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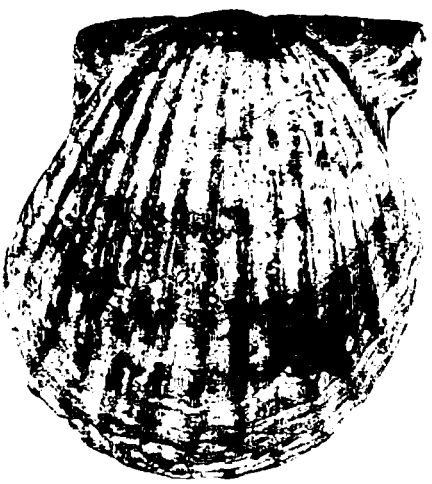

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505. PLANKTONIC FORAMINIFERA FROM THE SÔMACHI FORMATION, KIKAI-JIMA, KAGOSHIMA PREFECTURE, JAPAN*

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鹿児島県喜界島早町層の浮遊性有孔虫：喜界島の基盤をつくる早町層の浮遊性有孔虫化石を調べた結果，12属40種を検出した。この化石群は九州の高鍋層，東部台湾の三仙溪セクション，南部台湾の下部嘉義層，および琉球嶼泥岩等の浮遊性有孔虫化石群に近似している。化石群集の組成，殻の巻型，および中新世特有の種の欠如等によつて，早町層の時代は下部鮮新世と考える。

黄　敦友

Introduction

Twenty-four rock samples for micropaleontological study were collected by Dr. Hisao NAKAGAWA from the Sômachi Formation of Kikai-jima, Kagoshima Prefecture, during the summers of 1963 and 1964.

On washing, all of the samples yielded abundant and well preserved smaller Foraminifera except four which had very poorly preserved foraminifera or were barren of them. In total 40 species and subspecies of planktonic Foraminifera were discriminated from the washed materials.

The planktonic Foraminifera were chosen for the biostratigraphic study of the Sômachi Formation because of their abundance, good preservation, value in age determination and importance for world wide correlation.

So far as is known, this report is the first specifically designed to elucidate the planktonic foraminiferal fauna and their stratigraphic position in the Sômachi Formation of Kikai-jima. It is hoped that the present report on the planktonic foraminiferal fauna will contribute to a more satisfactory correlation and age-determination of the strata on Kikai-jima with the late Cenozoic deposits of southern Japan, Okinawa and Taiwan.

* Received August 14, 1965; read June 20, 1965 at Kanazawa.

Acknowledgements

The writer expresses his gratitude to Professor Kiyoshi ASANO of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University for his kind guidance and encouragement. Gratitude is expressed to Professor Kotora HATAI of the same Institute for reading the manuscript and valuable advice. Thanks are due to other members of the same Institute, Drs. Taro KANAYA for his kind advice and encouragement, Yokichi TAKAYANAGI for his permission to study his type specimens and other planktonic Foraminifera from the Nobori Formation, Shikoku; Hisao NAKAGAWA for his

valuable information on the geology of Kikai-jima, Messrs. Hiroo NATORI and Hiroshi NODA for joining in discussions on several problems.

Acknowledgment is made for the partial financial support of this investigation through a grant from the Japan Society for the Promotion of Science as part of the Japan—U. S. Cooperative Science Program.

Geography and General Geology

Kikai-jima is an islet of the Ryukyu Islands and is situated at about 10 kilometers east of Naze, Amamiôshima and 80 kilometers south of Kagoshima, Kyushu (Fig. 1). The geographic position of Kikai-jima is between Long. 129°54′53″ and 130°2′18″E., and Lat. 28°16′13″ and 28°22′52″N. The islet is oriented

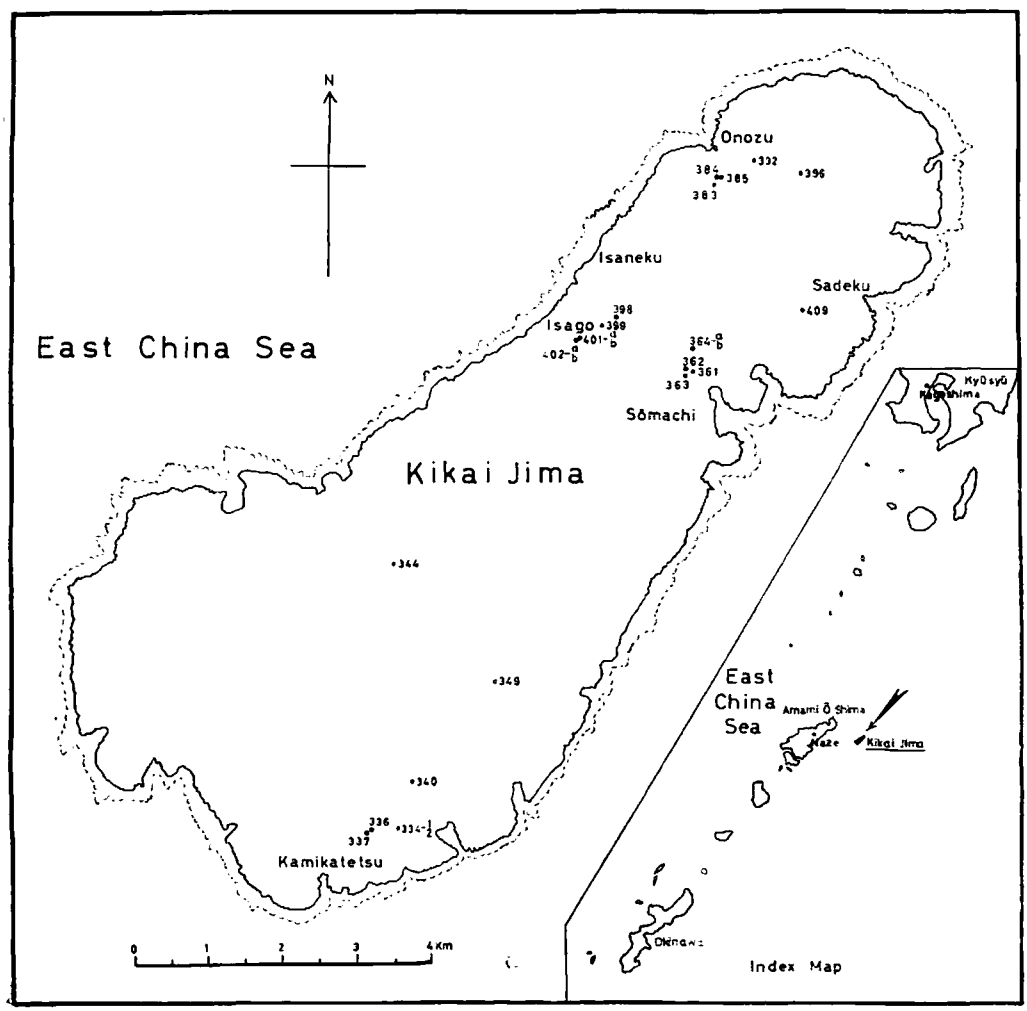


Figure 1. Map showing sample locations.

approximately N 30°E. and has an area of about 55 square kilometers. It is covered in part by uplifted coral limestone and living coral reefs. The Sômachi Formation which is newly proposed by NAKAGAWA (1965, personal communication) is a part of the so-called Shimajiri Formation (HANZAWA, 1925). The Sômachi Formation is about 300 meters in thickness and overlain with unconformity by the deposits of younger terraced coral reef limestones. The Sômachi Formation is composed of massive greenish or bluish gray siltstones and sandstone, sometimes intercalated with very thin tuffaceous layers. Descriptions on the geology of the islet will be given by Hisao NAKAGAWA in a paper now in preparation.

Method of Study

A uniform procedure was followed for quantitative analysis of the Foraminifera. The samples were washed on a 200 mesh screen. Two hundred specimens of planktonic and benthonic Foraminifera were counted and picked up at random according to the method described by ISHIWADA (1951), and their frequency composition was determined. Benthonic foraminifers were omitted because of being out of the scope of the present work.

Material Examined

The localities of the samples are shown on the map of Kikai-jima, Kagoshima Prefectcre (Fig. 1). The materials examined for the planktonic foraminifers comprised 24 field samples; these were obtained from four areas (Sadeku, Kamikatetsu-Sômachi, Isago-Isaneku, and On ozu) of the Sômachi Formation. The stratigraphic positions of the samples from the Sômachi Formation are indicated on the side of the columnar section (Fig. 2), and the lithology of these samples are given in the following chapter. The planktonic Foraminifera are illustrated (see plates) and the distribution of the species is shown in the chart (Table 1).

No Foraminifera were found in the samples from Nos. 349 and 396, and at Nos. 344 and 398 the samples yielded only ill preserved specimens whose external surface was dull colored, the chamber cavities are filled with calcite or limonite, and for such reasons they were not subjected to identification and therefore, omitted from the chart.

Except for the four samples mentioned above all the others without exception yielded more planktonic than benthonic species. In all of these samples the Foraminifera specimens showed tests with a fresh, lustrous appearance, with pores clearly visible and the chamber cavities usually empty.

All of the fossil specimens studied and figured in the present article are deposited in the collection of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, Sendai, Japan.

Descriptions of the Samples

The lithology of each sample and their localities are as follows in ascending stratigraphic order:

Loc. No. 337. Greenish gray, massive sandy siltstone, with sponge spicules and "OST".

Loc. No. 336. Yellowish brown, fine-grained, massive loose sandstone, with siliceous sponge spicules and "OST".

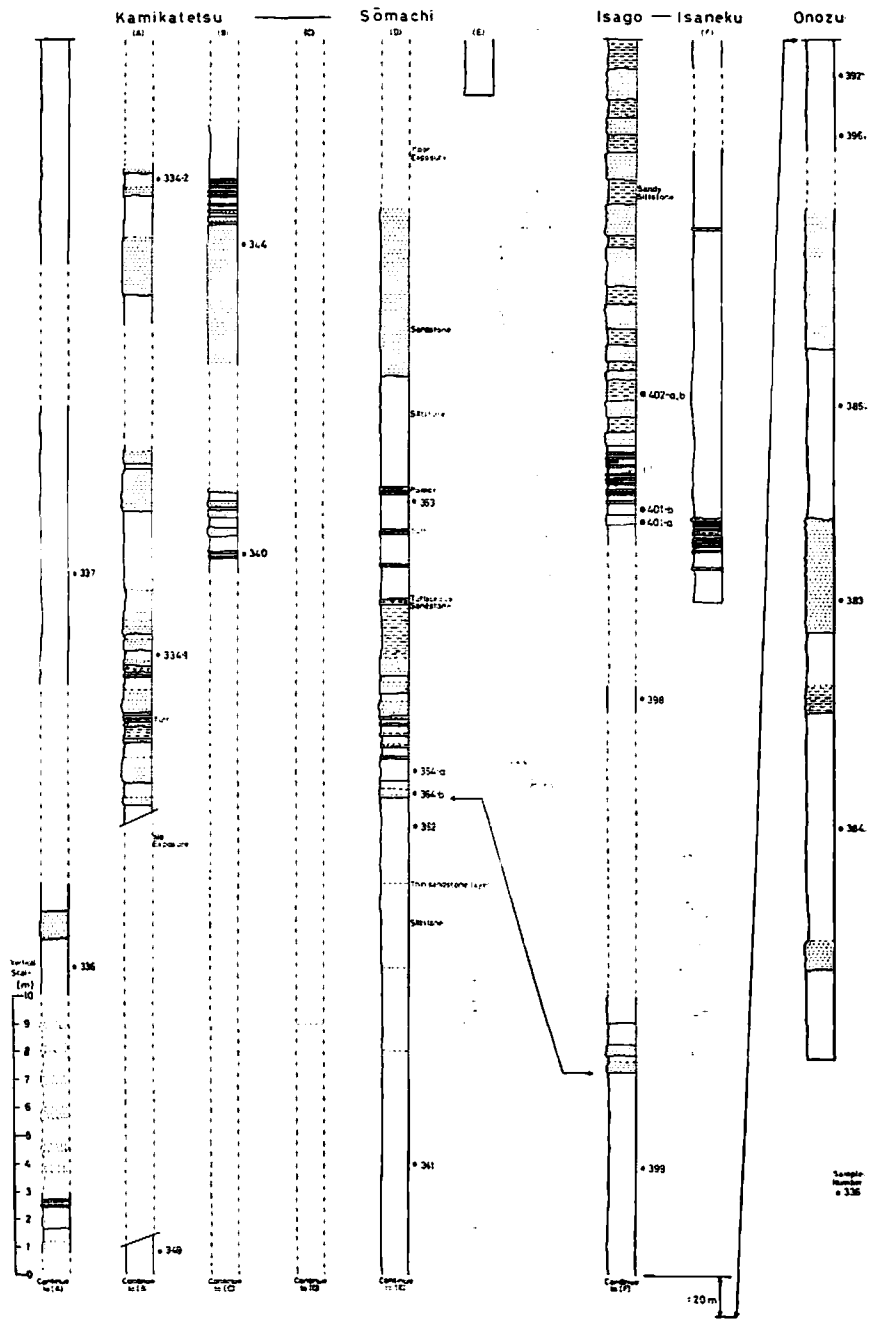


Figure 2. Composite stratigraphic column of the Sômachi Formation in Kikai-jima (after H. NAKAGAWA).

Table 1. Distribution of planktonic Foraminifera from the Sômachi Formation.
Key: Numbers represent percent of total planktonic population.

Formation	Sômachi																	
Sample Number	337	336	334-2	334-1	340	402-a	402-b	401-b	401-a	363	364-a	362	399	361	392	409	395	383
Planktonic population (in per gram)	1028	946	210	866	158	679	40	124	76	1949	71	103	88	177	172	58	1403	3034
Bolliella																		
adamsi													1					
Candeina																		
nitida		1			1								1					
Globigerina																		
apertura								1	1		1			2				
bulloides		3	6	6	4	9	3	4	3	3	4			2	3	2	4	2
decoraperta	8				3	5	10	6	5	2	4	2	7	11	7	8	5	5
diplostoma	1									1	1							
foliata	6	3	6	3	6	3	5	2	3	2	3	6	2	13			6	2
incompta	8		2	1		3		3	2	3	1	6	4	6	3	3	12	4
pachyderma	2	1	3	2		2			1		1		3	1			5	1
quinqueloba	1		1		1		3	1	1	1	1	1	5	8	1	1	5	1
woodi		2	1	1			2	5	9	1		2	6	5	3	1		8
Globigerinita																		
glutinata	26	9	23	15	13	20	31	11	21	14	20	58	12	20	51	47	14	15
humilis	2						3		1	1		4		5	2	5	5	
uvula	1																	
Globigerinoides																		
conglobatus	1			2				3	2		1		2		2		1	1
cyclostomus	1	5	3		2	1				2					1		2	
elongatus		4	1		3		1	4	2	3	3		4		1	1	2	1
immaturus		2			4		5	1		1	1		1		2	1	1	
obliquus		1		1		1		5	2		1		1		1			
ruber	14	19	14	14	6	8	7	8	10	13	14	4	10	8	3	8	6	12
sacculifer		3	1	4	3	3	1	1		3	4	2	3				4	
sacculifer fistulosus		1		1	1			3		1								1
trilobus	5	4	5	6	6	5	2	5	4	7	8	3	3	4	2	2	4	3
Globoquadrina																		
dutertrei	3	9	8	8	8	5	7	7	4	8	9	3	5	4	2	1	13	5
Globorotalia																		
crassaformis	1		1	3	5	2	6	2	1	4	1	2	4	1		2	1	4
hirsuta					1	1		1					1				1	
menardii menardii	1	1		3	6		6	2	1		3		5	2	1	5	1	1
menardii multicamerata					2			2			2		3			1	1	1
menardii tumida		3	3	3	4			2		4	4	1			2	2		1
tosaensis	1				1								1		1			
truncatulinoides		1	5	2											1			
Hastigerina																		
siphonifera	2	3	1	2	3	1		4	2	1	1	2	4		2		2	4
Orbulina																		
universa	1	1	1	1	9	2	1	2		1	3	1	7	1		1	1	1
Pulleniatina																		
obliquiloculata	4	7		7	2					3			1					
Sphaeroidinella																		
dehiscens		3	2	3	2		1			2		1	2		3	2	2	1
Subbotina																		
falconensis	6	2	4	2	3	3		2	1	1	1			5	5	1	1	3
Turborotalia																		
acostaensis	4	4	6	4		2	1			4	2	2	2	1		3		2
inflata		7	3	5		24		12	24	13	5				1	2	1	30
obesa		1		1			2	1								1		
scitula	1				1		1			1	1			1				1

Loc. No. 334-1. Pale yellowish to pale greenish gray silstone, with siliceous sponge spicules and "OST".

Loc. No. 334-2. Greenish gray mudstone, with siliceous sponge spicules and "OST".

Loc. No. 349. Whitish gray massive siltstone, barren of fossils.

Loc. No. 344. Yellowish brown, fine-grained loose sandstone, with alcyonarian skeletes, fragments of crab, and molluscan shells.

Loc. No. 340. Greenish gray, massive sandy siltstone, with fish otoliths, siliceous sponge spicules and "OST".

Loc. No. 402-a. Dark bluish gray, fine-grained, massive loose sandstone, with siliceous sponge spicules, echinoderm spicules and "OST".

Loc. No. 402-b. Greenish gray, massive sandy siltstone, with siliceous sponge spicules and "OST".

Loc. No. 401-b. Greenish gray sandy siltsone, with Ostracoda, siliceous sponge spicules, fragments of molluscan shells and "OST".

Loc. No. 401-a. Greenish brown, fine-grained, massive loose sandstone, with siliceous spicules, Bryozoa, Ostracoda and "OST".

Loc. No. 398. Greenish gray, massive sandy siltstone, with siliceous sponge spicules.

Loc. No. 363. Pale greenish gray mudstone, with siliceous sponge spicules and "OST".

Loc. No. 364-a. Pale greenish gray, massive siltstone, with siliceous sponge spicules and "OST".

Loc. No. 364-b. Yellowish brown, fine-grained, massive loose sandstone, barren of fossils.

Loc. No. 362. Pale greenish gray siltstone, with siliceous sponge spicules and Radiolaria.

Loc. No. 399. Greenish gray, massive sandy siltstone, with siliceous sponge spicules and "OST".

Loc. No. 361. Pale yellowish to pale greenish gray, massive sandy siltstone, with siliceous sponge spicules and "OST".

Loc. No. 392. Pale yellowish siltstone, with siliceous sponge spicules and "OST".

Loc. No. 396. Yellowish brown, fine-grained, massive loose sandstone, with siliceous sponge spicules.

Loc. No. 385. Yellowish brown, fine-grained, massive loose sandstone, with Ostracoda.

Loc. No. 383. Yellowish brown, fine-grained, massive loose sandstone.

Loc. No. 384. Greenish gray massive sandy siltsotone, with siliceous sponge spicules.

Loc. No. 409. Greenish gray, massive siltstone, with Radiolaria, siliceous sponge spicules and "OST".

"OST"=Abbreviation for a peculiar radiolarian fossil which will be described in an article now in preparation.

Faunal Consideration

The planktonic Foraminifera examined comprise three families (LOEBRICH and TAPPAN, 1964), 12 genera, and 40 species, and many of the species are identical with those commonly found in the late Tertiary sediments and Recent deposits of the Pacific region. Table 1 shows the stratigraphic distribution and relative abundance based on percentage-abundance count per sample of the species discriminated from the Sômachi Formation.

Although the compositions of each assemblages differ somewhat from one

another, they may be considered as a fauna representing one and the same geologic age.

The planktonic assemblages from the Sômachi Formation, with the exception of those from samples Loc. Nos. 349, 396, 344, and 398 are well preserved. The assemblages are characterized, in general, by large populations of planktonic Foraminifera and rare benthonic ones (Table 1 and Fig. 3). The planktonic Foraminifera found in abundance in the samples from the Sômachi Formation show that, during the deposition, the ecological conditions favored their flourishing.

Many of the late Tertiary and Recent species of the Pacific Islands, as well as those of the late Tertiary of Japan, Okinawa, Taiwan and the Philippines are represented in the fauna. With concern to the Sômachi fauna (Table 1), the Foraminifera from the Chiayi Formation of the Peikang PK-3 Well of the Peikang Shelf (HUANG, 1963), the Takangkou Formation and Chimei Formation in the Sanhsien-chi section of eastern Taiwan (HUANG, 1964) and the Liuchiuhsu Mudstone of Liuchiuhsu off the southwestern coast of Taiwan (HUANG, 1960) are recorded in the present article because of their intimate relation therewith. The majority of the species from the Sômachi Formation are identical with those from the Nobori Formation of Shikoku which TAKAYANAGI and SAITO (1962) reported, except for some that are restricted to the Miocene. Close affinity of the Sômachi fauna with that of the Takanabe Formation of Kyushu is evident.

The Sômachi fauna should be distinguished from the *Globigerina nepenthes*, *Globoquadrina altispira* and *Sphaeloidinelopsis seminulina* bearing rocks of the Taiwan-Kyushu region, because it is composed of planktonic Foraminifera much younger than the *Sphaeroidinella dehiscens-Sphaeroidinella seminulina subdehiscens* zone described by BANDY (1964).

In the Lower Pliocene according to BANDY (1964) there is a definite direction in the coiling of the Foraminifera whorls. And this is established evidence for age determination of a fauna. The coiling direction is determined to be right-handed or dextral when viewed from the dorsal side, the chambers being added in a clockwise direction, and left-hand or sinistrial when the chambers are added in counterclockwise direction. *Globigerina incompta*, *Globigerina pachyderma*, *Globorotalia hirsuta*, *Globorotalia menardii menardii*, *Globorotalia menadii multicamerata*, *Globorotalia scitula*, *Globorotalia tosaensis*, and *Globoquadrina dutertrei* show right coiling and *Globorotalia inflata*, *Globorotalia crassaformis*, *Globorotalia menardii tumida*, *Globorotalia truncatulinoides*, and *Pulleniatina obliquiloculata* show left coiling of the whorls. The results of the present study coincide in general with those obtained by BANDY, 1964; BELFORD, 1963; ERICSON *et al.*, 1961; and TAKAYAMA, 1962, MS., *etc.* It is considered that the foraminiferal fauna of the Sômachi Formation is early Pliocene in age as stated later.

Geologic Age of the Fauna and Correlation

The planktonic foraminiferal fauna of the Sômachi Formation is characteristic of the Pliocene sediments of southern Kyshu, Okinawa and Taiwan.

The planktonic formainiferal assemblages examined by the writer from the Sômachi Formation in Kikai-jima are not older than the Pliocene and are probably equivalent to the lower Pliocene Miaoli Group of Taiwan.

Many of the species identified in the assemblage are unknown below the Pliocene. The occurrence of *Globigerina quinqueloba*, *Globorotalia inflata* and *Globorotalia truncatulinoides* substantiates the assignment of an age not older than the Pliocene.

All the planktonic species found in the samples from the Sômachi Formation have also been reported from the Pliocene formations of the Pacific Island. The characteristic species of wide distribution in the Pacific area are *Globigerinoides sacculifer fistulosus* and *Globorotalia menardii multicamerata* which occur frequently in the Sômachi Formation. As already mentioned the change to left coiling in *Pulleniatina obliquiloculata* and to right coiling in *Globorotalia menardii menardii*, indicate a definite horizon in the lower Pliocene according to BANDY (Op. cit.).

Based on the studies of the late Tertiary planktonic foraminiferal faunas from southwest Japan, Okinawa, Taiwan, Philippines, Java, Borneo, Sumatra, and New Guinea, and the analysis of the planktonic foraminiferal fauna composition, coiling direction and population of the Sômachi Formation, it is concluded that the planktonic foraminiferal fauna of the Sômachi is lower Pliocene in age.

The foraminiferal fauna of the Sômachi Formation can be correlated with those from the upper part of the Takanabe Formation of southern Kyushu, the Shinzato Member of the Shimajiri Formation of southern Okinawa, the lower part of the Miaoli Group of Taiwan, the Panoran Mudstone of southern Iloilo, Philippines, the lower Kalibeng beds of Bodjonegoro, Java, and the Kalea Formation on the island of Siberoet off the west coast of Sumatra, and further, it is judged to correspond roughly to *h* stage of Indonesia and the Opoitian stage of New Zealand (HORNIBROOK, 1958).

Remarks on the Benthonic Foraminifera

Although the benthonic Foraminifera do not form the purpose of the present study, it may be worthwhile to present

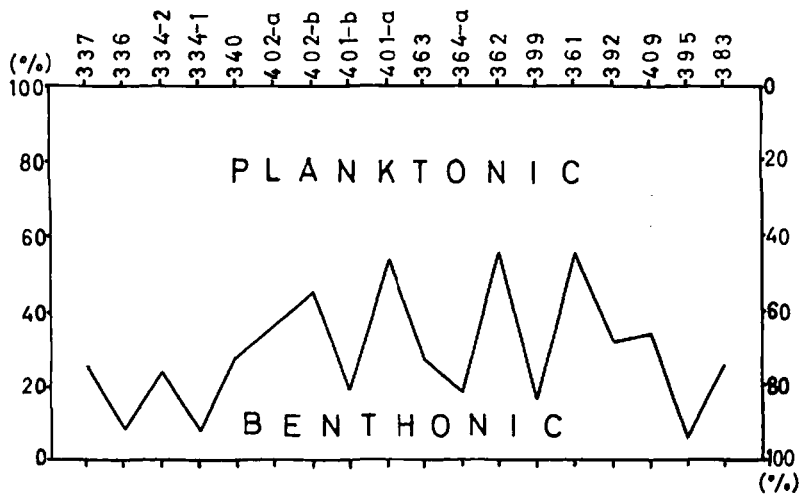


Figure 3. Cumulative percentage of Foraminifera from the Sômachi Formation.

a general aspect of the ones found in the samples from the Sômachi Formation.

The actual count of the individuals of planktonic and benthonic Foraminifera from the Sômachi Formation in terms of percentage is shown in Figure 3.

In composition the benthonic population does not differ much from sample to sample. Qualitatively, most of the species fall in the Lagenidae, Cassidulinidae, Uvigerinidae, Bolibinidae, Buliminidae, Rotaliidae. Representatives of the Miliolidae and Textularidae are rare. A few specimens of *Amphistegina* were found in the sample from Loc. No. 361.

The benthonic foraminiferal fauna from the Sômachi Formation as a whole shows striking resemblance with the fauna reported by OINOMIKADO (1955) and by the writer (1957 and 1964) from the formations of the lower part of the Miaoli Group in southern and eastern Taiwan. The benthonic fauna resembles the one from the Shinzato Member of Shimajiri Formation reported by LEROY (1964) and the upper part of the Miyazaki Group of Kyushu recorded by MURATA (1952).

So far as can be judged from the assemblage of the benthonic Foraminifera, the Sômachi Formation was deposited under the influence of moderately warm water at moderate depths in the open sea.

Associated with the benthonic Foraminifera are the remains of Ostracoda, fish otoliths, Bryozoa, Radiolaria, echinoid spines, coral (Alcyonarian skeletons), siliceous sponge spicules, fragments of minute molluscan shells and a peculiar radiolarian fossil which will be described in a paper now in preparation.

Remarks on the Paleoecology of the Planktonic Foraminifera of the Sômachi Formation

The planktonic foraminiferal fauna of the Sômachi Formation are representative of warm to temperate water similar to the present day seas of the area studied. The ecological studies on planktonic Foraminifera have progressed rapidly during the past ten years, but unfortunately, the knowledge on the Recent fauna is inadequate for interpretation of the paleoecology, and, as already pointed out by PARKER (1960), "nothing further can be said until more is known about the habits of the planktonic foraminifera". However, a few remarks with concern to geographic distribution of certain species can be given. *Globigerinoides sacculifer fistulosus* originally described from the Sandwich Islands of the Bismarck-Archipelago by SCHUBERT, does not extend its distribution very far north (TODD, 1964). *Globigerina pachyderma* and *Globigerina humilis* are fairly common in the Sômachi Formation but they have never been reported from the vicinity of Kikai-jima either living or fossil. *Globigerinita glutinata* is more common, but it seems to be restricted to the upper 50 meters in depth (SMITH, 1963; CIFELLI, 1961).

The data given above, although inadequate suggest that the Sômachi planktonic population is composed of species transported by the warm and the cool currents. In other words, although, it may be inferred that the Sômachi Formation was mostly influenced by the paleo-Kuroshio Current but the southward extension of the ancient Oyashio Current may have reached the area also.

According to BÉ (1960 and 1965), *Sphaeroidinella* does not live in waters shallower than about 300 meters, and it is probably rare even in basins not much deeper than 300 meters. From the depth range of that genus and its occurrence in the Sômachi Formation, it is inferred

that a deep basin existed in Kikai-jima during the deposition of that formation.

The planktonic population is represnted in terms of its percentage to the entire foraminiferal population of each sample (Fig. 3) and is treated as a separated group for comparison with the benthonic population. And, according to WALLER and POLSKI (1959), there is an increase in the percentage of planktonic Foraminifera with depth. From the above it is concluded that the Sômachi Formation was deposited in a moderately deep open sea of temperate to subtropical environment.

List of Foraminifera of the Sômachi Formation

The planktonic species are listed in alphabetic order with their original references and remarks are given necessary. All the species are illustrated in the annexed plates and taxonomic notes are included for some species.

Bolliella adamsi (BANNER and BLOW). pl. 28, fig. 23. (*Hastigerina* (*Bolliella*) *adamsi* BANNER and BLOW, 1959, *Palaeont., vol. 2, pt. 1*, p. 13, text-fig. 4). TODD (1963) expressed that *Globigerina digitata* BRADY is a synonym of *Hastigerina adamsi* BANNER and BLOW.

Candeina nitida D'ORBIGNY. pl. 28, fig. 25. (D'ORBIGNY, 1839, *in* de la Sagra, *Hist. Phys. Pol. Nat. Cuba*, "Foraminifères" p. 108, pl. 2, figs. 27 and 28). *Candeina nitida* is one of the less common species, and has been found in only three of the samples from Kikai-jima.

Globigerina apertura CUSHMAN. pl. 28, fig. 12. (CUSHMAN, 1918, *U. S. Geol. Surv., Bull. 676*, p. 57, pl. 12, fig. 8). In Kikai-jima, *G. apertura* was found only in four samples all of which belong to the lower part of the Sômachi Formation. The specimens from the Sômachi Formation coincide with CUSHMAN's figured holotype, described from the Miocene of Virginia, U. S. A.

Globigerina bulloides D'ORBIGNY. pl. 28, fig. 1. (D'ORBIGNY, 1826, *Ann. Sci. Nat., ser. 1, vol. 7*, p. 277, Modèles, no. 76). The specimens from the Sômachi Formation are considered to be identical with PARKER's figures of the species from the South Pacific (1962).

Globigerina decoraperta TAKAYANAGI and SAITO. pl. 28, figs. 16, 21, 27. (*Globigerina druryi* AKERS *decoraperta* TAKAYANAGI and SAITO, 1962, *Tohoku Univ., Sci. Rept. 2nd ser., Sp. Vol.* p. 85, pl. 28, fig. 10). *G. decoraperta* occurs frequently in the majority of the samples examined. TAKAYANAGI and SAITO (1962) figured one specimen from the Miocene Nobori Formation of Shikoku, Japan. The writer follows SAITO (1963) and PARKER (1964) in rising *decoraperta* to specific rank. PARKER pointed out that the species is very variable in morphological characters, and under the circumstances, TAKAYANAGI and SAITO's *G. nepenthes* (1962, pl. 26, figs. 2a-c) becomes a synonym of this species. Some specimens from the Sômachi Formation have an elongated final chamber such as is seen in *G. nepenthes* TODD, and some are similar to *G. tenera* which was described from the Pacific by PARKER.

Globigerina diplostoma REUSS. pl. 28, fig. 9. (REUSS, 1850, *Denkschr. Akad. Wiss., Vien. vol. 1*, p. 373, pl. 47, figs. 9, 10, pl. 48, fig. 1.

Globigerina foliata BOLLI. pl. 28, fig. 2. (BOLLI, 1957, *U. S. Nat. Mus., Bull. 215*, p. 111, pl. 24, fig. 1). The writer's specimens are slightly smaller than the typical ones.

Globigerina incompta CIFELLI. pl. 27, figs. 3, 7, 14. (CIFELLI, 1961, *Cushman Found.*

Foram. Res., Contr. vol. 12, pt. 3, p. 83-86, pl. 4, figs. 1-7). Generally, a well-defined lip is present. Often a fifth chamber is seen in various stages of development. This appears to be derived from the lip and often takes the appearance of a porch over the umbillical area. This form includes SMITH's *Globigerina pachyderma-eggeri* type (1963), which is stated to be most abundant among the surface samples reported by him.

Globigerina pachyderma (EHRENBERG). pl. 27, figs. 6, 10. (*Aristerospira pachyderma* EHRENBERG, 1861, *K. Preuss. Akad. Wiss. Berlin, Monatsber*, p. 276, 277, 303; 1873, pl. 1, fig. 4). *Globigerina pachyderma* from the Sômachi Formation, is a warm-water form as described by PARKER from the South Pacific.

Globigerina quinqeloba NATLAND. pl. 27, fig. 16. (NATLAND, 1938, *Univ. California, Scripps Inst. Oceanogr., Bull., Tech. ser., vol. 4, no. 5*, p. 149, pl. 6, fig. 7). The only difference observed compared with the type desribed by NATLAND is that frequently the lip over the aperture is absent, having been either broken or not developed. Young specimens (without aberant chamber) are difficult to separate from *Globigerina angustiumbillicata*.

Globigerina woodi JENKINS. pl. 28, fig. 5. (JENKINS, 1960, *Micropaleont., vol. 6, no. 4*, p. 352, pl. 2, fig. 2).

Globigerinita glutinata (EGGER). pl. 28, fig. 22. (*Globigerina glutinata* EGGER, 1893, *Abhandl. K. Bayer. Akad. Wiss., München, CLII, vol. 18, pt. 2*, p. 371, pl. 13, figs. 19-21). *G. glutinata* is abundant in the samples examined. Most of the specimens are with an umbilical cover-plate (bulla), which is variable. In this paper *Globigerinita* is used for the modern form, which includes forms with or without the bullae and with or without secondary apertures at the spiral side.

Globigerinita humilis (BRADY). pl. 27, figs. 2, 12. (*Truncatulina humilis* BRADY, 1884, *Rept. Voy. Challenger, Zool. vol. 9*, p. 665, pl. 94, fig. 7). The specimens of *G. humilis* from the Sômachi Formation show two kinds of wall structure. Most of the specimens have the wall finely perforate and a few specimens show densely perforate wall. The surface of the test is finely and sparsely hispid.

Globigerinita uvula (EHRENBERG). pl. 28, fig. 6. (*Pylodoxia uvula* EHRENBERG, 1861, *K. Preuss Akad. Wiss. Berlin, Monatsber.*, p. 276, 277, 308; 1873, pl. 2, figs. 24 and 25). The specimens of this species were found only in sample No. 337. The writer's specimens differ from the ones figured from the Pacific by PARKER (1962), by being slightly shorter.

Globigerinoides conglobatus (BRADY). pl. 28, figs. 18, 19. (*Globigerina conglobata* BRADY, 1879, *Quart. Jour. Micr. Sci., n. ser., vol. 19*, p. 286, 1884, *Rept. Voy. Challenger, Zool., uol. 9*, pl. 80, figs. 1-5; pl. 82, fig. 5).

Globigerinoides cyclostomus (GALLOWAY and WISSLER). pl. 28, fig. 13. (*Globigerina cyclostomus* GALLOWAY and WISSLER, 1927, *Jour. Pal., vol. 1, no. 1*, p. 42, pl. 7, figs. 8 and 9).

Globigerinoides elongatus (D'ORBIGNY). pl. 28, fig. 14. (*Globigerina elongata* D'ORBIGNY, 1826, *Ann. Sci. Nat., ser. 1, vol. 7*, p. 277).

Globigerinoides immaturus LEROY. pl. 28, figs. 15, 20. (*Globigerinoides sacculiferus* (RRADY) var. *immatura* LEROY, *Naturk. Tijdschr. Nederl. Inderl. Indie, vol. 99, no. 6*, p. 263, pl. 3, figs. 19-21).

Globigerinoides obliquus BOLLI. pl. 28, fig. 10. (BOLLI, 1957, *U. S. Nat. Mus., Bull. 215*, p. 113, pl. 25, figs. 9 and

10). *G. obliquus* is rare in the samples from the Sômachi Formation; the observed forms are all as high-spired as the paratype figured by BOLLI (1957), but the primary and supplementary apertures are smaller than the holotype and paratype.

Globigerinoides ruber (D'ORBIGNY). pl. 28, fig. 11. (*Globigerina ruber* D'ORBIGNY). 1839, *in* de la Sagra, *Hist. Phys. Pol. Nat. Cuba*, "*Foramnifères*", p. 82, pl. 4, figs. 12-14). *G. ruber* is frequent in most of the samples examined. PARKER (1962) based on his study of the South Pacific specimens divided the species into three groups. The specimens from the Sômachi Formation are of the cold-water type discussed by PARKER.

Globigerinoides sacculifer (BRADY). pl. 28, fig.4. (*Globigerina sacculifera* BRADY, 1877, *Geol. Mag., n. ser., dec. 2, vol. 4, no. 12*, p. 535; figure *in* 1884, *Rept. Voy. Challenger, Zool., vol. 9*, p. 604, pl. 80, figs. 11-17, pl. 82, fig. 4). In this paper *G. sacculifer* is used for modern forms with or without the saclike final chamber and includes *G. sacculifer irregularis* LEROY.

Globigerinoides sacculifer fistulosus (SCHUBERT). pl. 28, figs. 17, 30. (*Globigerina fistulosa* SCHUBERT, 1910. *Geol. Reichsanst. Verk., Wien., no. 14*, p. 324, fig. 2). A review of the geographic distribution of this species has been described and discussed by many authors (TODD, 1964). The species probably evolved from *G. sacculifer* within the early Pliocene. This variety, which is rarely found in the Sômachi Formation is of the typical form. It was first described from the Bismark Archipelago by SCHUBERT. The known records of this subspecies were listed by TODD who gave discussions concerning it. The majority of the records of this form are from the Pliocene. BRAMLETTE, FAUGHN and HURLEY (1959, p. 1550-1) have pointed out that the common occurrence of *G. fistulosus* may indicate the Pliocene.

Globigerinoides trilobus (REUSS). pl. 28, fig. 8. (*Globigerina triloba* REUSS, 1850, *K. Akad. Wiss. Wien., Math-Nat. Cl., Denkschr., vol. 1*, p. 374, pl. 47, fig. 11).

Globoquadrina dutertrei (D'ORBIGNY). pl. 27, figs. 22, 23. (*Globigerina dutertrei* D'ORBIGNY, 1839, *in* de la Sagra, *Hist. Phys. Pol. Nat. Cuba*, "*Foraminifères*", p. 84, pl. 4, figs. 19-21). This species is common in the samples from the Sômachi Formation. *G. dutertrei* which PARKER (1962) reports from the South Pacific, may belong to the genus *Globoquadrina* because it has a coarsely pitted wall and well developed umbilical teeth. The writer has not observed specimens of *G. dutertrei* with umbilical teeth from either Taiwan or Kikaijima (specimens are all in good preservation).

Globorotalia crassaformis (GALLOWAY and WISSLER). pl. 27, figs. 9, 20. (*Globigerina crassaformis* GALLOWAY and WISSLER, 1927, *Jour. Pal., vol. 1*, p. 41, pl. 7, fig. 12). The present species from the Sômachi Formation has a rather similarity to the one figured by PARKER from the Pacific (1962). It includes *Globorotalia* cf. *oceanica* form (TAKAYANAGI and SAITO, 1962 and SAITO, 1963) as its synonym.

Globorotalia hirsuta (D'ORBIGNY). pl. 27, fig. 4. (*Rotalina hirsuta* D'ORBIGNY, 1839, *in* Barker-Webb and Berthelot, *Hist. Nat. Ies. Canaris*, "*Foraminifères*", *vol. 2, pt. 2*, p. 131, pl. 1, figs. 37-39).

Globorotalia menardii menardii (D'ORBIGNY). pl. 28, fig. 26. (*Rotalia menardii* D'ORBIGNY, 1826, *Ann. Sci. Nat., ser. 1, vol. 7*, p. 273, no. 26; Modèles no. 10). *G. menardii menardii* and *G. menardii*

tumida found in the Sômachi Formation have quite different coiling-direction.

Globorotalia menardii multicamerata CUSHMAN and JARVIS. pl. 28, figs. 24, 32. (CUSHMAN and JARVIS, 1930, *Jour. Pal., vol. 4*, p. 367, pl. 34, fig. 8). Common in the Sômachi Formation. Typical specimens of *G. menardii multicamerata* occur in considerable numbers in the assemblages, and some seem to be similar to *G. menardii fijiensis* CUSHMAN.

Globorotalia menardii tumida (BRADY). pl. 28, fig. 31. (*Pulvinulina menardii* (D'ORBIGNY) var. *tumida* BRADY, 1877, *Geol. Mag., n. ser., dec. 2, vol. 4, no. 12*, p. 535; fig. in BRADY, 1884, *Rept. Voy. Challenger, Zool., vol. 9*, p. 692, pl. 103, figs. 4-6).

Globorotalia tosaensis TAKAYANAGI and SAITO. pl. 27, figs. 5, 15. (TAKAYANAGI and SAITO, 1962, *Tohoku Univ., Sci. Rept., 2nd ser. Spec. Vol.* p. 81, pl. 28, figs. 11-12). *G. tosaensis* was first described by TAKAYANAGI and SAITO from the upper Miocene Nobori Formation of Shikoku, Japan. As a result of the discussion with TAKAYANAGI, the writer here proposes the lineage *G. crassaformis—G. tosaensis—G. truncatulinoides* based upon study and comparison of their type specimens in the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan. Whatever the origin of these forms may be, they have considerable stratigraphical value. *G. crassaformis* occurs in the older samples and is associated with *G. tosaensis*. In younger samples (HUANG, 1964) *G. tosaensis* occurs with *G. truncatulinoides*. These latter two have not been observed in strata higher than the Pliocene in Japan and Taiwan. *G. tosaensis* has not been reported in deposits earlier than the *G. cultrata cultrata—Globigerina nepenthes* Zone. In addition, the two species have different coiling-direction distributions in the Sômachi Formation.

Globorotalia truncatulinoides (D'ORBIGNY). pl. 27, fig. 18, (*Rotalina truncatulinoides* D'ORBIGNY, 1839, *in* Barker-Webb and Berthelot, *Hist. Nat., Iles Canaries, "Foraminifères", vol. 2, pt. 2*, p. 132, pl. 2, figs. 25-27).

Hastigerina siphonifera (D'ORBIGNY). pl. 28, figs. 28, 29. (*Globigerina siphonifera* D'ORIGNY, 1839, *in* de la Sagra *Hist. Phys. Pol. Nat. Cuba, "Foraminifères"*, p. 83, pl. 4, figs. 15-18). The specimens studied are juveniles to adults. In all cases the young stages are planispiral. It is difficult to distinguish the juvenile forms from *G. obesa* (BOLLI). The earliest occurrence known to the writer is the middle Miocene Peikang Formation of Taiwan.

Orbulina universa D'ORBIGNY. pl. 27, fig. 24. (D'ORBIGNY, 1839, *in* de la Sagra, *Hist. Phys. Pol. Nat. Cuba, "Foraminifères"*, p. 3, pl. 1, fig. 1). The present specimens are all well developed, of the monothalamous type and the diameter is commonly up to 1 mm or more.

Pulleniatina obliquiloculata (PARKER and JONES). pl. 27, fig. 19. (*Pullenia sphaeroides* (D'ORBIGNY) var. *obliquiloculata* PARKER and JONES, 1865, *Roy. Soc. London, Phil. Trans., vol. 155*, p. 365, and 368, pl. 19, fig. 4).

Sphaeroidinella dehiscens (PARKER and JONES). pl. 27, fig. 1. (*Sphaeroidina bulloidaes* D'ORBIGNY var. *dehiscens* PARKER and JONES, 1865, *Roy. Soc. Lodon, Phil. Trans., vol. 155*, p. 369, pl. 19, fig. 5). In this paper *Sphaeroidinella dehiscens* is used for the modern form with or without the cortex as mentioned by BÉ (1965).

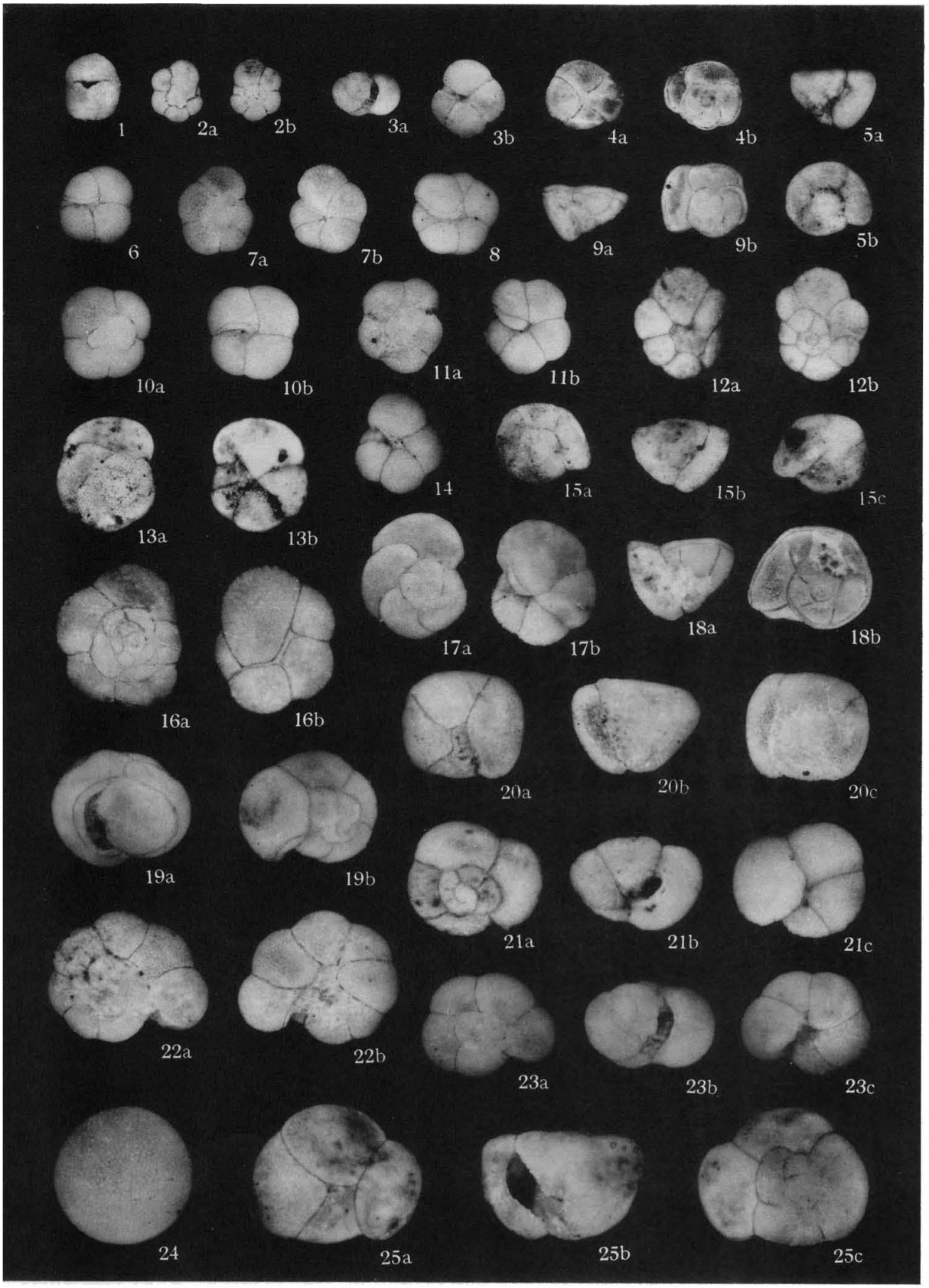
Subbotina falconensis (BLOW). pl. 28, fig. 3. (*Globigerina falconensis* BLOW, 1959,

Bull. Amer. Paleont., vol. 39, no. 178, pl. 9, figs. 40 and 41). The Sômachi form of this species closely resembles PARKER's figures of the species from the Recent sediments of the Pacific (1962). *G. falconensis* from the Sômachi Formation appears to be slightly more compressed, with a more lobulated periphery and a more open umbilicus compared with the type. The final chamber is almost invariably smaller than the penultimate one, and the aperture is low arched with a broad lip.

Turborotalia acostaensis (BLOW). pl. 27, figs. 8, 11. (*Globorotalia acostaensis* BLOW, 1959, *Amer, Pal., Bull. 39, no. 178*, p. 208-210, pl. 17, figs. 106-107). *Globigerina acostaensis* was first described by BLOW from Pozón. The Kikaijima specimens, the writer believes, are identical with *G. acostaensis*. The writer's specimens compare excellently with BLOW's figured holotype, described from the Miocene of Venezuela. This species shows typically the fairly rapidly enlarging spire, the 11-13 chambers composing the spire, and the 5-6 chambers of the last whorl. The last chamber is much reduced in size compared with its predecessor, and is occasionally somewhat displaced towards the umbilical side. The spiral side is almost flat, or occasionally slightly concave due to the inflated nature of the chambers of the last whorl. The aperture has a distinct lip.

Explanation of Plate 27

Fig. 1. *Sphaeroidinella dehiscens* (PARKER and JONES). From sample no. 365. ×26.
Figs. 2a-b. *Globigerinita humilis* (BRADY). From sample no. 401-b. ×55.
Figs. 3a-b. *Globigerina incompta* CIFELLI. From sample no. 401-a. ×50.
Figs. 4a-b. *Globorotalia hirsuta* (D'ORBIGNY). From sample 334-1. ×50.
Figs. 5a-b. *Globorotalia tosaensis* TAKAYANAGI and SAITO. From sample no. 392. ×50.
Fig. 6. *Globigerina pachyderma* (EHRENBERG). From sample no. 362. ×50.
Fig. 7a-b. *Globigerina incompta* CIFELLI. From sample no. 399. ×50.
Fig. 8. *Turborotalia acostaensis* (BLOW). From sample no. 364-a. ×50.
Figs. 9a-b. *Globorotalia crassaformis* (GALLOWAY and WISSLER). From sample no. 399. ×50.
Figs. 10a-b. *Globigerina pachyderma* (EHRENBERG). From sample no. 336. ×55.
Figs. 11a-b. *Turborotalia acostaensis* (BLOW). From sample no. 334-2. ×50.
Figs. 12a-b. *Globigerinita humilis* (BRADY). From sample no. 362. ×110.
Figs. 13a-b. *Turborotalia scitula* (BRADY). From sample no. 383. ×40.
Fig. 14. *Globigerina incompta* CIFELLI. From sample no. 362. ×34.
Figs. 15a-c. *Globorotalia tosaensis* TAKAYANAGI and SAITO. From sample no. 392. ×50.
Figs. 16a-b. *Globigerina quinqueloba* NATLAND. From sample no. 399. ×100.
Figs. 17a-b. *Turborotalia scitula* (BRADY). From sample no. 340. ×50.
Figs. 18a-b. *Globorotalia truncatulinoides* (D'ORBIGNY). From sample no. 334-2. ×50.
Figs. 19a-b. *Pulleniatina obliquiloculata* (PARKER and JONES). From sample no. 336. ×50.
Figs. 20a-c. *Globorotalia crassaformis* (GALLOWAY and WISSLER). From sample no. 399. ×40.
Figs. 21a-c. *Turborotalia inflata* (D'ORBIGNY). From sample no. 392. ×100.
Figs. 22a-b. *Globoquadrina dutertrei* (D'ORBIGNY). From sample no. 364-a. ×40.
Figs. 23a-c. *Globoquadrina dutertrei* (D'ORBIGNY). From sample no. 365. ×55.
Fig. 24. *Orbulina universa* D'ORBIGNY. From sample no. 399. ×40.
Figs. 25a-c. *Turborotalia inflata* (D'ORBIGNY). From sample no. 365. ×50.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Turborotalia inflata (D'ORBIGNY). pl. 27, figs. 21, 25. (*Globigerina inflata* D'ORBIGNY, 1839, *in* Barker-Webb and Berthelot, *Hist. Nat. Iles Canaries, "Foraminifères", vol. 2, pt. 2*, p. 134, pl. 2, figs. 7-9). This species occurs comonly in most of the samples examined. The specimens coincide with the typical form, and therefore ASANO's form (1957) and WALLER and POLSKI's form (1959, pl. 10, fig. 2) are placed in the synonymy of this specific name in this paper. According to SAITO (1963), this species is known only from the Pliocene of the Kakegawa district, Japan. GEIGER (1962) reported this species from a lower Pliocene formation of Taranaki Province, New Zealand. CHANG (1960, Table 1) pointed out that the species if found in beds of both Pliocene and Pleistocene age in Taiwan. The occurrence of it in the Liuchiuhsu Mudstone (Pliocene) (HUANG, 1960), and Takangkou and Chimei Formations (HUANG, 1964) of Taiwan are confirmed by the writer.

Turborotalia obesa (BOLLI). pl. 28, fig. 7. (*Globorotalia obesa* BOLLI, 1957, *U. S. Nat. Mus., Bull. 215, no. 5*, p. 119, pl. 29, figs. 2-3).

Turborotalia scitula (BRADY). pl. 27, figs. 13, 17. (*Pulvinulina scitula* BRADY, 1882, *Roy. Soc. Edinburgh, Proc., vol. 11*, p. 716; fig. in BRADY, 1884, *Rept. Voy. Challenger, Zool., vol., 9*, pl. 103, fig. 7). *T. scitula* occurs rarely in some samples, but the few examined agree closely with the original description.

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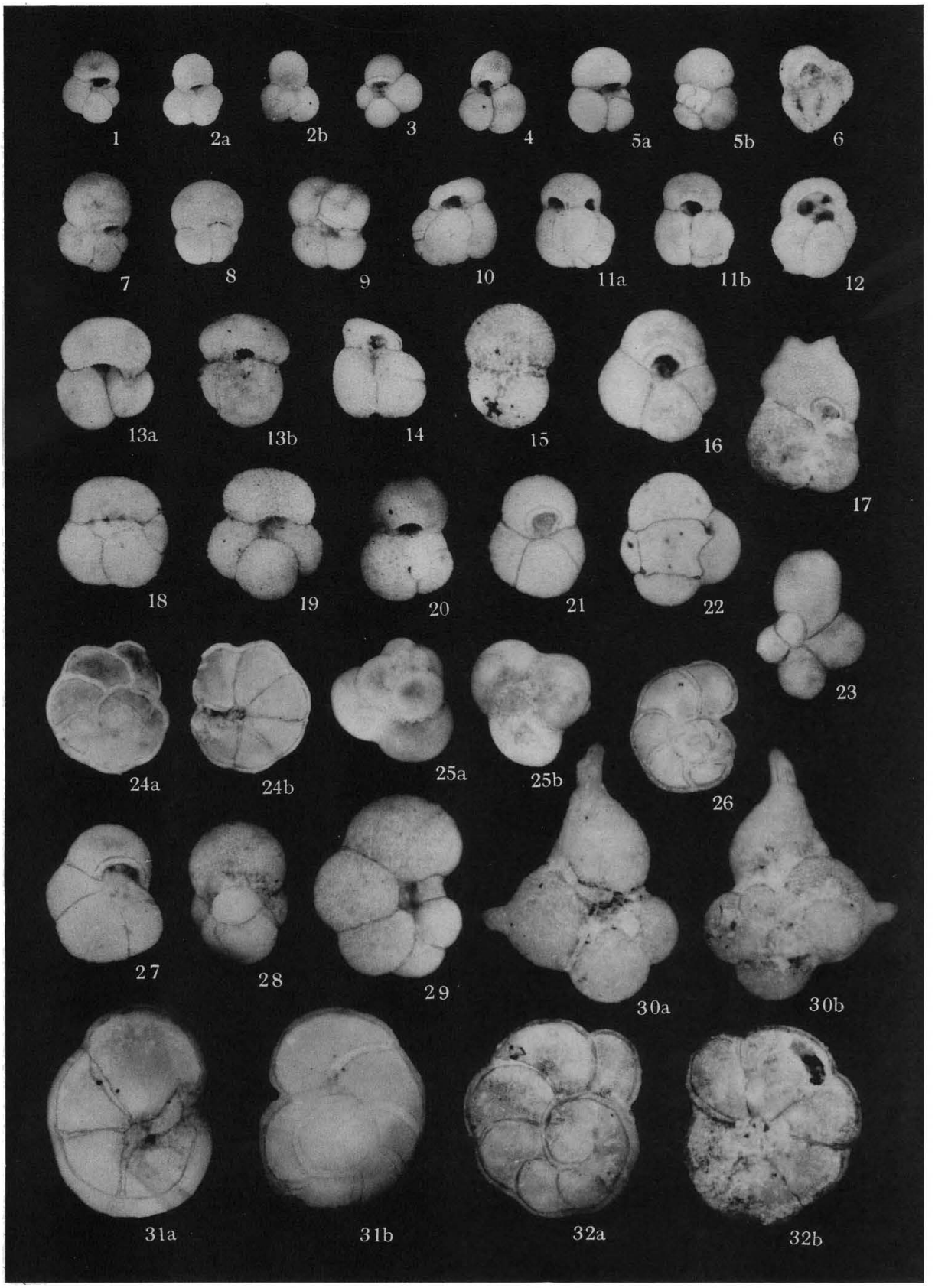
Explanation of Plate 28

Fig. 1. *Globigerina bulloides* D'ORBIGNY. From spmple no. 365. ×60.
Figs. 2a-b. *Globigerina foliata* BOLLI. From sample no. 334-1. ×50.
Fig. 3. *Subbotina falconensis* (BLOW). From sample no. 392. ×60.
Fig. 4. *Globigerinoides sacculifer* (BRADY). From sample no. 365. ×20.
Figs. 5a-b. *Globigerina woodi* JENKINS. From sample no. 392. ×60.
Fig. 6. *Globigerinita uvula* (EHRENBERG). From sample no. 337. ×58.
Fig. 7. *Turborotalia obesa* (BOLLI). From sample no. 336. ×55.
Fig. 8. *Globigerinoides trilobus* (REUSS). From sample no. 365. ×50.
Fig. 9. *Globigerina diplostoma* REUSS. From sample no. 337. ×55.
Fig. 10. *Globigerinoides obliquus* BOLLI. From sample no. 364-a. ×40.
Figs. 11a-b. *Globigerinoides ruber* (D'ORBIGNY). From sample no. 365. ×50.
Fig. 12. *Globigerina apertura* CUSHMAN. From sample no. 364-a. ×50.
Figs. 13a-b. *Globigerinoides cyclostomus* (GALLOWAY and WISSLER). From sample no. 365. ×50.
Fig. 14. *Globigerinoides elongatus* (D'ORBIGNY). From sample no. 365. ×40.
Fig. 15. *Globigerinoides immaturus* LEROY. From sample no. 399. ×44.
Fig. 16. *Globigerina decoraperta* TAKAYANAGI and SAITO. From sample no. 401-a. ×100.
Fig. 17. *Globigerinoides sacculifer fistulosus* (SCHUBERT). From sample no. 336. ×40.
Fig. 18. *Globigerinoides conglobatus* (BRADY). From sample no. 365. ×50.
Fig. 19. *Globigerinoides conglobatus* (BRADY). From sample no. 364-a. ×50.
Fig. 20. *Globigerinoides immaturus* LEROY. From sample no. 392. ×45.
Fig. 21. *Globigerina decoraperta* TAKAYANAGI and SAITO. From sample no. 392. ×100.
Fig. 22. *Globigerinita glutinata* (EGGER). From sample no. 392. ×80.
Fig. 23. *Bolliella adamsi* (BANNER and BLOW). From sample no. 399. ×110.
Figs. 24a-b. *Globorotalia menardii multicamerata* CUSHMAN and JARVIS. From sample no. 409. ×50.
Figs. 25a-b. *Candeina nitida* D'ORBIGNY. From sample no. 336. ×40.
Fig. 26. *Globorotalia menardii menardii* (D'ORBIGNY). From sample no. 336. ×60.
Fig. 27. *Globigerina decoraperta* TAKAYANAGI and SAITO. From sample no. 365. ×110.
Fig. 28. *Hastigerina siphonifera* (D'ORBIGNY). From sample no. 336. ×80.
Fig. 29. *Hastigerina siphonifera* (D'ORBIGNY). From sample no. 399. ×50.
Figs. 30a-b. *Globigerinoides sacculifer fistulosus* (SCHUBERT). From sample no. 383. ×45.
Figs. 31a-b. *Globorotalia menardii tumida* (BRADY). From sample no. 364-a.
Figs. 32a-b. *Globorotalia menardii multicamerata* CUSHMAN and JARVIS. From sample no. 340. ×40.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Chiayi Formation	嘉義層	Naze	名瀬
Chemei Formation	奇美層	Amamioshima	奄美大島
Isago	伊砂	Peikang PK-3 Well	北港PK第三号井
Isaneku	伊実久	Sadeku	佐手久
Kamikatetsu	上嘉鉄	Sanhsien-chi	三仙溪
Kikai-jima	喜界島	Sômachi Formation	早町層
Liuchiuhsu	琉球嶼	Takangkou Formation	大港口層
Miaoli Group	苗栗層群		

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506. A MESOZOIC AMMONITE FROM AMAMI-OSHIMA

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奄美大島産中生代アンモナイト：鹿児島県大島郡龍郷村秋名川下流の大勝頁岩層から得たアンモナイトを記載した。これは保存の不完全な外型であるが，特性をかなりよく示し，*Collignoniceras* (*Selwynoceras*) に属するらしいが，既知種のどれとも若干異なる点がある。他方 *Protacanthoras* でありうる可能性も保留しておきたい。従つて時代的には Turonian 下半かまたは Cenomanian 上半が暗示される。これを基に，奄美大島の地層の対比について一試案を提出した。またこのような装飾の強いアンモナイトが四万十相の時代未詳層から稀ながら産出することに関し，問題点を指摘した。　　松本達郎・石川秀雄・山口四郎

Introduction

Amami-Oshima, i.e. the main island of the Amami Archipelago, is located about 300 kilometers southwest off the southern coast of the main island of Kyushu and lies on the northeastern part of the arc of the Ryukyu Islands (Nansei-shoto). It consists primarily of folded sedimentary rocks which were at one time referred to the Upper Palaeozoic. Recently, however, possibility that the sedimentary series could be partly Mesozoic has been suggested by several persons (e.g. YANAGIDA, OTA and AKATSU, 1959, personal communication; KONISHI, 1963) from the comparison with the geology of southern Kyushu and also Okinawa. Therefore a confirmation on fossil evidence has been keenly needed.

* Received 9 December, 1965; read January 25, 1966 at Sendai.

While the two junior authors were engaged in a geological field work, a specimen of ammonite was fortunately found there (by S. Y., September, 1964), which was sent to the senior author (T. M.) for identification. The discovery was preliminarily reported in Japanese by ISHIKAWA and YAMAKUCHI (1965). The present paper contains the description of the ammonite, to which the senior author is primarily responsible, and also the discussion of the stratigraphic correlation. Before going further the writers wish to thank Professor Nobuhiro HATAE, Professor Shigeyuki MONDEN, Dr. Kametoshi KANMERA, Dr. Kenji KONISHI, Dr. Juichi YANAGIDA, Dr. Hakuyu OKADA and Dr. Itaru HAYAMI for their encouragement and kind help. Miss Misako KIDO and Miss Tomoko MIYAZAKI assisted in preparing the manuscript.

Palaeontologic Description

Family Collignoniceratidae

Genus *Collignoniceras* BREISTROFFER, 1947

Subgenus *Selwynoceras* WARREN and STELCK, 1947

Type-species:—*Prionotropis borealis* WARREN, 1930

Remarks:—There is a nomenclatorial question as regards the status of *Collignoniceras* and *Selwynoceras*. The senior author (MATSUMOTO, 1965, p. 9) has already given remarks on this point and also the distinction of *Selwynoceras*.

Collignoniceras (*Selwynoceras*) sp. nov. (?)

Text-fig. 1

Material:—A single specimen, a deformed external mould on black slaty shale, in the collection of S. YAMAKUCHI, Oshima High-School, Kagoshima Prefecture. A plaster cast of it is preserved in Kyushu University, GK.H 9298 (Fig. 1).

Description:—Although the specimen is incompletely preserved, it does exhibit some characteristic features. It is about 95 mm. in longer diameter but originally it must have been larger, since the last part is missing. The whorl enlarges moderately; the outer one overlapping

Fig. 1. *Collignoniceras* (*Selwynoceras*) sp. nov. (?). A plaster cast, GK. H 9298, for an impression on slaty shale of the Ohgachi Formation, Akina, Amami-Oshima, natural size (Kyushu Univ. photo). The original specimen is preserved in Earth Science Room, Oshima-High School, Nazé.

about one third of the inner. The umbilicus is approximately estimated at 28 percent of the diameter. The whorl is apparently higher than broad and seems to have rather flat flanks and a narrow venter, but the deformation is so strong that the original dimensions are hardly estimated with accuracy. The umbilical wall is low on the inner whorl and becomes fairly high and steeply inclined on the outer whorl.

The shell is characteristically ornamented with ribs and tubercles. The ribs are numerous, rather crowded, separated by somewhat narrower interspaces, normally alternately long and short, moderately strong and rectiradiate or slightly prorsiradiate. They become broader and apparently flatter on the outer whorl. On the inner whorl the umbilical tubercles are situated at the edges of the longer ribs. On the outer whorl they become stronger and are shifted upwards, being highest somewhat above the edges of the major ribs. The lower and upper ventrolateral and also siphonal tubercles are all clavate on the outer whorl and nearly equidistant. The lower ventrolateral ones are rounded on the inner whorl. The siphonal clavi are discontinuous, without forming a distinct keel. The ribs which run across the venter are nearly perpendicular to the siphonal line on the outer whorl and slightly curved forward on the inner whorl. They do not form distinct chevrons as in the adolescent stage of *Collignoniceras woollgari*. The tendency to form ventrolateral horns in the late growth-stage is not seen in the specimen at hand, probably because its last part is not preserved.

The suture is not impressed on the specimen, except for a faint, doubtful one on a portion of the surface.

Comparison:—As the specimen is imperfectly preserved there is some uncertainty in the identification. Comparison should be made carefully with all possibly allied species.

The specimen from Amami-Oshima apparently resembles some species of *Eucalycoceras* SPATH, 1923, such as *E. pentagonum* (JUKES-BROWNE, 1896) from the Upper Cenomanian of England, India (KOSSMAT, 1897) and Madagascar (COLLIGNON, 1964), and *E. underwoodi* POWELL (1963, p. 315, pl. 31, fig. 17, text-fig. 3e, g), from the Lower Turonian (?) of Trans-Pecos Texas, especially in the immature stage. In the adult body-whorl of these species of *Eucalycoceras* the ventral and ventrolateral tubercles are weakened and may finally disappear and in *E. pentagonum* the ribs become more crowded and numerous, while in the observable last part of the present specimen the tubercles are strengthend and the ribs become broader.

Our specimen is similar to some species of *Protacanthoceras* SPATH, 1923, such as *P. judaicum* (TAUBENHAUS, 1920) (see AVNIMELECH and SHORESH, 1964, p. 531, pl. 15, fig. 1), from the "Middle Cenomanian" near Jerusalem, but this and other typical species of *Protacanthoceras* have three closer rows of ventral clavi. In its crowded and rather rectiradiate ribbing our specimen is distinguished from any of the hitherto described species of *Protacanthoceras*.

The specimen from Amami-Oshima closely resembles *Collignoniceras* (*Selwynoceras*) *schlueterianum* (LAUBE and BRUDER, 1887) (see PETRASCHECK, 1902, p. 150[20], pl. 10[4], fig. 3; pl. 11[5], fig. 3; pl. 12[6], fig. 1), from the Lower Turonian of Bohemia and Sachsen, in the septate stage, but the former has more distinctly clavate lower ventrolateral tubercles than the latter. On the last body-whorl of that European species

the major ribs are distant, the ventrolateral tubercles are exaggerated to form large horns and the ventral clavi are more numerous than the horns. These features are not seen in our specimen, as far as the preserved part is concerned.

A specimen from the Lower Turonian *Labiatus*-Pläner of Leubnitz, Sachsen, which was described by PETRASCHECK (1920, p. 147[17], pl. 11[5], fig. 1) as "*Acanthoceras fleuriausianum*" is also allied to ours. The two specimens are, however, distinguished in that the former has less crowded ribs in the immature stage, more distant umbilical tubercles and more rounded, instead of clavate, lower ventrolateral tubercles than the latter. That specimen from Sachsen may not be identical with the holotype and other typical examples of *Collignoniceras* (*Selwynoceras*) *fleuriausianum* (D' ORBIGNY, 1841), from France, because the French ones have much broader whorls and more distant, stronger, mammillate umbilical tubercles.

Our specimen somewhat resembles the immature shell (as represented by paratypes) of *Collignoniceras* (*Selwynoceras*) *borealis* (WARREN, 1930), the type-species from the Turonian of Canada, but the ribs are more crowded and the lower ventrolateral tubercles are clavate in ours. The adult shell of *C.* (*S.*) *borealis*, as represented by the holotype, has a broader whorl and much more distant, somewhat prorsiradiate ribs which are flared at the ventrolateral shoulders on the whorl of the same diameter as that of the present specimen.

To sum up the specimen from Amami-probably represents a species of *Collignoniceras* (*Selwynoceras*) which is distinct from any of the hitherto described ones. As the last part of the whorl is not preserved the determination is not conclusive. A possibility that the specimen could be a new species of *Protacanthoceras* should be retained. Anyhow, the available material is so incomplete that a proposal of a new specific name is deferred until a better one is obtained.

Occurrence:—Found from a rolled block in the lower stream of the Akina, Tatsugo-mura, Oshima-gun, Kagoshima Prefecture, probably derived from the Ohgachi Shale (Fig. 2).

Stratigraphic Correlation

The geology of the Amami Islands was investigated by HATAE *et al.* (1959) and an outline geological map (Fig. 2) of Amami-Oshima is here adapted from them, with much simplification. Aside from small intrusive bodies of granitic rock and flat-lying Quaternary sediments, the island consists of the following sedimentary formations exposed from northwest to southeast.

(1) Naon Chert Formation: Chert with subordinate limestone, basic tuff, diabase, slate and sandstone, over 2000 m. thick.

(2) Odana Sandstone Formation: Predominant sandstone, partly conglomeratic, with some phyllitic slate, about 2000 m.

(3) Shinmura Slate Formation: Predominant slate, partly alternated with sandstone and basic tuff in thin beds, about 2200 m.

(4) Naze Slate and Tuff Formation: Slate and basic tuff, with some sandstone, about 2500 m.

(5) Ohgachi Shale Formation: Sandstone followed by dark coloured shale, repeated four times, about 4000 m. thick altogether.

(6) Wano Sandstone and Shale Formation: Alternating sandstone and shale, with thin coaly seams, about 2000 m.

Following HANZAWA's (1935) previous view, HATAE *et al.* considered (1) to (5) as Upper Paleozoic and (6) as Mesozoic. KONISHI (1963), on the basis of the comparison with the geology of Okinawa Island, led a tentative conclusion to date (1) as Palaeozoic, (4) as Triassic and Jurassic, and (2) and (6) as Cretaceous. Later KONISHI (1965) referred (6) to Eocene, because he and his colleague, T. ISHIBASHI, discovered *Nummulites*.

The ammonite described in this paper is probably a new species of *Collignoniceras* (*Selwynoceras*). The hitherto described species of *C.* (*Selwynoceras*) occur in the Turonian (more commonly in the Lower Turonian). It follows that the present ammonite suggests a Turonian

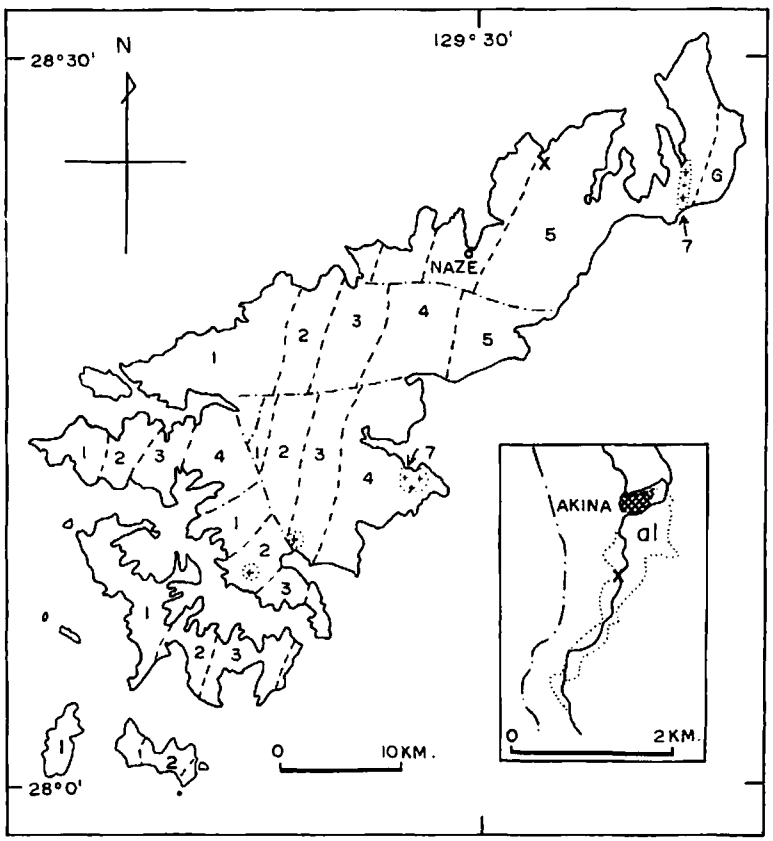

Fig. 2. Geological outline map of Amami-Oshima, with an enlarged map of an area near Akina at the lower right corner. Ammonite locality is indicated by ×. Geological map is adapted from HATAE *et al.* (1959), although KONISHI (1965, p. 446–7) considers the distribution of the formations in somewhat different way.

1: Naon Chert, 2: Odana Sandstone, 3: Shinmura Slate, 4: Naze Slate and Tuff, 5: Ohgachi Shale, 6: Wano Sandstone and Shale, 7: Granitic rock; al (in the smaller map): Alluvium along the stream of Akina.

age. Even if it could be referred to *Protacanthoceras*, a Middle to Upper Cenomanian age would be indicated by it. Therefore the Gyliakian (Cenomanian *plus* Turonian) is strongly suggested for the ammonite bearing bed.

The Ohgachi Formation was estimated to be as thick as 4000 m. by HATAE *et al.* (1959), who subdivided it into four units of a cyclic sequence from sandstone to shale (and then to alternating shale and sandstone in some cases). The ammonite came from what they considered the fourth, i.e. the uppermost, unit. According to them the first unit of the Ohgachi Formation is in fault contact with the Lower Tertiary Wano Formation. If we followed the stratigraphic sequence of HATAE *et al.*, the Naze Shale and Tuff would be ascribed to the upper half of the Upper Cretaceous. KONISHI (1965), however, interprets the order of succession by contraries. If this opinion was warranted, the Naze Formation would be older than Turonian (or Cenomanian), i.e. mainly Lower Cretaceous and possibly also a part of Jurassic, and the Ohgachi Formation would be younger than Cenomanian, i.e. mainly Upper Cretaceous.

Amami-Oshima and other islands of the Ryukyu arc are geologically intimately related to the southern part of the main island of Kyushu. As regards the knowledge of the pre-Tertiary geology of southern Kyushu the results of the recent studies by HASHIMOTO (1962) and KANMERA *et al.* (1964) are reliable. On the grounds of major stratigraphic sequence, lithologic similarly and tectonic configuration the following correlation may be tentatively proposed:

Amami-Oshima	South Kyushu	Geological age
Naon Formation	Konosé Group	Permian and Triassic
Odana Formation	Isshochi Group	Upper Cretaceous (?)
Shinmura Formation	Kawabé Group	Lower Cret.-Jurassic (?)
Naze Formation	Youra Group	Lewer Cret.-Jurassic (?)
Ohgachi Formation	Hyuga Group (Lower)	Upper Cretaceous
Wano Formation	Hyuga Group (Upper)	Lower Tertiary

The area of the Naon Formation, which was referred to the Motobu belt of Okinawa by KONISHI (1963, 65), may tectonically correspond with the southern part (Sambosan belt) of the Chichibu belt and that of Odana to Wano Formations with the Shimanto belt in the Outer Zone of Southwest Japan. Inasmuch as a significant thrust marks the southern limit of the Chichibu belt and also that of the Motobu belt, the boundary between the areas of Naon and Odana Formation is open for further reexamination. It is also claimed to decide more clearly the order of stratigraphic sequence in Amami-Oshima on various lines of evidence.

The thick series of shale and sandstone of the Shimanto belt is somewhat similar to the Flysch of the Alps and the Carpathians in various sedimentary features and in tectonotype. The Ohgachi Formation may be comparable with a part of the Flysch. Aside from certain kinds of trace fossils, megafossils are very rare in this kind of sedimentary group. The ammonite described above really exemplifies an exceptional occurrence. It is furthermore noted that this rare megafossil is that of the ornate

ammonite group, the Acanthocerataceae, which normally occur more commonly in the epicontinental shallow sea environments. A similar statement can be extended to the rare occurrence of ammonites from the Shimato belt of Shikoku, *Dipoloceras* and *Kazanskyella* described by MATSUMOTO *et al.* 1952, and *Cheloniceras* by NAKAI and HADA, 1966, which all belong to the ornate ammonites, Acanthocerataceae and Hoplitaceae. Whether these ammonite shells were transported from the adjacent epicontinental sea to the basin of flysch-type sediments or their habitats were extended to at least a part of this kind of sedimentary basin is a question which needs further study.

It should be recalled in this connection that DZULYNSKI and SANDERS (1962, p. 80, pl. 18B, pl. 19B) showed roll marks in the Mancos Shale, Arizona, which were interpreted to have been made by rolling of ammonite *Collignoniceras woollgari* as supported by an experiment. We should search for such marks and imprints in the Ohgachi Shale for the reasonable solution of the above question.

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Locality Guide

Akina, Tatsugo-mura, Oshima-gun, Kagoshima Prefecture (Approximately 129°33′30″ East Long., 28°26′7″ North Lat.) 鹿児島県大島郡龍郷村秋名 (国土地理院5万分の1地形図幅「赤木名」の北西隅からほぼ南に 7300 m., 東に 5750 m. の地点)

Alphabetic List of Formational Names Cited in the Text

Hyuga Group	日向層群	Odana Formation	大棚層
Isshochi Group	一勝地層群	Ohgachi Formation	大勝層
Kawabé Group	川辺層群	Shinmura Formation	新村層
Konosé Group	神ノ瀬層群	Wano Formation	和野層
Naon Formation	名音層	Youra Group	四浦層群
Naze Formation	名瀬層		

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 62, pp. 242-250, pls. 29, 30, June. 30, 1966

507. DISCOVERY OF APTIAN AMMONITES FROM THE SHIMANTO TERRAIN, WESTERN SHIKOKU*

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and

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西部四国の四万十帯より Aptian Ammonites の発見：愛媛県北宇和郡広見町近永国鉄駅の南西方約500 mの道路の切割りで，アンモナイト数個体が得られた。産出地層はこれまで，宇和島東部地方の四万十帯中の“鳥ノ巣統”相当層と考えられていた。なお，正確な産出地点は不明であるが，同一地域からの類似岩石中から産したアンモナイト2個体を，高知大学の甲藤次郎教授から頂いた。これらのアンモナイトを検討した結果，1個体は *Cheloniceras* (s.s.) *minimum* CASEY の近似種，残りの個体は同亜属の新種であることが判明した。同亜属はアプチアン階（下部白亜系下部宮古統）を指示する。よつて，この付近のユラ系とされていた地層は，宇和島南方に分布する北灘層と同一系統であり，アプチアン階であると判断される。

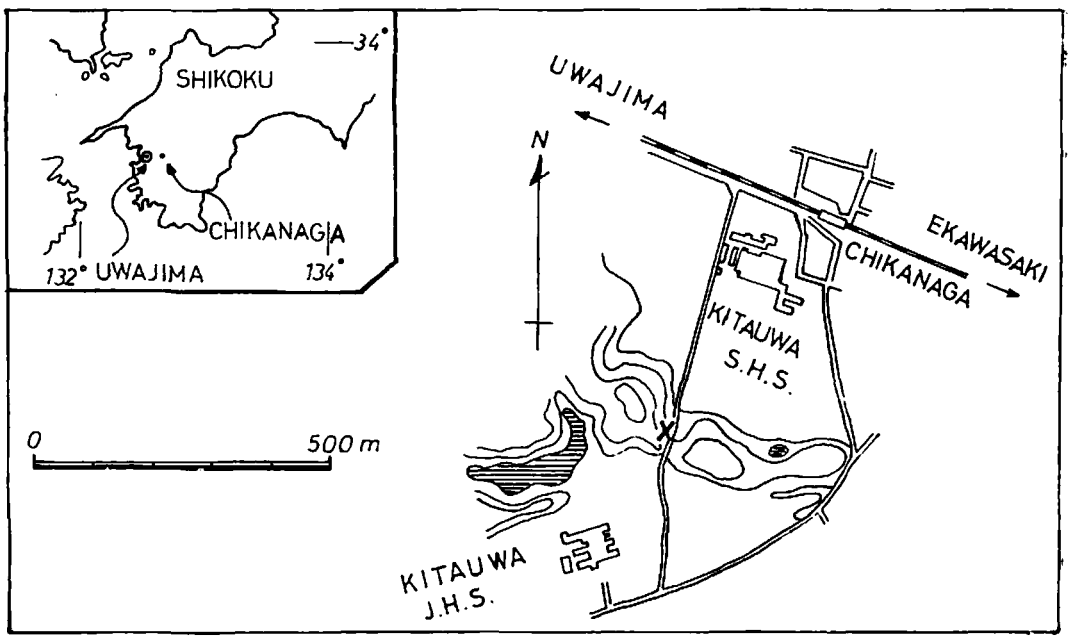
中居 功・波田重熙

Introduction

In January, 1963, Mr. Tsutomu TAKADA, teacher of the Kitauwa Senior High School, sent to one of us (S. H.) an ammonite specimen collected from a road cut (then under reconstruction) about 500 m southwest of the Chikanaga Station of the National Railway, Hiromi-cho, Kitauwa-gun, Ehime Pref., Shikoku.

When Prof. K. ICHIKAWA visited Kyushu University (in July, 1963), this was shown to Prof. T. MATSUMOTO, who preliminarily identified it as *Cheloniceras* sp. aff. *Ch. minimum* CASEY of the Aptian age and suggested the need of further study. Stimulated by the discovery, one of us (S. H.), under Prof. ICHIKAWA's supervision, made a geological survey of the locality and its surrounding area, in August, 1963. The strata exposed at the very point of the fossil locality had been largely cut off already for the road construction. A few fragments of ammonites, however, were obtained from a pile of slabs which had been brought about from the locality. Furthermore, it was noticed that several better preserved larger specimens of ammonite had been collected at the same locality and kept in the Kitauwa Junior High School. They were later transferred to the collection of Department of Geoscience, Osaka City University, through the courtesy of Mr.

* Received December 23, 1965; read September 25, 1965, at Nagasaki.



Text-fig. 1: Index map (left) of Chikanaga district and locality map (right). Sign × shows the locality of the specimens. OCU. MM 901-906.

Toshihiro IZEKI, teacher of the Kitauwa Junior High School.

By the courtesy of Prof. J. KATTO, Kochi University, besides, a few fragmentary specimens which belong to the genus *Cheloniceras* were sent to Prof. T. MATSUMOTO, just then under whose supervision we were studying the Chikanaga specimens. According to his private communication to Prof. MATSUMOTO, these specimens had been collected several years ago from the Uwajima district, without record of the precise point. By his courtesy, they have been transferred to and are now preserved in the Department of Geology, Kyushu University.

Before going further, we wish to express our cordial thanks to Professors Tatsuro MATSUMOTO and Koichiro ICHIKAWA who have generously rendered us opportunity of studying these interesting specimens, given kind advice and read the manuscript. Thanks are also due to Prof. Jiro KATTO, Mr. Tsutomu TAKADA and Mr. Toshihiro IZEKI, who supplied the specimens for the study.

Geologic Notes

The Outer Zone of the Southwest Japan is divided by a major tectonic line, Butsuzo line, into two belts, that of predominantly Paleozoic rocks in the north and that Mesozoic and Lower Cenozoic strata in the south. The southern one is occupied by an apparently thick and monotonous series of sedimentary rocks generally called Shimantogawa Series or Complex. In spite of its wide distribution, it is generally so poor in fossils and so intensely folded that it used to be referred to as the "undifferentiated Mesozoic". Through intensive fossil

hunting, however, Late Jurassic, Cretaceous and Early Cenozoic fossils have hitherto been found here and there. The locality of the ammonites to be dealt with in this paper lies at the eastern margin of the Uwajima area where the fossiliferous, better defined Upper Cretaceous was mapped to be in contact with the undifferentiated Complex.

The stratigraphic works of the area have been made by YEHARA (1925), MATSUZAWA and SUGAI (1934, 36), SUZUKI (1935, 36), KUDO (1950), NAGAI (1957), NAKANO (1965), etc. In the western part of the area, including the Uwajima (proper), Yoshida and Iwamatsu districts, following succession has been discriminated in descending order (MATSUMOTO [Ed.], 1954, pp. 97-99).

(4) Uwajima Group, with ammonites and inocerami indicating the Upper Gyliakian and the Lower Urakawan ages.

(3) Shitaba* Formation, with *Inoceramus* sp. aff. *I. crippsi* MANTELL of Lower (or Lowest) Gyliakian age.

(2) Kitanada Formation, containing limestone lenses with *Stromatopora* sp. and *Petrophyton* sp. cf. *P. miyakoense* YABE.

(1) Undivided part of the Shimantogawa Complex.

The present fossil locality is included in the Chikanaga district, eastern part of the Uwajima area, where SUGAI (*in* KOBAYASHI, 1950) distinguished the Upper Cretaceous sequence from the older complex. The latter was divided, as YEHARA (1924) did, into the "Torinosu Group" and "Akigawa Group". Except for the specimens from Prof. KATTO, the present ammonites came from the "Torinosu Group" which is composed of fine sandy-mudstone and sandstones, with intercalation of a small body of limestone. As a result of a field survey (by S. H.), the bed exposed at the present fossil locality is determined as stratigraphically lower than the lenticular limestone to the southeast of Uchiko, about 1 km west-northwest of the ammonite locality. The limestone contains *Petrophyton miyakoense* YABE. Although the field relationship between the fossiliferous Upper Cretaceous and the so-called Torinosu Group is not yet determined, owing to complicated structure, it is quite certain that the formation including the limestone-lens and the ammonite-bearing bed under consideration should not be referred to the Upper Jurassic. This formation is probably contemporaneous with the Kitanada formation in the eastern part of the Uwajima area. MATSUMOTO (1954) pointed out previously that the Kitanada formation may tentatively be assigned to the Miyakoan.

* Read Shitaba for Shimonami in p. 97 of MATSUMOTO [Ed.], 1954, as corrected by NAGAI (1957, p. 29).

Paleontologic Description

Family Douvilleiceratidae PARONA and BONARELLI, 1897

Subfamily Cheloniceratinae SPATH, 1923

Genus *Cheloniceras* HYATT, 1903

Type-species:—*Ammonites cornuelianus* D'ORBIGNY, from Lower Aptian of the Paris Basin (by designation of International Commission of Zoological Nomenclature, Opinion 428, 1956).

Subgenus *Cheloniceras* (s. s.)

Cheloniceras (*Cheloniceras*) *shimizui* sp. nov.

Pl. 29, fig. 2a-e; Pl. 30, figs. 1-4; Text-figs. 2, 3.

1931. *Cheloniceras* sp. indet., SHIMIZU, pp. 33-34, pl. 3, figs. 12-14.

Material:—The holotype, OCU. MM901, and six paratypes, OCU. MM 902-905 and GK. H 6901-6902.

Measurements (in mm.):—

Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
OCU. MM 901 (inner whorl of the holotype)	45.5+	14.0	—	(−)	17.2	(39−)
OCU. MM 901 (outer whorl of the holotype, less deformed septate part)	—	33.2	38.3	(1.15)	—	(−)
OCU. MM 902	—	57.0	64.6+	(1.11+)	—	(−)
OCU. MM 903	—	72.6	66.5	(0.91)	—	(−)
OCU. MM 904	—	78.9	66.5+	(0.84+)	—	(−)
OCU. MM 905	—	—	125.0	(−)	—	(−)
GK. H 6901	—	76.0	68.0+	(0.89+)	—	(−)
GK. H 6902	—	57.8	62.4+	(1.08+)	—	(−)

Specific Diagnosis:—Shell large and similar to *Cheloniceras* (s. s.) *meyendorffi* (D'ORBIGNY) in mode of ribbing. Whorl not much depressed with rather broadly arched venter. Lateral tubercles, which persist until fairly later growth-stages, smaller than umbilical ones.

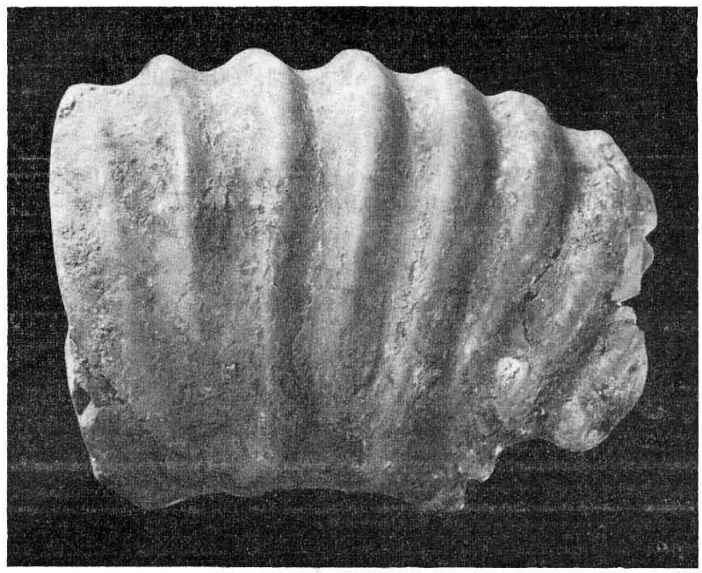
Description of holotype:—The holotype, which may represent comparatively earlier stages of growth, shows the following characters.

The shell is moderately evolute. The whorl grows rather slowly: it is at first apparently higher than broad and then nearly as broad as high, being subquadrate in section with a rather broadly arched venter and parallel, flattened flanks. The umbilicus is of moderate size (about 40 per cent of diameter), surrounded by a rather high umbilical wall and a subrounded umbilical shoulder. Ribs consist of primaries, secondaries and intercalatories. They are separated by narrower interspaces and slightly prorsiradiate on the flanks crossing nearly straightly over the venter in perpendicular to the siphonal line, and descend obliquely forwards on the umbilical wall. The primary has a tubercle respectively at the umbilical angle and at the mid-flank. The umbilical tubercle shows the pinched from which is flattened in lateral view, and triangular and spinose in frontal view. The lateral tubercle is conical and high. The former is larger and higher than the latter. The secondaries are branched from every lateral tubercle with a low angle, forming Y-shape. The intercalatories are rather thinner than the primaries and most of them disappear on the flanks, but some of them reach the umbilical margin or are combined with the primaries at the umbilical margin. On a half-whorl at 45 mm in whorl-height, there are eight primaries and one to three intercalatories between the primaries.

The suture-line is essentially of the same pattern as that of the type-species, *Cheloniceras* (s. s.) *cornuelianum*.

Description of paratypes:—Six paratypes, which seem to represent late growth-stage, show the following characters.

The whorls grow rapidly, and the whorl-section shows a subcircular shape with a rounded venter, inclined and gently inflated ventrolateral slopes, gently



Text-fig. 2. *Cheloniceras (Cheloniceras) shimizui* sp. nov. Paratype, GK. H 6901, ×2/3.

convex and rather convergent flanks and subrounded umbilical shoulder. Specimen, OCU. MM 905, which shows the tendency of an octagonal shape with a flattened and even slightly concave venter at the whorl-breadth of about 130 mm, is regarded as an extreme variant. The umbilical wall is rather high. Ribs consist of primaries and intercalatories. Each primary has an umbilical tubercle which becomes irregularly to be strong and stout or to be smaller and faint, and has a faint oblique, occassionally disappearing, lateral tubercle. No branching is seen at all. On the flank the intercalatories are finer than and alternated with the primaries. Ribs are very stout and plicate, and become to be separated by gradually broader interspaces. The rib-density fairly decreases in comparison with the young stage. On the dorsum, as seen in the specimens, OCU. MM 903 and OCU. MM 904, there are the impressions which seem to be made by the ribs on the venter of the earlier whorls such as on the outset one of the holotype.

The suture-line is exposed on the ventral and ventrolateral parts of OCU. MM 905, and almost wholly in OCU. MM 902. It is very similar to that of *Ch. (Ch.) cornuelianum*, but the external saddle is very strongly bifid.

Remarks:—Although the available specimens are incompletely preserved and more or less fragmentary, the largest one is presumed to be 600 mm in diameter when restored. The speçimen, OCU. MM 905, is about 130 mm wide and still septate. On closer inspection these fragmentary ones have proved to be all identified with one species of *Cheloniceras* (s. s.), which is closely related to *Ch. (Ch.) meyendorffi* (D'ORBIGNY) as defined by CASEY (1962). By comparison with his detailed description and illustration of *Ch. (Ch.) meyendorffi*, the following points are the distinction: (1) The present species does not show the typical *Cheloniceras*-like whorl-section as

Ch. (*Ch.*) *meyendorffi*. Its whorl is less depressed than the typical one at corresponding size. Its venter does not appear to be so flattened as in *Ch.* (*Ch.*) *meyendorffi*. (2) The present species has, conversely, a larger umbilical tubercle than lateral one. (3) The present species becomes much larger than *Ch.* (*Ch.*) *meyendorffi*. The holotype of the latter, from Saratov in Russia, is a smaller internal mould about 50 mm in diameter, while our largest specimen, OCU. MM905, is estimated to be at least 600 mm in a restored diameter. (4) The present species, as seen on the specimens, OCU. MM 902-905 and GK. H 6901-6902, has a faint and oblique lateral tubercle on the primary rib even in the adult stage, which disappears at about 120 mm in diameter in *Ch.* (*Ch.*) *meyendorffi* as in many other species of *Cheloniceras* (s. s.).

In view of the above mentioned differences, the present specimens are certainly referred to a new species.

In Japan the following species of *Cheloniceras* have been reported:

i) *Cheloniceras subcornuelianum* (SHIMIZU) [from the Hiraiga Sandstone of the Miyako Group in Iwate Prefecture (SHIMIZU, 1931) and from the Hibihara formation in the Ryoseki valley, Kochi Pref. (ISHIZAKI, 1960)].

ii) *Cheloniceras* sp. indet. [from the "Mochii Sandstone" (=the Hoji formation?) in the Katsuuragawa valley, Tokushima Pref. (SHIMIZU, 1931)].

The first species was originally referred to *Acanthoplites*, but later transferred to *Cheloniceras* by MATSUMOTO (1954). It probably belongs to *Cheloniceras* (*Epicheloniceras*), because it has ventral tubercles. The second species is represented by a rather large, fragmentary specimen (65 mm in whorl-breadth) [*see* SHIMIZU, 1931, pp. 33-34, pl. 3, figs. 12-14]. Judging from the whorl-section and the mode of ribbing, it is undoubtedly conspecific with the present species. This is the reason why we give the specific name *shimizui*.

Occurrence: — The specimens, OCU. MM 901-905, were collected from sandy mudstone at the road cut (now missed out) about 300 m south of the Kitauwa Senior High School, Hiromi-cho, Kitauwa-gun, Ehime Pref. The others, GK. H6901-6902, were collected also from the same area, although the very point is not known.

An allied species, *Ch.* (*Ch.*) *meyendorffi*, is characteristic of the upper Lower Aptian, as indicated by CASEY (1961a).

Cheloniceras (*Cheloniceras*) sp. aff. *Ch.* (*Ch.*) *minimum* CASEY

Pl. 29, fig. 1a, b; Text-fig. 4.

Compare:—
1962. *Cheloniceras* (*Cheloniceras*) *minimum* CASEY, p. 127, pl. 35, fig. 5a-c.

Material:—A single specimen, OCU. MM 906. It is incompletely preserved and represented by an internal mould of an inner whorl, and a part of the external mould of outer whorls.

Measurements (in mm.):—

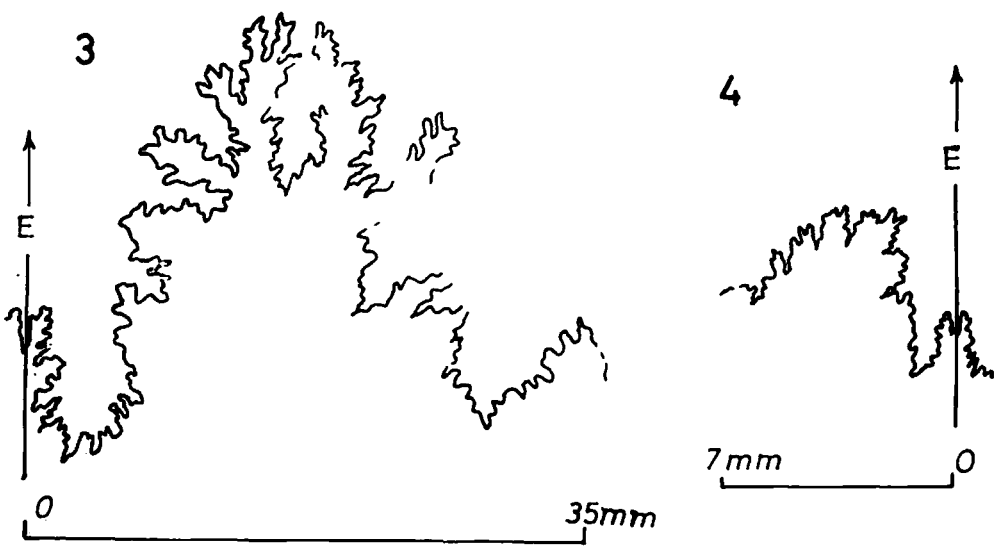
Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
OCU. MM906 (inner whorl)	20.8	8.4	10.6	(1.26)	5.0	(24)

Description:—The shell was probably of moderate size. The whorls grow rapidly with a little overlapping. The early part of the whorl shows an octagonal depressed shape with the broadly flattened venter and subparallel flanks.

The umbilicus is fairly narrow and deep, and the umbilical shoulder is rounded. The shell is ornamented with distinct and rather sharp ribs which are slightly narrower than interspaces. They are composed of primaries, secondaries and intercalatories. In the inner whorl, ribs are rectiradiate on the flanks, crossing almost straightly over the venter, and slightly concave above the siphonal line. Each of primaries has a pinched, flattened in lateral view, triangular in frontal view, tubercle at the mid-flank; some of them give rise to the secondaries at the tubercle but some others are single. The inner half-whorl has twenty-six ribs.

The suture-line, as far as seen, is essentially of the same pattern as that of typical species of *Cheloniceras*.

Remarks:—The better preserved internal mould represents a nuclear part of a large shell, as shown by the broad ribs on the external mould of two outer whorls. It is clearly distinct from any other young parts of the hitherto described species of *Cheloniceras* (s. s.).



Text-figs. 3–4. Suture-line of *Cheloniceras* (*Cheloniceras*) *shimizui* sp. nov., OCU. MM 902 (Fig. 3); *Cheloniceras* (*Cheloniceras*) sp. aff. *Ch.* (*Ch.*) *minimum* CASEY, OCU. MM 906 (Fig. 4).

Explanation of Plate 29

Fig. 1a–b. *Cheloniceras* (*Cheloniceras*) sp. aff. *Ch.* (*Ch.*) *minimum* CASEY
OCU. MM 906, from sandy mudstone at the road cut about 300 m south of the Kitauwa Senior High School, Hiromi-cho, Kitauwa-gun, Ehime Pref. Ventral (a) and lateral (b) views, ×3/2.

Fig. 2a–e. *Cheloniceras* (*Cheloniceras*) *shimizui* sp. nov.
The holotype, OCU. MM 901, from ditto. Two lateral (a, b), frontal (c) and ventral (d) views of the outer whorl and lateral (e) view of the rubber cast from the external mould of the inner whorls of the same individual. ×1.

Photos by NAKAI

2a

2b

2e

1a

2c

2d

1b

The inner whorl closely resembles the holotype of *Ch. (Ch.) minimum* CASEY (1962, p. 127, pl. 35, fig. 5a-c), from the Lower Greensand of England. CASEY believes that *Ch. (Ch.) minimum* is a micromorph species exceeding no more than 30 mm in diameter. In the present specimen, if the two outer whorls were complete, the shell would exceed 100 mm in diameter. Such a state was not recognized in CASEY's specimens, but the evidence does not seem sufficient to regard his specimens as representing an adult shell. If *Ch. (Ch.) minimum* CASEY is truly a micromorph, the present specimen probably represents a new species, which is distinct from but allied to it, but the available evidence is not so sufficient as to enable us to establish a new species.

Occurrence:—The specimen was collected from sandy mudstone at the road cut about 300 m south of the Kitauwa Senior High School, Hiromi-cho, Kitauwa-gun, Ehime Pref.

According to CASEY (1961a), *Cheloniceras* (s. s.) is common in the Lower Aptian in England, and *Ch. (Ch.) minimum* is known from the Lower Greensand of the Isle of Wight, the Zone of *Deshayesites deshayesi* (CASEY, 1961a), indicating the upper Lower Aptian.

Concluding Remarks

Ammonites obtained from the so-called Shimantogawa Complex of the Chikanaga district have been identified with two species of *Cheloniceras* (s. s.); one represents a new species, *Ch. (Ch.) shimizui* sp. nov., and the other has affinity with *Ch. (Ch.) minimum* CASEY.

The subgenus *Cheloniceras* (s. s.) is diagnostic of the Aptian. In Japan *Cheloniceras* (s. l.) has been reported from the Lower Miyakoan (MATSUMOTO [Ed.], 1954). Therefore, the age of the strata containing these ammonites is the Aptian, probably upper Lower Aptian.

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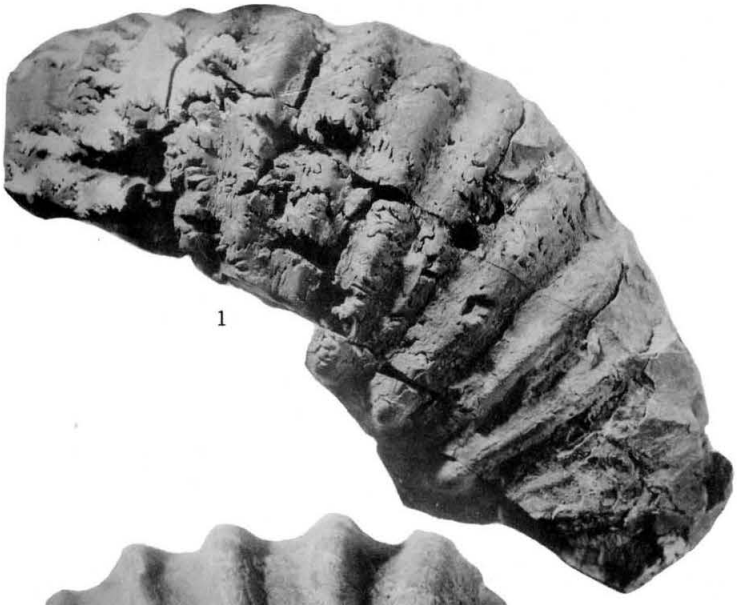
Chikanaga	近永	Hiromi-cho	広見町	Kitauwa-gun	北宇和郡
Kitanada	北灘	Shitaba	下波	Uwajima	宇和島

Explanation of Plate 30

Figs. 1-4. *Cheloniceras* (*Cheloniceras*) *shimizui* sp. nov.
The paratypes, OCU. MM 902-905, from ditto. All figures ×2/3.
1. Lateral view of OCU. MM 902.
2. Lateral view of OCU. MM 903.
3a-b. Ventral (a) and lateral (b) views of OCU. MM 904.
4. Lateral view of OCU. MM 905.

Photos by NAKAI



1

3a

2

3b

4

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 62, pp. 251-259, pl. 31, June 30, 1966.

508. MOLLUSCAN FOSSILS FROM THE NOBORI FORMATION SHIKOKU, JAPAN*

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四国、登層からの貝化石：上部中新統とされている登層の模式地から、*Amussiopecten praesignis*, *Venericardia panda* などの特徴種をふくむ貝化石19種の産出を報告。下部掛川フォーナに属するものとみられ、登層の対比、地質時代について再検討すべきことを指摘。シュクコウラ属の1新種を記載。 青木直昭

Introduction

In 1953, KATTO, NAKAMURA & TAKAYANAGI described the stratigraphy and paleontology of the younger Cenozoic deposits distributed locally at the foot of the low mountains along the southern coast of Shikoku, Japan, and they separated and proposed a new stratigraphic unit, the Nobori formation, recognizing it with unconformity under the well-known Pliocene "Tonohama shell bed". At first they regarded the Nobori formation as Lower Pliocene on the basis of the paleontological consideration of the molluscan, benthonic foraminiferal and pollen assemblages. The occurrence of seven molluscan shells identified by HATAI was reported from this formation.

OZAKI & KATTO (1955) listed about 40 species of molluscan shells from the Nobori formation and they revised the geologic age of this formation to Late Miocene. OZAKI (1956) described nine new species and subspecies of fossil molluscs. Later, TSUCHI (1961) considered this formation as Pliocene from the occurrence of some characteristic Pliocene species of Mollusca.

Recently, TAKAYANAGI & SAITO (1962) and SAITO (1962) studied the planktonic Foraminifera from the type locality of the Nobori formation. Describing 51 species they concluded that this horizon can be safely correlated with the *Globigerina nepenthes* Zone of Venezuela and with the Tortonian of Italy. In recent years this age determination has been accepted by many subsequent workers so far as the published opinions are concerned. Therefore, the Nobori formation is of particular interest for the study of the so-called Upper Miocene faunas in Japan.

In the spring of 1965, the author visited this field to collect foraminiferal material under the guidance of Kenji KURIHARA of the Tokyo University of Education, who has been studying the Cenozoic stratigraphy and the foraminiferal fossils of this area. They have succeeded, at the type locality of the Nobori formation, in obtaining some molluscan fossils formerly unknown from the present formation.

* Received January 21, 1966; read September 25, 1965, at Nagasaki.

This paper is supplementary to the work by OZAKI & KATTO (1955). The newly discovered species are recorded and the four species listed by TSUCHI (1961) are figured in this paper. Some of them may serve as useful and significant guide fossils for correlation and age determination of the formation. A probable faunal affinity of the Nobori molluscan fauna with the Pliocene Lower Kakegawa fauna is suggested and one new species of Harp Shell is described in the following.

Fossil Locality

The Nobori formation is distributed very narrowly in Hane on the western side of the Muroto Peninsula, and covers an area of only about 1.5 km by 0.7 km in maximum dimensions. No equivalent deposit is found around this area.

The formation lies on the Mesozoic basement rocks and is covered with the gravel bed which is, in turn, overlain by the marine sediments of the Pliocene Ananai formation of the Tonohama group. The Nobori formation is composed of massive and relatively homogeneous, gray siltstone, with thin intercalations of white tuff and sandy siltstone. The molluscan shells occur sporadically in the siltstone or crowd in thin lenses. They are fragile but rather well-preserved in general.

The molluscan fossils reported in this paper were collected from a hill-side cliff, at Minami-habuki (near Nobori), Nishinohama, Hane-machi, Muroto City, Kochi Prefecture, situated immediately north of the national highway No. 55 that connects Kochi and Muroto-saki. This locality is the same as the "Locality A" of KATTO, *et al.* (1953) and is the type locality of the Nobori formation.

Faunal Remarks

The following 19 species are distinguished from the Nobori fromation. The species marked by an asterisk were recorded by TSUCHI (1961).

Neilonella coix HABE
Anadara suzukii (YOKOYAMA)
Anadara sp. A
Glycymeris nakamurai MAKIYAMA
Limopsis cumingii ADAMS
Limopsis cf. *forskalii* ADAMS
**Amussiopecten praesignis* (YOKOYAMA)
**Venericardia panda* (YOKOYAMA)
Ventricoloidea foveolata (SOWERBY)
Periploma sp. B
Turritella perterebra YOKOYAMA
Granulifusus dualis (YOKOYAMA)
Siphonalia cf. *sikokuana* NOMURA
Babylonia elata (YOKOYAMA)
Fulgoraria cf. *cancellata* KURODA & HABE
**Lyria mizuhonica* MAKIYAMA
Leucosyrinx coreanica (ADAMS & REEVE)
**Spirotropis subdeclivis* (YOKOYAMA)
Harpa tosa AOKI, n. sp.

Two species of *Lima* and several gastropod species were also found. They are not specifically determined because of their small importance at present.

Including the species reported by OZAKI & KATTO (1955) and TSUCHI (1961), more than 60 species have been collected from the Nobori formation, of which 31 are pelecypods, more than 30 gastropods and 3 scaphopods, and the fauna consists of the following elements:

1) new species and subspecies 10 species
2) specifically indetermined 12 species
3) doubtfully determined 7 species
4) characteristic species of the Lower Kakegawa fauna (so-called Lower Pliocene

fauna)	17 species
5) elements of Pliocene to Recent faunas (chiefly of the deep water ones distributed along the Pacific side of southern Japan)	17 species
6) others	3 species

It is easily understood that the Nobori molluscan fauna comprises many elements in common with those of the "Lower Pliocene" fauna as pointed out by TSUCHI (1961). The species from the Nobori formation, being comparatively small in number, are largely found in the Ananai formation (="Tonohama shell bed") which contains numerous characteristic species. OZAKI & KATTO (1955) had already realized the presence of such Pliocene elements in the present fauna. However, they considered that the Nobori fauna includes several species whose morphological characters are essentially identical with those of the Miocene species rather than the Pliocene ones, and they concluded the fauna is of Late Miocene age.

It must be noticed that a considerable number of molluscs from Nobori are the characteristic and important elements of the Lower Kakegawa group, Shizuoka, and are found exclusively in this zone. The representative species are: *Glycymeris nakamurai*, *G. totomiensis* MAKIYAMA, *Amussiopecten praesignis*, *Venericardia panda*, *Turritella perterebra*, *Granulifusus dualis*, *Ancilla okawai* YOKOYAMA and *Lyria mizuhonica*.

The Miyazaki group, ranging in age from Upper Miocene to Lower Pliocene, is widely developed in the southeastern part of Kyushu Island, *ca.* 300 km SW of the Nobori locality. SHUTO (1952-1962) clarified a zonal succession of the molluscan fossil assemblages of this group. Of the Nobori species 20 were found in the Miyazaki group. They are: *Glycymeris nakamurai*, *G. totomiensis*, *Amussiopecten praesignis*, *Venericardia panda*, *Granulifusus dualis*, *Babylonia elata*, *Ancilla okawai*, *Lyria mizuhonica*, *Spirotropis subdeclivis*, etc. In general these species are found in the upper part of the Miyazaki group, that is, the 4th to 6th horizons or the *Amussiopecten praesignis-Granulifusus dualis* Zonule of SHUTO, which is regarded as Lower Pliocene in age and as equivalent to the Lower Kakegawa fauna.

As a result, the following two hypotheses may be proposed:

1) Some of the Lower Kakegawa elements which are accepted as the Lower Pliocene species appear in the Nobori formation which is of Late Miocene or Tortonian age, and then range upwards beyond the Miocene-Pliocene boundary. Therefore, this boundary is not so definite as considered from the molluscan fossils at present.

2) The current interpretation of the geologic age and correlation of the Nobori formation, based on the molluscan and planktonic foraminiferal fossils, must be reexamined.

Although it is difficult to determine an exact stratigraphic relationship or geologic age based on the abundance or ratio of the species in common between the faunas, the present data show that the Nobori fauna bears a close similarity to the Lower Kakegawa fauna rather than to any other Pliocene and Miocene faunas in Japan. Some diversities in species association could be largely dependent on differences in sedimentary environments rather than in horizons. It seems highly probable that the Nobori fauna is a member of the Lower Kakegawa fauna, representing the so-called Lower Pliocene fauna according to our present knowledge of the

molluscan fossils, and so the Tortonian dating of the Nobori fauna becomes questionable.

For overseas correlation of the "Upper Miocene to Pliocene" strata as well as for determination of the boundary between these two series in Japan, further detailed and precise evidences are required. A special attention must be paid to the more detailed vertical distributions of species and their assemblages in the Upper Miocene to the Lower Pliocene formations, especially in the province of the "Lower Kakegawa molluscan fauna", that is, in southern Japan.

Remarks on the Species

Neilonella coix HABE

Neilonella coix HABE, 1951, p. 23, tf. 12-13.
—AOKI, 1960, pl. 34, f. 1-3.

Neilonella coix was first reported from Tosa Bay and is known in the Upper Pliocene beds of Miura and Kakegawa. *Saccella confusoides* OZAKI (1955, p. 3, pl. 1, f. 8) reported from Nobori is probably similar to this species.

Anadara suzukii (YOKOYAMA)

Arca suzukii YOKOYAMA, 1926b, p. 368, pl. 42, f. 6-7.
Anadara (*Scapharca*) *suzukii*, NODA, 1965, p. 100, pl. 10, f. 3-7, 10-13; pl. 11, f. 9-10.

One mature valve which has 23 radial ribs was collected. This species is widespread in the Lower Pliocene formations of southern Japan.

Anadara sp. A

One fragment of the postero-ventral margin of left valve was obtained.

The shell is large in size and has a nearly straight postero-ventral margin with a produced end. The surface is ornamented with numerous, wide, low and flat-topped radial ribs which are very narrowly interspaced. Some ribs are dichotomous by a fine longitudinal furrow and each subrib is also scalptured with one or two fine striations in its dextral part.

This species is probably similar to *Anadara sedanensis* (MARTIN) (NODA, 1965, pl. 11, f. 1-2) known from the Pliocene Nakoshi sandstone, and to *Anadara tosaensis* NODA (1965, p. 105, pl. 11, f. 11-13) from the Pliocene Ananai formation.

Glycymeris nakamurai MAKIYAMA

Pl. 31, figs. 10a, b

Glycymeris nakamurai MAKIYAMA, 1927, p. 30, pl. 1, f. 5-6.

The fragmental specimens of *Glycymeris nakamurai* are not rare at the type locality of the Nobori formation. This species was reported from the Lower Pliocene beds of the Kakegawa and Miyazaki groups.

Limopsis cumingii ADAMS

Limopsis (*Empleconia*) *cumingii* ADAMS, HABE, 1953, p. 203, pl. 29, f. 1, 5.

Limopsis cumingii is frequent in the siltstone of the Nobori formation.

Limopsis cf. *forskalii* ADAMS

Cf. *Oblimopa forskalii* (ADAMS), HABE, 1953, p. 206, pl. 29, f. 17.

Limopsis cf. *forskalii* is rare in the siltstone of the Nobori formation.

Amussiopecten praesignis (YOKOYAMA)

Pl. 31, figs. 8a, b

Pecten praesignis YOKOYAMA, 1922, p. 1, pl. 5, f. 1-3.
Amussiopecten praesignis, AKIYAMA, 1957, p. 33, pl. 7, f. 5-6. —MASUDA, 1962, p. 226, pl. 27, f. 4-5.

This species is comparatively frequent at the type locality of the Nobori formation. About 5 valves and more than 20 fragmental specimens were found there. The maximum length of the largest specimen obtained is 84 mm and the shell outline is nearly circular.

According to MASUDA (1962), this species occurs in the Lower Pliocene beds at various localties of the Pacific side of southern Japan.

Venericardia panda (YOKOYAMA)

Pl. 31, figs. 11a, b

Cardita panda YOKOYAMA, 1926a, p. 355, pl. 39, 1-2.
Venericardia panda, MAKIYAMA, 1927, p. 40, pl. 2, f. 15-16.
Venericardia (Megacardita) panda, SHUTO, 1957, p. 81, pl. 22, f. 14.

Three specimens of a large size are obtained. The general shape and characters of the radial ribs are closely similar to those of *Venericardia panda* which was first reported from Dainichi, Shizuoka, and was redefined by SHUTO (1957). The number of ribs is about 15 ± 1 and the length of the largest specimen is 50 mm. The stratigraphical occurrence of *Venericardia panda* is believed to be restricted to Lower Pliocene.

Ventricoloidea foveolata (SOWERBY)

Pl. 31, fig. 9

Chione casinaeformis YOKOYAMA, 1926b, p. 368, pl. 42, f. 3.

One right valve was obtained. This Recent species had been reported from the Pliocene Ananai formation.

Periploma sp. B

The occurrence of the only one "Miocene species, *Periploma pulchellum*", was reported by OZAKI & KATTO (1955) from the Nobori formation without figures or adequate description. *Periploma pulchellum* HATAI & NISIYAMA (1949, p. 90, pl. 23, f. 17-18) was originally recorded from the Upper Miocene Kokozura formation in the Joban coal field, and is rarely known from other localities, but its stratigraphical occurrence is restricted to Miocene so far as known at present.

One species of *Periploma* is frequent in the siltstone of the Nobori formation and may correspond to *P. pulchellum* of OZAKI & KATTO. This is similar to the Kokozura species, but some forms closely allied to the Nobori specimens were found in the Pliocene formations of Kakegawa and southern Kwanto regions. Consequently, the *Periploma* species from Nobori cannot be considered a reliable index species of the Upper Miocene age, before a further detailed taxonomic study is made.

Turritella perterebra YOKOYAMA

Pl. 31, fig. 1

Turritella perterebra YOKOYAMA, 1923, p. 11, pl. 2, f. 2-5.
Turritella (Turritella) perterebra, IDA, 1952, p. 40, pl. 1, f. 2-3; pl. 7, f. 2. —KOTAKA, 1959, p. 63, pl. 1, f. 1-7; pl. 14, f. 1.

Only one specimen was obtained. According to KOTAKA (1959), this species

is restricted in the early Pliocene beds distributed along the Pacific coast of Shizuoka, Kochi and Miyazaki Prefectures.

Granulifusus dualis (YOKOYAMA)

Pl. 31, figs. 5a, b

Fusus dualis YOKOYAMA, 1928, p. 344, pl. 67, f. 3. —YOKOYAMA, 1929, p. 12, pl. 7, f. 5.
Granulifusus dualis, SHUTO, 1958, p. 254, pl. 37, f. 5-6, 10-12.

This species is relatively frequent at the type locality of the Nobori formation. It was reported from the Lower Pliocene Takanabe and Ananai formations.

Siphonalia cf. *sikokuana* NOMURA

Pl. 31, fig. 7

Cf. *Siphonalia sikokuana* NOMURA, 1937, p. 86, pl. 6, f. 1.

This species, doubtfully assigned to the Pliocene Ananai species, is occasionally found at the type locality of the Nobori formation. The figured specimen is the largest one obtained, being 34 mm in length.

Babylonia elata (YOKOYAMA)

Pl. 31, fig. 2

Eburna elata YOKOYAMA, 1923, p. 9, pl. 1, f. 16-17.
Babylonia (*Babylonia*) *elata*, SHUTO, 1962, p. 43, pl. 6, f. 7-8; pl. 7, f. 14, tf. 5.

Babylonia elata is known in the Upper Miocene to the Lower Pliocene beds of the Miyazaki group and in the Lower Pliocene beds of the Kakegawa group. Only one imperfect specimen was found in the Nobori formation.

Fulgoraria cf. *cancellata* KURODA & HABE

Cf. *Fulgoraria cancellata* KURODA & HABE, 1950, p. 34, pl. 5, f. 11.
Cf. *Fulgoraria* (*Psephaea*) *cancellata cancellata*, SHUTO, 1962, p. 65, pl. 12, f. 1-2, 8.

One imperfect specimen is similar to the Recent species *Fulgoraria cancellata* which was reported from Tosa Bay, Shikoku.

Lyria mizuhonica MAKIYAMA

Pl. 31, fig. 6

Lyria mizuhonica MAKIYAMA, 1927, p. 76, pl. 3, f. 12-13.
Lyria (*Paralyria*) *mizuhonica mizuhocica*, SHUTO, 1962, p. 71, pl. 12, f. 11-12.

One perfectly preserved specimen of *Lyria* was obtained. It is closely similar to *Lyria mizuhonica* which is first reported from the Ten'no sandstone of the Lower Kakegawa group and later recorded from the Lower Pliocene of the Miyazaki group. The specimen from Nobori has a lower spire so that the shell outline is short and thick. The short radial plicate ribs are 9 in number on the last whorl. It is also similar to the Recent species *Lyria pallidula* HABE (1961, p. 71, pl. 35, f. 10, app. p. 26) reported from the offing of Ashizuri-misaki, Shikoku.

Leucosyrinx coreanica (ADAMS & REEVE)

Pl. 31, figs. 4a, b

Pleurotoma shimomatana YOKOYAMA, 1926a, p. 330, pl. 38, f. 6-7.
Turricula coreanica (ADAMS & REEVE), KURODA, 1934, p. 386, tf. 15-16.
Leucosyrinx coreanica, SHUTO, 1961, p. 104, pl. 8, f. 12; pl. 9, f. 5, 13, tf. 7-8.

The fossil record of this Recent species is from the Pliocene beds along the Pacific coast of southern Japan.

Spirotropis subdeclivis (YOKOYAMA)

Pl. 31, figs. 3a, b

Pleurotoma subdeclivis YOKOYAMA, 1926a, p. 329, pl. 38, f. 8. —YOKOYAMA, 1926b, p. 367, pl. 42, f. 4.

Spirotropis subdeclivis, SHUTO, p. 102, pl. 9, f. 2-3, 8-9, 11-12, tf. 7-8.

This species is known in the Pliocene formations of Kakegawa, Tonohama and Miyazaki.

Harpa tosa AOKI, n. sp.

Pl. 31, figs. 12a, b

Only one, rather well-preserved and almost complete specimens was collected. It is somewhat deformed transversely due to the diagenesis.

Shell moderate in size for the genus, vertically elongate, subovate, tumid and rather stout, height about 7 cm, maximum width about 4 cm at the upper one-third of the shell, consisting of about five whorls rapidly increasing in size; protoconch relatively small and compressed globose in shape; spire very low and bluntly pointed at the apex; body whorl very large, about 5/6 of the size of the shell; longitudinal ribs prominent, regularly arranged, thirteen in number at the body whorl, flat-topped and wide, running parallel to the growth lines; interspaces wider than ribs, posterior edges of ribs tending to pointed nodes at the shoulder, earlier five ribs of the body whorl covered with callus layer extending from the inner lip, becoming round-topped, weak and somewhat indistinct; growth lines fine but distinct on the ribs and interspaces; no spiral ornamentation present; aperture large and wide, subquadrangular in shape, more than 4/5 of the hight of the shell, inner surface smooth, covered with a thick callus layer; outer lip rather thick; columella nearly straight, fold nothing; canal short and wide, somewhat recurved.

Holotype, Saitama Univ., Paleont. Coll., Reg. no. 11245; from a hill-side cliff, at Minami-habuki, Nishinohama, Hanemachi, Muroto City, Kochi Prefecture; Nobori formation, Upper Miocene or Lower Pliocene.

This is the first record of a fossil species of *Harpa* in Japan. *Harpa tosa*, new species, is distinguishable from the Recent species of this genus in having the more elongate and slender shell with a less marked shoulder and a lower spire, comparatively narrower interspaces of longitudinal ribs, and better-developed callus layer on the body whorl and a spire.

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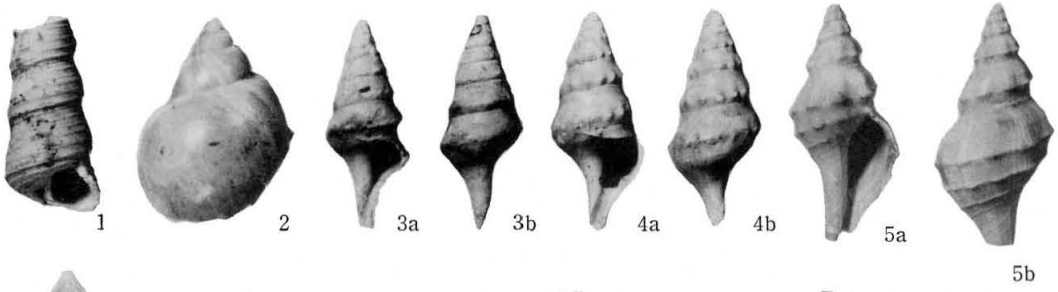
Explanation of Plate 31

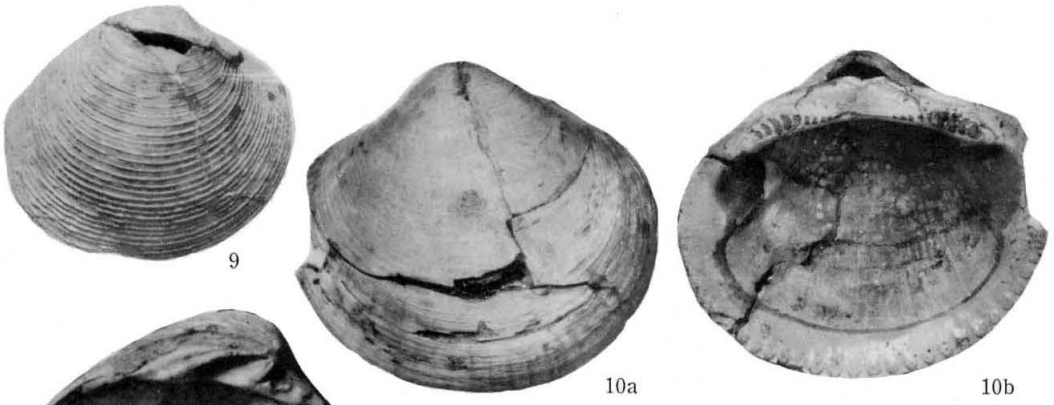
Fig. 1. *Turritella perterebra* YOKOYAMA. ×1.5, Reg. 11241.
Fig. 2. *Babylonia elata* (YOKOYAMA). ×1. Reg. no. 11243.
Figs. 3a, b. *Spirotropis subdeclivis* (YOKOYAMA). ×1, Reg. no. 11247.
Figs. 4a, b. *Leucosyrinx coreanica* (ADAMS & REEVE). ×1. Reg. no. 11248.
Figs. 5a, b. *Granulifusus dualis* (YOKOYAMA). ×1, Reg. no. 11244.
Fig. 6. *Lyria mizuhonica* MAKIYAMA. ×1. Reg. no. 11246.
Fig. 7. *Siphonalia* cf. *sikokuana* NOMURA. ×1, Reg. no. 11242.
Figs. 8a, b. *Amussiopecten praesignis* (YOKOYAMA). ×0.7. Reg. no. 11238.
Fig. 9. *Ventricoloidea foveolata* (SOWERBY). ×0.8, Reg. no. 11240.
Figs. 10a, b. *Glycymeris nakamurai* MAKIYAMA. ×0.6, Reg. no. 11237.
Figs. 11a, b. *Venericardia panda* (YOKOYAMA). ×0.9, Reg. no. 11239.
Figs. 12a, b. *Harpa tosa* AOKI, n. sp. ×0.9. Holotype, Reg. no. 11245.

All of the illustrated specimens were collected from the type locality of the Nobori formation; a hill-side cliff, at Minami-habuki, Nishinohama, Hane-machi, Muroto-City, Kochi Prefecture, and are preserved in the paleontological collection of the Department of Earth Sciences, Saitama University.

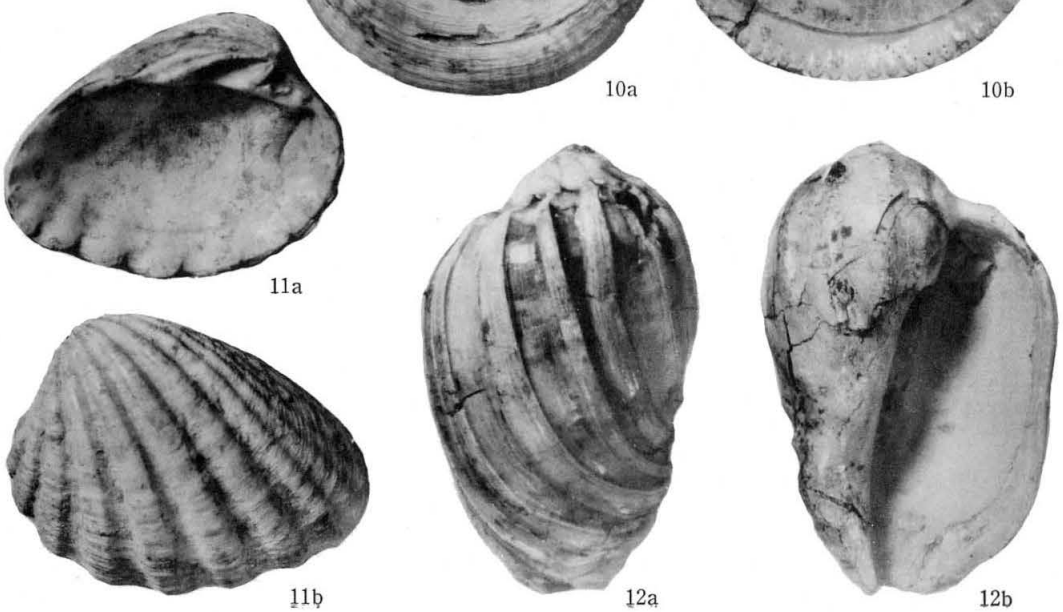


1 2 3a 3b 4a 4b 5a 5b

6 7 8a 8b



9 10a 10b



11a 11b 12a 12b

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

(4) 申込締切　1966年11月15日（消印有効）。採否は 1967 年 1 月の評議員会で審議決定の上申込者に回答の予定です。ただしその前または後に，申込者との細部の交渉を，編集委員から求めることがあるかもしれません。

(5) 印刷予定　論文が完全な場合には，決定後できるだけ早く印刷にとりかかる予定です。文部省の刊行助成金（「研究成果刊行費補助金」）を申請希望の場合には，学会から申請（例年は 2 月上旬中に申請締切）し，その採否・金額など決定後印刷にとりかかります。その場合は会計事務上の必要から，10 月中に初校を出すことになっています。

例会通知

	開催地	開催日	講演申込締切日
第94回例会	秋田大学	1966年9月24, 25日	1966年8月15日
第95回例会	名古屋大学	1966年11月下旬	1966年10月下旬

News

◎ 国際古生物学連合 (I. P. U.) の会合は第23回国際地質学会議と同時に Prague で 1968 年に開催され通常の委員会の他には次の問題に関する会合が計画されている。

1. Paleoecology
2. Evolution
3. Paleobiogeography
4. Ostracoda
5. Palcobotany
6. Other subjects.

◎ 第11回太平洋学術会議の期間中 1966 年 9 月 1 日午後東京大学総合研究資料館会議室において国際古生物学連合アジア部会を開催し部会の今後の活動について討議することになつている。

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