Matsumotoa : A New Prionodont Pelecypod Genus from the Cretaceous Mifuné Group, Kyushu, Japan

Okada, Hakuyu
Faculty of Sciences, Kyushu University

https://doi.org/10.5109/1524322

出版情報：九州大學理學部紀要 : Series D, Geology. 8 (2), pp.35-48, 1958-05-28. Faculty of Science, Kyushu University
バージョン：
権利関係：

Mem. Fac. Sci., Kyushu Univ., Ser. D, Geology, Vol. VIII, No. 2, pp. 35-48,
text-figs. 1-5, pls. 10, 11, June 1958.

Matsumotoa: A New Prionodont Pelecypod Genus from the Cretaceous Mifuné Group, Kyushu, Japan*

By

Hakuyu OKADA

Introduction

Professor Tatsuro MATSUMOTO (1939) reported that the Cretaceous Mifuné group of central Kyushu contains a prolific fauna of pelecypods and gastropods that is quite unique. He described the stratigraphy of the group in detail, and his paper included a preliminary list of fossils, but a full description of the fossils is as yet unpublished. Some of the species listed occur also in the nearly contemporaneous Goshora group, fauna of which has already been described (MATSUMOTO, 1938).

Under Professor MATSUMOTO's guidance, I undertook a restudy of the strata and fossils of the Mifuné group. One result of the study is the discovery of an interesting prionodont pelecypod which is wholly unlike anything previously known. It is here described as a new genus and species.

The description is based on specimens in the collections of T. MATSUMOTO (1939), J. YANAGIDA (1954) and myself (1955, 1956 & 1957). Some of these collections are in the Department of Geology, Kyushu University (GK) and some are in the Geological Institute, University of Tokyo (GT).

Acknowledgements

I am especially indebted to Professor T. MATSUMOTO of Kyushu University, who suggested this study and who has been a constant source of encouragement and supervision in following it to completion. To Dr. F. S. MACNEIL of the United States Geological Survey, Menlo Park, California, U. S. A., I wish to express my sincere thanks for his kindness in reading the original manuscript and for his very helpful suggestions and criticisms in regard to the taxonomic problem. Thanks are due to Dr. T. KURODA and Assistant Professor K. NAKAZAWA of Kyoto University, Professor T. KOBAYASHI of University of Tokyo, Assistant Professors K. KANMERA and T. SHUTO of Kyushu University, Assistant Professor M. AMANO of Kumamoto University, and Messrs. Y. UÉDA and I. OBATA of Kyushu University for their help in various ways. Mr. J. YANAGIDA of the same university kindly offered me his collection for study.

This study was partly financed through Prof. T. MATSUMOTO by the Grant in Aid for Scientific Researches from the Ministry of Education, Japan.

* Received April 30, 1958

Description

Family Noetidae MACNEIL, 1937

Subfamily Noetinae MACNEIL, 1937

Matsumotoa gen. nov.

Type species.—Matsumotoa japonica sp. nov. (described below)

Generic diagnosis.—The shell is of moderate size, ovally subtrapezoidal, longer than high, and moderately inequilateral. The umbo is moderately high and orthogyrate or somewhat prosogyrate, located at about the anterior third of the shell. A ridge extends from the umbonal region to the postero-ventral extremity, and a rather large radial depression runs from the umbonal region to the ventral border along the anterior side of the ridge. The anterior margin is rounded, the posterior margin is obliquely truncated, and the ventral margin is more or less sinuous.

The hinge line is relatively long and almost straight. The ligament area is subtrigonal and vertically striated by two kinds of grooves, the larger grooves and the secondary striae. The hinge plate is asymmetrically arched and the lateral wings of the plate are very broad and heavy. The central teeth are very short and converge ventrally. The side teeth are long and slender, and although being usually parallel with the hinge line they may be slightly oblique to it.

The surface of the shell is ornamented by numerous, closely spaced concentric lines and somewhat beaded radial ribs, which are distinct on the anterior and mesial parts but nearly obsolete on the region posterior to the radial ridge. Further interstitial or secondary ribs appear sometimes near the margin of the shell.

Both muscle scars are well defined, but the anterior scar is much smaller than the posterior one. The pallial line is angularly inflected or subcentrally cordate. The inner ventral margin is smooth.

Remarks.—MATSUMOTO (1939) tentatively listed the present form as a probable new species of *Trigonarca*, *T. japonica* (MS *nom. nud.*). No description was given. Later, in a still unpublished manuscript, he was inclined to regard it as a new subgenus of the genus *Trigonarca*. Recent study of a sufficient number of well preserved specimens, has shown it to be so unique that a new generic name is proposed for it. It is named in honor of Professor MATSUMOTO.

The characters which distinguish the new genus are as follows: (a) the inequilateral shell-form, (b) the orthogyrate or slightly prosogyrate orientation of the beaks, (c) the vertical grooves with secondary striae on the ligament area, (d) the particular attitude of the hinge and teeth, (e) the beaded radial ribs of unequal strength and a large radial depression, (f) the dissimilar muscle scars and the lack

of a buttress, and (g) the thick test. The vertical ligament elements of *Matsumotoa* place it definitely in the family Noetidae, but it does not fall easily into any of the three named subfamilies. Although no new subfamily is proposed for it at present, such action may someday be necessary. The present discussion first compares *Matsumotoa* with representative genera of the named subfamily, and then considers its probable systematic position.

1) Comparison with some noetid genera

(a) *Striarca*, a genus of Striarcinae

Striarca CONRAD (1862, p. 290) [Type species: *S. centenaria* (SAY)* from the Miocene of Virginia] resembles *Matsumotoa* in some respects: The two genera agree in having a generally similar shell-form, orthogyrate beaks in the adult which are anteriorly located, a broad ligament area with vertical grooves, and a more or less well-defined sulcus whose terminus makes a sinuosity along the ventral border. *Striarca* is, however, easily distinguished from *Matsumotoa* in having a narrower and somewhat more arcuate hinge, finer and denser radial riblets which uniformly cover the whole external surface, a weak sulcus, and a thinner test. Further particular attention should be called to the secondary striae in the vertical ligament grooves of the shell of *Matsumotoa* (Text-figs. 2, 3, 5). This feature is, according to MACNEIL (1937, p. 7), observable only in the Noetinae but not in the Striarcinae. The attitude of the beaks is of another problem to be especially mentioned. According to MACNEIL'S personal communication,** very small shells of *Striarca centenaria* is very strongly opisthogyrate and the orthogyration of the beaks in adult is secondary. Of course, the possibility still remains that juveniles of *Matsumotoa* are also opisthogyrate, although they have not been found.

The genus *Striarca* has not been reported from strata older than the Miocene. This great difference in geological age, together with the lack of known intermediate forms, makes any possible phylogenetic relationship between the two genera obscure.

I am, however, inclined to believe that *Matsumotoa* is rather remote from *Striarca* in the accounts mentioned above.

(b) Certain genera of Trinacriinae

The genera *Linter* STEPHENSON (1937, pp. 449–451) [Type species: *Linter acuta* STEPHENSON from the Upper Cretaceous of Texas], *Trinacria* C. MAYER [Type species: *Trigonocoelia crassa* (DESHAYES) (by subsequent designation of GARDNER, 1926, p. 21) from the Eocene of Paris basin] and *Halonanus* STEWART (1930, pp. 78–79) [Type species: *Noetia pulchra* GABB from the Eocene of Texas] are characterized

* Prof. T. MATSUMOTO kindly supplied me with information on the type species of *Striarca*, the types of which are preserved in the Academy of Natural Sciences of Philadelphia [A letter of June 13, 1957, from Philadelphia, U. S. A.].

** A letter through Prof. T. MATSUMOTO of January 2, 1958.

by having a vertically striated ligament area. Their ligament area, however, is very narrow. In all three genera the umbo is strongly opisthogyrate, and the hinge line is relatively short. Some individuals of all three genera have a break between the anterior and posterior rows of teeth. *Linter* is characterized by a trigonal shell-form and a sharply acute umbonal ridge. *Trinacria* possesses a deep ligament pit. *Halonanus* is similar to the Noetinae in its hinge characters. However, MACNEIL (1937) in commenting on the ontogeny of *Halonanus* says, "in *Halonanus pulchra* there is an initial anterior diagonal groove which later develops into a vertically striated ligament." Well preserved juveniles of *Matsumotoa* which might show this character have not been found.

In view of these differences I believe *Matsumotoa* has no close relationship with any genera of the Trinacriinae.

The Upper Cretaceous genus *Breviarca* CONRAD (1872, p. 55, pl. 2, figs. 3, 4, subgenus of *Trigonarca*) [Type species: *Breviarca haddenfieldensis* STEPHENSON (= *Trigonarca* (*Breviarca*) *saffordi* CONRAD) from the Upper Cretaceous of New Jersey], which was placed in the subfamily Trinacriinae by STEPHENSON (1941), is another form which should be compared with the present genus. Both genera possess a broad ligament area which is striated at right angles to the hinge line, and both have similar muscle scars. *Breviarca* is, however, easily distinguished from *Matsumotoa* in having more prominent beaks which are centrally located with respect to the ligament area. The more minutely striated ligament area of *Breviarca* compares more closely with that of *Striarca*, as does its narrower and less arched hinge plate, its more numerous and much fainter radial lines on the shell-surface, and its lack of a sulcus and a resulting sinuosity on the ventral border.

Of the noetid genera, a Japanese Upper Cretaceous species which was described as *Breviarca unisulcata* AMANO* (1956, pp. 66–68, pl. 1, figs. 6–8) most resembles *Matsumotoa* in many respects. It has orthogyrate or nearly prosogyrate beaks which are anteriorly located, a broad, trigonal ligament area with vertical grooves accompanied by the secondary vertical striae, a prominent sulcus and ridge, a shell-surface sculptured by strong radial ribs, and a smooth inner ventral margin. AMANO's species, however, is clearly distinguished from *Matsumotoa* primarily in its hinge structure: a narrower and slightly more arcuate hinge plate with an *Anadara*-like arrangement of the teeth, and a longer hinge line. It cannot be exactly referred to *Breviarca* because of its oblong shell-form, the presence of the secondary striae in the vertical grooves on the ligament area, the orientation of its beaks, its hinge characteristics, and its strong sulcus. A new genus of the subfamily Noetinae may be appropriate for that species.

* Assistant Professor M. AMANO of Kumamoto University has kindly given me an opportunity to examine the type specimens which are preserved in the Department of Geology, Kumamoto University.

Although in *Matsumotoa* the teeth are the most aberrant thing, the similarities mentioned above lead me to believe it to be closely related to "*Breviarca*" *unisulcata*.

(c) Genera of Noetinae

The subfamily Noetinae which is based on the genus *Noetia* GRAY, 1857 [Type species: *Noetia triangularis* GRAY, 1857 (Synonym of *Arca reversa* SOWERBY, 1833)] (see MACNEIL, 1938, pp. 38–39, pl. 6, figs. 7, 22, 23; REINHART, 1943, p. 77, figs. 5, 7, 8) is, according to MACNEIL (1938), generally characterized by the following features in its phylogeny as well as in its morphology: In the genera of the Noetinae are found on the one hand two kinds of vertical ligament grooves, the larger grooves and the smaller or secondary grooves or striae. On the other hand the sculpture in the Noetinae is composed of two kinds of ribs, primary and secondary. MACNEIL (1938, pp. 5–6) in describing them says, "The primary ribs are of varying importance and always well developed and furnish the strong sculpture of the Noetinae." He revealed that most genera of the Noetinae have three well-defined stages in growth, the unsculptured nepionic stage, the primary-ribbed nealogic stage, and the adult stage, mentioning that in many species of the genera *Noetia* and *Protonoetia*, "the primary ribs become obsolete at some time during the adult stage, so that there is really a young adult stage characterized by both primary and secondary ribs and a later adult stage having secondary ribs only."

In the genus *Matsumotoa* are also found similar characters. *Matsumotoa* is strikingly marked by the secondary striae in the vertical ligament grooves and is sculptured by the beaded radial ribs on the shell-surface which would correspond to the primary ribs described for *Noetia* by MACNEIL. These ribs are not reflected as crenulations on the inner ventral margin. The heavier set of ribs in *Noetia* is secondary, and these are reflected as internal crenulations. On a few casts of *Matsumotoa* (Sp. Reg. No. GK. H 6025 & GT. MM 7738; Pl. 11, figs. 7, 12) there appears to be an incipient swelling in the interspaces which might well foreshadow the secondary ribs.

However, *Noetia*, the most advanced form of this subfamily, differs from *Matsumotoa* in having a subrhomboidal or markedly trigonal shell-form, strongly opisthogyrate beaks which are situated at the posterior end of the cardinal area or even behind it, and narrower ligament areas which are entirely anterior to the beaks. The most anterior teeth are L-shaped but those farther back on the anterior hinge plate are inclined posteriorly; the posterior teeth are short, inclined, and ventrally divergent. Moreover, the shell-surface is strongly sculptured by the neat radial ribs which give rise to crenulations along the inner ventral margin. Other genera of the Noetinae are distinguished from *Matsumotoa* in much the same way.

Another remark to be made is that, according to MACNEIL (1938, p. 2), the earliest members of the Noetinae are orthogyrate or prosogyrate, but the later

members are all opisthogyrate. In this respect, one genus in particular is *Protonoetia* MACNEIL, 1938 [Type species: *Anadara nigeriensis* NEWTON from the Eocene of Nigeria], which was considered by MACNEIL (1938) to be the earliest known member of his Pacific supergeneric group of the subfamily Noetinae. REINHART (1943), however, regarded it as a member of MACNEIL's Atlantic group. It has orthogyrate beaks and a subquadrate shell as does *Matsumotoa*, but it is clearly different from the latter principally in its *Anadara*-like hinge structure and its crenulations on the inner ventral margin.

In short, however, *Matsumotoa* is believed to be more closely related to the Noetinae than to any other groups of the family Noetidae.

2) The systematic position of *Matsumotoa*

First, it should be pertinent to cite the definition of the Noetidae given by MACNEIL (1937, p. 458): "The family Noetidae includes all of the forms having vertical ligament elements." According to MACNEIL, the structure of the ligament is the most important criterion of the family. If the importance of the ligament is admitted, it seems almost certain that *Matsumotoa* should be placed in the Noetidae rather than in any other of the prionodont groups.

In my opinion, however, all of the morphological characters of the shell should be taken into account in determining the true systematic position of the genus. There are similarities as well as dissimilarities with other groups. The present genus has a cucullaeid-type hinge, like that of *Cucullaea*, *Parallelodon* (see ARKELL, 1930), and other genera related to them. However, *Matsumotoa* can hardly be included in the Cucullaeidae because the cuculaeids have prominent chevron-shaped ligament grooves, the sculpture of the valves is different from that of the present form, and the posterior muscle scar is located on a raised buttress (see NICOL, 1954, p. 96).

The extreme elongation of the hinge of *Matsumotoa* can be expressed as F in letter index system of NICOL (1950, p. 94). It compares in this respect with the cucullaeid subgenus *Dicranodonta* WOODS (1899, p. 53) [Type species: *Cucullaea donningtonensis* KEEPING (original designation)] from the Lower Cretaceous of England, although *Matsumotoa* has somewhat shorter teeth than the latter. The hinge of *Matsumotoa*, however, is more advanced in some respects than that of other prionodont groups.

In addition, the large radial depression or sulcus of *Matsumotoa* recalls *Pettersia* NICOL (1953, pp. 103–105) [Type species: *P. abnormalis* (OLSSON)] from the Upper Cretaceous of Peru and Colombia. This gives rise to a sinuation on the ventral margin, but judging from both right and left valves, *Matsumotoa* is not believed to have a byssal gape. *Pettersia* is similar to *Matsumotoa* in both the profile of its shell and its thick test. However, *Pettersia* has a buttress for the posterior muscle

scar, a ligament area with chevron-shaped grooves, ornamentation of very weak radial lines, an arcuate hinge, and crenulations on its inner ventral margin. Although *Pettersia* was placed in the Cucullaeidae by NICOL (1954), he pointed out the peculiarity of the genus.

NICOL (1954) commented on the high degree of variability in the Cucullaeidae and suggested that some of the genera might be separated into subfamilies and even different families in the future. The same remarks might be extended to the family Noetidae. Taking all these points into consideration, I am inclined to place *Matsumotoa* in the Noetidae rather than in the Cucullaeidae.

According to MACNEIL (1937), the family Noetidae includes three subfamilies, the Striarcinae, the Trinacriinae, and the Noetinae. From a comparison with some noetid genera, the present genus is superficially similar in some morphological points to the Miocene to Recent species of *Striarca* of the Striarcinae. *Matsumotoa*, however, cannot be regarded as a closely related form to the Striarcinae, principally because of the presence of the secondary striae in the vertical ligament grooves, as discussed in the preceding chapter.

On the other hand, *Matsumotoa* shares a set of characters with the Noetinae, representing the earlier stage in the ontogeny of *Noetia*, as is observed in the surface sculpture. MACNEIL (1938, and a personal communication, 1958) suggested that the hypothetical primitive type of the Pacific Noetinae would have a nearly equilateral ligament, orthogyrate or prosogyrate beaks, and a shell probably with a median sulcus and a posterior ridge, and with fine radial ribs which are not reflected as crenulations on the inner ventral margin. In these respects *Matsumotoa* approaches that hypothetical type, together with "*Breviarca*" *unisulcata* AMANO mentioned in page 38.

Thus I am inclined to conclude that *Matsumotoa* should be placed in the subfamily Noetinae rather than in the Striarcinae.

It should be emphasized, however, that the hinge of *Matsumotoa* is too extreme to place it in the direct evolutionary line of *Noetia* and to regard it as possible progenitor of any of the Noetinae, whereas a probable new genus to which "*Breviarca*" *unisulcata* is quite as justifiably referred is expected to be a possible direct ancestor of the Pacific group of the Noetinae. These two contemporary Japanese prionodont genera are most closely related to each other and probably had a common ancestry. *Matsumotoa* might be regarded as an aberrant type in that it is too far advanced in some characters, especially in the hinge.

To sum up, so far as the available evidences are concerned, *Matsumotoa* is most warrantably placed in the subfamily Noetinae of the family Noetidae. Phylogenetically speaking, this new genus may represent a primitive group of the subfamily, but has some peculiarities which might indicate an aberrant offshoot in the early history of the Noetidae.

Distribution.—The type species occurs in the Mifuné group (Gyliakian, approximately Cenomanian-Turonian) of central Kyushu.

Further research may greatly extend the known distribution of the genus.

Matsumotoa japonica sp. nov.

Pl. 10, figs. 1–5; Pl. 11, figs. 6–12; Text-figs. 2–5

Material.—Holotype, GK. H. 6027, from loc. MF(f) 62, the sandy mudstone bed exposed along the Mifuné, about 500 meters north of Tsuzumi, Mifuné-machi (formerly Takimizu-mura), Kamimasuki-gun, Kumamoto Pref.,* Kyushu (H. OKADA Coll.). Paratypes, GK. H 6022 and 6023 (J. YANAGIDA Coll.). Loc. ditto; GK. H 6024, from loc. MF(f) 15 by the Akai, about 1 kilometer east of Kawachida, Masuki-machi (formerly Fukuda-mura),** Kamimasuki-gun (H. OKADA Coll.); GK. H. 6025 and 6026, from loc. MF(f) 24 on the Kanayama, about 5 kilometers upstream from its junction with the Kiyama and about 800 meters south-east of Sarugaéri, Kawaharu-mura,*** Kamimasuki-gun (H. OKADA Coll.); GK. H 6028, from loc. MF(f) 59, the medium- to coarse-grained sandstone bed exposed about 1200 meters east of Fukura, Nakashima-mura,**** Kamimasuki-gun (H. OKADA Coll.); GK. H 6029, from the same locality as the holotype (loc. MF(f) 62) (H. OKADA Coll.); GK. H. 6030, from loc. MF(f) 79 on the Midori, about 2300 meters north of the Kosa***** railway station, Kamimasuki-gun (H. OKADA Coll.); GT. MM 7734, 7735, 7736, 7737, 7738 and 7739, all from loc. K-38 (MATSUMOTO, 1939), a tributary of the Akai, about 900 meters south of Asanoyabu, Mifuné-machi (formerly Nanataki-mura)****** (T. MATSUMOTO Coll.). All the above localities are indicated in the geological map (Text-fig. 1).

Specific diagnosis.—The shell is of moderate size, ovally subtrapezoidal, longer than high, and very inequilateral. The test is very thick. The anterior margin forms an obtuse angle of about 120° to 140° with the hinge line, and is rather strongly rounded ventrally. The ventral margin is gently curved, sloping downwards from the antero-ventral extremity, and is noticeably sinuated at about the posterior third of the shell by the intersection of a broad and well-defined radial depression. The posterior margin is more or less narrowly rounded or obliquely subtruncated ventrally, and nearly straight or slightly convex dorsally, forming a more obtuse angle with the hinge line than the antero-dorsal angle.

The umbo protrudes more or less moderately above the hinge line and is orthogyrate or slightly prosogyrate. It is of moderate size, incurved, and located at

* 熊本県上益城郡御船町（旧滝水村）粒麦
** 益城町（旧福田村）川内田
*** 河原村猿帰
**** 中島村福良
***** 甲佐
****** 御船町（旧七滝村）浅ノ藪

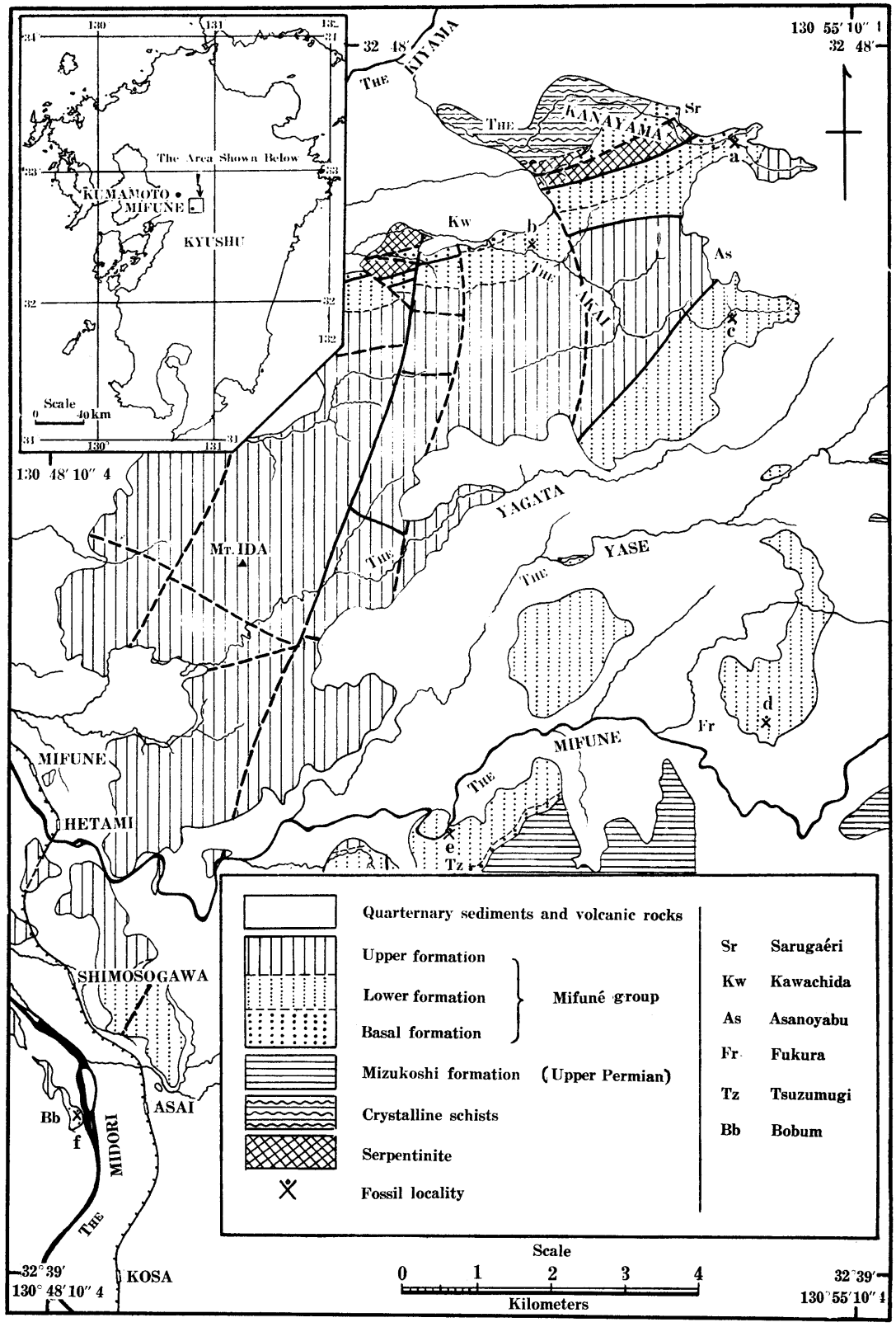


Fig. 1. Geological map of the Mifuné area (adapted from MATSUMOTO, 1939, showing distribution of the Mifuné group and localities where specimens of *Matsumotoa* have been collected (H. OKADA Del.).

a. Loc. no. MF(f) 24
b. Loc. no. MF(f) 15
c. Loc. no. K-38
d. Loc. no. MF(f) 59
e. Loc. no. MF(f) 62
f. Loc. no. MF(f) 79

Index map of Kyushu, showing location of the Mifuné area, at the upper left corner.

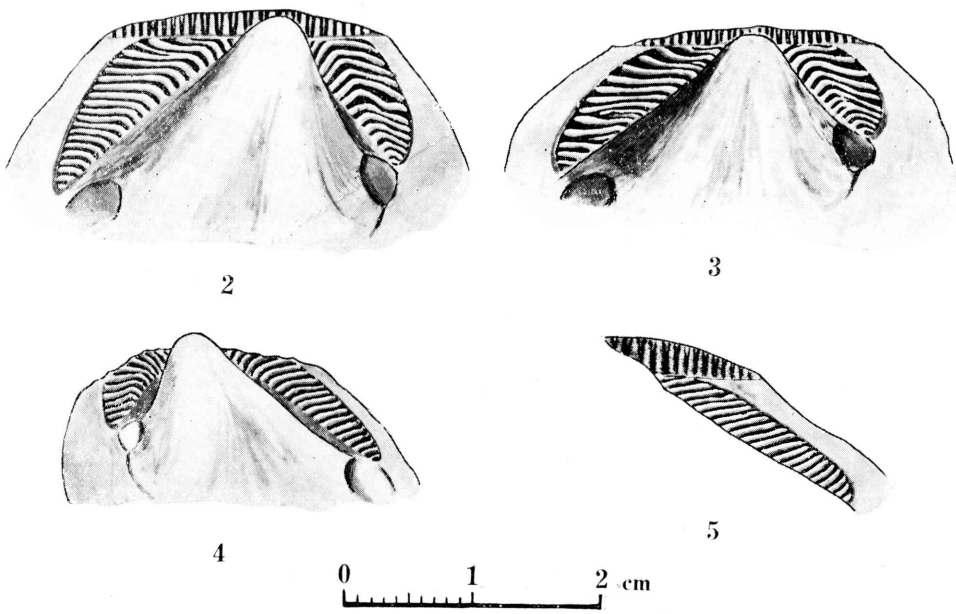
about two-fifths the length of the ligament area from its anterior extremity.

A distinct ridge extends from the umbonal region to the postero-ventral extremity. It is broadly rounded to sharp on top (see Pl. 11, fig. 12). The surface of the shell is ornamented by closely spaced, weak, concentric lines of growth, a number of coarse concentric undulations, and distinct radial ribs. The surface of the shell is divisible into three regions of somewhat different ornamentation; anterior, mesial, and posterior. The ridge divides the latter two regions, while the former two are gradational. The concentric lines of growth are almost equally strong all over the valve. The radial ribs are very narrow, rounded, more or less beaded, and sometimes slightly sinuous. They are rather weak on the anterior region, more distinct and obliquely straight on the mesial region, and obsolete or indiscernible on the posterior region. The ribs are separated by flat interspaces which are generally about three or four times as wide as the ribs and sometimes sculptured by interstitial or secondary ribs or swellings that are strongest near the margin (Pl. 11, figs. 7, 12).

The hinge line is moderately long and nearly straight. The ligament area, which is well shown on the holotype and some of the paratypes (Pl. 10, figs. 1d, 2, 3b, 9b; Text-figs. 2, 3, 5), is amphidetic, rather broad and nearly trigonal in shape, and extends the entire length of the hinge line, which is about two-thirds as long as the greatest length of the shell. The ligament area whose anterior extension is shorter than its posterior extension, is coarsely striated at right angles to the hinge line, the striae in turn being faintly and horizontally marked by minute lines (see Text-fig. 5). The vertical grooves on the ligament area are not as crowded and minute as in *Striarca*, *Breviarca*, and *Noetia*, but moderately coarse and well-marked. They are coarser centrally. The secondary vertical striae in these ligament grooves are also well observable (see Text-figs. 2, 3, 5).

The hinge plate is very large for the size of the shell, rather asymmetrically arched, steeply sloping towards the antero-ventral border, and more gently sloping posteriorly. The hinge plate is widest beneath the extremities of the hinge line, decreasing in width both ventrally and rather abruptly towards the center where it is overlapped progressively by the ligament area. The central part of the hinge plate is short and narrow; being about one-third as long as the entire length of the hinge line, and narrowest just beneath the umbo.

The prionodont teeth are divisible into three parts, the central row, and the antero- and postero-lateral clusters. The centrally located teeth, about six in number, are the shortest, and they converge ventrally. The side teeth are very long and slender, being longest near the hinge line, but shortening progressively downwards. They are nearly parallel with the hinge line. In addition to this general arrangement, about twelve or thirteen teeth on the anterior wing of the hinge plate are more or less hooked or chevron-shaped, the exterior leg of the chevron being in-



Figs. 2-5. *Matsumotoa japonica* sp. nov., showing the ligament area and the hinge plate (H. OKADA Del.).
2. Holotype, Sp. Reg. No. GK. H 6027, internal cast of a right valve; loc. MF(f) 62.
3. Paratype, Sp. Reg. No. GT. MM 7739, internal cast of a right valve; loc. K-38.
4. Paratype, Sp. Reg. No. GT. MM 7737, internal cast of a left valve; loc. ditto.
5. Paratype, Sp. Reg. No. GK. H 6029, internal cast of a left valve; loc. MF(f) 62.

clined downwards. On the posterior wing, the side teeth, about fifteen to twenty in number, are almost straight or slightly sinuous, but occasionally they show a weak tendency to be chevron-shaped (see Text-fig. 2).

The anterior adductor scar is small but well-defined, subtrigonal and strongly depressed. The posterior adductor scar is large and oval, but not as much depressed as the anterior scar. It is faintly bounded along its inner margin by a depressed line which extends apically away from the scar, and which is traceable, although becoming fainter, nearly to the umbo. The interior of the shell is marked by a few faint radial lines. The inner ventral margin is smooth. The pallial line is angularly inflected or cordate, corresponding in location to the radial depression on the outer surface of the shell.

Measurements (in millimeters).—

Specimen Reg. No.	Valve	Length	Height	Thickness of one valve	H/L×100
GK. H 6022	Left	37.3	29.3	9.6+	78.5
GK. H 6023	Right	36.9	26.3	8.1+	71.2
GK. H 6024	Left	34.7+	30.4	9.0	

GK. H 6025	Left	30.1	18.9	5.2	62.8
GK. H 6026	Left	26.1	20.0	6.7	77.6
GK. H 6027	Right	41.2	31.9		79.8
GK. H 6028	Left	29.7	25.5	5.5+	85.8
GT. MM 7734	Right	45.4	31.8	8.6	70.0
GT. MM 7735	Right	19.7	11.8	6.3	77.4
GT. MM 7737	Left	33.5	22.0	6.7+	65.7
GT. MM 7738	Left	38.2	27.3	8.6+	71.5
GT. MM 7739	Right	39.3+	22.5+	7.3	

Remarks.—The present species shows the following variation in shell-form and hinge character:

a) The present species has a well-defined radial ridge located just behind the sulcus which changes in sharpness in accordance with differences in the hinge plate mentioned in the following paragraph. The majority of the specimens at hand, including the holotype, have a broad, rounded ridge (see Pl. 10, figs. 1a, 3a; Pl. 11, figs. 6–8), but a few specimens have a sharp or inversely V-shaped ridge, the latter apparently a variety of the former (see Pl. 11, fig. 12).

b) Another variation to be mentioned concerns the lateral hinge plate. In the typical form with a rounded ridge the broad posterior wing of the hinge plate decreases rapidly in width downwards and becomes sub-lanceolate in form (see Text-fig. 2; Pl. 10, figs. 1d, 2, 3b, 4, 5). In the variety having a sharp ridge, the posterior hinge plate does not decrease markedly in width downwards, but remains of almost constant width, and its extremity is truncated or narrowly rounded (see Text-figs. 4, 5; Pl. 11, figs. 10, 11). The teeth on the posterior side are more or less straight and converge ventrally.

This relationship may not be constant, for there is a specimen in which the shell has a discernible sharp ridge, but its posterior hinge plate narrows as in the typical form, and the extremity of the hinge plate rounded (see Text-fig. 3; Pl. 11, figs. 9a, 9b). Regarding the attitude of the anterior hinge plate there is no significant difference between the variety and the typical form.

c) In addition, there is an apparent morphological difference in the profile of the shell, that may have been caused by a condition of preservation. The shell of some specimens is more oval and more elongate laterally (see Pl. 10, figs. 3a, 3b; Pl. 11, figs. 7, 8, 10) than the typical form (see Pl. 10, figs. 1a, 1d, 2, 4), which is quadrate in outline.

Thus the present species shows a rather wide variation in shape. It is probably true that some intrinsic variation exists in the original shells, but it seems to have been exaggerated by later deformation in some specimens. This secondary deformation is especially evident because it is not essentially in harmony with the variation of other characters. The possibility of deformation makes it unsafe to separate the

available specimens into different species on shape alone, and more material is needed to determine the original variation of the present species.

Comparison.—This species is characterized by very coarse, vertical grooves with secondary striae on its ligament area, a hinge plate with broad, heavy lateral wings, long, slender hinge teeth which resemble those of *Cucullaea,* a large radial depression or sulcus, and a prominent posterior ridge.

In the species described as *Breviarca unisulcata* AMANO (1956, *loc. cit.*), from the Upper Cretaceous of Shishi-jima, Kagoshima Pref., Kyushu, are found strikingly similar characters, but it is distinguished from the present species in having a much more oblong shell, which is about twice as long as high, a more minutely striated ligament area, a much longer hinge line, a considerably narrower and lighter hinge plate, more strongly divergent hinge teeth, the anterior and posterior teeth being subequal in number, stronger radial ribs which cover the entire shell-surface, and a thinner test.

In the species of the genera *Noetia* and *Protonoetia, Protonoetia nigeriensis* (NEWTON) MACNEIL has orthogyrate beaks and a subquadrate shell with a subcarinated ridge, but it clearly differs from *Matsumotoa japonica* in its neatly ribbed shell-surface, a lighter hinge plate with *Anadara*-like arrangement of teeth, and an inner ventral margin strongly crenulated.

Another species to be compared with is *Noetia nagaoi* MACNEIL (1938, pp. 30–31, pl. 4, figs. 19, 20) [Synonym of *Arca* (*Noetia*) *pondaungensis* COTTER var. *transversa* NAGAO, 1928] from the Upper Eocene of the Asakura coal field, Kyushu, which was hitherto only one Japanese known species of the Noetinae. MACNEIL (1938, p. 31) considered it to be the most extreme of the known species of *Noetia* and to approach the genus *Protonoetia.* It has a trigonal shell-form, a strongly ribbed shell-surface, and a lighter hinge plate, as do many species of *Noetia.* In these respects it is distinctly different from the present species.

Striarca centenaria (SAY) (see CONRAD, 1862, *loc. cit.*, no figs.) from the Miocene of Maryland, Virginia, agrees fairly well with the species here described in general outline and in the presence of a radial depression, but it has still more minute and closely spaced vertical grooves without any secondary striae on its ligament area, a hinge plate with less arched and narrower teeth resembling those of *Arca,* much weaker and more crowded radial ribs on the surface of its shell, and a thinner test.

Occurrence.—The stratigraphic position of all the specimens examined is the lower formation of the Mifuné group of Gyliakian (the lower part of the tripartite Upper Cretaceous) and they were obtained from both the northern and southern wings of the syncline in the Mifuné district of central Kyushu.* The specimens

* For an account of the stratigraphy and geological structure of the Mifuné district, the reader is referred to the works of MATSUMOTO, 1939 and MATSUMOTO [Editor], 1954 (pp. 142–144).

are found mainly in sandy mudstones on both wings, but they occur also in fine- to medium-grained sandstones (e. g. loc. MF(f) 24 & 59). They are not limited to a definite horizon. The sharply ridged variety (see p. 45) seems to occur in the finer grained sediments. Among the species with which this species is associated are; *Astarte* aff. *trigonoides* (STOLICZKA), *Pseudasaphis japonicus* MATSUMOTO, *Pseudamiantis crenulatus* MATSUMOTO, *Siliqua* sp., and *Paravernedia* sp. Generally speaking, *Matsumotoa japonica* is not as abundant as these other species, although it is not rare. At one locality (MF(f) 79) an unidentified echinoid was obtained together with this species.

References Cited

AMANO, M. (1956): Some Upper Cretaceous Fossils from South-Western Japan Part I *Kumamoto Jour. Sci., Ser.* B, *Sec.* 1, *Geol., Vol.* 2, *No.* 1, pp. 63–94, 2 pls., 2 text-figs.

ARKELL, W. J. (1930): The Generic Position and Phylogeny of Some Jurassic Arcidae *Geol. Mag., Vol.* 67, *No.* 7, pp. 297–310; *No.* 8, pp. 337–352, 3 pls.

CONRAD, T. A. (1862): Descriptions of New Genera, Subgenera and Species of Tertiary and Recent Shells *Proc. Acad. Nat. Sci. Philad., Vol.* 14, pp. 284–291. no figs.

——— (1872): Descriptions and Illustrations of Genera of Shells *Ibid. Vol.* 24, pp. 50–55, 2 pls.

GARDNER, J. (1926): The Molluscan Fauna of the Alum Bluff Group of Florida Part I Prionodesmacea and Anomalodesmacea *U. S. Geol. Survey Prof. Paper,* 142-A, pp. 1–79, 15 pls.

GRAY, J. E. (1857): A Revision of the Genera of Some of the Families of Conchifera or Bivalve Shells Part III Arcadae *Mag. Nat. Hist., Ann., Ser.* 2, *Vol.* 19, pp. 366–373.

MACNEIL, F. S. (1937): The Systematic Position of the Pelecypod Genus *Trinacria Jour. Washington Acad. Sci., Vol.* 27, *No.* 11, pp. 452–458.

——— (1938): Species and Genera of Tertiary Noetinae *U. S. Geol. Survey Prof. Paper,* 189-A, pp. 1–49, 6 pls.

MATSUMOTO, T. (1938): Geology of the Goshora Island, Amakusa, with Special Reference to the Cretaceous Stratigraphy (in Japanese) *Jour. Geol. Soc. Japan, Vol.* 45, *No.* 532, pp. 1–47, 2 pls.

——— (1939): Geology of the Mifuné District, Kumamoto Prefecture, Kyushu, with Special Reference to the Cretaceous System (in Japanese) *Ibid. Vol.* 46, *No.* 544, pp. 1–12.

——— [Editor] (1954): The Cretaceous System in the Japanese Islands xiv+324 p., 34 pls., Tokyo

NAGAO, T. (1928): Palaeogene Fossils of the Island of Kyushu, Japan Part II *Tohoku Univ. Sci. Rept., Ser.* 2, *Geol., Vol.* 12, *No.* 1, pp. 11 (1)-140 (130).

NICOL, D. (1950): Origin of the Pelecypoda Family Glycymeridae *Jour. Pal., Vol.* 24, *No.* 1, pp. 89–98, pls. 20–22.

——— (1953): A New Prionodont Pelecypod Genus *Jour. Washington Acad. Sci., Vol.* 43, *No.* 4, pp. 103–105, 5 figs.

——— (1954): Nomenclatural Review of Genera and Subgenera of Cucullaeidae *Jour. Pal., Vol.* 28, *No.* 1, pp. 96–101.

REINHART, P. W. (1943): Mesozoic and Cenozoic Arcidae from the Pacific Slope of North America *Geol. Soc. Amer., Special Paper, No.* 47, xi+95 p., 15 pls.

SOWERBY, G. B. (1833): Characters of New Species of Mollusca and Conchifera *Zool. Soc. London, Pr.*, pp. 16–22.

STEPHENSON, L. W. (1937): *Linter*, a New Taxodont Genus from the Upper Cretaceous of Texas *Jour. Washington Acad. Sci., Vol. 27, No.* 11, pp. 449-451.

——— (1941): The Larger Invertebrate Fossils of the Navarro Group of Texas *Univ. Texas Publ., No.* 4101, 641 p., 95 pls., 13 figs., 6 tables.

STEWART, R. B. (1930): Gabb's California Cretaceous and Tertiary Type Lamellibranchs *Acad. Nat. Sci. Philad., Special publ., No.* 3, 314 p., 17 pls.

WOODS, H. (1899): A Monograph of the Cretaceous Lamellibranchia of England Part I Nuculanidae, Nuculidae, Anomiidae, and Arcidae *Palaeontographical Soc., London, Vol. for 1899*, 72 p., 14 pls.

H. OKADA

Matsumotoa: A New Prionodont Pelecypod Genus from the Cretaceous Mifuné Group, Kyushu, Japan

Plates 10–11

Plate 10

Explanation of Plate 10

Matsumotoa japonica sp. nov. . . . . Page 42

Figs. 1a, b, c and d. Holotype. GK. H 6027, from loc. MF(f) 62, the sandy mudstone bed exposed along the Mifuné, about 500 meters north of Tsuzumugi, Mifuné-machi (formerly Takimizu-mura), Kamimasuki-gun, Kumamoto Prefecture, Kyushu (H. OKADA Coll.).

a. Exterior of a right valve, ×1 1/4.
b. Anterior side view, ×1 1/4.
c. Dorsal view, ×1 1/4.
d. Internal cast, ×1 1/4.

Fig. 2. Internal cast of a left valve, ×1 1/2. Paratype, GK. H 6022 (J. YANAGIDA Coll.). Locality ditto.

Figs. 3a and b. Paratype, GT. MM 7734, from loc. K-38, a tributary of the Akai, about 900 meters south of Asanoyabu, Mifuné-machi (formerly Nanataki-mura) (T. MATSUMOTO Coll.).

a. Exterior of a right valve, ×1 1/4.
b. Internal cast, showing the hinge character, ×1 1/4.

Fig. 4. Internal cast of a left valve, ×1 1/4. Paratype, GK. H 6028, from loc. MF(f) 59, about 1200 meters east of Fukura, Nakashima-mura, Kamimasuki-gun (H. OKADA Coll.).

Fig. 5. Internal cast of a right valve, showing the side teeth, ×1 1/2. Paratype, GT. MM 7736, from loc. K-38 (T. MATSUMOTO Coll.).

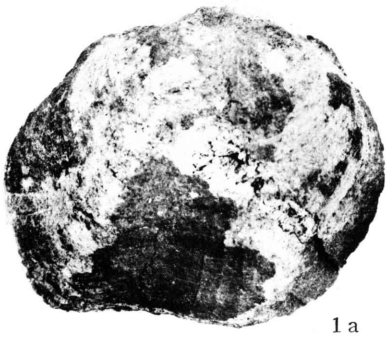
Photos by I. OBATA and H. OKADA

4

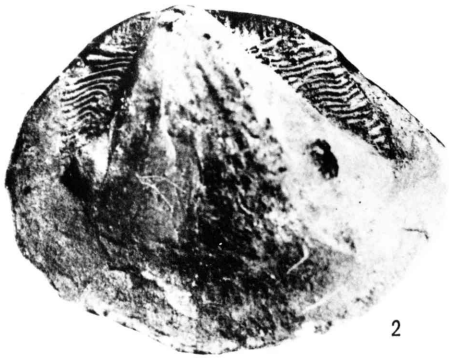
1c

5

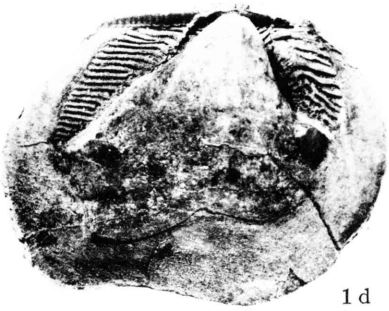
1b



1a



2



1d

3a

3b

Plate 11

Explanation of Plate 11

Matsumotoa japonica sp. nov.

Fig. 6. Exterior of a left valve, ×1 1/4. Paratype, GK. H 6026, from loc. MF(f) 24, on the Kanayama, about 5 kilometers upstream from its junction with the Kiyama and about 800 meters south-east of Sarugaéri, Kawaharu-mura, Kamimasuki-gun (H. OKADA Coll.).

Fig. 7. Exterior of a left valve, ×1 1/4. Paratype, GK. H 6025, from locality ditto (H. OKADA Coll.).

Fig. 8. Exterior of a right valve, ×1 1/4. Paratype, GK. H 6023 (J. YANAGIDA Coll.). Locality is same as that of the holotype (loc. MF(f) 62).

Figs. 9a and b. Paratype, GT. MM 7739, from loc. K-38 (T. MATSUMOTO Coll.).

a. Exterior of a right valve, ×1 1/4.
b. Internal cast, ×1 1/4.

Fig. 10. Internal cast of a left valve, ×1 1/2. Paratype, GT. MM 7737 (T. MATSUMOTO Coll.). Locality ditto.

Fig. 11. Internal cast of a left valve, ×1 1/2. Paratype, GK. H 6024, from loc. MF(f) 15 by the Akai, about 1 kilometer east of Kawachida, Masuki-machi (formerly Fukuda-mura), Kamimasuki-gun (H. OKADA Coll.).

Fig. 12. Exterior of a left valve, × 1 1/4. Paratype, GT. MM 7738, from loc. K-38 (T. MATSUMOTO Coll.).

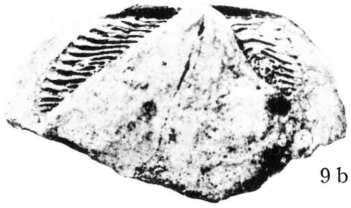
Photos by I. OBATA and H. OKADA

6

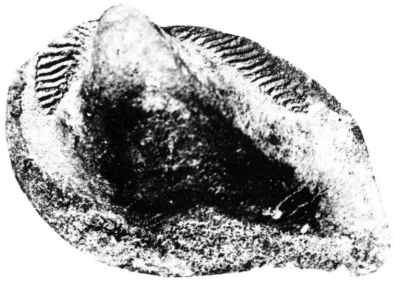
7

8

9 a



9 b



10

11

12