

広島大学学術情報リポジトリ
Hiroshima University Institutional Repository

Title	Notes on the Relationship of Trigonioides and Plicatounio, Non-marine Mesozoic Bivalvia from Eastern Asia
Author(s)	OTA, Yoshihisa
Citation	Geological report of the Hiroshima University , 12 : 503 - 512
Issue Date	1963-03-30
DOI	
Self DOI	10.15027/52547
URL	https://ir.lib.hiroshima-u.ac.jp/00052547
Right	
Relation	



Notes on the Relationship of *Trigonioides* and *Plicatounio*,
Non-marine Mesozoic Bivalvia from Eastern Asia¹⁾

By

Yoshihisa OTA

with 7 Text-figures

ABSTRACT: I propose new two subgenera of bivalvia from the non-marine Mesozoic of Kyushu, and discuss the relationship of *Plicatounio* and *Trigonioides*.

CONTENTS

- I. Introduction
 - II. Proposal of two new subgenera
 - III. Further comparisons
 - IV. Concluding remarks
- References

I. INTRODUCTION

I described, in 1959, two new non-marine species, "*Nippononaia*" *wakinoensis* and "*N*" *sengokuensis*, which occurred with *Plicatounio naktongensis*, "*Plicatounio*" *kwanmonensis* and *Brotiopsis wakinoensis* in the late Mesozoic Wakino subgroup of the Kwanmon group in North Kyushu. Recently I received an information from Emeritus Prof. Dr. T. KOBAYASHI of the Tokyo University that the holotype of *Nippononaia ryosekiana* was discovered in a storage of Tokyo University. Through the courtesy of Prof. T. KOBAYASHI, I had an opportunity of examining the holotype of *N. ryosekiana*, and restudied the species of "*Nippononaia*" and "*Plicatounio*". In the present paper I establish two subgenera and then discuss the relationship of *Plicatounio* and *Trigonioides*.

Before entering into the detailed description, I wish to express my sincere thanks to Prof. T. MATSUMOTO of the Kyushu University for his invaluable advices and reading the typescript. Thanks are due to Emeritus Prof. Dr. T. KOBAYASHI and Dr. I. HAYAMI of the Tokyo University for their continuous encouragement and privileges to study the holotype of *Nippononaia ryosekiana*.

1) Read in the annual meeting of the Palaeontological Society of Japan, June 1, 1962, at Kumamoto

II. PROPOSAL OF TWO NEW SUBGENERA

Genus *Plicatounio* KOBAYASHI and SUZUKI, 1936.Subgenus *Kwanmonia* nov.*Type-species*.—“*Plicatounio*” *kwanmonensis* Ota, 1959a.

Generic diagnosis.—The shell is large, moderately convex, subquadrate in outline. The umbo is large and somewhat prosogyrate, more or less incurved, situated at a point about one-fourth of the length from the anterior end. The dorsal margin is broadly arched, passing insensibly into the well rounded anterior margin, forming an obtuse angle with the posterior one which is nearly straight or weakly curved and descends rapidly. The ventral margin is gently arched, ascending gradually into the anterior, and bent upwards into the posterior, showing a moderate curve.

The hinge margin forms an angle of 90 to 130 degrees below the umbo. The hinge teeth are five on each valve; two anterior cardinals are subparallel to each other, feebly curved, fairly long and solid, distinctly and acutely crenulated; a median cardinal is situated below the beak and is rather massive with fairly strong striations; two posterior lateral teeth are widely apart from the median cardinal and nearly straight, longer and far more weakly crenulated than the anterior cardinals.

The surface of the shell is ornamented with four or five, moderately elevated plications radiating from the umbo to the posterior margin, besides concentric folds and lines of growth.

Both muscle scars are well defined, but the anterior scar is larger than the posterior one. The pallial line is entire. The inner ventral margin is crenulated especially on the posterior half.

Occurrence.—Sengoku black shale of the lower formation of the Wakino subgroup (Lower Cretaceous), Kwanmon group, in North Kyushu.

Remarks.—*Kwanmonia* resembles *Plicatounio* (*s.s.*) [type-species: *P. naktongensis* KOBAYASHI and SUZUKI] in having the same dental formula, striation on the median cardinal and posterior lateral teeth as well as the strong radial plications on the posterior part, but differs in the outline of the shell and the features of the hinge. The former is subquadrate in outline but the latter elongate subelliptical. The vertical crenulation on the anterior cardinals is stronger and more distinct in the former than in the latter. The vertical crenulation is, furthermore, developed in the posterior lateral teeth of *Kwanmonia* but absent in *Plicatounio* (*s.s.*).

I described previously (Ota, 1959c) *K. kwanmonensis* under the generic name “*Plicatounio*”, although I discriminated some difference between it and *P. naktongensis*. As described above the distinction is now enough for the subgeneric separation.

Genus *Trigonioides* KOBAYASHI and SUZUKI, 1936.Subgenus *Wakinoa* nov.

Type-species.—“*Nippononaia*” *wakinoensis* OTA, 1959c.

Included species and their occurrence.—In *Wakinoa* following species are to be included:

“*Nippononaia*” *wakinoensis wakinoensis* OTA, from the lower formation of the Wakino subgroup.

“*Nippononaia*” *wakinoensis intermedia* HASE, from the upper formation of the Wakino subgroup.

“*Nippononaia*” *sengokuensis* OTA, from the lower formation of the Wakino subgroup.

“*Nippononaia*” (?) *obsoleta* HASE, from the Shiohama formation of the Shimonoseki subgroup.

Generic diagnosis.—The shell is of moderate size, oboval to subelliptical in outline. The umbo is moderately high and prosogyrate, more or less incurved, located at about the two-fifths of the length from the anterior end. The anterior margin is rounded, the posterior margin is rounded or obliquely truncated, and the ventral margin is slightly curved.

The hinge line is relatively long and nearly straight or gently curved. The two cardinal teeth are relatively short, narrow and finely crenulated in the both valves; the two lateral teeth are fairly long, lamellar, finely crenulated, but in the right valve the posterior teeth are weaker and lower than the anterior ones. The median cardinals are feebly developed, being smaller than the others, but have distinct crenulation.

The dental formula of *Wakinoa* is as follows:

5	3	(I)	PI	(PIII)
(4)	2	1'	PII	PIV

where the teeth in parentheses are variable and sometimes absent.

- 5 stout, elongated, ridge-like, crenulated on both-sides, subparallel to the anterior-umbonal margin;
- 3 elongated, anterior side only crenulated;
- 1 low and weak, but having small number of distinct crenulation;
- 4 elongated, posterior side only crenulated;
- 2 stout, elongated, ridge-like, crenulated on both sides;
- 1' united with 2 at the dorsal end (i.e. immediately below the beak) in the early stage, having distinct vertical crenulation, and becoming a small independent tooth in the late stage;
- PI long, stout, more or less curved, both sides finely crenulated;
- PIII weak, smooth, formed by a thickening of posterior shell margin;
- PII shorter than PIV, both sides or posterior side only crenulated;
- PIV long, both sides crenulated, subparallel to post-umbonal margin.

The surface of the shell is ornamented with many V-shaped ribs crossed by numerous, closely spaced concentric growth lines; the radial ribs are fine and closely set in the middle; the several middle ribs are converging to form acute chevrons on a line from the beak to the mid-venter; anterior and posterior parts of the shell are regularly ornamented with reversed V-shaped ribs; the anterior ribs are smaller and more numerous than the posterior.

Both muscle scars are well defined, but the anterior scar is larger than the posterior one. The pallial line is entire. The inner ventral margin is crenulated especially on the posterior half.

Remarks.—I (OTA, 1959c) tentatively described *wakinoensis* and *sengokuensis* under generic name “*Nippononaia*” of the Unionidae. As the result of a comparison with the holotype of *Nippononaia ryosekiana* SUZUKI, the type-species of *Nippononaia*, the Wakino specimens are not identified with *Nippononaia*, because it has no vertical crenulation on the hinge teeth, contrary to SUZUKI’s (1941, p. 413) original description.

REESIDE (1957) described *Nippononaia asinalia* from the Lower Cretaceous of Colorado, North America. I have mentioned the generic difference between the American species of *Nippononaia* and my “*Nippononaia*” (OTA, 1959c, p. 107). From the comparison of its hinge structure with that of the holotype of *Nippononaia ryosekiana*, *N. asinalia* certainly belongs to the genus *Nippononaia* but not to *Wakinoa*.

The type-species of *Trigonioides* is *T. kodairai* as originally designated by KOBAYASHI and SUZUKI (1936, p. 248). The type locality of the type-species is Suimondo, Keisyo-nando in the area of Lower Cretaceous Naktong series in Korea. The holotype and paratype cannot be reexamined by us, because they were burnt by the fire of the second great war. I depend on the original description and illustration of KOBAYASHI and SUZUKI for the characters of the type-species. For the diagnosis of *Trigonioides* subsequent observations by MATSUMOTO (1938), SUZUKI (1940, 1943), KOBAYASHI (1956) and myself (1959b) are also taken into consideration. *Wakinoa* resembles *Trigonioides* (*s.s.*) in the ornament and outline of the shell, but they are distinguished by the character of the hinge. *Trigonioides* has better developed median teeth than *Wakinoa*, as shown in the following dental formula:

			<i>Wakinoa</i>			
	5	3	(1)		PI	(PIII)
(4)	2	1'			PII	PIV
			<i>Trigonioides</i>			
	(5)	3	Ia	(Ib)		PI
(4)	2	1'a	(1'b)		PII	PIV

where the teeth in parentheses are variable and sometimes absent. Furthermore, the difference between them exists in the disposition of hinge teeth. Two pseudocardinal teeth are subparallel to the anterior hinge margin in the left valve of *Wakinoa*, while in that of *Trigonioides* four pseudocardinals diverge from the beak

FIG. 1. *Plicatounio* (*Plicatounio*) *naktongensis* KOBAYASHI and SUZUKI. Sengoku Beds, Kurate-gun, Fukuoka Pref. (no. WLS. 5030) Hinges of right valve (a) and left valve (b), natural size.

FIG. 2. *Plicatounio* (*Kwanmonia*) *kwanmonensis* OTA. Sengoku Beds. (no. Wl. S. 5005) Hinges of right valve (a) and left valve (b), natural size.

FIG. 3. *Trigonioides* (*Wakinoa*) *wakinoensis* OTA. Sengoku Beds. (no. Wl. S. 5051) Hinges of right valve (a) and left valve (b), natural size.

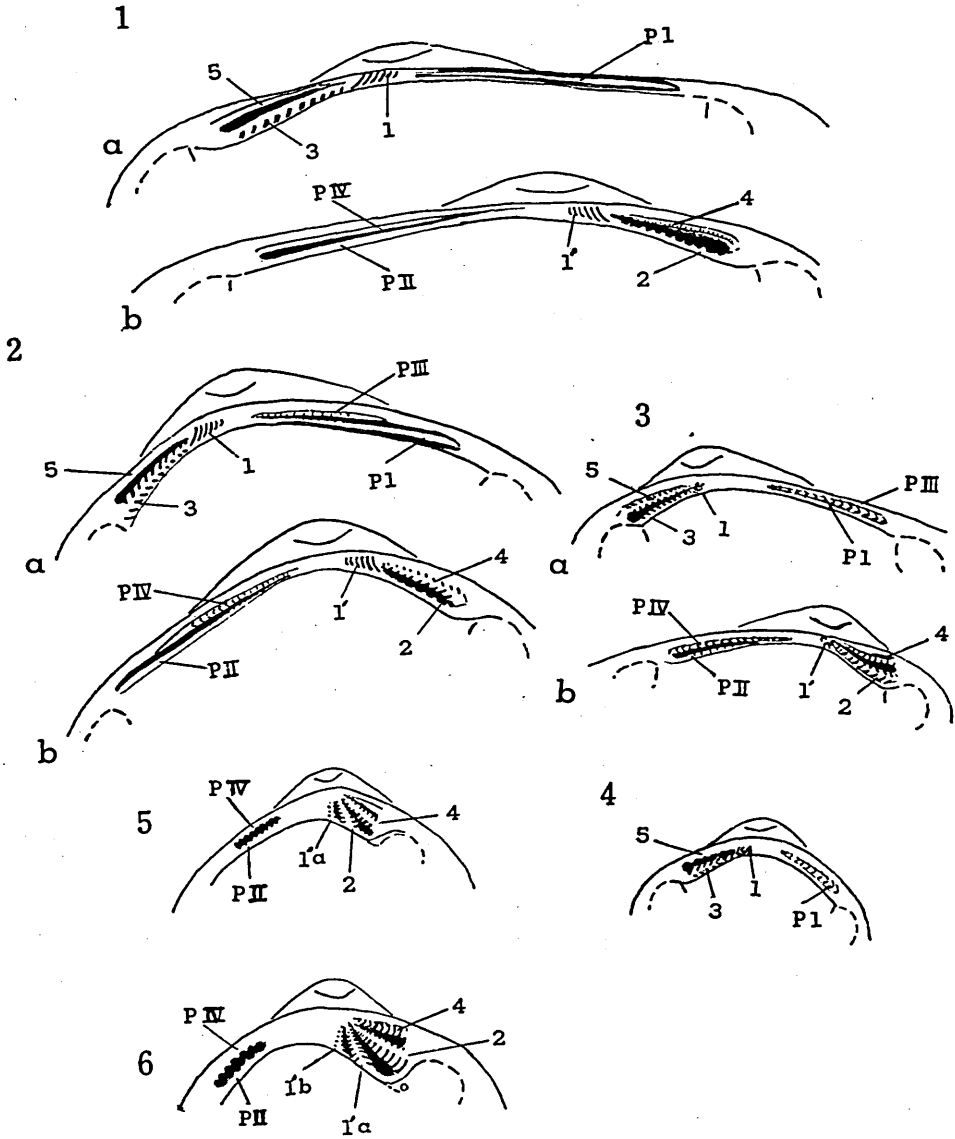


FIG. 4. *Trigonioides (Wakinoa) sengokuensis* Ota. Sengoku Beds. (no. Wl. S. 5081) Hinge of right valve, enlarged $\times 2$.

FIG. 5. *Trigonioides (Trigonioides) paucisulcatus suzukii* Ota. Wakamiya Beds, Katsuki-machi, Yahata city, Fukuoka Pref. (no. Wu. K. 104) Hinge of left valve, natural size.

FIG. 6. *Trigonioides (Trigonioides) matsumotoi* Kobayashi and Suzuki. Upper Gosyonoura Beds. (no. GK. 1500) Hinge of left valve, natural size.

to the anterior margin with angles of 0° , 30° , 60° and 90° . The hinge plate of *Wakinoa* is narrow with slender teeth and that of *Trigonioides* wide with stout dentition. Both genera are, however, closely related to each other in the vertical crenulation of hinge teeth. If the hinge teeth of *Wakinoa* became more stout and the median cardinals grew, the dentition of *Trigonioides* would be formed. Therefore, *Wakinoa* is instituted as a new subgenus in the genus *Trigonioides*.

III. FURTHER COMPARISONS

Plicatounio KOBAYASHI and SUZUKI (1936, p. 250), with the type-species: *P. nak-tongensis* KOBAYASHI and SUZUKI, from the Lower Cretaceous Naktong and Wakino series, can be easily distinguished from *Wakinoa* in having the elongated subelliptical outline and strong posterior radial plications. In *Plicatounio* "internally, anterior, or pseudocardinal, tooth relatively long and regularly crenulated; posterior one prominent, non-crenulated (KOBAYASHI and SUZUKI, 1936, p. 250)". Its hinge is somewhat similar to that of *Wakinoa*, in having the trigonian shizodont anterior cardinals (Text-fig. 1).

Kwanmonia kwanmonensis differs from the species of *Wakinoa* in the size, outline and ornamentation, although its feature of hinge is very similar to that of *Wakinoa*. Its median tooth is rather massive, having the unioid oblique radial striations as well as that of *Plicatounio* (*s.s.*) (Text-fig. 2). This feature cannot be observed in the species of *Wakinoa*.

All the genera of the Trigoniidae have regular vertical crenulation and a definite number of teeth in regular arrangement. The teeth of *Wakinoa* have regular vertical crenulation like those of Trigoniidae, but the former genus differs from the latter in the number and arrangement of the dentition. The stout median tooth of the left valve is characteristic of the Trigoniidae but is absent in *Wakinoa*.

Castalia LAMARCK, with the type-species: *C. ambigua* LAMARCK, living in South America, is similar to *Wakinoa* in that the hinge teeth have vertical crenulations and that the radial ribs cover all over the surface of shell. The former, however, differs from the latter in that its shell is rather higher than long, that its beak is very excentric, that it has no V-shaped ribs on the surface, that there is no marked crenulation on the inner side of the ventral margin, the dentition is not quite identical as described below and that the vertical crenulation on the anterior cardinal and posterior lateral is irregular.

Cox called attention to the close affinity of *Trigonioides* with *Castalia* in the feature of hinge. The pseudocardinals of *Castalia* are fairly variable between small and large specimens in the number and arrangement. The anterior cardinal tooth of a small specimen is rather massive and is accompanied with branched two or three small teeth. On a large specimen these branched teeth become independent although they are small and situated below the umbo. Thus, in the dentition *Wakinoa* is somewhat similar to the large specimen of *Castalia*, but quite differ-

ent from the small one.

IV CONCLUDING REMARKS

The ontogeny can be observed in some specimens of *Wakinoa wakinoensis*. In the early growth-stage, the very small, crenulated median cardinal of left valve is not yet an independent tooth. It is united with 2 at the dorsal end (i.e. immediately below the beak). Therefore, the dorsal part of 2 forms a double line of crenulation and thicker than the single ventral part of 2. Its vertical crenulation is more or less irregular in this stage. In the late stage, the median cardinal is more or less separated from 2 and it becomes a small but distinct independent tooth disposed obliquely to 2. On the other hand, a small socket which receives the left median cardinal 1' is formed on the inner side of 3. In the early stage, it was a row of minute holes. The socket becomes deep and distinct, and the median cardinal 1 is formed below the beak in the late stage. It is small and only its anterior side is crenulated. This process of development of the median cardinals can be also observed in the species of *Trigonioides*, *T. suzukii*, *T. matsumotoi* and *T. kobayashi*. If this point is taken into consideration, it would be more probable to regard *Trigonioides* as a derivative from *Wakinoa*. This assumption is further supported from the stratigraphical evidence. The species of *Wakinoa* occur commonly in the lower formation of Wakino subgroup and persist in the upper. The late representative of *Wakinoa* as represented by *W. wakinoensis intermedia* (HASE) from the upper formation of Wakino subgroup, and *W(?) obsoleta* (HASE) from the Shiohama formation of the Shimonoseki subgroup (HASE, 1960, pp. 316-318), the radial ornamentation is weakened and obsolete especially on the umbonal area.

In connection with the problem of the family to which *Wakinoa* should belong, the discussion on the family of *Trigonioides* between KOBAYASHI and COX must be referred. *Trigonioides* was ascribed to the Unionacea by COX (1955) but to the Trigoniacea by KOBAYASHI (1936, 1956). KOBAYASHI's opinion has been supported by HOFFET (1937), DECHASEAUX (1952) and HASS (in COX, 1955). While MATSUMOTO (1938) hesitated its reference to the Trigoniidae (s.s.). I once (1959b) supported KOBAYASHI's opinion, but am now inclined to have another opinion as a result of the study of *Wakinoa* and *Kwanmonia*. *Kwanmonia kwanmonensis* is very similar to *Wakinoa wakinoensis* in the vertical crenulation, arrangement and the number of teeth, but differs from the latter in having a unioid oblique striations on the median cardinal. However, the median cardinal of *Wakinoa* has more or less irregular crenulation in the early stage. So far as the dentition is concerned, I think that *Wakinoa* was derived from this kind of *Kwanmonia*. *Kwanmonia* is closely allied to *Plicatounio* (s.s.) in the outline, size and ornamentation. The dentition of *Plicatounio* has the vertical crenulation on the anterior cardinal, but the posterior teeth has the unioid striation more or less diagonally to the teeth. *kwanmonia* was probably derived from *Plicatounio* (s.s.) by addition of the crenulation of

Subgenus	Lower Cretaceous			Upper Cretaceous		
	Lower	Middle	Upper	Lower	Middle	Upper
<i>Plicatounio</i> s.s.	<i>P. naktongensis</i> <i>naktongensis</i>	<i>P. naktongensis</i> <i>multiplicatus</i>			<i>P. suzuki</i> <i>P. maxima</i>	
<i>Kwanmonia</i>	<i>K. kwannonensis</i>					
<i>Wakinoa</i>	<i>W. sengokuensis</i> <i>W. wakinoensis</i> <i>wakinoensis</i>	<i>W. wakinoensis</i> <i>intermedia</i>	<i>W. (?) obsolata</i>			
<i>Trigonioides</i> s.s.	<i>T. kodairai</i>	<i>T. paucisulcatus</i> <i>suzukii</i>	<i>T. paucisulcatus</i> <i>paucisulcatus</i>	<i>T. matsumotoi</i>	<i>T. diversicostatus</i> <i>T. kobayashi</i> <i>T. trigonus</i>	

FIG. 7. Geological ranges of the species of *Plicatounio* and *Trigonioides*.

the preexisting posterior teeth. When I draw inferences from the aforementioned fact, the phylogenetical relation among the above genera as follows: *Plicatounio* (s.s.) → *Kwanmonia* → *Wakinoa* → *Trigonioides* (s.s.). If this relation is warrantable, the family which these genera are placed, should be identical with that of *Plicatounio* (s.s.). *Plicatounio* (s.s.) was provisionally placed in the Unioninae by KOBAYASHI and SUZUKI (1936). The malacological criteria between the Unionidae and the Mutelidae is based mainly upon the features of soft part, so it is not easy to decide their family by the hard parts only. Judging from the following facts that the trigonian regular crenulation on the hinge teeth is rare in the Unionidae, and the feature that the umbonal radial ribs are common in the Mutelidae, I am inclined to conclude that *Plicatounio* should be placed in the Mutelidae rather than in the Unionidae. At any rate, *Plicatounio* belongs undoubtedly to the Unionacea. From the fact that the vertical crenulation on the hinge teeth is well developed, Trigonioididae can be recognized as a valid family and it includes *Trigonioides*, with subgenera *Trigonioides* (s.s.) and *Wakinoa*. On the basis of the above discussed phylogeny the Trigonioididae has proved to be a derivative of *Plicatounio*, a genus of Unionacea, and not that of the Trigoniidae.

From the available evidence, the stratigraphic range of the species of the discussed genera can be summarized as follows (Fig. 7).

REFERENCES

- COX, L. R. (1952): Notes on the Trigoniidae, with Outlines of a Classification of the Family. *Proc. Mal. Soc. London*, 29, 45-70, pls. 3-4.
- (1955): On the Affinities of the Cretaceous Lamellibranch Genera *Trigonioides* and *Hoffetrigonia*. *Geol. Mag.*, 92, (4), 345-349.
- DECHASEAUX, C. (1952): Classe des Lamellibranches in Piveteau's *Traite de Paleontologie*, Tom. 2.
- HASE, A. (1960): The Late Mesozoic Formation and their Molluscan Fossils in West Chugoku and North Kyushu, Japan. *Jour. Sci. Hiroshima Univ., Series C*, 3, (2), 283-338.
- HOFFET, J. H. (1937): Les Lamellibranches saumâtres du Senonien de Muong Phalane (Bas-Laos). *Bull. Serv. Geol. Indochine*, 24, (1), 4-25, pls. 1-5.
- KOBAYASHI, T. and SUZUKI, K. (1936): Non-Marine Shells of the Naktong-Wakino Series. *Jap. Jour. Geol. Geogr.*, 13, (3-4), 243-257, pls. 27-29.
- (1954): Studies on the Jurassic Trigonioids in Japan. Part 1, Preliminary Notes. *Ibid.*, 25, (1-2), 61-80.
- (1956): On the Dentition of *Trigonioides* and its Relation to Similar Pelecypod Genera. *Ibid.*, 27, 79-94, pl. 5.
- MATSUMOTO, T. (1938): Geology of Gosyonoura Islands, Amakusa, with Special Reference to the Cretaceous Stratigraphy (in Japanese, with Preliminary Notes on Some of the More Important Fossils among the Gosyonoura Fauna in English). *Jour. Geol. Soc. Japan*. 45, (532), 1-47, pls. 1-3.
- OTA, Y. (1959a): *Plicatounio* of the Wakino Formation. *Trans. Proc. Pal. Soc. Japan, new ser.*, (33), 15-18, pl. 3.
- (1959b): *Trigonioides* and its Classification, *Ibid.*, (34), 97-104.
- (1959c): On the "*Nippononaia*" from the Lower Cretaceous Wakino Subgroup, North Kyushu, Japan. *Ibid.*, (34), 105-110, pls. 10-11.
- REESIDE, J. B. (1957): Nonmarine Pelecypod (*Nippononaia asinaria*) from the Lower Cretaceous of Colorado. *Jour. Pal.*, 31, (3), 651-653.

- SUZUKI, K. (1940): Non-Marine Molluscan Faunule of the Siragi Series in South Tyosen. *Jap. Jour. Geol. Geogr.*, 17, (3-4), 215-231, pls. 22-24.
- (1941): A New Naiad, *Unio* (*Nippononaia*) *ryosekiana*, n. subgen. and n. sp., from the Lower Cretaceous of Japan. *Jour. Geol. Soc. Japan*, 48, (575), 410-413.
- (1943): Restudy on the Non-Marine Molluscan Fauna of the Rakuto Series in Keisyo-do, Tyosen. *Jour. Sigen. Ken.*, 1, (2), 189-219, pls. 14-19.
- THIELE, J. (1934-35): *Handbuch der systematischen Weichtierkunde*, Bd. 2. Jena.

FUKUOKA TEACHER'S COLLEGE at TAGAWA