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Author(s)	OTA, Yoshihisa
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On the Corbiculidae from the Lower Neocomian of Japan.¹⁾

By

Yoshihisa Ota

with 2 Plates

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ABSTRACT : The Corbiculidae from the Lower Neocomian of Japan are re-examined, and a new species, *Tetoria (Paracorbicula) yoshimoensis*, is described with a revision on genus *Tetoria*.

CONTENTS

- I. Introduction and acknowledgements
- II. Historical review
- III. Systematic description
- IV. Concluding remarks

I. INTRODUCTION AND ACKNOWLEDGEMENTS

The Cenozoic and Recent representatives of the Corbiculidae are taxonomically well settled, for their hinge structures are stable and distinct and also their ecological evidence is fairly clear. The systematic position of the Mesozoic ones, however, remains generally obscure both in Europe and Asia. Therefore, the classification system of the Mesozoic Corbiculidae has been in great confusion. In former times, all the Mesozoic *Corbicula*-like species were included under the genus "*Cyrena*", but subsequently some authors attempted to classify more systematically the so-called Mesozoic Corbiculidae. And yet, there are still many unsettled problems. In this paper, I re-examined mainly "*Corbicula (Paracorbicula) sanchuensis* (YABE and NAGAO)" from the Lower Neocomian non-marine Yoshimo Formation and its equivalent ones, and on the genera of Corbiculidae from the Upper Mesozoic in Japan.

Before entering into the description, I wish to express my sincere thanks to Prof. Tatsuro MATSUMOTO and Dr. Itaru HAYAMI of the University of Kyushu for their invaluable advices and critical reading of the typescript.

Thanks are due to Emeritus Prof. Dr. Teiichi KOBAYASHI of the University of Tokyo and Prof. Dr. Kotora HATAI of the University of Tohoku for privileges of studying the type-specimens preserved in the universities.

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II. HISTORICAL REVIEW

A classical study on the Cyrenoids of the Mesozoic in Japan was that of NEUMAYR (1890), who described *Cyrena naumanni* and two other species from the Ryoseki Series at Yanagidani in Shikoku. Subsequently, more species were described under the generic name *Cyrena* from the Jurassic and Cretaceous non-marine formations (YOKOYAMA, 1904; YABE and NAGAO, 1926).

KOBAYASHI and SUZUKI (1936, 1937, 1939) studied the non-marine faunas from the Upper Mesozoic Tetori, Naktong-Wakino and Ryoseki Series. In those studies, a preliminary sorting of the Mesozoic Corbiculidae was attempted by them. Namely, they established some new sections and indicated the following morphological relations among them: *Batissa*—*Tetoria*—*Paracorbicula*—*Corbicula*.

SUZUKI and OYAMA (1943) showed a summarized scheme of classification on the Corbiculidae including the living and fossil species in Eastern Asia. This has been accepted by many stratigraphers in Japan.

Recently, MAEDA (1959) described *Polymesoda (Isodomella) kobayashi* MAEDA and *Corbicula (Paracorbicula) sanchuensis* KOBAYASHI and SUZUKI, from the Itoshiro Formation of the Tetori Series. In the meanwhile, HAYAMI (1958–1960) published a series of magnificent papers mainly on the Jurassic pelecypods from Japan, in which he made clear the taxonomical positions of the so-called cyrenoid pelecypods from the Jurassic formations in Japan. According to him, species of the so-called Jurassic "*Cyrena*" do not belong to the Corbiculidae, but are ascribed to the Neomiodontidae and other families. Furthermore, he has suggested that a further re-examination is needed for a clearer classification of the Mesozoic Corbiculidae in Japan. This paper would meet a part of the requirements.

III. SYSTEMATIC DESCRIPTION

Family Corbiculidae GRAY, 1847 (=Cyrenidae GRAY, 1840)

Genus *Tetoria* KOBAYASHI and SUZUKI, 1937

Type-species.—*Batissa yokoyamai* KOBAYASHI and SUZUKI, 1937 (Probably Lower Neocomian Itoshiro Formation of the Tetori Group, Japan).

Diagnosis.—Shell relatively large, subequilateral, subcircular to subelliptical, more or less longer than high; moderately inflated. Surface sculptured with concentric lines of growth and radial markings, without definite lunule or escutcheon; ligament external. Pallial sinus deep, narrowly subquadrate, and located just inside of the adductor scar. Hing of cyrenoid type as formulated

below:

AI	AIII	3a	1	3b	PI	PIII
AII		2a	2b	4b	PII	

2b and 3b more or less stronger than the anterior cardinals (1, 2a and 3a); 1 and 2a rarely bifid. Anterior cardinals generally connected with the anterior laterals. Laterals long, curved, faintly crenulated; posterior laterals shorter than anterior ones and very remote from the cardinals with a fairly wide flattened intervening space.

Remarks.—*Tetoria* was established as a section in the genus *Batissa* for *B. yokoyamai* by KOBAYASHI and SUZUKI (1937, p. 44). *B. yokoyamai*, however, is obviously different in the elongated and curved laterals, and in the mode of pallial sinus from *B. tenebrosa* HINDS, the type-species of *Batissa*. On account of the internal aspect, especially of the sinupalliate nature, the pallial line of *Batissa* is apparently simple and entire. This distinction is, in my opinion, sufficient to separate *Tetoria* from *Batissa* as a distinct genus in the Corbiculidae. *Tetoria* is classified into two subgenera, *Tetoria s. s.* and *Paracorbicula*, from the difference of the surface ornament of the shell.

Cyrena shiroiensis YABE and NAGANO, 1926, from the Lower Neocomian Shiroi and Yoshimo Formations was renamed *Polymesoda (Isodomella) shiroiensis* by KOBAYASHI and SUZUKI (1937). However, this species should be excluded from the Corbiculidae, for its cardinal structure differs entirely from that of Corbiculidae. KOBAYASHI and SUZUKI (1937) described two species, *Corbicula (s. s.) amagashiraensis* and *C. (Veloritina) tetoriensis*, from the Itoshiro Formation of the Tetori Group. Subsequently, SUZUKI and OYAMA (1943) established a new section *Mesocorbicula* in *Corbicula s. s.* which was founded on *C. tetoriensis*. These two species, of course, have corbiculoid elongated laterals, but their cardinal structures entirely differ from those of the Corbiculidae, namely the cardinal 1 and 2a are not developed in them. They may rather belong to the Neomiodontidae.

Filosina jusanhamensis HAYAMI (1960), from the uppermost Jurassic or lowest Cretaceous Tategami member in the Kitakami massif, lacks PIII, and shows non-sinuuated pallial line and subtrigonal outline. Therefore, it can be well distinguished from *Tetoria yokoyamai*.

Because the cardinal 1 is more or less embryonal, and not completely separated from AI, and because 2a is fairly opisthocline and connected intimately with AII, *Tetoria* is somewhat similar to *Eocallista (s. s.)* and *Eocallista (Hemicorbicula)*, from the Upper Jurassic of Europe, but pallial line of *Tetoria* is sinuate while that of *Eocallista* entire.

In the sinupalliate nature, *Tetoria* is somewhat similar to *Fulpia* STEPHENSON, 1946, which was founded on *Fulpia pinguis* STEPHENSON from the Cenomanian of Texas, but in the former the posterior laterals are shorter than the anterior ones and the lunule is not impressed.

Incidentally, in *Veloritina* MEEK, 1872, from the Upper Cretaceous Bear River

Formation of Wyoming (HENDERSON, 1935, p. 127), the cardinal 4b is indistinct and the pallial line is not sinuate. *Tetoria* is, thus, clearly distinguished from *Veloritina*.

Subgenus *Tetoria s. s.*

Subgeneric characters.—Surface sculptured with concentric lines of growth and radial grooves.

Remarks.—The radial grooves on the surface of the holotype (KOBAYASHI and SUZUKI, 1937, pl. 4, figs. 3a, b) of *B. yokoyamai* are distinct and regular in the median portion. This character cannot be considered as a secondary product. The paratypes (pl. 4, figs. 4a, 5) of *B. yokoyamai* should be excluded from that species, for they do not reveal radial grooves on the surface.

Subgenus *Paracorbicula* KOBAYASHI and SUZUKI, 1939

Type-species.—*Corbicula sanchuensis* YABE and NAGAO, 1926 (Lower Neocomian Shiroi Formation, Japan).

Subgeneric characters.—Surface sculptured only with concentric lines of growth. Hinge with the cardinal teeth connected with the anterior laterals, and 1 and 2a rarely bifid; laterals curved and anterior ones long.

Remarks.—*Paracorbicula* was established by KOBAYASHI and SUZUKI, 1939, as a new section of *Corbicula s. s.* and was founded on *C. sanchuensis* YABE and NAGAO 1926, from the Lower Neocomian Shiroi "Group" in the Sanchu graben, Kwanto mountains. *Paracorbicula* differs from *Corbicula*, *Batissa* and other members of the Corbiculidae in its primitive cardinals and long, curved lateral dentition and ascending deep pallial sinus. *Paracorbicula* is very similar to *Tetoria s. s.* in many characters, but the latter is distinguished chiefly by its combination of concentric and radial ornament.

Tetoria (Paracorbicula) yoshimoensis, n. sp.

Pl. 12, figs. 1–22, and Pl. 13, figs. 1–13

Materials.—Holotype GT. Y64325, from the Yoshimo Shale, exposed at a locality on the beach 500m northwest of Yoshimo, Shimonoseki city, Yamaguchi Pref.; paratypes GT. Y64323, 64371, from the type locality and the nearby localities on the about 500m northwest of Yoshimo, Shimonoseki city, Yamaguchi Pref.; GT. K64961–64963, sandy shales at the Cape of Tanoura and the cutting of the road-side near Tanoura railroad-tunnel, Ashikita-gun, Kumamoto Pref.; GT. T64710, 64711. Izuki Shale, a cutting of the road-side on the right side of the river Itoshiro at Izuki, Ōno-gun, Fukui Pref.; GT. T64801, 64802. Numamachi Shale of Itoshiro Formation, a cliff on the right side of the stream, 500m west of Kurouchi, Furukawa-machi Yoshiki-gun, Gifu Pref.

Description.—Shell of medium to large in size, subequilateral, subquadrate to subcircular in outline, moderately convex. Test thin. Umbo relatively small, located at a point from median to about one-third from the anterior end; beak prosogyrous, somewhat projected beyond the hinge margin. Antero-dorsal margin well rounded but somewhat excavated near the umbo; ventral margin long, very broadly arched, gradually passing into the fairly long, arched posterior margin. Surface ornamented with lines of growth. Lunule and escutcheon absent. Ligament external, but not well preserved. Nymph comparatively wide. Adductor scars fairly large, lanceolated ovate; posterior one more or less broader than the anterior. Pallial line deeply sinuate; the sinus being acutely subtrigonal in outline and located just inside of the adductor scar.

Hinge composed of cardinals of cyrenoid type and elongated laterals on a fairly wide hinge plate; dentition formula as noted in the generic diagnosis. Cardinal teeth radially disposed from the beak; 3a narrow, thin, elongated, prosocline, subparallel to post-umbonal margin and connected with AIII; 2a small, elongated, opisthocline, rarely bifid, connected with AII; 1 stout, more or less opisthocline, rarely bifurcated; 2b stout, large, acutely trigonal, prosocline; 4b small, thin, ridge-like, very prosocline, adjacent to nymph. Lateral teeth strong, elongated, curved and posterior laterals shorter than anterior ones; all anterior ones connected respectively with anterior cardinals; AI long, curved, narrow, gently convex, connected intimately with AIII, forming U-shape at the anterior end; AII long, narrow, gently convex; AIII long, curved, narrow, gently convex, variable in length; PI remote from cardinals, long, curved, gently convex, connected with PIII, forming U-shape near the posterior adductor scar; PII long, rounded at top, gently convex.

Measurements in mm.—

Specimen	Length	Height	$\frac{1}{2}$ Thickness
GT. Y64333	38	39	9
" 64312	20	18	4
" 64315	29	26	6.5
" 64376	26	26	6
" 64325 (holotype)	35.5	36	7.5
" 64313	31	29	7
" 64330	38	32	7
" 64307	32	37	8.5
" 64321	28	27	7
" 64369	28	26	7

Remarks.—KOBAYASHI and SUZUKI (1939) identified the Yoshimo specimens (= *Tetoria (Paracorbicula) yoshimoensis* in this paper) with *Corbicula (Paracorbicula) sanchuensis*. *T. (P.) yoshimoensis* is indeed very similar to *T. (P.) sanchuensis* in the

outline, size, ornament, hinge and internal characters, but the former differs from the latter in the convexity of the shell, inflation of the umbo and the degree of the umbonal protrusion from the hinge margin.

P. yoshimoensis is also similar to *Tetoria yokoyamai* in many characters, but *T. yokoyamai* is easily distinguished by its radial markings on the surface of the shell. The paratypes of *Batissa yokoyamai* KOBAYASHI and SUZUKI (1939, pl. 4, figs. 4a, 5) from the Itoshiro Formation are conspecific with *P. yoshimoensis*. About 60 specimens from the Yoshimo Formation show a great extent of variation in outline. The holotype and many others are subcircular and somewhat inequilateral. Some others (Pl. 12, figs. 5, 9) look like *B. antiqua*, being very inequilateral; some others (Pl. 12, fig. 15 and Pl. 13, fig. 4) have circular forms, apparently similar to *T. (P.) sanchuensis*; some others (Pl. 12, fig. 11; Pl. 13, fig. 2) have elliptical forms and one (Pl. 13, fig. 12) has an ovate form. But all are specifically identical with the holotype in view of the similarly developed long, curved laterals, deep pallial sinus, small umbo, etc. SUZUKI and OYAMA (1943) considered that *B. antiqua* was synonymus with *T. yokoyamai*, but *T. antiqua* is distinguished from *T. yokoyamai* by the absence of the radial ornament. Since the hinge and other internal characters of the holotype and paratype of *B. antiqua* are obscure, it is questionable whether the species belongs certainly to the Corbiculidae or not. The specimens (Pl. 13, figs. 10, 11) which I obtained from the type-locality of *B. antiqua* differ in outline from the holotype and paratype of that species. They are rather identified with *P. yoshimoensis*. In view of the variation of outline in the present species, *B. antiqua* might possibly be conspecific with *P. yoshimoensis*, but the available evidence is not sufficient for such a conclusion.

Occurrence.—Common in black fine sandstones and shales of the lower Neocomian Yoshimo Formation at Yoshimo and rare in fine black sandy shales at Utsui in Shimonoseki city, Yamaguchi Pref.

Rather rare in black sandy shales of the probably lower Neocomian Itoshiro Formation of the Tetori Group at Izuki, Ushimaru and Kurouchi in Fukui and Gifu Prefectures (Hida province).

Rather rare in black fine sandstones and shales of the lower Neocomian Kawaguchi Formation at Fukami and Tanoura in Kumamoto Pref.

To sum up, this species is common in the lower Neocomian of the Inner Side of Southwest Japan but rather rare in the Outer Side.

IV. CONCLUDING REMARKS

Hitherto, fairly many genera and sections of the Corbiculidae have been described from the Upper Jurassic to the Lower Cretaceous in Japan, but genus *Tetoria*, with two subgenera *Tetoria s. s.* and *Paracorbicula*, and genus *Filosina* are ultimately valid.

CASEY (1955a) considered that the non-sinuate genus *Filosina* with non-sinuate pallial line was derived from the Purbeckian subgenus *Hemicorbicula* of genus *Eocallista* of the Corbiculidae, and HAYAMI (1960) supported his opinion. Incidentally, the ancestor of sinupalliate genus *Tetoria* is not well known, but the bifurcation of the cardinals suggests that this genus is more closely related to the advanced Cyprinidae such as *Eocallista* than to Neomiodontidae. This is a moot question which should be resolved in future.

P. yoshimoensis is mainly distributed in the Inner Side of Southwest Japan, but *P. sanchuensis* is predominant in the Outer Side in the same early Neocomian epoch. This difference in distribution may depend on environmental factors such as degree of salinity etc., as judged from the faunal assemblage. *P. yoshimoensis* probably likes the environment of less salinity than *P. sanchuensis*.

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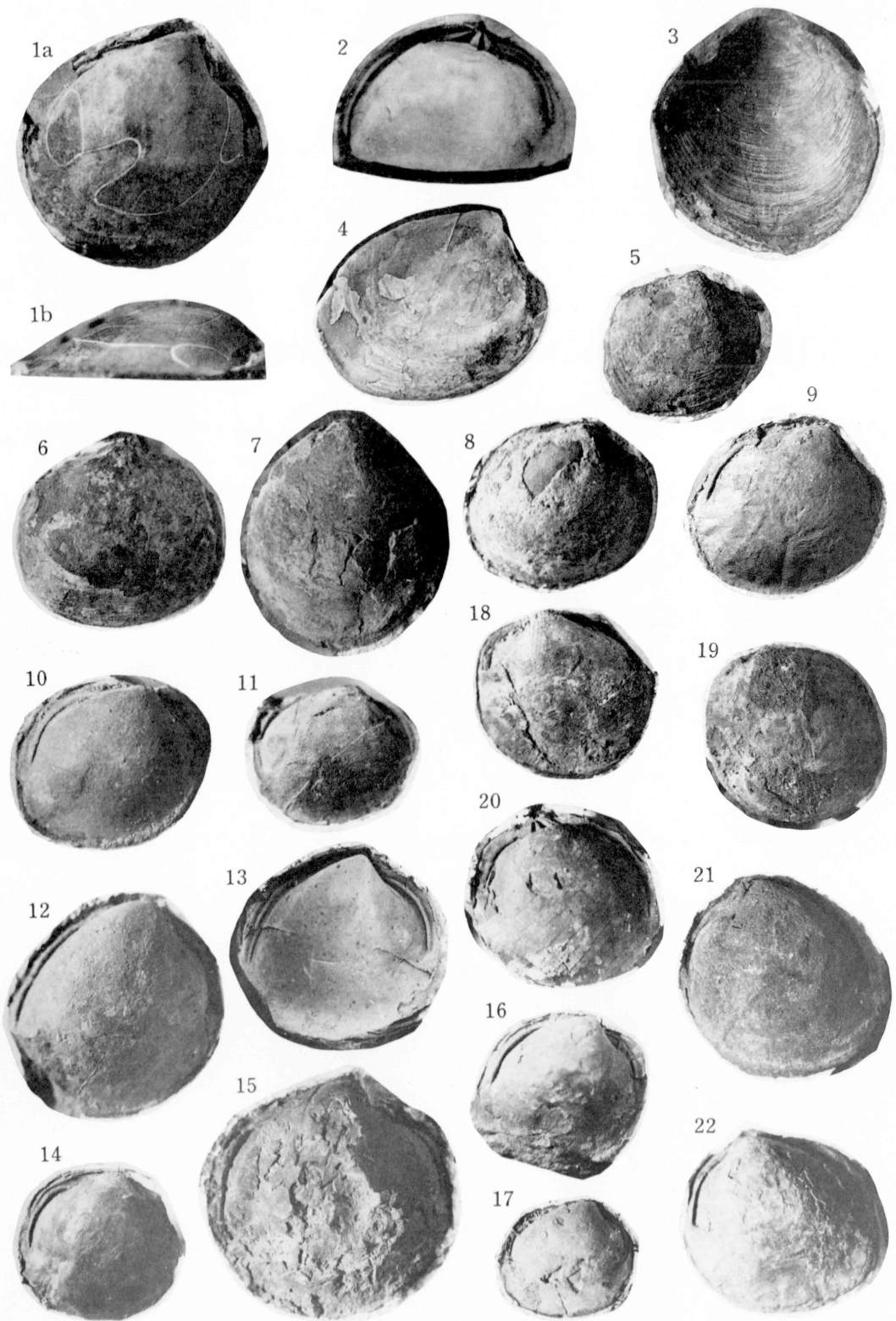
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EXPLANATION OF PLATE XII.

All specimens illustrated in this plate XII are from the Lower Neocomian Yoshimo Formation of Toyonishi Group at Yoshimo, Shimonoseki-city, Yamaguchi Pref., and are natural size.

Tetoria (Paracorbicula) yoshimoensis n. sp.

- FIGS. 1a, 1b. (Holotype) Right internal mould.
- FIG. 2. (Paratype) Right internal mould.
- FIG. 3. (Paratype) Right external mould.
- FIGS. 4-8. Right valves
- FIGS. 9-17. Right internal moulds.
- FIGS. 18, 19. Left valves.
- FIGS. 20-22. Left internal moulds.



EXPLANATION OF PLATE XIII

All natural size

Tetoria (Paracorbicula) yoshimoensis n. sp.

- FIGS. 1-3. Right internal moulds, Kawaguchi Formation: Tanoura, Ashikita-gun, Kumamoto Pref.
FIG. 4. Right internal mould, Yoshimo Formation: Yoshimo, Shimonoseki-city, Yamaguchi Pref.
FIG. 5. Right valve, Ditto.
FIG. 6. Right internal mould, Ditto.
FIG. 7. Left valve, Ditto.
FIGS. 8,9. Bivalved specimens. Ditto.
FIG. 10. Right valve, Itoshiro Formation: Izuki, Ono-gun, Fukui Pref.
FIG. 11. Left internal mould, Ditto.
FIG. 12. Left valve, Itoshiro Formation: Kurouchi, Furukawa-machi, Yoshiki-gun, Gifu Pref.
Fig. 13. Right internal mould, Ditto.

Tetoria (Paracorbicula) sanchuensis (YABE and NAGAO)

- FIG. 14a, 14b. Right internal moulds, Ryoseki Group: Yonamoto, Kōchi-city, Kōchi Pref.

All specimens illustrated here are kept in the Fukuoka Gakugei University.

Photo. by Y. Ota

