	strongly plicated
N. (*N.*) *syriaca amanoi*	small 25 mm	P-3-P	round-topped simple	flattened bipartite

ribs of right valve; interspaces of primaries broadly concave, provided with weak secondary ribs which are normally two in number; numerous concentric growth lamellae cross the radials and interspaces, more squarrose than in right valve, indicating notably digitate ventral margin. Both auricles of two valves acutely triangular, well developed; anterior auricle somewhat longer than posterior one but distinctly narrower with smaller apical angle; byssal notch shallow throughout the growth; anterior and posterior gaping, if present, very narrow; hinge line moderately long, provided with numerous denticles; a pair of strong and transversely striated crural teeth developed on the both sides of resilifer, elongated along the boundary between the disc and two auricles. Musculature unknown.

Remarks.—In Japan this giant species has been called *Neithea* (*Neithea*) *kanmerai*, since one of us (HAYAMI, 1965) proposed it as a new specific name. DHONDT (1973) examined many hitherto described specimens of *Neithea* from Europe and clarified the diagnostic characters of *N. atava* which had been somewhat controversial among authors. At the same time she properly pointed out that *N. kanmerai* from Japan is synonymous with *N. atava* of original sense. On the other hand, several well preserved specimens were recently collected from the Haidateyama Formation of central Kyushu and the Arida Formation of Kii Peninsula.

The shell material is completely eroded away except for an incomplete conjoined specimen (UMUT MM5706), but the surface ornamentation of two valves are well recognizable in other external moulds. The hinge structure is exhibited

of the Japanese species of *Neithea*

lateral areas (RV)	ventral margin	auricles	convexity (RV)	convexity (LV)	age (in Japan)
striated	polygonally angulated	?	moderate	?	low. Albian
smooth	slightly digitate	?	moderate	concave	Berriasian
striated	strongly digitate	subequal	strong-moderate	concave→flat or convex	Barremian to Aptian
smooth	slightly digitate	subequal	strong	weakly concave	up. Aptian
striated	?	?	moderate	?	Aptian or Albian
striated	polygonally angulated	subequal	moderate	nearly flat	Albian
striated	polygonally angulated	?	moderate	nearly flat	low. Albian
smooth	strongly digitate	unequal an.>pos.	strong	convex→ concave	Barremian to Aptian
smooth	rounded	subequal	moderate	nearly flat	Aptian

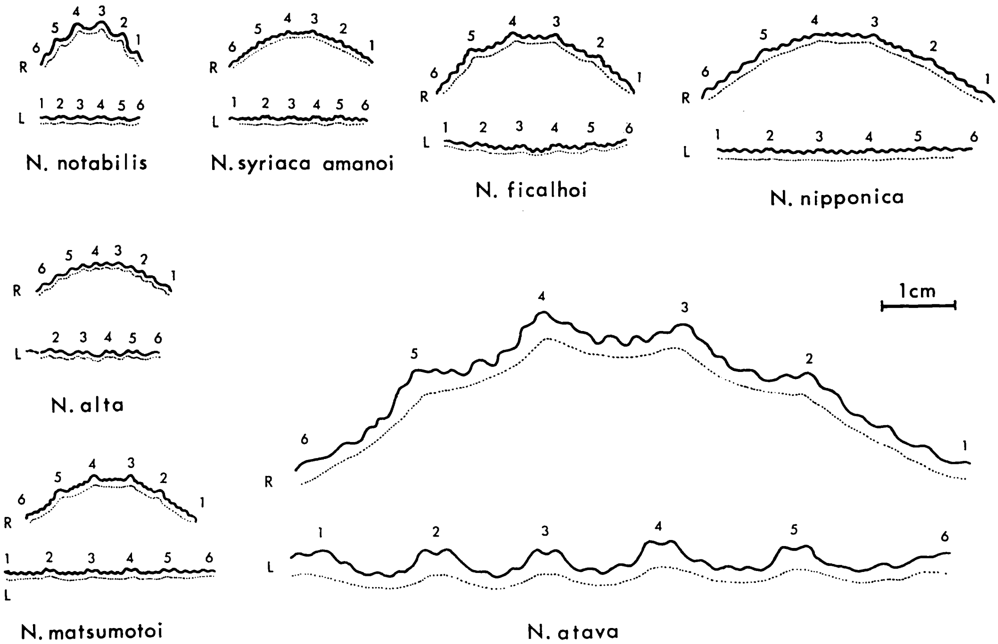
in the right internal mould (NSM MM 7348) and the auricles are completely impressed on the left external mould (UMUT MM5703). The characteristic shape of primary ribs, which are tripartite in the right valve and bipartite in the left, is commonly seen, while the secondary ribs of two valves seem to be considerably variable in prominence.

In 1965, one of us proposed *Neithea kanmerai* mainly on the basis of four deformed right internal moulds and one incomplete left external moulds from the Aptian Hinagu Formation of central Kyushu. Because the original description was based on such incomplete material, the external features of right valve were not precisely known, and the mode of radial ornament, especially the relationship of surface relief between two valves, was erroneously interpreted. As the result of reexamination on the Hinagu specimens, the primary ribs of left valve must be also six in number (instead of five) and distinctly bipartite. Tripartition of primary ribs in right valve is hardly ascertained from the impression of radials on the internal moulds, but it is also indistinct in the newly obtained internal moulds. Anyhow, no essential difference can be found between the type specimens of *N. kanmerai* and the present material.

On the other hand, as pointed out by DHONDT (1973), the Hinagu specimens as well as the present ones are quite similar to the European specimens of *Neithea* (*Neithea*) *atava* (ROEMER, 1839) of proper sense in every diagnostic character. In addition to the occurrence in western Europe and north Africa, several firmly identical specimens were recorded from the Barremian or Aptian of Trinidad (COX, 1954), Lower Cretaceous of southeast Mexico (ALENCASTER, 1956) and Hauterivian—Aptian of Crimea and Caucasus (DRUSCHIZA and KUDRJAVTSEVA, 1960). In every area *N.* (*N.*) *atava* is distinguishable from other species by the enormously large size and characteristic radial ribbing, and its geographic variation in morphology, if present, seems to be rather slight.

Occurrence.—The distribution of the present species seems to be world-wide, and the vertical range extends from the Berriasian to the Albian. In Japan this species is also common in the Barremian and Aptian sandstones at the following localities (see also Text-fig. 1). 1) Middle part of the Hinagu Formation at loc. Km. 3085c, south of Kobaru, Toyo-mura, Yatsushiro-gun, Kumamoto Prefecture (type locality of *N. kanmerai*); 2) Middle part of the Arida Formation at loc. Ys. 103, west of Kumai, and loc. 1908, Hozudo, both in Yuasa-cho, Arida-gun, Wakayama Prefecture; 3) Lower part of the Hanoura Formation at loc. Hy. 5004, north of Hiroyasu, Katsuura-cho, Katsuura-gun, Tokushima Prefecture; 4) Ishido Formation at loc. Hy. 4001, near Ichinose-bashi, south of Kagahara, Nakazato-mura, Tano-gun, Gumma Prefecture; 5) Lower member of the Haidateyama Formation at loc. Hk204 on the southern slope of Mt. Haidateyama, and upper member of the same formation at loc. Hk304 on the path along the eastern side of a valley from Kamikoshigoe to Mejiro-pass, both in Honjo-mura, Minamiamabe-gun, Oita Prefecture. At loc. 1908 some Barremian ammonites were found in association (OBATA and OGAWA, 1976), and at loc. Hk304 this species is accompanied by *Ancyloceras* (*Ancyloceras*) *vandenheckii* (see NODA, 1977).

Neithea (*Neithea*) *ficalhoi*
(CHOFFAT, 1888)



Text-fig. 5. Diagrammatic transverse section of disk along the maximum length to show the variability of radial ornaments among main Japanese species of *Neithea*. R: right valve, L: left valve, numerals 1 to 6: number of primary ribs from the anterior side, solid line: outer surface, broken line: supposed internal surface.

Synoymy.—See HAYAMI (1965, p. 302; 1975, p. 75).

Remarks.—This species was originally described from the (?) Albian of Angola. In Japan specimens referable to this species occur commonly from the Tanohata and Hiraiga Formations (upper Aptian-lowest Albian) of the Miyako Group. A specimen from a boulder of sandstone at the upper stream of Onkonosawa in Yamabe area of central Hokkaido (MATSUMOTO and OKADA, 1973, p. 293) also certainly belongs to the same species. This is easily distinguishable from other Japanese species of *Neithea* by the combination of the following characters: relatively small size, subequal auricles, feebly but regularly tripartite primary ribs and invariably two secondaries on each interspace in the right valve, strong convexity of right valve and broadly concave left valve. In these characters the Japanese specimens are probably identical with the original specimens of *Janira ficalhoi* from Angola (CHOFFAT and LORIOL, 1888). As noted before (HAYAMI, 1965), the present species may be intimate to *Neithea alpina* (D'ORBIGNY, 1847) from the Upper Cretaceous of western Europe. DHONDT (1973) synonymized *J. ficalhoi* with *N. alpina* together with *Pecten tricostatus* BAYLE *in* FOURNEL, 1849, and *Janira doumerci* PERON, 1877. The present Japanese specimens are, however, not coincident with DHONDT's description of *N. alpina* in some characters. On the basis of the lectotype and other Upper Cretaceous specimens of *N. alpina*, she noted, "The right valves are not very convex, particularly so on large specimens, and left valves are flattened: I have not come across concave left valves. ··On convex valves the [lateral] areas are slightly curved outwardly and are covered by a variable number of riblets." On the contrary, the Miyako specimens in question are characterized by the comparatively strongly inflated right valve and distinctly concave left valve, though they are generally smaller than European specimens of *N. alpina*. One or two radial undulations are commonly seen on the lateral areas of the right valves in the Miyako specimens, but they are too inconspicuous and weak to be called riblets. Moreover, *N. alpina* survived in Europe from the Albian to the Maastrichtian (DHONDT, 1973) and has generally been recognized as an Upper Cretaceous species, while the stratigraphic occurrence of *N. ficalhoi* in Japan is confined to the upper Aptian and lowest Albian. Several species of *Neithea* from the Lower Cretaceous Comanche Series in the Gulf Coast region are also characterized by two secondary ribs on each interspace in right valve. Among others *Neithea occidentalis* (CONRAD, 1855) [=*Neithea irregularis* (BÖSE, 1910)] from the Albian seems to share many common characters with the present specimens. Further comparative studies between the two nominal species are desirable. At present *N. ficalhoi* is regarded as specifically distinct from *N. alpina* and *N. occidentalis*, but the three nominal species are certainly closely related to one another and seem to constitute one and the same group of common phylogenetic origin.

Neithea (*Neithea*) *kochiensis* HAYAMI *in* HAYAMI and KAWASAWA, 1967

Synonymy and type.—See HAYAMI, 1975, p. 76.

Remarks.—This is an imperfectly known species founded on a solitary internal mould of right valve from the Albian (if not Aptian) Doganaro Formation of the Shimantogawa Group in south Shikoku. Though nothing has been known about the left valve, it seems to be distinct from any other species of *Neithea* from Japan by the relatively large size, round-topped and comparatively narrow primary ribs, wide and flattened interspaces, weak and undeveloped secondary ribs and angularly pointed umbonal area. The external feature is precisely unknown, but the internal mould lacks any impressions of secondary ribs even near the ventral margin but for numerous faint striae. In the large shell size only *Neithea* (*Neithea*) *atava* is comparable with the present species, but the apical angle is larger, the primary ribs are more roof-shaped in transverse section and the secondary ribs are more developed in the former. The holotype of *N.* (*N.*) *kochiensis* occurred together with a specimen of *Neithea* (*Neithea*) *matsumotoi*, but the morphological difference between the two species is quite obvious. Among various European species this may be somewhat similar to *Neithea* (*Neithea*) *striatocostatus* (GOLDFUSS, 1833) (DHONDT, 1973) from the Cenomanian—Maastrichtian, but the umbonal area is narrower than in that species. The present species was originally referred to subgenus *Neithella* HAYAMI, 1965, with a query. As renamed already (HAYAMI, 1975), however, it seems to belong to *Neithea* (s. s.), since the weakness of secondary ribs do not necessarily characterize that subgenus.

Neithea (*Neithea*) *matsumotoi* HAYAMI, 1965

Synonymy and type.—See HAYAMI, 1975, p. 76.

Remarks.—This species was originally described from the Albian Yatsushiro Formation of central Kyushu, and also known from the Haidateyama Formation of central Kyushu (HAYAMI, 1965) and the Doganaro Formation in south Shikoku (HAYAMI and KAWASAWA, 1967). A left valve of *Neithea* sp. from the core of test boring at Peikan of west Taiwan (MATSUMOTO, HAYAMI and HASHIMOTO, 1965) probably belongs to the same species. It is characterized by the small size, small and subequal auricles, strong and well discriminated primary ribs in the right valve, commonly four weak secondary ribs on each interspace and weakly striated lateral areas of the right valve, round-topped radial ribs on the flattened left valve, of which six pairs are notably heavier than other ribs, and relatively prominent concentric growth lamellae on the left valve. As remarked by HAYAMI (1965) and also DHONDT (1973), the present species actually resembles *Neithea sexcostata* (WOODWARD, 1833) in many essential characters. Yet, the resemblance is rather curious, as the geologic ages of the two species are quite different. In various areas of western Europe *N. sexcostata* commonly occurs in the Chalk and ranges from the Cenomanian to the Maastrichtian, whereas in Japan and Taiwan *N. matsumotoi* is known only from the Albian (? and Aptian) non-calcareous deposits. As the result of our comparative study with the specimens of *N. sexcostata* from the Chalk of England and Scania, it was proved that the apical angle of right valve is a little larger, the convexity of right valve is slightly weaker and the six paired ribs of the left valve are distinctly heavier in the Japanese specimens. *N. matsumotoi* is thus regarded as distinct from *N. sexcostata*, but it remains unsolved whether the morphological resemblance suggests some phylogenetic relation between the two species or is only due to convergence. The morphological similarity between *N. matsumotoi* and *Neithea attockensis* COX, 1935, from the Albian of India may offer another taxonomic problem, but any conclusion is now difficult, since that species is represented by an poorly preserved specimen.

Neithea (*Neithea*) *nipponica* HAYAMI, 1965

Synonymy and type.—See HAYAMI, 1975, p. 76.

Remarks.—This species commonly occurs in the uppermost part of the Hiraiga Formation and the Aketo Formation of the Miyako Group. The age is certainly lower Albian as indicated by associated ammonites. This appears to have suddenly substituted the pre-existing species, *N.* (*N.*) *ficalhoi*, but the two species are rarely but strictly associated with each other at a few localities. There are no individual showing intermediate morphology, and no direct phyletic relationship can be expected between the two species. Rather it seems more reasonable to consider that *N. nipponica* migrated from somewhere to this area and usurped within a short time the niche which had been occupied by *N. ficalhoi*. *N. nipponica* clearly differs from other Japanese species of *Neithea* in the combination of the following characters: medium size, rather weak contrast of prominence between the primary and secondary ribs, almost invariably four secondary ribs on each interspace in the right valve, indistinctness of six pairs of ribs in the left valve, and fine radial riblets on the lateral areas of the right valve.

In many of these characters *N. nipponica* resembles some specimens of *Neithea quinquecostata* (SOWERBY, 1814). DHONDT (1973) regarded the morphological differences between the two species stated by HAYAMI (1965) as insignificant and interpreted *N. nipponica* as a junior synonym of *N. quinquecostata.* As the result of further comparative studies with the specimens of *N. quinquecostata* preserved at the British Museum (Nat. Hist.) and some other institutions in western Europe, however, one of us (I. H.) maintains the taxonomic distinction between the two species. In comparison with the Upper Greensand and Chalk specimens of *N. quinquecostata* including the lectotype (BMNH no. 43324), the Japanese specimens have much narrower umbonal area, more slender primary ribs and more rounded anterior and posterior extremities of right valve, less polygonally angulated ventral margin of two valves, smaller size and probably thinner test. These difference cannot be attributed to the difference of ontogenetical stages between the materials, though once assumed by DHONDT. At the same time, however, it must be noted that the morphological differences are not so significant between the Japanese specimens of *N. nipponica* and those of "*N. quinquecostata*" from the Lower Greensand and Gault of England. Our specimens are likewise similar to the illustrated specimens of *N. quinquecostata* from the upper Albian of Crimea (DRUSCHIZA and KUDRJAVTSEVA, 1960), which also show more rounded ventral margin and weaker contrast between the radial ribs of two orders. It is thus suggested that somewhat significant morphological change occurred in the stock of *N. quinquecostata*, and that the name of *N.* (*N.*) *nipponica* is possibly applicable also for the fossil populations from the Lower Cretaceous of Europe. We think the nomenclatural translation of *N.* (*N.*) *nipponica* to subspecies is not necessary, even if it proves to be phyletically related to *N. quinquecostata.*

Neithea (*Neithella*) *notabilis*
(MÜNSTER *in* GOLDFUSS, 1833)

Synonymy.—See HAYAMI. 1975, p. 77.

Remarks.—In Japan this species occurs, though rarely, in the upper Neocomian Ishido Formation of Kwanto mountains (YABE, NAGAO and SHIMIZU, 1926), the upper Aptian part of the Miyako Group in north Honshu (HAYAMI, 1965) and the Aptian (?) part of the Choshi Group of east Kwanto (SHIKAMA and SUZUKI, 1972). A few specimens from these areas had been called *Neithea* (*Neithella*) cf. *atava* (RÖMER), until in opposition to WOODS' (1903) view DHONDT (1973) properly pointed out that the name of *Neithea* (*Neithea*) *atava* should be applied for an unrelated species of much larger size. In comparison with many European specimens referred by her to *Neithea* (*Neithella*) *notabilis*, every essential character of two valves is in fact so similar that no taxonomic distinction seems necessary for these Japanese specimens. This species has small shells, angular to round-topped primary ribs which become much broader through the individual growth, finely striated interspace without any ribs of secondary order in the right valve, strong convexity of right valve and angularly plicated and strongly digitate left valve.

As to the subgeneric diagnosis of the subgenus *Neithella*, DHONDT (1973, p. 8) wrote, "*Neithella* has been created for species with 4-6 asymmetrical ribs and highly unequal auricles. The ribs of the left valve are the reflection, and not the negative impression, of those of the right valve". In fact, this subgenus is well characterized by the very unequal auricles: the anterior auricles is pointed forward and much larger than the posterior, though in most Japanese specimens it is imperfectly preserved. In some species of *Neithella*, as originally noted, the 1st and 6th primary ribs are much weaker than others or so inconspicuous that they appear to have only four or five ribs. Such a tendency is scarcely known in *Neithea* (s. s.). We also feel the necessity of some additional explanation about the relation of radial relief between two valves. In *Neithea* and a few other Mesozoic genera of the Pectinidae, unlike ordinary pectinids, the primary ribs of right valve correspond with the radial elevations of left valve to give digitations to the ventral margin, whereas the secondary ribs commonly interlock with the grooves of the counter valve. Such a feature is clearly observable in many digitate species of *Neithea* (s. s.), and in this point *Neithella* does not differ from *Neithea* (s. s.).

Neithea (*Neithea*) *syriaca amanoi* HAYAMI, 1965

1957. *Pecten* (*Neithea*) cf. *morrisi* (PICTET and RENEVIER): AMANO, *Kumamoto Jour. Sci.*, ser. B, sec. 1, vol. 2, no. 2, p. 88, pl. 1, figs. 17, 18, 20-25, 27-29.
1965. *Neithea* (*Neithea*) *amanoi* HAYAMI, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, vol. 15, no. 2, p. 299, text-fig. 4, pl. 41, figs. 8-10, pl. 42, figs. 1-4.
1972. *Neithea* (*Neithea*) *amanoi* HAYAMI: SHIKAMA and SUZUKI, *Sci. Rept. Yokohama Nat. Univ.*, ser. 2, no. 19, pl. 4, fig. 15.
1973. *Neithea* (*Neithea*) *syriaca* (CONRAD): DHONDT, *Mém. Inst. roy. Sci. nat. Belgique*, no. 176, p. 37 (pars).
1975. *Neithea* (*Neithea*) *syriaca* (CONRAD): HAYAMI, *Bull. Univ. Mus. Univ. Tokyo*, no. 10, p. 75.

Type.—Holotype of *N.* (*N.*) *amanoi* (GK. H6267) from the Aptian Hagino Formation at Hagino, Kahoku-cho, Kochi Prefecture.

Remarks.—This subspecies is known only from the type locality and the Choshi Group of east Kwanto. It is characterized by the small size, almost invariably three secondary ribs on each interspace in the right valve, fine radial ribs of nearly one order of prominence in the left valve, almost smooth lateral areas, not strongly inflated right valve and nearly flat left valve without marginal digitations. DHONDT (1973) regarded *Pecten* (*Neithea*) cf. *morrisi* by AMANO (1957), which was described on the basis of the same fossil population, as belonging to *Neithea* (*Neithea*) *syriaca* (CONRAD, 1852). In fact, *Janira morrisi* PICTET and RENEVIER, 1858, appears to be synonymous with *Janira syriaca* CONRAD, 1852. According to VOKES (1947), the original specimen of *J. syriaca* from Abeih of Lebanon was lost, but its specific characters can be recognized in some "neosyntypes" from the type locality. The Japanese specimens actually resemble the topotypes of *N.* (*N.*) *syriaca* and also some European specimens hitherto described under the name of *N. morrisi*. The small size, relatively narrow and rounded outline and smooth lateral areas of right valve are particularly similar, while the radial ornaments of two valves are somewhat different. In the Lebanon specimens there are commonly four secondary ribs on each interspace in the right valve and 26 to 28 ribs in the left, whereas the Japanese specimens usually possess three secondary ribs in the right valve and totally 22 to 24 ribs in the left. The six pairs of ribs in the left valve, which correspond to the primaries of the right valve, are probably more prominently elevated in the Japanese specimens. Although one of us (HAYAMI, 1975) once regarded *N. amanoi* as a synonym of *N. syriaca*, the above mentioned slight but clear difference seems to deserve certain taxonomic distinction. At present it is difficult to say with documentation whether the difference represents the distinctness of species or is merely due to geographic variation, but the Japanese specimens are here tentatively treated as a subspecies, considering the Japanese and Lebanon populations are almost contemporaneous. Most of European specimens of "*N. morrisi*" are more similar to the Lebanon specimens than to Japanese ones, and they may be generally referable to the nominate subspecies, *N.* (*N.*) *syriaca syriaca*.

Various diagnostic characters of these Japanese species and subspecies of *Neithea* are collectively shown in Table 4. The taxonomic names here adopted may be considerably different from DHONDT's (1973), but in many cases we agree with her in recognizing the morphological resemblance between European and Japanese specimens. The mode of radial ribbing not only in the right valve but also in the left seems to be important for the taxonomic distinction, and the transverse sections of two valves in main Japanese species are diagrammatically shown in Text-fig. 5.

Summary

1) The mode of radial ribbing in *Neithea* is, because of its peculiarity and regularity, regarded as an interesting character not only for the taxonomic criterion but also for the general consideration about the differentiation of radial ribs into two orders. Many species with strongly digitate ventral margin show marked contrast of prominence between the primary and secondary ribs in the right valve and have six pairs of contiguous ribs (or six bipartite ribs) in the left valve. The total number of radial ribs is basically expressed as: $6+5n$ in the right valve, and $12+5(n-1)$ in the left valve (n varies among species).

2) It is worthy of notice that the presence of aragonitic inner layer is indirectly but strongly suggested in the original shells of *Neithea* and *Weyla*. Though any hasty conclusion on their taxonomic significance is avoided here, it may bear something informative for the consideration of shell structure evolution from the Aviculopectinidae to the Pectinidae as well as the relationship between the Pectinidae and the Spondylidae.

3) Analogy with *Pecten* in the modern seas leads us to suspect that the plano-convex shells of *Neithea* and *Weyla* represent a kind of gryphaeate morphology which may be advantageous in preventing the commissure from sinking into soupy substrate, even though they were not so excellent swimmers as *Pecten*. Their nearly flat or even concave left valve with frequently more squarrose surface are probably quite effective to hold a layer of sediments in order to conceal themselves from predators.

4) All the species of *Neithea*, which had been known from the Lower Cretaceous of Japan, were taxonomically restudied, and their specific names and affinity were discussed in some detail on the basis of a comparative study with European specimens. As pointed out by DHONDT (1973), there are some common or closely related species between Japan

and Europe, though the actual geographic distribution and migration route of each species are difficult to say owing to the deficiency of fossil records in the midway areas.

5) *Neithea kanmerai* HAYAMI, 1965, should be regarded as a synonym of *Neithea* (*Neithea*) *atava* (ROEMER, 1839), which actually shows very wide distribution. Detailed surface features of two valves were known in the newly collected materials from southwest Japan.

6) *Neithea* (*Neithea*?) *alta* sp. nov. from the Lowest Cretaceous of north Honshu is probably one of the earliest species of this genus and appears to indicate an early stage of differentiation of radial ribs into two orders.

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Explanation of Plate 5

Figs. 1-3. *Neithea* (*Neithea*?) *alta* HAYAMI, sp. nov.

Fig. 1. Internal mould of a right valve, (UMUT MM5698), holotype, from the Kobitawatashi Member of the Ayukawa Formation at Yokone, Ajishima Island, Ojika-cho, Ojika-gun, Miyagi Pref. (TAKIZAWA coll.) ×2.

Fig. 2. Rubber cast of a fragmentary left external mould, (UMUT MM5700), paratype, from the same locality. (TAKIZAWA coll.) ×2.

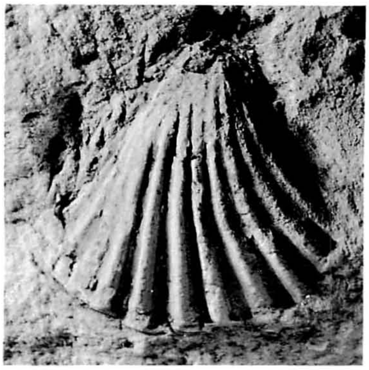
Fig. 3. Rubber cast of a fragmentary left external mould, (UMUT MM5699), paratype, from the same locality. (TAKIZAWA coll.) ×2.

Figs. 4, 5. *Neithea* (*Neithea*) *atava* (ROEMER)

Fig. 4a. Right internal mould (UMUT MM5703) from the lower part of the Haidateyama Formation at loc. HK204 on the southern slope of Mt. Haidateyama, Honjo-mura, Minamiamabe-gun, Oita Pref. (NODA coll.) ×1. The impression of both wings is on the external mould of the counter valve.

Fig. 4b. Rubber cast of the left external mould of the same individual. ×1.

Fig. 5. Plaster cast of a left external mould (GK. H10297) from the same locality. (NODA coll.) ×0.9.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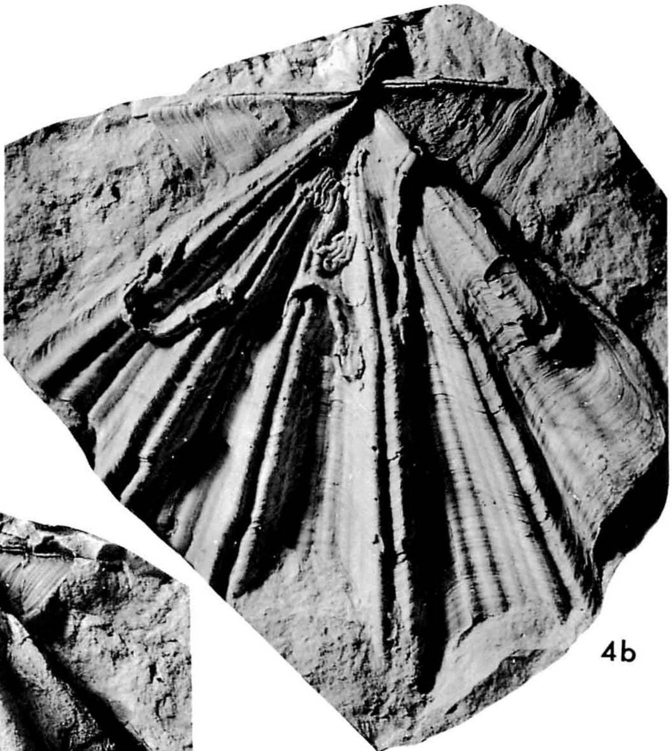
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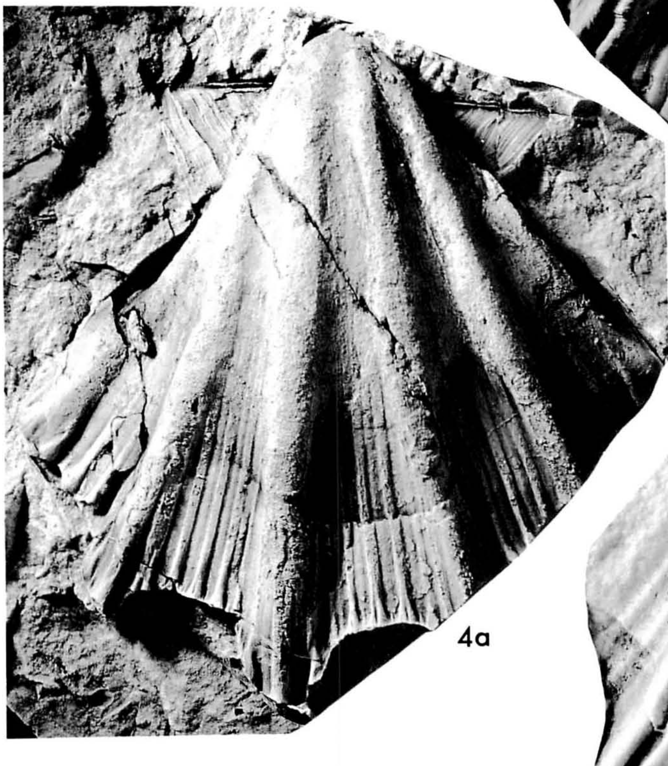
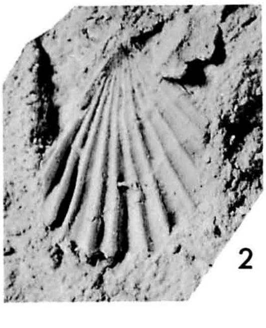

4a


5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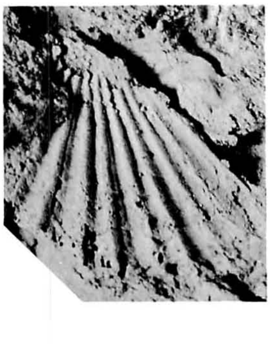
3

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Explanation of Plate 6

Figs. 1, 2. *Neithea* (*Neithea*) *atava* (ROEMER)

Fig. 1. Plaster cast of a right external mould (GK. H5002) from the lower member of the Haidateyama Formation at loc. Hk204 on the southern slope of Mt. Haidateyama, Honjo-mura, Minamiamabe-gun, Oita Pref. (NODA coll.) ×1.

Fig. 2a. Internal mould of a right valve (NSM MM7348) from the middle part of the Arida Formation at loc. 1908, Hozudo, Yuasa-cho, Arida-gun, Wakayama Pref. (OGAWA coll.) ×1.

Fig. 2b. Rubber cast of the right external mould of the same individual. ×1.

1

2a

2b

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

学会記事

○1976年11月に行われた1977・78年度評議員選挙の結果，次の諸氏が当選した（アルファベット順）。浅間一男，鎮西清高，浜田隆士，花井哲郎，速水格，早坂祥三，猪郷久義，亀井節夫，勘米良亀齢，小高民夫，松本達郎，首藤次男，高柳洋吉，棚井敏雅，氏家宏。

○1977年1月20日の評議員会において1977・78年度の会長には鳥山隆三，常務委員には勘米良亀齢（特別号），高柳洋吉（「化石」），鎮西清高，花井哲郎，氏家宏，浜田隆士，速水格，浅間一男，猪郷久義の9名が選出された。なお，その後の話合いにより次の業務分担が決った。庶務（鎮西），外国庶務（浜田），会計（氏家），会員（浅間），「報告・記事」編集（速水），行事（猪郷）。

○同評議員会で賞の委員会委員の半数改選が行なわれた結果，本年度の委員は鳥山隆三会長のほか高柳洋吉・速水格（以上留任），浜田隆士・早坂祥三（以上新任）となった。

○改正された会則第15条により，柳田寿一特別会員を常務委員に加えた。

○同評議員会で承認された会員の動静は次の通りである（受付順）。

〔入会者〕 秋元和実，大石徹，堀内順治，大花民子，天野和孝，後閑雅文，山崎純夫，阿部勝巳，大塚泰代，原田耕嗣，小野慶一，杉山哲男，富沢昭文，竹谷陽二郎，中島浩一，岡田尚武（16名）。

〔退会者〕 坂本峻雄，山田利仁，皆川信弥，丹羽俊二，鹿股信雄，佐藤幸二（6名）。

〔逝去者〕 土田定次郎，三井忍，Harlan Johnson，小川勇吉（4名）。

〔特別会員に推せんされた会員〕 中村万次郎，上野輝弥，鈴木順雄，蟹江康光，岩崎泰頴，小沢智生（6名）。

その結果，本会会員は普通会員311名，特別会員154名，在外会員54名，名誉会員6名，賛助会員10社となった。

○本会特別号第20号として小林貞一・浜田隆士君の “Devonian trilobites of Japan in comparison with Asian, Pacific and other faunas” が刊行された。第21号として松本達郎君ほかの “Mid-Cretaceous events, Hokkaido Symposium, 1976” が予定され印刷中である。第22号として “Bibliography of Paleontology in Japan, 1961-1975” の刊行が予定されている。また，「化石」27号が近刊の予定である。

○本会会誌「日本古生物学会報告・紀事」の定価がNo. 105より2,000円に改訂された。

○1977年度学会誌論文賞は，大村明雄君の “Thorium and protactinium isotopes in some present-day hermatypic corals and their implications to dating”（報告・紀事101号）に授与された。

○1977年度学術奨励金は，小畠郁生君（白亜紀アンモナイトの研究）と斉藤常正君（白亜紀および第三紀の浮遊性有孔虫の研究）に授与された。

会則改正

1977年1月21日の総会において会則12条および15条が次のように改正された。〔 〕内は旧条文。

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**4,500円**〔4,000円〕，特別会員年**6,000円**〔5,600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。在外会員の会費は年U.S. $ 22〔20〕とする。

第15条　本会の役員は会長1名，評議員15名，**および常務委員若干名**〔とし，うち若干名を常務委員〕とする。任期は……（以下同文）。**常務委員会は評議員会において互選された者で構成される。但し会務上必要とする場合は，特別会員の中から常務委員若干名を評議員会の議を経て加えることができる**〔常務委員は評議員会において互選される〕。評議員は……（以下同文）。

日本古生物学会1977年総会・年会は1977年1月21日（金）・22日（土）に東京学芸大学において開催された（参加者114名）。

会長講演

Some heteromorph ammonites from the Upper Cretaceous of Hokkaido…………T. MATSUMOTO

学会報告

CPNS ……………………………………………………………………………高柳　洋吉
Mid-Cretaceous Events 北海道集会 ……………………………………………松本　達郎
IPAオーストラリア会議 …………………………………………………………浜田　隆士
第6回貝形虫国際会議 ……………………………………………………………石崎　国熙

記念講演

飛驒山地上部古生界の古生物学的研究史 ………………………………………鹿沼茂三郎

個人講演

西日本における *Eostaffella*・*Millerella* 類の層位的分布について……………佐田　公好
琉球列島伊平屋島の石炭紀紡錘虫化石 …………………………………………石橋　　毅
Colania douvillei from the western part of the Kwanto Mountainland, Japan
……………………………K. MATSUMARU and K. OSAWA
Oligocene and Miocene larger foraminiferal biostratigraphy of the Minamizaki
Limestone, Chichi-Jima, Ogasawara Islands, Japan ……………………K. MATSUMARU
On two new species of *Nephrolepidina* and *Miogypsina* from the Chichibu Basin,
Saitama Prefecture, Japan ………………………………………………K. MATSUMARU
Two *Miogypsina* and *Operculina* assemblages from the eastern marginal area of
the Kwanto Mountainland, Japan ……………………K. MATSUMARU and A. HAYASHI
旗立層の微化石層序—浮遊性有孔虫および放散虫— ……………………酒井豊三郎・尾田　太良
房総半島後期新生代の微化石相の変遷 ……………………………………………北里　　洋
群馬県高崎地域の微化石層序（補遺）……………………
高柳洋吉・高山俊昭・酒井豊三郎・尾田太良・織山　純・金子　　稔
岩手県盛産石灰岩中のギンカクラゲ化石 ……………………………………………岡村長之助
秋吉石灰岩岩永台産石炭紀こけ虫化石について …………………………坂上　澄夫・杉村　昭弘
秋吉岩永台の *Millerella* 帯石灰岩より産出した腕足類化石…………………………柳田　寿一
The Upper Jurassic and Middle Cretaceous terebratulid brachiopods from the Bau
Limestone Formation in West Sarawak, Malaysia ……………J. YANAGIDA and J. LAU
熊本県星原層産の *Ginkgo biloba* LINNÉ について …………………………………岩尾雄四郎
玖珠層群から産出する植物化石 ……………………………………………………岩尾雄四郎
手取統植物群に産出した *Nageiopsis Kuwajimensis* (n. sp.) と *Podozamites lanceolatus*
L. et H. との関係について……………………………………………………………松尾　秀邦
手取統植物群産 *Podozamites reinii* の果実について…………………………………松尾　秀邦
Mesozoic plants from the Sebayashi Formation (Aptian), Kwanto Mountainland,
Gumma Prefecture, Outer zone of Japan ……………T. KIMURA and M. MATSUKAWA
Addition to the Mesozoic plants from the Akaiwa Formation (Upper Neocomian),
Itoshiro Group, Central Honshu, Japan ……………………T. KIMURA and S. SEKIDO
Some conifer remains from the Eocene beds of Kuji, Iwate Prefecture, Japan
……………………………T. KIMURA and J. HORIUCHI
Late Neogene flora from the southern part of Kwanto Plain, Japan
……………………………T. KIMURA and T. OHANA
天北上部新第三系産無装飾針状新属 *Yatakaiella*（7新種を含む）と珪藻進化に対するその意
義 …………………………………………………………………………………小村　精一
Palynology of the Lower Tertiary Concepcion Formation, Central Chile …………K. TAKAHASHI
四国松山付近から産出したイノセラムスについて …………………………………野田　雅之
Note on some Cenomanian mollusks from Diego-Suarez, Madagascar ……………………Y. KANIE
日本産白亜紀 *Neithea* の分類と古生態……………………………………………………速水　　格

A new fossil *Chlamys* from the Miocene Otsutsumi Formation, Miyagi Prefecture ……K. Masuda and Y. Sato
Colour pattern in fossil Umboniinae and its paleontologic significance ……T. Ozawa
男鹿半島上部新生界の巻貝化石の種間関係 ……小高　民夫
Nautilus pompilius の形態変異について（予察）……平野　弘道
樋口層産ジュラ紀アンモナイトについて ……平野弘道・三上貴彦・宮川秀樹
耐圧構造上みたアンモナイト殻の成長の規則性と変異性（予報）……棚部　一成
Further notes on the Vascoceratids from Hokkaido, part 2……T. Matsumoto and M. Nihongi
X線マイクロアナライザーを用いた貝殻中の Ca, P, Na の偏在の検討……小池　裕子
Manchuroceras in South Korea with notes on the Manchuroceratidae and *Manchuroceras* province ……T. Kobayashi
Upper Ordovician trilobites from the Langkawi Islands, Malaya ……T. Kobayashi and T. Hamada
韓国の三葉虫について ……小泉　斉
男鹿半島上部新生界の層序とオストラコーダ・フォーナについて ……岡田　豊
琉球列島島尻層群の貝形虫，殊に知念砂岩の *Manawa* 属について……野原　朝秀
Quaternary Ostracoda from Kisarazu near Tokyo……M. Yajima
東シナ海の貝形虫分布 ……石崎　国熙
蔓脚類にみられる性淘汰 ……山口　寿之
千葉市谷当町の木下部層産の穿孔性蔓脚類について ……福田　芳生
千葉市谷当町の木下部層産の正形ウニによる食痕化石について ……福田　芳生
日本の中古生界より産するナマコの骨片化石 ……金杉　洋美
日本のシルル・デボン・石炭系のコノドントの生層序 ……猪郷久義ほか
日本の二畳系のコノドントの生層序 ……猪郷久治ほか
三畳系上村石灰岩層のコノドント生層序 ……渡辺耕造・勘米良亀齢・中島浩一
日本の三畳系のコノドントの生層序 ……小池敏夫ほか

1976年度日本古生物学会論文賞受賞者推薦文

大村明雄君：Thorium and protactinium isotopes in some present-day hermatypic corals and their implications to dating. *Trans. Proc. Palaeont. Soc. Japan*, N. S. No. 101, pp. 271-290, 7 tables, 9 text-figs., 1976.

本論文は，四国・小笠原・南西諸島・台湾およびニューブリテン産イシサンゴの骨格内の U・Th・Pa 同位体（^{238}U, ^{234}Th, ^{230}Th, ^{231}Pa）の平均含有量，南西諸島産ミドリイシの ^{238}U の骨格内変動量，ならびに同地域の沿岸水中の ^{230}Th/^{232}Th 比を，従来の分析法に若干改良を加えることによって詳細に分析し，その結果，少くとも南西諸島産イシサンゴの現世化石試料に対し適用しうる，^{230}Th 成長年代測定法の，初生 ^{230}Th に関する経験的補正式を導き出したものである。

この際，現生骨格試料の示す ^{230}Th/^{232}Th 比が，棲息環境水のそれより若干高く出ることを見出し，この増加を，骨格形成に際し取り込まれた ^{234}U から採集・分析されるまでの期間中に壊変により生じた ^{230}Th の増加によるものと考えたことは，本論文の結論中もっとも独創的な点である。

なお，このように補正された ^{230}Th 年令は，同一試料の ^{14}C 補正年令（たとえば Suess, 1969）に近づき，補正式の妥当性を示唆するものと思われる。

本研究は，このように第四紀後期サンゴ礁の年代測定に有効な ^{230}Th 成長法を，現世試料に適用する際に問題点の一つとなる試料内の初生 ^{230}Th 量に関して，新しい考察を加えたもので，この成果は同位体古生物学の領域における注目すべき貢献とみなされる。日本古生物学会は，ここに大村明雄君に対して論文賞を贈る。

1976年度日本古生物学会学術奨励金推薦文

小畠郁生君：白亜系アンモナイトの研究

小畠君は1955年から1966年にかけて主として白亜紀後期のアンモナイトの古生物学的研究を続行し，特にデスモセラス科・バキュリテス科・コリグノニセラス科などの系統分類学的研究に当って，他の研究者と力を合せて本邦アンモナイト研究の国際レベルへの引き上げに貢献した。また世界に先がけていち早く相対成長の概念をアンモナイト研究に積極的に導入して一連の成果を得た。この種の研究が日本を含めて世界的に発展しつつあり，小畠君の研究がその誘因の一つとも考えられ，先見の明として高く評価したい。

1967年以後同君の研究の主力は宮古層群産アンモナイトに関する一連の研究に見られるように下部白亜系産アンモナイトの研究に注がれた。共同研究者を育成しつつ行った各地の白亜系の化石層位学的研究が研究上一つの支柱となった。特に1975年以後現在に至るまで，本邦下部白亜系に関するアンモナイトによる化石層位学的研究が極めて精力的に行われ，この方面の知識は一新され，今日では的確な国際対比が可能となった。この分野における同氏の貢献は極めて大きいと考えられる。今後は同氏を中心として本邦白亜紀前期アンモナイトの系統分類学的研究の推進を期待したい。

次に小畠君の研究上の関心が白亜紀アンモナイトの化石層位学以外にも広く及んでいることは他の専門研究者に協力した各種の論文により知られるが，中でも1970年以後から本邦の白亜紀脊椎動物化石の地質時代の決定を含アンモナイト層との関連から地史的に追求していることは注目に価する。従来不明であったこの方面の基礎的知識を蓄積するだけでなく古地理学的にも重要な貢献である。

以上を要するに，小畠君による研究は本邦白亜系のアンモナイト，ならびにその層位学的研究に大きく貢献した。よって日本古生物学会はここに学術奨励金を贈り，今後いっそうの発展を期待するものである。

斎藤常正君：白亜紀および新生代の浮遊性有孔虫の研究

浮遊性有孔虫の化石層位学は1940年代に開花し，地域的には限られていたが着実に検討が加えられた結果，1950年代の後半においてカリブ海沿岸では，上部白亜系より新第三系にかけて化石帯区分が一応設定されるに至った。このような世界的傾向の下で，斎藤君は本州の中新統の研究を志し，主要地域の化石層序を調査し，詳細な分類学的検討を行った結果，8化石帯に区分することに成功した（1963）。これによって，日本の海成中新統は初めて国際的に共通する基準により分帯され，対比されたのである。

同君は本研究の完成後，米国におもむき，海洋地質学の分野において先進的研究がなされることで令名の高いLamont-Doherty Geological Observatoryにおいて，主として海洋底堆積物中の浮遊性有孔虫化石の研究に従事し，深海掘削計画（DSDP）等にも活動的メンバーとして加わり今日に至っている。同君および協同者達の業績はあまたあるが，大西洋底における音響学的反射面Aの時代決定（1966），中央大西洋海嶺の堆積物の時代論（1966），太平洋底（Shotsky Rise）における最初の下部白亜系の発見（1966）等に続き，最上部新生界の地磁気層序と微化石層序との総合（1969）は注目すべき成果であった。また赤道太平洋における微化石層序の研究（1975）は，上部新生界の層位学的区分に新たな規準を付け加えた。さらに浮遊性有孔虫の殻の超微細構造に基づく分類体系の検討（1976）や，殻の酸素および炭素同位体測定による古生態の推定と古環境論（1974）は，今後この分野の大展開を予告するものとして高く評価される。

このように斎藤常正君は，世界的視野に立って浮遊性有孔虫の化石層序の追求と精細な分類学的基準の吟味を基礎として，浮遊性有孔虫の進化・古生態の解明さらにその生息環境の復元に著しい貢献をしている。よって日本古生物学会はここに学術奨励金を贈り，今後のいっそうの発展を期待する。

日本古生物学会特別号の原稿募集

PALAEONTOLOGICAL SOCIETY OF JAPAN, SPECIAL PAPERS, NUMBER 23を1978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，原稿の写しを添えて，〒812 福岡市東区箱崎 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。申込書とともに必ず原稿の写しを提出して下さい。（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。〔800～1,200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) 他からの印刷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〕。

(g) その他参考事項。

(4) 申込及び原稿提出締切 1977年10月25日（必着）。採否は 1978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) 上記（f）の他からの印刷経費支出の見込みがない場合は，1978年度の文部省刊行助成金（「研究成果刊行費補助金」）を申請いたしますので，上記 (2) の条件がみたされている場合にのみ考慮されます。

(6) 論文が完全な場合には，評議会での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の申請は，学会から行ない（例年は 11月末に申請締切），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。

(7) 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。

お知らせ

○**日本古生物学会特別号 No. 20**, “Devonian trilobites of Japan in comparison with Asian, Pacific and other faunas”（小林貞一・浜田隆士著，202頁，13図版，昭和52年1月31日発行）が文部省刊行助成金を得て刊行されました。定価は1部5,500円（郵送料・梱包料300円）です。特別号の国内販売は次の要領で行ないます。

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⑵ 申込ならびに送金先：〒812 福岡市東区箱崎 九州大学理学部地質学教室内 日本古生物学会特別号編集委員会〔振替口座 福岡19014；三和銀行福岡支店上記委員会普通預金口座 12172（注文通知は別に九大へ）〕。

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○**日本古生物学会報告・紀事（新篇）**のバックナンバーを購入御希望の方は 〒113 東京都文京区弥生 2-4-16 日本学会事務センター または 〒113 同区本郷 7-3-1 東京大学出版会にお問合せ下さい。なお，No. 97 以前の号には売切れになっているものがありますので，あらかじめ御了承下さい。

○**化石 No. 27** が近日中に刊行されます。予定されている内容は次の通りです。大場忠道・L. Ku：深海底堆積物中の炭酸塩溶解量の測定，首藤次男：群集古生態研究の現状と展望—底生群集を例として，石

崎国照：貝形虫研究の動向--Messinian Crisis の研究を例として，中川久夫：地中海地域上部新生界層序調査について（1），浜田隆士：化石余聞（その１）クラゲが化石になるとき，その他学会報告・抄録など。「化石」にかんする問合せと購入申込は下記にお願いします。〒980 仙台市青葉山東北大学理学部地質古生物学教室内　化石編集部。

行事予定

	開催地	開催日	講演申込締切
119回例会	静岡大学	1977年6月18日	1977年4月15日
120回例会	熊本大学	1977年10月16日	1977年8月15日
1978年総会・年会	京都大学	1978年1月	1977年11月

講演申込先：〒113 東京都文京区弥生 2-4-16　日本学会事務センター　日本古生物学会行事係

会計係より

○別記のように本年の総会で会費の金額が改正されました。会員の皆様には旧金額の会費振込用紙をお送りしておりますが，まだ御送金されていない方は，普通会員4,500円，特別会員6,000円に用紙の金額を訂正の上お送り下さい。なお，すでに御送金いただいた方の会費の差額につきましては別途に御案内いたします。

編集係より

○1975・76年度に投稿原稿の校閲者として尽力された諸兄に感謝いたします（御氏名は申し合わせにより公表いたしません）。

○本誌への投稿数が少なくなっておりますので，適当な原稿をお持ちの方は編集出版規約（1973年に配布した投稿案内または本誌 no. 100, pp. 240-241）を御参照の上，ふるって御寄稿下さい。近日中に投稿を予定されている方には投稿カードを送りますので御連絡下さい。

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○本誌 no. 104 の p. 464 の次にとじこんである2年分のタイトルページに次の誤りがありましたので，おわびして訂正します。

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