日本古生物学會
報告・紀事

Transactions and Proceedings
of the
Palaeontological Society of Japan

New Series No. 10

日 本 古 生 物 學 會

Palaeontological Society of Japan

July 31, 1953

CONTENTS

TRANSACTIONS

All Communications relating to this Journal should be addressed to the

PALAEONTOLOGICAL SOCIETY OF JAPAN

Geological Institute, Faculity of Science, University of Tokyo, Japan

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 10, pp. 31—36, 2 text-figs., Pl. 4, July 31, 1953

231. VARIATION OF JAPANESE *Anadara granosa**

TAMIO KOTAKA

Tohoku University, Sendai

本邦産 *Anadara granosa* の変異: 本邦産化石及び現生 *Anadara granosa* の計測の結果を報告した。推計学の教える所により，棄却楕円面の公式を用いて，産地毎の変異の位置と大きさとを推定した。パラメーターは，測定し易く，且殻の形態を最もよく代表するものを選定した。H/L 及び C/L は，歯列に平行な L と，垂直な H，及び殻の最もふくらんでいる点と，内線面との距離 C との比である。一般的傾向として，大略，形態上三つの変異群が区別された。これらは互いに overlap して居り，各群の間には，直接的に何等かの関係があつたと推定される。統計の結果及び殻の非常に厚いことより一新種を区別し，*Anadara obessa* なる新種の記載を行なつた。小高民夫

INTRODUCTION

The so-called *Anadara granosa* is a common Arcid pelecypod in the Pleistocene deposits of the Miura and Bôsô Peninsulas in the Kwantô area, the Furuya shell beds in Shizuoka Prefecture, and occurs in the raised beach deposits of these Peninsulas and in other regions. It is also commonly found in the shell mounds distributed from Miyato-jima in Matsushima Bay, Miyagi Prefecture to Kyûshû along the Pacific boaderland. As living it is known from the littoral zone of the Setouchi, Okayama Prefecture, Ise-Bay, Mie Prefecture; and Ariake Bay, western Kyûshû. It is known that the fossil and Recent forms have remarkable variations in the shape, thickness and other character of shell. J. B. P. A. LAMARCK recognized three varieties of the species, namely, *a*, *b* and *c*. Of his species, L. A. REEVE allocated LAMARCK'S var. *a* to *Anadara rhombea* (BORN) which is said to be characterized by having a greater number of radial ribs, and the other two varieties to *Anadara granosa*. In 1938, H. G. SCHENCK and P. W. REINHART separated the Japanese Recent form from the typical *granosa* by the less number of ribs, more elongated shell outline and rather narrow umbones. For this type of shell they proposed the name to *bisenensis* and added that this occurs in Japan also as fossil. T. KURODA and T. HABE, from their observations on Recent material, treat *bisenenesis* as a subspecies of *Anadara granosa*.

To determine the limits of variation and taxonomic values of the shells hitherto referred to *granosa* and *bisenensis* in Japan, a survey of the statistics of the conchometry of these shells was made. The mathematical values obtained from measurements of length, height and convexity were considered by the formula of the rejection-ellipse. The results in terms of position and range of the variation are as shown in figure 2, in which the respective localities of the measured specimens are given.

Heartiest appreciations are due to Professor Shôshirô HANZAWA for encour-

* Read June 22, 1952; received Aug. 28, 1952.

agement and also to Professor Kotora HATAI for his contiguous guidance during the course of the present study. Thanks are also due to Professor T. IMAI, Fisheries Institute and Professor I. MOTOMURA, Institute of Biology, both of the Tôhoku University for their advices concerning biological statistics.

During this study, specimens have been received from the following persons to whom acknowledgements are due, Mr. T. HABE and F. UTSUMI, Zoological Institute, Kyoto University; Mr. H. OZAKI, Tokyo Science Museum; Mr. K. SUYARI, Geological Institute, Tokushima University; Dr. I. TAKI, Onomichi Marine Laboratory, Hiroshima University; and to the officials of the Fisheries Experimental Stations of Fukuoka and Saga Prefectures.

METHOD OF MEASUREMENT

Arcid shells are characterized by having a straight hinge provided with serial teeth. This taxodont character is important in taxonomy and is also convenient for a conchometric study. As shown in Fig. 1, the more accurately measurable

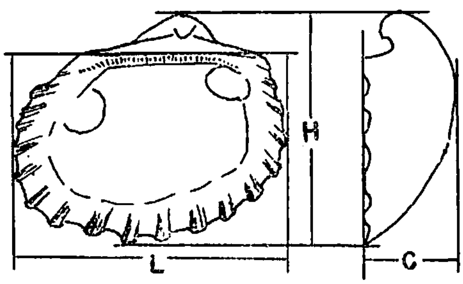


Fig. 1

dimensions are chosen; that is, the length (L) of the shell is represented by the maximum distance between two lines perpendicular to the hinge line and in contact with the anterior and posterior margins of the shell; the height (H) by the maximum distance between two lines parallel with the hinge line and in contact with the ventral margin and the top of the umbo; and the convexity (C) is defined as the distance from the plane of the inner margin of the shell to the most inflated point on the outer surface. These dimensions are measured carefully with callipers, and the values are counted to the degree of 1/20 mm.

REJECTION-ELLIPSE

Brief notes on the rejection-ellipse are quoted as follows.

Let us denote, hereupon, H/L by x, C/L by y, and let $\bar{x}$, and $\bar{y}$ be mean values respectively. Then the equation of the rejection-ellipse is

$$F_0 = \frac{(N-2)N}{2\Delta(N+1)} \left\{ \Phi_{11}(x-\bar{x})^2 - 2\Phi_{12}(x-\bar{x})(y-\bar{y}) + \Phi_{22}(y-\bar{y})^2 \right\} \quad \ldots\ldots\ldots\ldots (1)$$

where, $\Phi_{11} = \Sigma(x-\bar{x})^2$, $\Phi_{12} = \Sigma(x-\bar{x})(y-\bar{y})$, $\Phi_{22} = \Sigma(y-\bar{y})^2$; $\Delta = \Phi_{11}\Phi_{22} - \Phi_{12}^2$; N: number of specimens; F_0: the value of F, in the F-distribution under the two degrees of reedom $n_1 = 2$, $n_2 = N-2$, and level of significance (0.05); x_i and y_i are each measured values ($i = 1, 2, 3, 4, \ldots\ldots, N$).

In the equation (1), let $\xi_1 = x-\bar{x}$, $\xi_2 = y-\bar{y}$, then (1) is introduced into $a_{11}\xi_1^2 + 2a_{12}\xi_1\xi_2 + a_{22}\xi_2^2 = 0$, in general.

Whereupon, the inclination (θ) of the long axis of the rejection-ellipse is given by the following equation;

$$\tan 2\theta = \frac{2a_{12}}{a_{11}-a_{22}}$$

and the lengths of the two axes are two real roots of

$$\lambda^2 - (a_{11}+a_{22})\lambda + (a_{11}a_{22} - a_{12}^2) = 0 .$$

Results and Considerations

The results of calculation are shown in Table 1 and Figure 2. In Table 1, the samples without the values of θ, a and b do not indicate the true values of the equation of the rejection-ellipse, because of some of the measurements of H, C, or L are inaccurate due to damage of the shell by subsequent agencies as erosion, water-worn etc.

As shown in Figure 2, although the rejection-ellipses, which represent the position, range and tendency of variation of the so-called Japanese fossil and Recent *granosa* and *bisenensis*, overlap each other and thus suggest a continuous change of shell shape between the fossil and Recent forms, they can be divided into three groups. That is, Group 1 represented by the rejection-ellipses of Dutch Borneo and Minato silt (1), Group 2 by that of Kojima Bay and Ariake Bay and Group 3 by that of Okinawa, Minato silt (2) and the Byôbugaura formation.

Judging from the arrangement of the rejection-ellipses, it is inferred that the *granosa* or *bisenensis* of Japan can be divided into three forms according to their shell profiles.

The first form is shown by the ellipses for Dutch Borneo and Minato silt (1) in Figure 2; this form may be safely assigned to *Anadara granosa* (s.s.), based upon the morphological coincidence with L. A. Reeve's description of the species The second form which is represented by the ellipses of Kojima Bay and Ariake Bay has an elongated shell profile, rather narrow and low umbones and less number of ribs as has been pointed out by H. G. Schenck and P. W. Reinhart; this is *Anadara granosa bisenensis* Schenck and Reinhart. The third form is represented by the ellipses of fossil and semi-fossil forms from the raised beach deposits of Okinawa-Island, Minato silt (2)

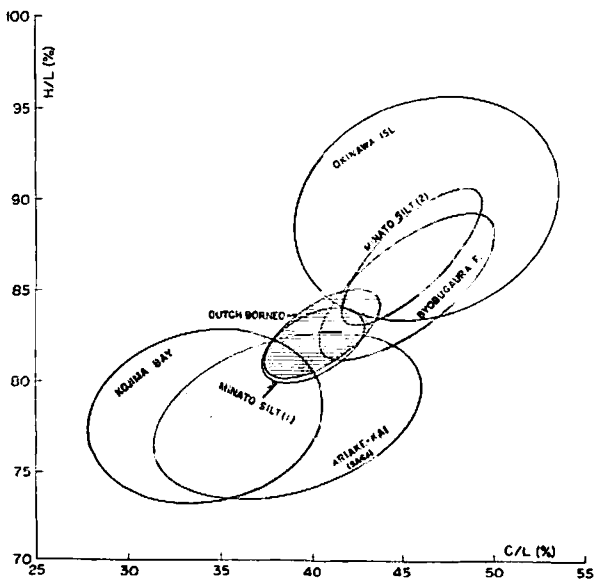


Fig. 2. Graph showing the Rejection-Ellipses (Level of significance; 0.05) of the specimens from Each Localities.

Table 1

No.	Horizon or Age	N	$\bar{x}$=H/L	$\bar{y}$=C/L	θ	a	b	Remarks
1.	Recent	63	78.0	34.2	15°5′	64.3	46.0	g. b.
2.	〃	62	78.1	38.7	19°2.5′	75.2	38.1	g. b.
3.	〃	10	80.1	39.5	11°32′	76.1	12.7	g. b.
4.	〃	11	82.7	40.5	34°56.5′	37.2	15.5	g.
5.	Shell mound	33	83.2	38.4	39°41′	19.1	8.4	g.
6.	Minato Silt (1)	30	82.1	40.0	30°38′	31.1	15.0	g.
7.	Raised Beach?	11	89.7	46.1	24°55′	73.8	55.5	o.
8.	Minato Silt? (2)	6	87.0	45.4	45°	51.3	17.9	o.
9.	Taito Shell Bed R. B.	37	83.9	43.7	36°18.5′	59.7	33.2	o.
10.	Byobugaura F.	18	85.4	45.1	40°28.5′	58.4	19.3	o.
11.	〃	7	86.4	46.7	42°20.5′	144.3	38.0	o.
12.	Shell mound	10	85.5	45.3				(o.)
13.	Yurakucho F.	25	81.5	37.9				(g.)
14.	Narita F.	10	84.9	38.7				(g.)

θ: Inclination of the long axis
a: Length of the long axis } of the rejection-ellipse.
b: Length of the short axis }
g. b.: *Anadara granosa bisenensis*
g.: *A. granosa*
o.: *A. obessa*

Table 2

No. Locality

1. Kojima Bay, Okayama Prefecture.
2. Ariake Bay, Saga Prefecture.
3. 〃 , Fukuoka Prefecture.
4. Dutch Borneo.
5. Horinouchi, Yôrô-mura, Ichihara-gun, Chiba Prefecture.
6. Coast of Kazusaminato-machi, Kimitsu-gun, Chiba Prefecture.
7. Coast of Nago-machi, Kunigami-gun, Okinawa Island.
8. Coast of Sanuki-machi, Kimitsu-gun, Chiba Prefecture.
9. Coast of Okayoshi-machi, Isumi-gun, Chiba Prefecture.
10. Kamisawa-nakamura, Totsuka-ku, Yokohama City, Kanagawa Prefecture.
11. Atoyamada, Totsuka-ku, Yokohama City, Kanagawa Prefecture.
12. Tsukumo, Okayama Prefecture.
13. Near the Funabashi race-course, Funabashi City, Chiba Prefecture.
14. Otake-machi, Inba-gun, Chiba Prefecture.

and Byôbugaura formation. Although the morphological characters of H/L and C/L more or less overlap those of *Anadara granosa bisenensis*, the very thick shell and more than 84% of C/L seem to warrant the proposal of the new name of *Anadara obessa*.

It is interesting to find two types of shell among the samples from the Minato silt. The specimens from Minato silt (1) were collected from the exposure near the coast of Kazusaminato-machi, while those of (2) are uncertain because they were collected from the shore and are thought to have been washed out from a submerged different horizon of probably of the Minato silt. According to the oral information of Mr. F. UEDA who made a pioneer stratigraphic work on the Miura and Bôsô Peninsulas, the Minato silt contains two horizons of *Anadara*.

The arrangement of the ellipses of fossil and semi-fossil forms and their relation to those of the forms as shown by groups 1 and 3 in the figure suggests migration and a type of differentiation of species or phylogenetic development, but details will be reserved for another opportunity.

DESCRIPTION OF NEW SPECIES

Family Arcidae

Genus *Anadara* GRAY, 1847

Subgenus *Tegillarca* IREDALE 1939

Anadara (Tegillarca) obessa KOTAKA, n. sp.

Pl. 4, Figs. 1a-6c.

Description: Shell thick, large in size, quadrate in outline, posterior border more or less straight; equivalve, inequilateral, heart-shaped in lateral view, ventral margin squarely rounded; umbonal region swollen, beak more or less incurved and directed anteriorly; ligamental area broad, arcuately trigonal in profile, sculptured with five chevron-shaped grooves; surface with 17 radial ribs cross with concentric growth lines, anterior part of shell with 12 strongly granulated ribs and the posterior with 5 smooth ribs which are slightly broader than their flattened interspaces in width.

Measurement:

Valve	Length	Height	Convexity	Number of ribs	H/L	C/L	
R.	71.5	64.15	32.35	17	89.8	45.3	Holotype
R.	64.35	52.0	29.4	17	88.5	45.7	Paratype
R.	57.0	52 0	27.2	17	91.2	47.7	"
L.	55.1	52.4	27.1	19	95.0	49 2	"
R.	53.0	48 65	24.67	17	91.9	46.6	"
R.	52.0	45.0	22.75	18	86.5	43.8	"
L.	51.6	45.4	23.15	17	88.0	44.9	"
L.	51.3	41.9	21.73	16	87.5	43.2	"
L.	50.0	44.4	24.0	17	88.8	48.0	"
R.	48.7	42.25	21 0	17	86.8	43.1	"
L.	47.25	44.0	23.1	19	93.2	48 6	"

Holotype: IGPS coll. cat. no. 66356; Coast near Nago-machi, Kunigami-gun, Okinawa-Island. Derived from the raised beach deposits,

Remarks: *Anadara rhombea* (BORN) (L. A. REEVE, Conch. Icon., 1844, sp. 12) from the Chinese Seas and Ceylon possesses a similar shell profile, but is distinguishable from the present species by greater number of radial ribs and shape of umbones. *Anadara* (*Anadara*) *kakehataensis* HATAI and NISIYAMA (1949, pl. 23, figs. 8–10) from the Miocene Susahara formation of Toyama Prefecture is distinguished from the present form by the sculpture and number of radial ribs, posterior slope and profile of ligamental area.

LITERATURE CITED

HAMAI, I. and ITO, K., (1950). Systematic Relative Growth in Molluscan Shells (2), Potamididae. (in Japanese). *Venus, vol. 16, nos. 1-4*, pp 57-63.

HAMAI, I., (1951), Systematic Relative Growth in Molluscan Shells (3), Buccinacea and Land Shells. (in Japanese). *Venus, vol. 16, nos. 5-8*, pp. 104-111.

HATAI, K. and NISIYAMA, S., (1949), New Tertiary Mollusca from Japan. *Journ. Paleont.*, vol. 23, no. 1, pp. 87-94.

HUXLEY, J. S., (1932), Problems of Relative Growth. *Methuen & Co. Ltd., London.*

MASUYAMA, M., (1949), Methods of small Sample Statistics and Planning of Experiments. Revised Edition. (in Japanese). *Kawade-Shobō, Tokyo.*

REEVE, L. A., (1844), Conchologia Iconica, vol. 2, Monograph of the Genus *Arca*.

SCHENCK, H. G. and REINHART, P. W., (1938), Oligocene Arcid Pelecypods of the Genus *Anadara*. *Mém. Mus. Roy. d'Hist. Nat. de Belgique. 2me sér., fasc. 14*, pp 1-73.

Explanation of Plate 4

Figs. 1a-1d—*Anadara* (*Tegillarca*) *obessa* KOTAKA, n. sp. ×2/3. Holotype, IGPS coll. cat. no. 66536. Loc. Coast near Nago-machi, Kunigami-gun, Okinawa Island. Raised Beach Deposits.

Figs. 2a-2d—*Anadara* (*Tegillarca*) *obessa* KOTAKA, n. sp. ×2/3. Paratype, IGPS coll. cat. no. 66536.

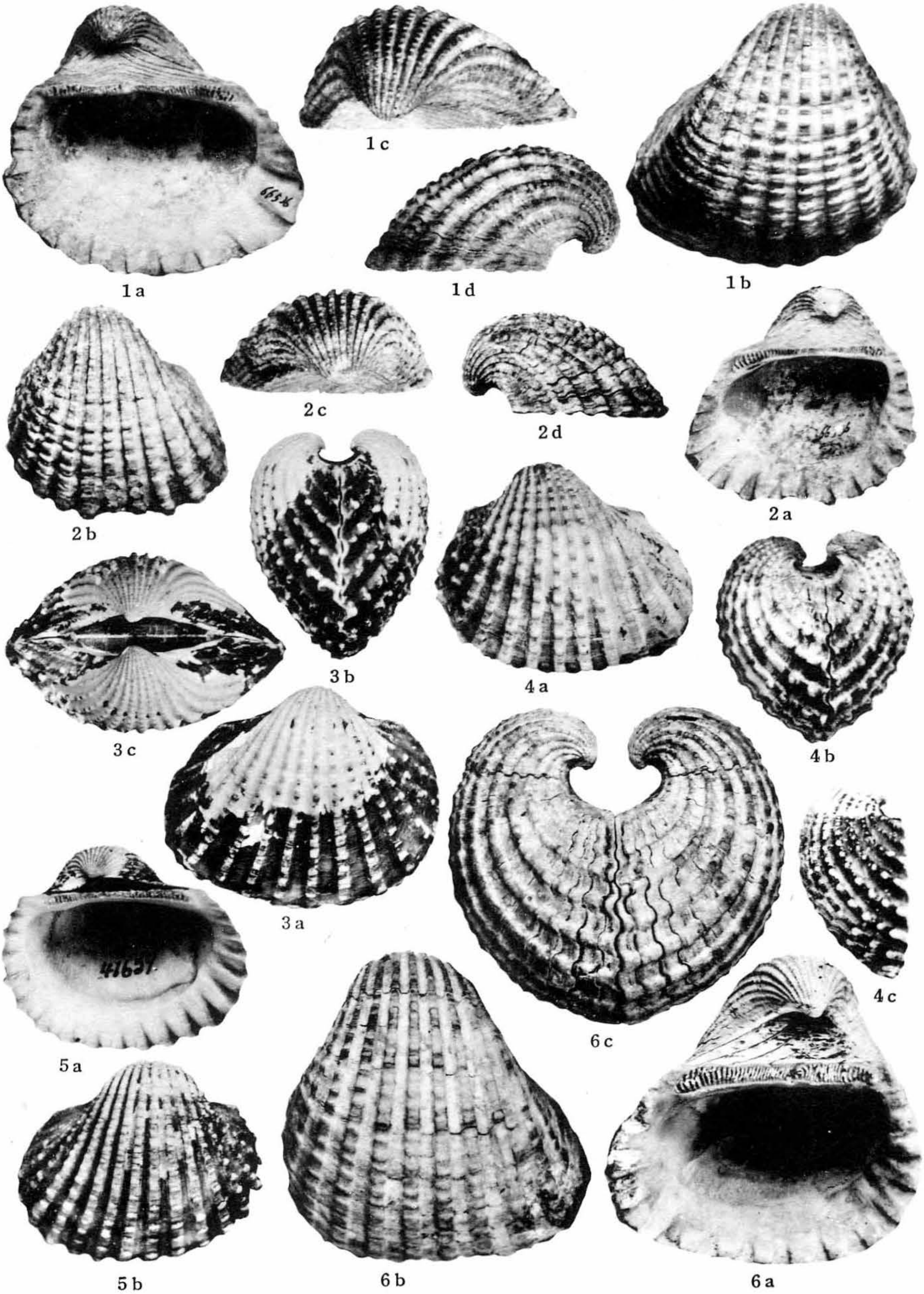
Figs. 3a-3c—*Anadara* (*Tegillarca*) *granosa bisenensis* SCHENCK and REINHART. Topotype, IGPS coll. cat. no. . Loc. Kojima Bay, Okayama Prefecture. Recent.

Figs. 4a-4c—*Anadara* (*Tegillarca*) *granosa* LINNÉ. IGPS coll. cat. no. 13229. Loc. Coast of Kazusa-minato-machi, Kimitsu-gun, Chiba Prefecture. Minato silt, Holocene.

Figs. 5a-5b—*Anadara* (*Tegillarca*) *granosa* LINNÉ. IGPS coll. cat. no. 41659. Loc. Dutch Borneo. Recent.

Figs. 6a-6c—*Anadara* (*Tegillarca*) *obessa* KOTAKA, n. sp. Saito Ho-on Kai Mus. Reg. no. 6703. Loc. Coast, W of Sanuki-machi, Kimitsu-gun, Chiba Prefecture. Minato silt. Holocene.

(All figures in natural size unless otherwise stated).


1a
1c
1d
1b
2b
2c
2d
2a
3b
4a
3c
4b
3a
41637
5a
6c
4c
5b
6b
6a

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 10, pp. 37—44, Pl. 5, July 31, 1953

232. FOSSIL ASSEMBLAGES OF MOLLUSCS AND BRACHIOPODS OF UNUSUALLY LARGE SIZES FROM THE PERMIAN OF JAPAN*

ICHIRÔ HAYASAKA

Hokkaidô University and Kanazawa University

and

SHÔZÔ HAYASAKA

Tôhoku University

古生物学では，無脊椎動物についても，その矮小集団は屢々研究の対象となつているが，巨大集団の方は，産出の例が少ないためなのか，あまり論議された例がないように思う。この点で，岐阜県赤坂の金生山産の巨大な軟体類の集団と，栃木県葛生に近い鍋山地方産の巨大な腕足類の集団とは，珍らしい例であろう。本文では，鍋山の巨大腕足類集団も，二畳紀のものであることの事実を掲げた。そして，どちらも黒色の瀝青質（腐泥質）石灰岩の薄い層の中に埋蔵されている事は著しい事実である。

これ等の集団に属する個体が巨大に成長したのは，一応環境の影響に依るものとして種々，考究して見たが，結局，現在の程度の資料に依つては，瀝青質沈積物を生ずる様な，沼状にくびれた盆地状の浅海中の生活の結果として現はれた病的肥大型と見るべきものであるまいか，と結論し得るに止まる。斯様な病的肥大型は屢々それ等の種族の絶滅の前徴と考えられる。（早坂一郎・早坂祥三）

It is well known to the geologists and paleontologists of Japan that the *Fusulina*-limestone of Kinshôzan, Akasaka-machi, Gifu Prefecture, yields, or at least yielded, abundant fossils of several species of molluscs of enormous sizes at a certain bed of the limestone sequence. Although known for a very long time, this faunule had not been paleontologically studied until the senior author of this paper described a part of it in 1925. The study was suspended for about a dozen of years, and then continued in Taiwan (HAYASAKA, 1938–43).

Kinshôzan has been visited by many geologists and paleontologists, and studied biostratigraphically by some of them. But nobody has ever explained the mode of occurrence of these huge molluscs but T. WAKIMIZU (1902), who briefly accounted for how these fossils were found in the mother rock. In the upper part of the "Black zone" which is the 4th from below of his 8 "zones," altogether estimated to be about 500–600 meters in thickness, there are thin beds of "very impure," black limestone, rather earthy and brittle, having a tendency to cleave. These beds are usually not more than 30 cm. thick. It is in these beds that WAKIMIZU collected his excellent lot of specimens described by the senior auther. These fossils have been found at Kinshôzan very abundantly since long before WAKIMIZU's time, and consequently many specimens are found in the natural his-

* Read Sept. 27, 1952; received Oct. 27, 1952.

tory collections of schools, not to say of universities and museums. They were supplied by specimen dealers. It is said that the specimens occur rather rarely these days. The molluscs are found in association with large specimens of *Neoschwagerina globosa* YABE and some others, which are often compressed into flat discs. Other fossils found together are a few brachiopods (HAYASAKA, 1932) and corals (YABE et HAYASAKA, 1915). The geological age of the faunule is late Permian. The black, bituminous limestone forms a part of the uppermost of the 4 *Neoschwagerina* zones into which OZAWA (1927) once divided the whole sequence of the *Fusulina*-limestone of Kinshôzan according to the different dominant species; namely, in descending order,

Zone of *N.* (*Yabeina*) *globosa* YABE
Zone of *N. margaritae* DEPRAT
Zone of *N. craticulifera* SCHWAGER
Zone of *N.* (*Cancellina*) *nipponica* OZAWA

Another Permian fauna which equals the foregoing one in point of being composed of extraordinarily large individuals is the brachiopod assemblage from the limestone of Kuzû region in the Kwantô mountainland near Utsunomiya city. In this region a *Fusulina*-limestone formation occupies a wide area, and the foraminifers are collected very abundantly at many localities. Mammalian remains are also rich in the limestone caves developed here and there (SHIKAMA, 1949). At a few quarries several species of brachiopods of enormous sizes were collected by the senior author in a rather thin (about 15 m.), black, bituminous bed of limestone, exposed around Kadosawa in a small tributary of the Nagano-gawa, West of Nabeyama. The descriptions of these fossils, also by the senior author, were published in 1933. At these localities the black brachiopod-limestone bed does not contain fusulinids, while they are very richly found in the gray limestone bed overlying the former. This fact, combined with the general older, Carboniferous aspect of the general that are mostly represented by new species, made the senior author regard the faunule upper Carboniferous, though rather hesitatingly (HAYASAKA, 1933, pp. 15–16). In reality he was deeply concerned about the fact that the huge specimens are confined to the bituminous rock just like in the case of the mother rock of the molluscan assemblage of huge individuals of Kinshôzan, Gifu Prefecture. However, it seems there are subsequent field observations by some geologists by which the geological age of the brachiopod fauna is claimed to be Permian. According to the kind oral information of Saburô YOSHIDA, Kushiro Branch of the Hokkaidô College of Liberal Arts (Gakugei Daigaku), who carried out field surveys in the Kuzû region a few years ago, the black, bituminous limestone with huge brachiopods, but without fusulinids, is continuous with the gray *Fusulina*-limestones both above and below in the immediate neighborhood of Yamasuga, about 5 km. south of Kadosawa, and close to the town of Kuzû. We are indebted to YOSHIDA for several specimens among which there are two of *Orthotichia japonica* from Yamasuga (Pl. I, Fig. 2). Once NAGAO and MINATO reported that they had found pieces of *Fusulina*-limestone at the foot of a cliff formed of the black, bituminous limestone in the neighborhood of the exposure of Kadosawa where the brachiopods had been collected. It is they that first cast doubt on the Carboniferous age of the brachiopod fauna. That the branchiopod-bed and the overlying *Fusulina*-bearing limestone are stratigraphically continuous was recognized in Kadosawa region: no evidence of a physical unconformity was recognized between them. Thus, it now seems clear that the Nabeyama fauna also is of Permian age, although it may not be synchronous with the molluscan fauna of Kinshôzan.

Almost all the other occurrences of Permian macro-faunas in Japan are in the Kitakami mountains in northern Honshû. There the fossils are, even if found in limestones, of ordinary sizes, as if to correspond to the non-bituminous nature of the rocks.

Here, we will enumerate the members of the two assemblages of unusually large fossils from the two regions referred to above. Measurements given are the miximum values obtained of the specimens so far studied by the senior author.

(*indicates specimens not unusual in size.)

(1) The Kinshôzan fauna, Gifu Prefecture.

A. **Pelecypoda**: (H, height; L, length; in mm.)

Liebea sinensis FRECH. H, 46; L, 30
Myophoria japonica HAYASAKA H, 35; L, 45
Parallelodon obsoletiformis HYSK. H, 22; L, 48
Solenomorpha elegantissima HYSK. H, 90; L, 240

B. **Scaphopoda**: (L, length; D, diameter in mm.)

Dentalium akasakensis HYSK. L, 150; D, 17
D. neornatum HYSK. L. ca. 220; D, ca. 24
D. (*Plagioglyota*) *herculeum* DEKON. L, 200; D, 22

C. **Gastropoda**: (H, height; W, width: in mm.)

Bellerophon jonesianus DEKON. H, 130; W, 124 (Pl. L, Fig. 1) This is the largest specimen of this species we have ever come across with. This specimen happened to be in the collection of the Department of Geology and Mineralogy, Hokkaido University, together with several other kinds of fossils.
**B. jonesianus* var *hiulciformis* HYSK. (Only 1 specimen) H, ca. 30; W, ca. 32
**Pleurotomaria* aff. *multicarinatus* MANSUY. (Only 1 specimen) H, ca. 65; W, 60
P. Yokoyamai HYSK. H, 180; W, 160
Murchisonia Yabei HYSK. H, 400; W, 130
**Solenopsis multicostata* HYSK. H. 14; W, 5.5
Naticopsis Wakimizui HYSK. H, 140; W, 120
**N. minoensis* HYSK. H, 40; W, 30
**N. fasciata* HYSK. (Only 1 specimen) H, 14; W, 12
**N.* cf. *praealta* WANNER. H, 45; W, 35
Naticella japonica HYSK. H, 8.6; W, 6.2
Trachydomia magna HYSK. H. 68. W, 61
T. conica HYSK. H 92; W, 75
**Spiromphalus Yabei* HYSK. H, 14; W. 4

As far as the material examined is concerned the specimens of ordinary sizes are very few in number of individuals except the last one. *Spiromphalus* is a new genus very much like such small forms as *Zygopleura* or *Pseudozygopleura* in point of size and external characters. This species abounds in the bituminous limestone. It was suggested that they also might represent unusually large forms of what is ordinarily much smaller. It is also possible, however, that this species is indifferent to changing environmental factors or conditions adverse to other gastropod kinds. Although *Spiromphalus Yabei* is a small gastropod, yet it is as a whole larger than species of *Pseudozygopleura* described by KNIGHT (1913).

At any rate, it is fascinating to look at these specimens gathered together, because the dominant and more numerous members are extraordinarily large, and also the shells are all very thick and massive as is recognized in the pictures given in the papers describing them.

(II) The Nabeyama fauna, Tochigi Prefecture.

This is a brachiopod fauna in which the following species have been recognized. (L, length; W, width D, depth: in mm.)

Orthotichia japonica HYSK. L, 94; W, 97; D, 61
O. japonica subsp. *striata* HYSK. L. 75; W, 88
Enteletes acutiplicatus HYSK. (Only 1 specimen) L, 36; W. 39; D, 34
Meckella gigantea HYSK. L. 100; W, 127; D, 90
Orthotetina planoconvexa HYSK. (Only 1 specimen) L, 45; W, 55
O. eusarkos ABICH subsp. *lata* HYSK. (Only 1 specimen) L. ca. 65; W, ca 88; D, ca. 40
(?) *Davisiella comides* (SOWERBY) subsp. (Only 1 specimen) W. 170
Streptorhynchus sp. indet. W, ca. 40
**Productus* (*Echinoconchus*) *defensus* (THOMAS). W, ca. 45 (estimation)
**Spirifer acutiplicatus* HYSK. L. 35; W, 41
**Squamularia* sp. L, ca. 37; W, ca. 40
**Martinia* sp. L, 35; W, 33

This assemblage also gives a deep impression of magnificence when seen in an array.

In paleontology assemblages of diminutive fossils seem to have attracted attention of scientists, and much has been discussed, and many theories propounded, on the cause of such assemblages. On the contrary, assemblages of giant invertebrates seem to have occurred rather rarely. Occurrences of certain enormous individuals are on record, however, and various explanations have been tried. DACQUÉ (1921), for instance, cites the occurrence of Oligocene *Natica crassatina* in different growth sizes, namely, the specimens preserved in coarse sand facies are twice as high as those found in muddy matrix and considered as normal in growth. The same author mentions as factors stimulating unusual growth the changes in temperature of the sea water, isolation and protection from enemy on islands particularly in case of terrestrial animals, and so on. The relation between the growth size and the chemical properties of surrounding sea water is summarized by him as follows; animals grow larger in calcareous facies, smaller in pyritic facies, and those in phosphatic facies are intermediate in size (DAQUÉ, 1921, p. 37).

There may be many such cases and many such explanations in geological literature. For the understanding of such phenomena we have refer as much as possible to the observed facts and results of experiments in the ecological studies of life in Recent seas. We must have knowledge on the effects of sediments and sedimentation, chemical, physical and biological influences of environmental factors on life. In this connection we find G. E. MACGINITE's (1935) studies on the "Ecological Aspect of a California Marine Estuarry" very instructive and suggestive. In this paper MACGINITE gives the details of his very thorough observations during many years at Elkhorn Slough. It contains many facts that are important for geologists and paleontologists for their paleoecological interpretations and explanations of things and phenomena at hand. In connection with the problem of dwarf invertebrate assemblages, however, one of the recent papers of CLOUD (1948) is very instructive. In this paper he deals with the assemblages of diminutive fossil brachiopods on record in America. Various cases are analysed, and different theories scrutinized. After careful consideration he assumes that the following three cases are possibly responsible for dwarfed assemblages. Namely,

1) Assemblages of dwarfs (diminutive adults) due to physiological retardation of growth,
2) Mechanical segregation due to moving waters,

3) Assemblages of immature specimens arrested in growth or killed young by the change of evironmental factors.

The three causes CLOUD assumes possible for the production of dwarf assemblages similarly function in giving rise to giant assemblages. That is:

1) Assemblages of unusually large individuals resulted from the physiographical acceleration of growth.
2) Mechanical segregation of giants by moving waters,
3) Assemblages of individuals grown unusually large under changing environmental factors.

Of these three possiblilities 2 may be left aside with our giant assemblages, because they have particular compositions, one being chiefly molluscs and the other almost exclusively * brachiopods, and contain many smaller species in association. Mechanical segregation does not seem to have played any important part in these cases. 1 and 3 may be dealt with as in an intimate mutual relation. The influences of the changing environmental factors may affect organisms through physiological processes Consequently these two possible causes may be regarded as a continuous series of processes.

Strictly speaking, however, the same environmental factors, or their changes, may call forth more or less different responses in different organisms. For this AMEMIYA's (1928) ecological researches on the Japanese oysters, which will be referred to later, is suggestive. Our faunas can be regarded as assemblages of individuals which grew abnormally large in response, or adaptation, to certain particular ecological conditions or environmental factors.

Thus, our problem is reduced to what the environmental condition or conditions can be which provoked unusual growth of the fossils under discussion, on the assumption that such really did exist.

The environmental factors that have influences upon marine invertebrates are many as is discussed by MACGINITE, but 1) the chemical and physical nature of water including salinity, 2) the depth of habitat, and the character of bottom, may include most of them. In our cases, the depth and the bottom characters are rather easy to guess. The majority of molluscs and brachiopods are not deep-sea dwellers. The fossils under consideration are embedded in bituminous limestones, which are sediments rich in organic matter, that is, sapropelic, and deposited under stagnant condition of water, as is explicitly defined by KRUMBEIN and SLOSS in their recent trearise. Such sediments are formed in coastal, shallow seas, possibly seculuded at least partly from open ocean as almost basins.

The salinity comes into consideration. In this regard we find in GRABAU (1931) an interesting example, as we already quoted by the senior author in his Nabeyama paper. In his voluminous monograph on "the Permian of Mongolia" GRABAU described numerous species of of fossils including brachiopods and molluscs among others. According to him these molluscs and brachiopods dominantly show dwarf characters, that is, they are as a whole smaller in size than the same or allied forms known from the other parts of the world. He tried to find explanation of this phenomenon in the analogous Recent ecological facts observed in and around the Bay of Pe-

*By the courtesy of Saburô YOSHIDA we could see a picture of a *Pleurotomaris*-like gastropod he found in the black, bituminous, brachiopod-limestone of the Nabeyama region. The specimen will be examined in a near future.

chili, north China. On studying marine molluscs living in the Bay of Pechili, and comparing them with the corresponding forms living outside the Bay, he assured that the former are decidedly smaller than the latter. This is considered by him chiefly due to the subnormal salinity of the Pechili water caused by the great amount of fresh water poured in by the Yellow River. Of course it is not only the fresh water that is brought into the Bay by the Yellow River, but there is an enormous volume of fine debris carried down from the loess countries upstream: this must have some important influence upon the life in the Bay. GRABAU's (1931) conclusion concerning the subnormal growth of the Mongolian Permian marine invertebrate fauna is that the Permian sea in that region was of a similar character as the Pechili Bay of to-day, the salinity of the water having been subnormal as compared with that of the more open sea of the other parts of the world.

The significant bearing of the change in salinity of sea water on the life of marine invertebrates is exemplified in AMEMIYA's (1928) ecological studies on the oysters of Japan, as mentioned above. He made observations and experiments in the natural habitats and in laboratorium concerning the effects of change of salinity on the growth of oysters of several kinds. From his conclusive remarks we like to quote that:

1) there is the optimum of salinity; either too high or too low has an untoward effect upon reproduction, and 2) the suitable salinity for development in experimental studies coincides with the actual salinity of the natural habitat of the full grown oysters.

To speak of the optimum, it must be in each of the environmental factors, in theory, and, consequently the relation between environmental factors and organisms is a quite complicated matter. But if the conclusions of AMEMIYA on the Recent oysters hold true to a considerable extent with the other marine invertebrates both living and fossil, then we can not expect a high salinity as the factor stimulated the molluscs and brachiopods to grow unusually large, as the senior author assumed in his Nabeyama paper, in this case the term *growth* meaning the *normal* continuous changes from young to adult. It is because an unusually high salinity is an adverse condition for the animals to live under, just like a subnormal salinity causes damages to life. As a matter of fact the Zechstein faunas of Europe are known to be dwarfed because of the Zechstein sea having been too high in salinity (MACGINITE, 1939). Perhaps a case observed by MACGINITE on California shore may be mentioned here as an example of the lethal effect of abundant fresh water flowed into a shallow sea on the life therein. There may be many such cases which are useful data for the study of paleoecology. By way of referring to MACGINITE, he gives an interesting account of his observation on the effect of bottom material on the growth of *Schizohaerus nuttali* in Elkhorn Slough, California (MACGINITE, 1935 &' 39 a). The individuals living on loose sandy zone are the largest in growth, those on the heavy clay soil the smallest, and those inhabiting the *Zostera* ground intermediate in size. This almost corresponds to the case of Oligocene *Natica crassatina* referred to by DACQUÉ (1921), cited above.

Concerning the problem of unusually large growth there is very much more to be investigated and contemplated. First of all we have to look for examples comparable to the Japanese occurrences of the Permian assemblages discussed in this article. Ecological observations in the actual seas and inhabitants there must be extended to the assemblages of unusually large growth. At the present stage of our knowledge, however, we can not but try a tentative conclusion, that there is the possibility of the gigantic Permian fossil assemblages being the result of pathological plumpness, that is, hypertrophy. This, in turn, is considered closely related with the saproplelic nature of the marine sediments which were deposited in certain basins of limited extensions. Hypertrophy, in passing, is often a symptome of extinction of the animals. The so-called Anthracolithic fauna of Balia Maaden in Asia Minor (ENDERLE, 1900) also is in part, at least, preserved is a bituminous limestone, and consists of some huge specimens of gastropods (*Pleurotomaria*, *Murchisonia*) and *Dentalium*. The huge forms in this fauna also have symptomes of hypertrophy, and may represent an occurrence comparable to some extent with the Japanese ones.

One thing interesting to note before concluding this note is that in Mongolian Permian dwarf fauna Spirifers alone are recognized by GRABAU (1931) to be in normal size of growth. The reason is not clear at all. Among the fossils of the Japanese Permian faunas also Spiriferids of Kinshôzan and those and a *Productus* of Nabeyama are of sizes generally considered as normal, as is evident in the list of species given elsewhere. This is an interesting coincidence. This may be explained for the time being that Spiriferids are stable, and more resistant against the adverse life conditions than the other groups of brachiopods, this explanation involving some unsolved problems. However, the similar differential adaptation may take place in some other groups of marine invertebrates, as is suggested by some minute kinds of fossils found as members of the assemblages of giants.

REFERENCES

AMEMIYA, I. (1928):—Ecological Studies of Japanese Oysters, with Special Reference to the Salinity of their Habitats. *Jour. College of Agric., Imp. Univ. Tôkyô. vol. 9. no. 5.*

CLOUD, P. E., Jr. (1948):—Assemblages of Diminutive Brachiopods and their Paleoecological Significance. *Jour. Sedimentary Petrology, vol. 18, no. 2.*

DACQUÉ, E. (1921):—Vergleichende biologische Formenkunde der fossilen niederen Tiere, pp. 174-176, textfig. 48. This is a part of the author's very elaborate discussion on the fundamental form and the size of body ("Grundform und Körpergrösse der Typen.")

DACQUÉ, in his "Organische Morphologie und Paläontologie" (1935), remarks that anomalously large forms (Rissenformen) do not occur in the earlier stages of evolution of any groups or particular lineages of animals (p. 202). This means that the gigantic growth is on the way to extinction

ENDERLE, J. (1900):—Ueber eine Anthracolitische Fauna von Balia Maaden in Kleinasien. *Beitr. z. Palaeontol. Oesterr-Ungarns u. d. Orients, Bd. 13.*

GRABAU, A.W. (1931):—The Permian of Mongolia; *Natural History of Central Asia, vol. 4.*

HAYASAKA, I. (1925):—On Some Paleozoic Mollusca of Japan, I. Lamellibranchiata and Scaphopoda. *Science Reports, Tôhoku Imp. Univ., 2nd ser. (Geology). vol. 8, no. 2.*

——, (1932):—On three Brachiopod Species of the Subfamily Orthotetinae in the *Fusulina*- Limestone of Kinshozan, Akasaka-Mati, Prov. Mino, Japan. *Mem. Fac. Sci. and Agric., Taihoku Im. Univ., Taiwan, vol. 6, no. 1.* The three species described in this paper are not from the black, bituminous zone but from a lower one. But in this paper on older Japanese note dealt with the occurrence of 3 Reticularias and a Terebratuloid (?) in the former is reviewed.

HAYASAKA, I. (1933):—On the Upper Carboniferous Brachiopod Fauna from the Nabeyama Region, Totigi Prefecture, Japan. *Mem. Fac. Sci. Agric., Taihoku Imp. Univ, Taiwan, vol. 6, no. 2.*

——, (1938):—Two Species *Trachydomia* from Japan. *Memoirs, Faculty of Science and Agriculture, Taihoku Imp. Univ., Taiwan, vol. 22, no. 1.*

——, (1939):—*Spiromphalus*, a New Gastropod Genus from the Permian of Japan., *Ditto, no. 2.*

——, (1943):—On Some Permian Gastropods from Kinshôzan, Akasaka-Mati, Gihu Prefecture, pt. 1 (the only part published). *Mem. Fac. Science, Taihoku Imp. Univ., Taiwan, ser. 3, vol. 1, no. 2.*

KNIGHT, J. B. (1913):—The Gastropods of the St. Louis, Missouri, and Pennsylvanian Outlier: The Pseudozygopleurinae. *Journal of Paleontology, vol. 4, Supplement 1. Spiromphalus* is a small species, but still it is larger than species of *Pseudozygopleura*.

KRUMBEIN, W. C. and SLOSS, L. L. (1951):—Stratigraphy and Sedimentation, p. 146. The authors remark that in bituminous organic rocks "There is a complete range from slightly organic to highly organic sediments. Moreover, distinctions between humic and bituminous seiments are not always clear…
…" In our case neither of the limestones have been chemically studied.

MACGINITE, G. E. (1935):—Ecological Aspects of a California Marine Estuary. *Amer. Midland Naturalist, vol. 16, no. 3.* There may be many other, more recent works by this author on the similar subjects. We refer only to those within our easy reach.

——, (1939):—Some Effects of Fresh Water on the Fauna of Marine Harbor. *Amer. Midland Naturalist, vol. 21, no. 3.*

——, (1939a):—Littoral Marine Communities. *Amer. Midland Naturalist, vol. 21, no. 1.*

NAGAO, T. and MINATO, M. (1943):—*Parafusulina kaerimizuensis* aus der unterhalb der Brachioponden-Zone liegenden Schicht in der Gegend von Nabeyama. *Jour. Geol. Soc. Japan, vol. 50, no. 601.*

OZAWA, Y. (1927):—Stratigraphical Studies of the Fusulina Limestone of Akasaka, Province Mino. *Jour. Fac. Sci., Imp. Univ. Tôkyô, ser. 2, vol. 2, part 3.*

SHIKAMA, T. (1949):—The Kuzuu Ossuaries: Geological and Palaeonotological Studies of the Limestone Fissure Deposits, in Kuzuu, Totigi Prefecture. *Sci. Rep. Tohoku Imp. Univ., 2nd ser. (Geology), vol. 23.*

WAKIMIZU, T. (1902):—The Limestone Formation of Kinshôzan, Akasaka, Province Mino (in Japanese). *Jour. Geol. Soc. Tôkyô (Japan, afterwards), vol. 9*, pp. 71-75; 163-169: 205-212; 331-339; 1 pl.

YABE, H. and HAYASAKA, I. (1915):—Palaeozoic Corals from Japan, Korea and China. *Jour. Geol. Soc. Tokyô, vol. 22. Romingeris* (?) *Kotoi* and *Lonsdaleia* (*Waagenophyllum*) *akasakensis* are described.

Explanation of Plate 5

Fig. 1. *Bellerophon jonesianus* DEKONINCK. Natural size. This is the largest specimen we have seen, but we have no reason to say that this is the largest specimen of this species hitherto discovered at Kinshôzan, because it is not possible for us to examine all the specimens in various repositories in Japan. This specimen measures 130 mm. in height and 124 mm. In width. Many other specimens we have had chance to see are, on an average, not much smaller than 3/4 in height of the specimen here pictured.

Fig. 2. *Orthoticha japonica* HAYASAKA. Natural size. This is not to represent the largest size of this species, but is pictured to show one of the specimens discovered at other locality than Kadosawa where the original material of the Nabeyama fauna was found. This and a few other specimens were collected by Saburo YOSHIDA in the black, bituminous limestone developed at Yamasuga. Here the bituminous limestone does not contain fusulinids, and lies between *Fusulina*-limestones with *Parafusulina kaerimizuensis*. YOSHIDA presented to us several specimens of this species he collected at Kadosawa which used to be very popular at this place.

Fig 2

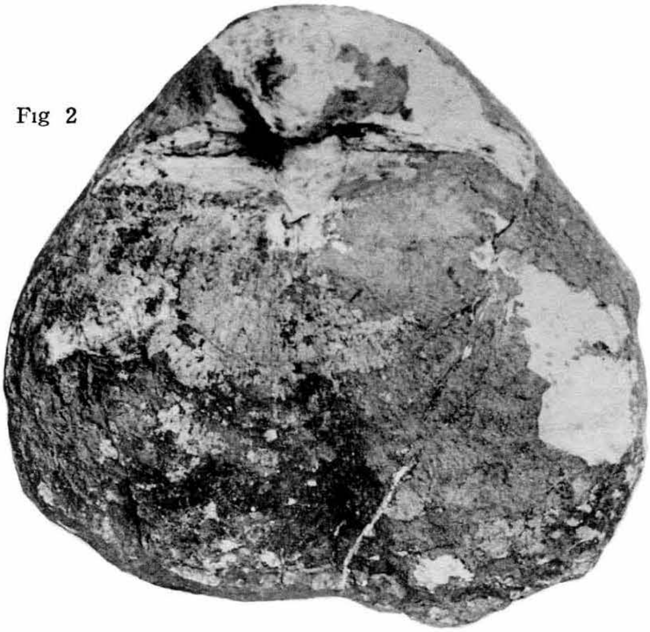
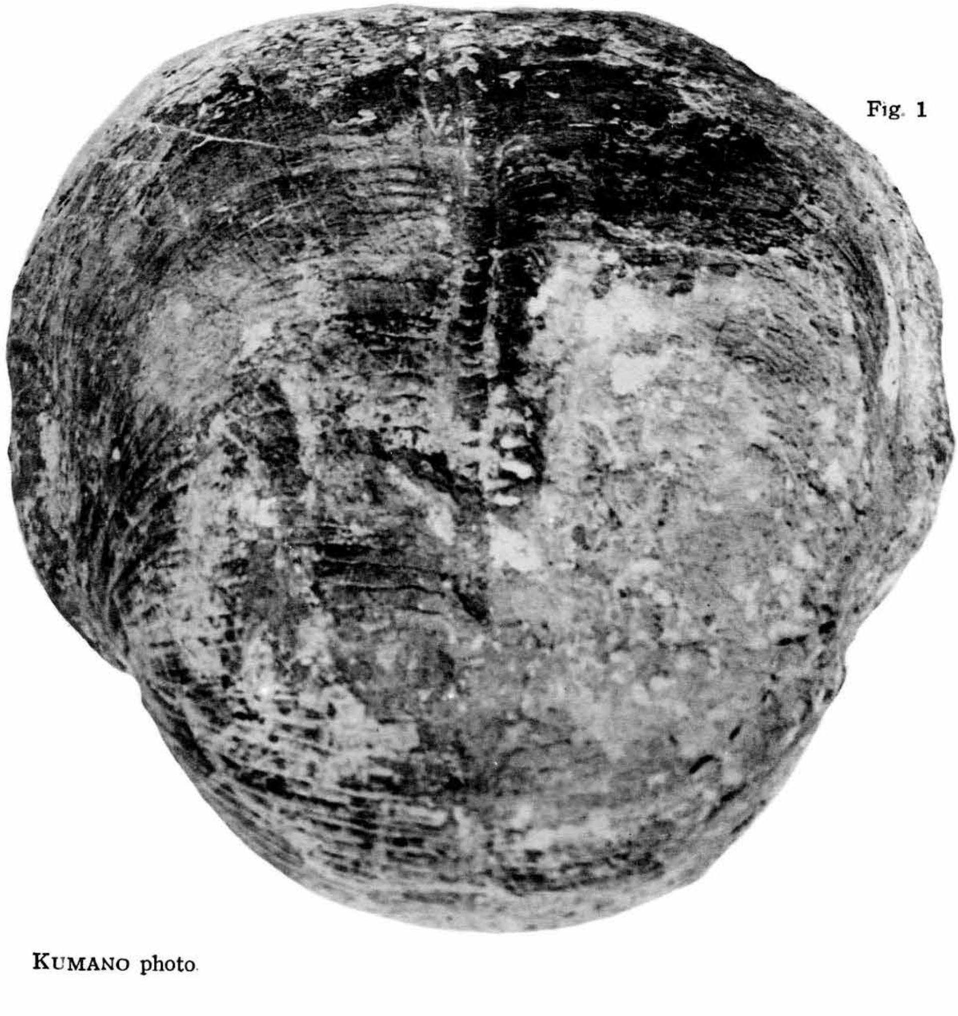


Fig. 1



KUMANO photo.

Trans. Proc. Palaeont. Soc. Japan, N. S. No. 10, pp. 45-54, 18 text-figs., July 31, 1953.

233. MIOCENE FORAMINIFERA FROM THE SHINTOTSUGAWA AREA, KABATO-GUN, HOKKAIDO*

KIYOSHI ASANO

Institute of Geology and Paleontology, Tôhoku University

北海道樺戸郡新十津川地域の中新世有孔虫群： 新十津川地域の層序は西徳富層群と新十津川層群とに分けられるが，前者からは裏日本の黒色頁岩の有孔虫と同様なものを産し，後者からは，前者と異つた要素が多くなり，秋田の北浦層又は新潟の椎谷層に対比されるであろうが，そのうちに中新世に限られる有孔虫を含むことから，前者を中部中新世，後者を上部中新世とした。 それらの有孔虫産地の古生態も論ぜられている。 浅 野 清

Introduction

This paper treats smaller Foraminifera collected by Prof. S. HANZAWA and Mr. S. IMANISHI from the Shintotsugawa area, Kabato-gun, Ishikari province, Hokkaido, in 1950.

A condenced summary of the Tertiary stratigraphy of the said area (HANZAWA and IMANISHI, 1951) is as follows:

Oshirarika group (Pliocene)

.........Unconformity.........

Shintotsugawa group (Upper Miocene)

- Gakuenzawa formation; siltstone intercalating tuffaceous sandstone, conglomerate at the base. 250 meters.
- Chashiparomanai formation; siltstone. 420-300 meters.
- Toppu formation; alternation of siltstone and shale, sandstone at the base. 350-300 meters.
- Rukushubetsu formation; tuff, sandstone, conglomerate. 75-5 meters.

.........Unconformity.........

Nishi-toppu group (Middle Miocene)

- Wakkauenbetsu formation; siltstone intercalating sandstone and conglomerate. 500 meters.
- Soshi formation; tuff, sandstone, conglomerate. 100 meters.

.........Unconformity.........

Kabato Paleozoic complex

The Nishitoppu group consists of two formations. The lower, Soshi formation rests unconformably on the Kabato Paleozoic complex and contains megafossils, such as *Ostrea*, but no Foraminifera. The upper, Wakkauenbetsu formation, mainly consisting of dark gray or black siltstone, contains a rich foraminiferal assemblage at many outcrops around Yoshino-machi, Shintotsugawa-mura, Kabato-gun. The localities, which yielded the Foraminifera herein reported, are:

IMANISHI Loc. No. 151: Toppu-river cliff 2 km southwest of Yoshino-machi

Loc. No. 526: Nuttapu-river cliff, 2 km, north of Yoshino-machi

Loc. No. 531: Nuttapu-river cliff, 2.5 km north of Soshi, Yoshino-machi

Loc. No. 787: Hamamasu, 0.5 km north of Soshi, Yoshino-machi

Loc. No. 868: Penkepetan-river cliff, 2 km southwest of Kokuryo, Uryu-mura

Loc. No. 1017: Wakkauenbetsu-river cliff, 0.6 km west of Yoshino-machi

Loc. No. 1018: Wakkauenbetsu-river cliff, 0.8 km west of Yoshino-machi

Loc. No. 1022: Inuno-sawa, Wakka, Yoshino-machi

Loc. No. 1028: 0.6 km west of Inuno-sawa, Wakka, Yoshino-machi

Loc. No. 1029: 0.7 km west of Inunosawa, Wakka, Yoshino-machi
Loc. No. 1930: 0.8 km west of Inunosawa, Wakka, Yoshino-machi
Loc. No. 1043: Rukushubetsu-river cliff, 1.3 km southwest of Yoshino-machi
Loc. No. 1049: Rukushubetsu-river cliff, 2 km southwest of Yoshino-machi

The Shintotsugawa group, consisting of four formations, overlies unconformably the Nishi-toppu group. Foraminifera are common in all of the formations of this group except the lowest, Rukushubetsu formation. The following localities have yielded Foraminifera dealt with:

Rukushubetsu formation
IMANISHI Loc. No. 322: Rokugosen-river cliff, 3.5 km southwest of Gakuen, Shintotsugawa-mura
Loc. No. 835: Oshirarika-river cliff at Gorobuchi, 4 km southeast of Kokuryo, Uryu-mura
Toppu formation
IMANISHI Loc. No. 76: Sopuchi-river cliff, 1.7 km west of Yoshizawa, Shintotsugawa-mura
Loc. No. 146: Toppu-river cliff, 1.2 km south of Yoshino-machi
Loc. No. 175: Rokugosen-river cliff, 3 km south of Gakuen, Shintotsugawa-mura
Loc. No. 176: Rokugosen-river cliff, 3.2 km south of Gakuen, Shintotsugawa-mura
Loc. No. 208: Yongosen-river cliff, 1.5 km southeast of Gakuen, Shintotsugawa-mura
Loc. No. 231: Icnigosen-river cliff, 3 km southeast of Gakuen, Shintotsugawa-mura
Chashiparomanai formation
IMANISHI Loc. No. 88: Sugiharadani-river cliff, 2.5 km west of Sopuchi, Shintotsugawa-mura
Loc. No. 89: Sugiharadani-river cliff, 2.6 km west of Sopuchi, Shintotsugawa-mura
Loc. No. 170: Rokugosen-river cliff, 2.8 km south of Gakuen, Shintotsugawa-mura
Loc. No. 326: Rokugosen-river cliff, 4 km southwest of Gakuen, Shintotsugawa-mura
Loc. No. 330: Hachigosen-river cliff, Chashiparomanai, Gakuen, Shintotsugawa-mura
Loc. No. 503: Toppu-river cliff, 0.5 km east of Yoshino-machi
Loc. No. 1076: Wakkauenbetsu-river cliff, Yoshino-bridge, Yoshino-machi
Loc. No. 1106: Yoshitsu-sawa, Oshirarika-river, Shintotsugawa-mura
Gakuenzawa formation
IMANISHI Loc. No. 378: Gakuenzawa-river cliff, 3 km northwest of Gakuen, Shintotsugawa-mura
Loc. No. 507: Nutappu-river cliff, 1 km east of Yoshino-machi
Loc. No. 516: Toppu-river cliff, 1.5 km east of Yoshino-machi
Loc. No. 1082: Nuttapu-river cliff, 0.9 km east of Yoshino-machi

Here, the writer expresses his cordial thanks to Prof. S. HANZAWA and Mr. S. IMANISHI for submitting their collections to the present study.

Faunal Consideration

An analysis of the composition and relative stratigraphic ranges of the foraminiferal assemblage from the treated area reveals that, (1) the Wakkauenbetsu foraminiferal assemblage is quite distinct from those of the overlying Shintotsugawa group and that, (2) the characteristic association of the Japanese Miocene Foraminifera, especially of the oil-fields in Akita, Yamagata and Niigata prefectures also occurs in Hokkaido.

The Foraminifera from the Wakkauenbetsu formation (Table 1) consists of 51 species. These species indicate that the formation was deposited in the medium-depth zones, such as in the neritic or bathyal. Of the species,

Table 1. Foraminifera from the Wakkauenbetsu Formation.

Species \ Localities	151	526	531	787	868	1017	1018	1022	1028	1029	1030	1043	1049
Ammobaculites sp.	–	–	–	–	–	F	–	–	–	R	–	–	–
Ammodiscus sp.	–	R	–	–	–	–	–	–	–	–	–	–	–
Angulogerina hughesi	–	–	–	R	–	–	–	–	–	–	–	–	–
Bathysiphon sp. (A)	–	A	F	–	–	F	–	–	–	–	–	–	F
Bathysiphon sp. (B)	–	C	–	–	–	–	R	–	F	R	F	–	–
Bolivina marginata	–	–	–	–	–	–	–	R	–	–	–	–	R
Bulimina inflata	F	–	–	R	–	–	–	–	–	–	–	–	–
Bulimina ovata	–	–	–	F	–	–	–	–	–	–	–	–	–
Cassidulina laevigata carinata	–	–	–	R	–	–	–	R	–	–	–	–	–
Cassidulina margareta	R	–	–	–	–	–	R	–	–	–	–	R	R
Cibicides aknerianus	–	–	–	R	–	–	–	–	–	–	–	–	–
Cibicides cf. *altamiraensis*	R	–	–	–	–	–	R	F	–	–	–	R	R
Cibicides cf. *lobatulus*	–	–	–	R	–	–	–	–	–	–	–	–	–
Cyclammina cancellata	R	–	–	–	–	–	–	–	–	–	R	–	–
Cyclammina czoensis	–	–	–	–	–	F	–	–	–	–	R	–	–
Cyclammina incisa	R	R	R	R	–	F	–	–	–	–	–	–	–
Cyclammina pusilla	R	R	R	R	–	F	–	–	–	–	–	–	–
Dentalina sp.	–	–	–	–	R	–	–	–	–	–	–	–	R
Discorbis sp.	–	–	–	–	–	–	–	R	–	–	–	–	R
Ehrenbergina notoensis	–	–	–	–	–	–	–	–	–	–	–	R	–
Entosolenia squamosa	–	–	–	–	–	–	–	–	–	–	–	R	–
Entosolenia sp.	–	–	–	–	–	–	–	–	–	–	–	R	–
Gaudryina sp.	R	–	–	–	–	–	–	–	–	–	–	–	R
Globigerina spp.	–	–	–	F	–	–	–	–	–	–	–	F	F
Gyroidina soldanii	C	–	–	C	–	–	–	–	–	–	–	–	–
Haplophragmoides canariensis	–	–	–	–	–	–	–	–	F	R	–	–	–
Haplophragmoides renzi	–	R	R	–	–	–	–	–	–	–	–	–	–
Haplophragmoides trullisatum	–	R	–	R	R	C	R	R	R	R	–	–	F
Lagena striata	–	–	–	R	–	–	–	–	–	–	–	–	–
Martinottiella communis	–	–	–	–	R	R	–	–	–	–	–	–	–
Nodosaria sp.	–	–	–	–	–	–	–	–	–	–	–	–	R
Nonion pompilioides	–	–	–	–	R	–	–	–	–	–	–	–	–
Nonion sp.	–	–	–	R	R	–	–	R	–	–	–	–	–
Nonionella hanzawai	–	–	–	C	–	–	–	–	–	–	–	–	F
Plectofrondicularia japonica	–	–	–	–	–	–	–	F	–	–	–	–	A
Plectofrondicularia miocenica	–	–	–	R	–	–	–	–	–	–	–	–	R
Plectofrondicularia sp.	R	–	–	–	–	–	–	–	–	–	–	–	–

Species \ Localities	151	526	531	787	868	1017	1018	1022	1028	1029	1030	1043	1049
Pullenia bulloides	R	–	–	–	–	–	–	–	–	–	–	–	–
Pullenia sp.	–	–	–	–	–	–	–	R	–	–	R	–	–
Quinqueloculina sp.	–	–	–	–	–	–	–	–	–	–	–	–	R
Robulus calcar	–	–	–	–	–	–	–	–	–	–	–	–	F
Robulus sp.	R	–	–	R	–	–	F	R	–	–	F	–	–
Rotalia tochigiensis	C	–	–	F	–	–	–	R	–	–	F	–	–
Rotalia yubariensis	–	–	–	–	–	–	–	F	–	–	R	–	–
Spiroplectammina niigataensis	–	–	–	–	–	–	F	A	A	–	R	–	A
Textularia sp.	–	–	–	–	–	–	–	–	–	–	–	–	R
Trochammina nipponica	–	–	–	–	–	R	F	F	C	R	F	–	F
Trochammina cf. *pacifica*	–	–	–	–	–	–	C	–	–	–	–	–	–
Uvigerina proboscidea	F	–	–	C	–	–	–	R	–	–	R	–	R
Uvigerina subperegrina	F	–	–	R	–	–	–	–	–	–	–	–	–
Valvulineria nipponica	R	–	–	F	–	–	–	C	–	–	–	C	F

A : Abundant, C : Common, F : Few, R : Rare.

Spiroplectammina niigataensis, *Bathysiphon* sp. (A), *Trochammina nipponica*, n. sp., *Haplophragmoides trullisatum*, *Plectofrondicularia japonica*, n. sp., *Nonionella hanzawai*, n. sp., *Valvulineria nipponica* are represented by a large number of individuals. These species except for the ones described herein as new to science are commonly found in the so called "Black shale" formations in Akita, Yamagata and Niigata prefectures. Lithologically, the Kubiki formation in Niigata prefecture, Funakawa formation in Akita and Yamagata prefectures, and Wakkauenbetsu formation under consideration are very similar, consisting of mainly black or gray siltstone. Their similar lithology and correlative foraminiferal assemblage suggest that they may have been deposited under similar environmental condition of the medium-depth zones. The "Black shale" formation often intercalates locally tuff or agglomerate. Where intercalation of volcanic material occurs (Loc. Nos. 526, 531 and 1017), somewhat different assemblages are found in the silty part; for example, large forms of *Cyclammina*, *Trochammina*, or *Bathysiphon*, such as, *C. ezoensis*, *C. cancellata*, *T. nipponica* or *B.* sp. (A) are found to be dominant and no calcareous Foraminifera are found in association. This suggests that the larger forms *Cyclammina*, *Trochammina* or *Bathysiphon* prefer a muddy sea bottom, due to volcanic activity or other agencies. It the Recent deposits around Japan, smaller forms of arenaceous Foraminifera are usually found to be accompanied with calcareous Foraminifera, but larger forms of *Cyclammina cancellata* was found abundantly in only one station (H 113, Lat. 35° 15′ 10″ N., Long. 140° 46′ E.), off Bôsô Peninsula, by the Sôyô-maru of the Fisheries Experimental Station in Tokyô, during her oceanographical observations and dredge operation on the continental shelf of Japan. The bottom characters of the station was recorded as gravels and clays and the depth was given as 196 meters. The ecological factors* govering such an abnormal fauna has not yet been ascertained.

The foraminiferal assemblages from the Shintotsugawa group are ecologically more diverse than those of the Wakkauenbetsu. Foraminifera from the lowest, Rukushubetsu formation consists of littoral forms (Table 2), but those from the Toppu, Chashiparomanai and Gakuenzawa formations (Tables 3-5) are mainly neritic or bathyal types, as represented by the Buliminidae, Cassidulinidae and Globigerinidae. There are also abnormal faunules consisting only of larger forms of arenaceous Foraminifera in some localities (Loc. Nos. 208, 835, 1106).

In general, the Shintotsugawa forami-

Table 2. Foraminifera from the Rukushubetsu Formation.

Species \ Localities	322	835
Cribroelphidium imanishii	F	–
Haplophragmoides spp.	–	C
Trochammina nipponica	–	F

Table 3. Foraminifera from the Toppu Formation.

Species \ Localities	76	146	175	176	208	231
Ammobaculites sp.	–	–	–	R	–	–
Bulimina ovata	R	–	C	C	–	–
Bulimina pyrula	–	R	–	F	–	–
Cassidulina laevigata carinata	–	–	C	C	–	–
Cyclammina cancellata	R	–	–	–	F	–
Cyclammina incisa	–	R	–	–	–	–
Eponides sp.	R	–	–	–	–	–
Epistominella japonica	–	–	–	–	–	F
Globigerina spp.	–	–	R	F	–	–
Gyroidina soldanii	R	–	–	–	–	–
Haplophragmoides canariensis	–	–	–	F	–	–
Haplophragmoides trullisatum	–	R	F	–	–	–
Martinottiella communis	–	–	–	–	R	–
Nonion pompilioides	R	–	–	–	–	–
Nonionella miocenica	–	–	F	F	–	C
Pullenia bulloides	R	–	–	–	–	–
Spiroplectammina niigataensis	–	–	–	R	–	–
Trochammina nipponica	–	–	R	F	R	–
Trochammina cf. *pacifica*	–	–	–	F	–	–

A: Abundant, C: Common, F: Few, R: Rare.

* R. M. STAINFORTH stated in his letter to the writer (Nov. 3, 1951); "My conclusion has been that the ecological factor causing such an abnormal fauna is turbidity of the sea water. The turbidity may be due to rapid deposition of shaley sediments as in a piedmont facies or in a graben-trough, or in an area of rapid floculation of clay colloids, off the mouth of a big river. The fossil examples which I have studied in several countries seem to give support to this idea, but I have never encountered a Recent fauna of the same type which could be used to check my deduction."

Table 4. Foraminifera from the Chashiparomanai Formation.

Species \ Localities	88	89	170	326	330	503	1076	1105
Bathysiphon sp. (A)	–	–	–	–	–	–	–	F
Bulimina inflata	–	–	–	–	R	–	–	–
Bulimina ovata	–	–	C	R	–	–	C	–
Cassidulina laevigata carinata	–	R	–	–	F	–	–	–
Cassidulina margareta	–	–	–	–	R	–	–	–
Cribroelphidium imanishii	–	C	–	–	–	–	–	–
Cyclammina cancellata	–	–	–	–	F	–	–	F
Dentalina sp.	R	–	–	–	–	–	–	–
Epistominella japonica	–	–	–	F	R	–	C	–
Eponides sp.	–	–	–	–	–	–	R	–
Globigerina spp.	F	–	–	R	–	–	F	–
Haplophragmoides canariensis	–	–	F	–	R	F	–	–
Haplophragmoides trullisatum	–	–	F	–	F	–	–	–
Martinottiella communis	–	–	F	–	–	–	–	R
Nonionella cf. *pulchella*	–	–	–	–	–	–	R	–
Pullenia apertula	–	–	–	–	–	R	–	–
Quinqueloculina vulgaris	R	–	–	–	–	–	–	–
Spiroplectammina niigataensis	–	–	–	–	F	R	–	–
Trochammina nipponica	–	–	F	–	–	F	R	R
Trochammina cf. *pacifican*	–	–	F	–	–	–	–	–
Uvigerina sp.	–	–	R	R	F	R	–	–

C: Common, F: Few, R: Rare.

niferal assemblages, although they belong to four rock-units, are distinct from the underlying Wakkauenbetsu assemblage; ***Cribroelphidium imanishii, Nonionella miocenica, Epistominella japonica, Nonionella*** cf. ***pulchella*** and ***Virgulinella miocenica*** are characteristic in this group, while ***Nonionella hanzawai, Plectofrondicularia japonica, P. miocenica, Bolivina marginata, Rotalia tochigiensis, R. yubariensis*** and ***Valvulineria nipponica*** are limited to the Wakkauenbetsu (Table 6).

Thus, there is a sharp line between the faunas of the Wakkauenbetsu and Shintotsugawa, which seems to be related to the unconformity between the two.

Age Consideration

A geosyncline was formed along the Japan Sea coast in the middle Miocene age, in which the Onnagawa siliceous shale, Funakawa black shale and the Kitaura alternation of sandstone and shale and its equivalent formations were deposited (S. HANZAWA, 1951). The Wakkauenbetsu formation, as abovestated, is correlated to the Funakawa black shale and the overlying Shintotsugawa group to the Kitaura formation. In the middle and late Tertiary, however, a pronounced provincialism affected the faunas, and the stratigraphic ranges of Foraminifera of these ages vary in different areas even in the same geosyncline, thus it is very

Table 5. Foraminifera from the Gakuenzawa Formation.

Species \ Localities	378	507	546	1082
Bulimina ovata	R	A	C	A
Bulimina pyrula	–	F	–	–
Cornuspira sp.	–	–	R	–
Epistominella japonica	–	R	–	–
Globigerina spp.	–	R	F	–
Glomospira sp.	–	R	–	–
Haplophragmoides sp.	–	R	–	–
Lagena perlucida	–	R	–	–
Nonion pompilioides	R	–	–	C
Nonionella miocenica	–	–	–	C
Nonionella cf. *pulchella*	–	A	C	C
Pullenia sp.	–	–	–	R
Spiroplectammina niigataensis	R	R	C	C
Trochammina nipponica	–	–	C	F
Trochammina cf. *pacifica*	–	–	–	F
Uvigerina cf. *hootsi*	–	R	–	F
Virgulinella miocenica	–	R	–	–

A: Abundant, C: Common, F: Few, R: Rare.

difficult to determine the geological age according to international standard. However, a comparison of the present assemblages with those of regions in which the foraminiferal sequences have been studied in detail is useful in showing the distribution of the characteristic species over wide areas.

The Gakuenzawa foraminiferal assemblage which is the youngest foraminiferal sequence of the treated area contains species which are dominantly found in the Upper or Middle Miocene formations of the Northwestern America, such as *Nonionella miocenica* and *Virgulinella miocenica*. Furthermore, the Gakuenzawa Foraminifera consists of many species which are usually found in the geosynclinal deposits of the Northwest Honshū.

Thus, in conclusion, it can be said that the Shintotsugawa assemblages represent the Upper Miocene foraminiferal sequence of the Japan Sea Coast,

Table 6. Stratigraphical Distribution of the Characteristic Foraminifera from the Shintotsugawa Area.

Formations	Gakuenzawa			Chashiparomanai				Toppu			Ru-ku.	Wakkauenbetsu				
Localities	507	546	1082	89	326	330	1076	175	176	231	322	151	787	1022	1043	1049
Spiroplectammina niigataensis	R	C	C	–	–	F	–	–	R	–	–	–	–	–	–	–
Virgulinella miocenica	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nonionella cf. *pulchella*	A	C	C	–	–	–	R	–	–	–	–	–	–	–	–	–
Epistominella japonica	R	–	–	–	F	R	C	–	–	F	–	–	–	–	–	–
Nonionella miocenica	–	–	C	–	–	–	–	F	F	C	–	–	–	–	–	–
Cribroelphidium imanishii	–	–	–	C	–	–	–	–	–	–	F	–	–	–	–	–
Bolivina marginata	–	–	–	–	–	–	–	–	–	–	–	–	–	F	–	R
Nonionella hanzawai	–	–	–	–	–	–	–	–	–	–	–	–	C	–	–	F
Plectofrondicularia miocenica	–	–	–	–	–	–	–	–	–	–	–	–	R	–	–	R
Plectofrondicularia japonica	–	–	–	–	–	–	–	–	–	–	–	–	–	F	–	A
Rotalia tochigiensis	–	–	–	–	–	–	–	–	–	–	–	C	F	R	F	–
Rotalia yubariensis	–	–	–	–	–	–	–	–	–	–	–	–	–	F	R	–
Valuvulineria nipponica	–	–	–	–	–	–	–	–	–	–	–	R	F	C	C	F

A: Abundant, C: Common, F: Few, R: Rare.

while the underlying Wakkauenbetsu can be correlated to the Funakawa and Kubiki and is Middle Miocene.

Description of New Species

Nonionella hanzawai ASANO, n. sp.

Text-figs. 4 a-c.

Test subglobular, slightly longer than broad, consisting of about 7 chambers, arranged inequilaterally, increasing rapidly in size as added, much inflated, ventral lobe of last chamber extending across umbilical area nearly to periphery, with several small lobelets at margin; sutures depressed, gently curved; wall smooth; aperture at base of apertural face. Length up to 1 mm.

Holotype: Institute of Geology and Paleontology, Tohoku University coll. cat. no. 75286. Hamamasu, 500 m. north of Soshi, Yoshino-machi (Lat. 43° 34′ 30″ N., Long. 141° 43′ 30″ E.), Wakkauenbetsu formation, Middle Miocene.

Remarks: Differs from both *N. globosa* ISHIWADA and *N. turgida digitata* NORVANG by the more globular test of which ventral lobelets are not completely separated from each other. This is a characteristic species in the Middle Miocene Wakkauenbetsu formation of Hokkaido.

Cribroelphidium imanishii ASANO, n. sp.

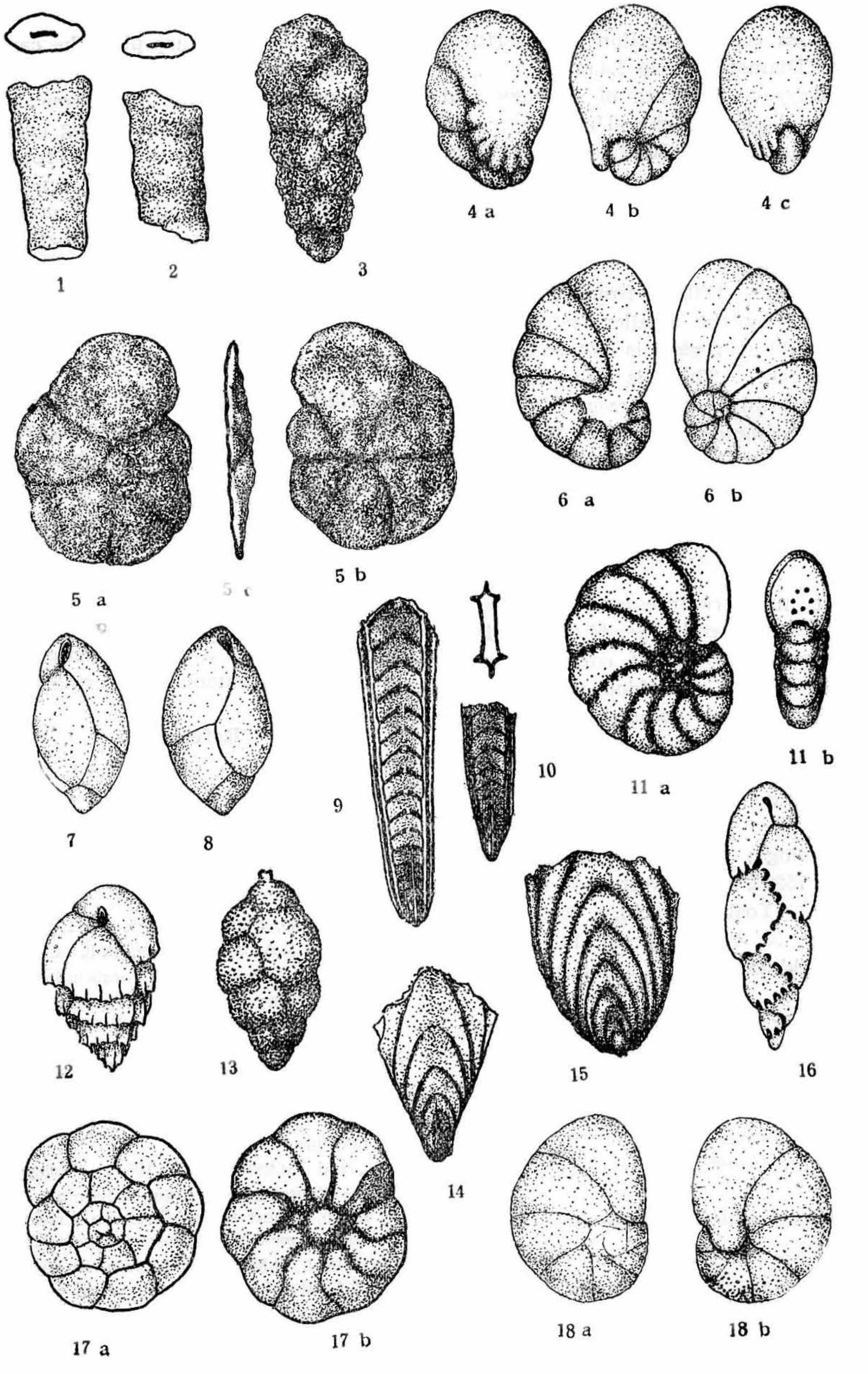
Text-figs. 11 a, b.

Test planispiral. compressed, periphery rounded, slightly lobulated; chambers 10–15 in last coil, umbilical region somewhat depressed, often filled with granular shell material; sutures gently curved, depressed in later ones, retral processes usually indistinct, short and numerous; wall smooth, somewhat inflated; aperture low openings at base of apertural face, with small circular

---

Explanation of Text-figures

Figs.	1-2.	*Bathysiphon* sp. (A) ×25 Loc. no. 1049, Wakkauenbetsu Formation
Fig.	3.	*Spiroplectammina niigataensis* ASANO and INOMATA ×25 Loc. no. 1049, Wakkauenbetsu Formation
Figs.	4 a-c.	*Nonionella hanzawai* ASANO, n. sp. ×25 Loc. no. 787, Wakkauenbetsu Formation
Figs.	5 a-c.	*Trochammina nipponica* ASANO, n. sp. ×25 Loc. no. 1028, Wakkauenbetsu formation
Figs.	6 a, b.	*Nonionella* cf. *pulchella* HADA ×25 Loc. no. 507, Gakuenzawa Formation
Figs.	7, 8.	*Bulimina ovata* D'ORBIGNY ×30 Loc. no. 507, Gakuenzawa Formation
Figs.	9, 10.	*Plectofrondicularia japonica* ASANO, n. sp. ×30 Loc. no. 1049, Wakkauenbetsu Formation
Figs.	11 a, b.	*Cribroelphidium imanishii* ASANO, n. sp. ×25 Loc. no. 89, Chashiparomanai Formation
Fig.	12.	*Bulimina inflata* D'ORBIGNY ×30 Loc. no. 151, Wakkauenbetsu Formation
Fig.	13.	*Uvigerina proboscidea* SCHWAGER ×40 Loc. no. 1049, Wakkauenbetsu Formation
Fig.	14.	*Plectofrondicularia miocenica* CUSHMAN ×25 Loc. no. 1049, Wakkauenbetsu Formation
Fig.	15.	*Plectofrondicularia* sp. ×25 Loc. no. 151, Wakkauenbetsu Formation
Fig.	16.	*Virgulinella miocenica* CUSHMAN and PONTON ×30 Loc. no. 507, Gakuenzawa Formation
Figs.	17 a, b.	*Rotalia tochigiensis* UCHIO ×25 Loc. no. 151, Wakkauenbetsu Formation
Figs.	18 a, b.	*Nonionella miocenica* CUSHMAN ×25 Loc. no. 1082, Gakuenzawa Formation


1
2
3
4 a
4 b
4 c
5 a
5 c
5 b
6 a
6 b
7
8
9
10
11 a
11 b
12
13
14
15
16
17 a
17 b
18 a
18 b

pores on central portion of apertural face. Diameter up to 1.4 mm.

Holotype: Institute of Geology and Paleontology, Tôhoku University, coll. cat. no. 75287. Sugiharadani, 2.6 km west of Sopuchi, Shintotsugawa-mura, Kabato-gun (Lat. 43° 32′ 50″ N., Long. 141° 50′ E.), Chashiparomanai formation, Upper Miocene.

Remarks: Differs from *C. ezoense* (ASANO) by the smaller test of which the umbilical region is not so strongly umbonated. This is perphaps an ancestral form of *C. ezoense.* It also occurs commonly in the Nakayama formation in the Jôban Coal-fields.

Trochammina nipponica ASANO, n. sp.

Text-figs. 5 a-c.

Test much compressed, large, composed of two coils, periphery angled: chambers 5 or 6 in last coil, increasing rapidly in size as added, very slightly inflated; sutures somewhat depressed, slightly curved; wall arenaceous, smoothly finished; aperture indistinct. Diameter up to 1.5 mm.

Holotype: Institute of Geology and Paleontology, Tôhoku University coll. cat. no. 75288. 600 m west of Inuno-sawa, Wakka, Yoshino-machi, Kabato gun (Lat. 43° 35′ 40″ N., Long. 141° 42′ 30″ E.), Wakkauenbetsu formation, Middle Miocene.

Remarks: This form may be easily distinguished from allied species by the larger and much compressed test, consisting of only two coils. It occurs widely in the "Black shale" formations of Northwest Honshu.

Plectofrondicularia japonica ASANO, n. sp.

Text-figs. 9, 10.

Test elongate, narrow, compressed, periphery with 3 sharp platelike carinae, one in the middle, the other two perpendicular to the middle one, broad sides concave or flat, diverging gradually from initial end which is round or sometimes pointed; chambers numerous, early ones biserial, later ones uniserial, low; sutures strongly limbate, not depressed, usually transparent at middle portion; wall smooth except early portion which is provided with short costae. Length up to 2 mm., breadth about 0.3 mm.

Holotype: Institute of Geology and Paleontology, Tôhoku University coll. cat. no. 75289. Rukushubetsu-river, 1.3 km southwest of Yoshino-machi, Kabato-gun (Lat. 43° 35′ N., Long. 141° 43′ 20″ E.), Wakkauenbetsu formation, Middle Miocene.

Remarks: Differs from *P. californica* CUSHMAN by the strongly limbate sutures. This is a characteristic species in the Wakkauenbetsu formation of Hokkaido.

Reference

ASANO, K. (1951), Recent and Tertiary *Cyclammina* from Japan and the Adjacent Regions, *Short Papers, Inst. Geol. Pal. Tôhoku Univ.*, no. 3, pp. 13–24, pls. 3, 4.

——, (1952), Foraminifera from the Miocene Takinoue Formation near Momijiyama, Hokkaido, Ibid., no. 4, pp. 47–51, pl. 6.

CUSHMAN, J. A. and Stewart, R. E. and K. C. (1947), Five Papers of Foraminifera from the Tertiary of Western Oregon, *Oregon Dept. Geol. Min. Ind., Bull.* 36, pp. 1–110, pls. 1–13.

HANZAWA, S. (1950), Tertiary Paleogeography of North Japan, *Short Papers, Inst. Geol. Pal. Tôhoku Univ*, no. 2, pp. 74–98, 4 text-figs.

—— , and IMANISHI, S. (1951), Geology on the Shintotsugawa Area, Kabato-gun, Hokkaido, Report to the *Ptroleum Exploration Advencement Committee of Japan* (MS).

KLEINPELL, R.M. (1938), Miocene Stratigraphy of California, *Am. Assoc. Petr. Geol.*, pp. 1–450, pls. 1–22.

1953 年度例会開催予定

	開催地	開催日	講演申込〆切日
第 55 回	仙台	10月 10日	9月 20日
第 56 回	大阪	12月 19日	11月 30日
第 57 回	札幌	未定	未定

講演御希望の方は本会宛御申込下さい

論文が奇数頁で終つた場合には次の空白頁を学会紀年や寄贈蔵書目録でうずめて来ましたが，今後はその外に短篇も挿入したいと思いますので，本文乃至本文とカットで一頁以内におさまる短稿(英文)がありましたら御寄稿下さい。短稿は空白の出来た場合に随時挿入して行きます，短稿に対しては学会からは抜刷を差上げられませんから，必要の場合は自費に願います。

1953 年 7 月 25 日　印　刷
1953 年 7 月 31 日　發　行

定價（會員外の方本號に限り） 1 部 200 圓

編集兼發行者　東京大學理學部地質學教室内
日本古生物學會　小　林　貞　一
(振替口座東京 84780 番)

印　刷　者　東京都港區芝浦1丁目1
株式會社 ヘラルド社　富　田　元

購讀申込は下記の賣捌店へ申込下さい
東京都千代田區神田神保町 1 丁目 6
大　久　保　書　店
電話神田 (25) 3403 番
振替口座東京 109140 番

CONSTITUTION
of the
PALAEONTOLOGICAL SOCIETY OF JAPAN

ARTICLE 1. Name

The Society shall be known as the Palaeontological Society of Japan. The Society is a section of the Geological Society of Japan.

ARTICLE 2. Object

The object of the Society shall be to promote the study of palaeontology and related sciences.

ARTICLE 3. Achievement

The Society in order to execute Article 2 shall (a) issue the Society journal and other publications, (b) hold or sponsor scientific lectures and meetings, and (c) sponsor collecting or field trips, and lectures.

ARTICLE 4. Membership

The Society shall be composed of persons who are active of interested in palaeontology or related sciences, and shall be known as regular members, honorary members, and patrons.

ARTICLE 5. The members of the Society shall be obliged to pay annual dues to the Society, for which they shall enjoy the privilege of receiving the Society's journal and of submitting papers which have been read and discussed at the meetings for publication in the Society's journal.

ARTICLE 6. Administration

The Society shall have the following organizations for its administration.

(a) General meeting. The general meeting shall be composed of the Society members. More than one tenth of regular members shall be present to hold general meetings. Administrative affairs shall be decided during the general meeting.

(b) President. The president shall be elected from among the regular members. The president shall represent the Society and supervise its business matters.

(c) Council. The council shall be composed of councillors who are elected from among the regular members. The council shall discuss administrative affairs.

(d) Business council. The business councillors shall be elected from among the council members, and shall administer business affairs.

(e) Officers shall be elected by vote of returned mail ballots, as a general rule.

ARTICLE 7. Amendments to the constitution shall be by decision of the general meeting.

By-Laws and Administration

ARTICLE 8. The Society's journal shall be issued three times a year.

ARTICLE 9. Regular members shall be persons who have knowledge, experience, or interest in palaeontology or related sciences.

ARTICLE 10. Patrons shall be selected individuals or organizations who give special support to the objectives of the Society.

ARTICLE 11. Honorary members shall be persons of distinguished achievement in palaeontology. The council shall nominate honorary members for decision by the general meeting.

ARTICLE 12. Applicants for membership to the Society shall submit their full name, mailing address, date of birth, occupation, and name of school from which they graduated.

Dues

ARTICLE 13. Rates for annual dues of the Society shall be decided during the general meeting. Annual dues for regular members is Yen 400.00 (domestic members) and U.S. $2.00 (foreign members). Patrons are individuals or organizations donating more than Yen 10,000.00 annually. Honorary members are free from obligations.

ARTICLE 14. The Society income shall be from membership dues and bestowals.

ARTICLE 15. The Society shall have one chairman, fifteen councillors, and several business councillors, whose term of office shall be two years. They may be re-elected.

Addendum

ARTICLE 1. There shall be four business councillors for the present.

ARTICLE 2. The Society journal shall be issued three times a year for the present.