

Permian Brachiopod Fossils of the Maizuru Group found on the North of Okayama City, Japan

By

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(Received January 28, 1963)

Abstract

Brachiopod fossils were found from a limestone lense of the Permian Maizuru Group, at Kutani of Mitsu-cho, Okayama Prefecture, Japan. The brachiopod species are described and compared with those of Permian faunas of southwestern China and of the Salt Range.

Introduction and Acknowledgement

On the brachiopod fossils of the Permian Maizuru Group, the writer had described them as the Takauchi, the Kawahigashi and the Gujō faunules and correlated them to the middle and upper Permian (SHIMIZU, 1961-62). He also analysed their stratigraphic succession and discussed their faunal change in a syntectonic view with paleogeographic aspects (1962). The Maizuru Group had been found in the Fukumoto District of Eastern Okayama Prefecture, but brachiopod fossils are not collected from there. NAKAZAWA and the writer found the Permian and the Upper Triassic formations around Kanagawa, on the north of Okayama City and reported their stratigraphic features briefly (1962). The area is situated in the western neighbourhood of the Fukumoto District and also the Yanahara Mine District. In this report, the writer intends to describe some brachiopod fossils collected at Kutani of this area from a limestone lense of the Permian formation.

The Permian formation of the Kanagawa District is divided into two units, one formation is an alternation of shale-sandstone-conglomerate, and the other is slaty formation with limestone lenses. Shale is black in color and massiv. Sandstone is coarse to fine grained and all of graywacke type and contains many fragments of shale. Conglomerate is intercalated in shale or sandstone, but not persistent. Pebbles of conglomerate are subround pebbles or cobbles of sandstone, slate, chert, green rock, limestone and granitic rocks. Granulic conglomerate is also intercalated in sandstone or shale and this rock contains many fusulines as pebbles in matrix. These fusulines are all of *Lepidolina toriyamai* faunule. From the fusulines, this

formation can be correlated to upper Permian. This formation occupies a narrow area around Ishihara and Shitori of Mitsu-cho, and trends north-south direction. The same formation is distributed in northwestern part of Kanagawa and also in the east of Fukuwatari-cho.

The slaty formation is mainly composed of black muddy slate or shale and is intercalated with small limestone lenses. Sandstones are also found in slate. They are graywacke type and medium to fine grained. Limestone lenses are scattered near Minotani Tunnel and west of Kutani of Mitsu-cho. They are dark gray in color, somewhat muddy and contains some oolitic parts. The greater part of limestones are considerably recrystallized and fossils are poorly preserved. From a limestone lense near Kutani the writer found many small brachiopod fossils with some gastropods (*Naticopsis?*), crinoid stems and many fragments of other fossils. Brachiopod species are as follows.

Wellerella nucula (SCHELLWIEN)

Wellerella saxatilis (REED)

Wellerella sp. A

Wellerella sp. B

Dielasma nummulus WAAGEN

Dielasma cf. *biplex* WAAGEN

Athyris subtriangularis (REED)

Athyris sp.

These species have never been found in Japanese Permian but some of them are common in the upper Permian Loping fauna of southern China and also in the middle division of the Productus Limestone of the Salt Range. The Kutani brachiopod faunule is probably correlatable with the middle Permian, like as the Takauchi faunule of the Maizuru Group in the Yakuno District.

These two formations are found separately and their stratigraphic relation is not observed. But it is probable that the alternation of slate-sandstone-conglomerate may be said upper than the slaty formation from similarity of lithologic succession in other districts of the Maizuru Zone. Fossil evidences do not contradict to this stratigraphic relation.

To the south of the area of the Permian formations, the upper Triassic Kanagawa formation develops around Kanagawa of Mitsu-cho, and it contains some Carnian pelecypod fossils. The Kanagawa formation is correlated to the Nabae Group in the Maizuru Zone.

On the north and south sides of these Permian and Triassic formations, the Yakuno Complex are distributed. The northern rock body is extended northwards, and on the other, the southern one southwestwards respectively. These rocks present some important suggestion on western extension of the Maizuru Zone in the Chugoku Region.

Before going into description, the writer wishes to express his sincere thanks to Prof. S. MATSUSHITA for his kind encouragement and critical reading of manuscript. To Prof. K. NAKAZAWA, the writer also much indebted for his kind guidance and advice. The writer had been given kind conveniences from Mr. Y. SHINAGAWA in the course of field study.

Description of Species

Wellerella nucula (SCHELLWIEN)

Pl. 4, figs. 1-7.

1900. *Camerophoria nucula* SCHELLWIEN. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, S. 100, Taf. XV, figs. 7-8. Abh. k. k. Geol. Reichsanst., Band XVI, Theil I.

General form of this species is globose, with very inflated valves, broader than long. A median sinus is found in ventral valve, and corresponding fold in dorsal valve. Surface of valves are covered by plications.

The ventral valve regularly and considerably curve, but in a lateral view this shell appears to be flatter than the dorsal one. The median part of this valve bends in a regular and strong curve to form the median sinus. The beak is not prominent, tolerably thick and well bent over and more or less firmly apressed to the apical part of the dorsal valve. From a distance under the beak commence three distinct ribs, passing through the sinus and end at frontal margin. Both lateral wings of this valve are rather small but somewhat pointed.

The dorsal valve is strongly inflated. Its curve is very distinct in both lateral and longitudinal directions. From beak to the middle of the valve, the valve is strongly curved and from there becomes more straight to the margin. Lateral inflation is very regular, but it is somewhat flat on both lateral wings. From the middle of this valve begin four small ribs and become more larger and distinct towards frontal line. These ribs on both valves form zigzag outline of the middle part of the shell. On both lateral wings, two rather indistinct ribs are found, and they are separated eachother by wide and round valleys.

Internally, the ventral valve has well developed dental plates. In the dorsal valve, the hinge plate is elevated along the midline into a bluntry angular ridge, forming a narrow spondilium, and supported by a short median septum which reaches dorsal bottom.

Measurements of the shell are as follows: (in mm.)

Height of the shell	11.7	12.0	10.5
Width of the shell	13.3	13.8	13.5
Thickness of the shell	9.5	8.9	8.0

Remarks: This species is characteristic in its globose outline and inflated form with plications on frontal part. This species much resembles to *Terebratuloides davidsoni* WAAGEN in its outline, but internal structures distinguish them. This species is identical to *Camarophoria nucula* SCHELLWIEN described from Trogkofelschichten of the Carnian Alps in its globose form and internal structures. They are rather grouped in Genus *Wellerella* DUNBAR and CONDRA on its slender beak and frontal plications.



Fig. 1 Apical sections of *Wellerella nucula* (SCHELLWIEN)

Wellerella saxatilis (REED)

Pl. 4, figs. 8-15.

- 1931 *Camarophoria nucula* var. *saxatilis* REED. New Fossils from the Productus Limestone of the Salt Range, with Notes on other species. pp. 35-36, Pl. VI, figs. 1-2, Pal. Indica, N.S., Vol. XVII.
- 1933 *Pugnax pseudoutah* HUANG. Late Permian Brachiopoda of Southwestern China, Pt. II, pp. 64-66, Pl. X, figs. 1-8, Pal. Sinica, Ser. B, Vol. 9, fasc. 2.
- 1944 *Pugnax (Wellerella) saxatilis*, REED. Brachiopoda and Mollusca from the Productus Limestone of the Salt Range, p. 123, Pl. XXII, figs. 2-3, Pal. Indica, N.S., Vol. XXIII, No. 2.

Outline of this species is suboval with extended lateral wings, or in other words, it is more exact, subpentagonal. The shell is slightly wider than long. Ventral valve is not so convex, with a median sinus in the anterior portion. Brachial dorsal valve is much convex with a median fold marked by three plications. Two lateral wings are rather extended and much curved towards ventral side. Plications are not developed, especially in posterior part, but somewhat distinct to the anterior part of the shell.

The ventral valve is only feebly convex and smooth near umbonal part. From middle part, the median portion abruptly curved to dorsal side and forms at the front a subrectangular lobe with the frontal part of the opposite valve. The somewhat extended lateral wings considerably bend up towards ventral side. Two distinct but low plications occur in sinus and develop near frontal margin. They are rather round topped and separated by sharp but very narrow valleys. One or two short plications are observable on each lateral wings, but they are rather indistinct.

The dorsal valve is intensively convex, especially its transverse profile forms more greater curvature. As same in the ventral valve, the surface is

smooth in the anterior part. In the postrior half of the shell, on the prominent median fold, three angular but narrow plications occur and separated by very narrow valleys, which correspond to the two plications in the median sinus of the other valve. Two very low and obscure plications are found on each lateral wings. No minute ornamentations of the shell surface is observable.

Internally in the ventral valve, two subparallel dental plates are developed. In the dorsal valve, hinge plates meet in the middle and form a very narrow spondilium and elevated. One sharp but thin median septum supports the hinge plate.

Measurements of the specimens are as follows: (in mm.)

Length of the shell	14.0	12.0
Width of the shell	13.0	12.6
Thickness of the shell	8.5	9.8

Remarks: Specimens in hand are very similar to *Pugnax pseudoutah* HUANG from the Loping Series of Southwestern China, in their outline, forms of both valves and surface plications. They also resemble to *Camarophoria nucula* var. *saxatilis* (REED) from the Productus Limestone of the Salt Range in same characters. Reed had identified the two species as the same and included them as *Pugnax (Wellerella) saxatilis*. In Huang's spesies, the internal structure of the cotype is not known, and only two dental plates are observed below the beak of the ventral valve. For the situation, the HUANG's species is tentatively identical to this species. Our specimens has the internal structures as enough to identify it as *Wellerella*.

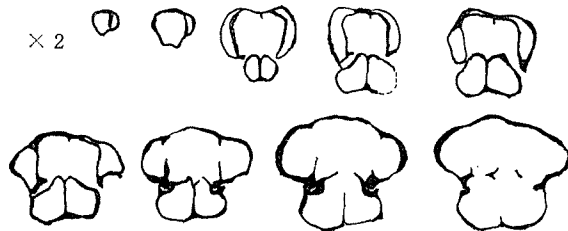


Fig. 2 Apical sections of *Wellerella saxatilis* (REED)

Wellerella sp. A

Pl. 4, figs. 16-18.

Outline of this species is pentagonal oval, wider than long, with moderately inflated both valves and covered with strong angular ribs.

The ventral valve is very vaulted, nearly flat, but from the middle curvature becomes more strong forming a median sinus. Laterally, the middle

part of this valve shows almost flat or slightly warped with extended both lateral wings. The beak is not pointed, well bent over and thick. In the sinus two strong and angular ribs commences at a distance from the beak and end frontal margin.

The dorsal valve is considerably convex in both lateral and longitudinal directions, but it is rather slightly curved in longitudinal direction. It is resulted by a high median fold corresponding a sinus of the opposite valve. Angular ribs on the shell surface is found three on the fold and also rather wings.

Internally, a strong median septum of dorsal valve and weak two dental paltes in the ventral valve are shown in the specimens.

Measurements of this species are as follows: (in mm.)

Length of the shell	11.7	12.7	13.?
Width of the shell	13.9	16.?	15.6
Thickness of the shell	6.4	6.8	6.7

Remarks: This species resembles to *Terepratuloidea minor* WAAGEN in its outline and external features, but internal structures distinguish it from the WAAGEN's species. This species is somewhat similar *Wellerella saxatilis* (REED) described above, but this species is less inflated and possesses wider wings than the REED's species.

Wellerella sp. B

Pl. 4, fig. 19; Pl. 5, figs. 1-6.

This species is characterized by laterally extended triangular outline with inflated both valves, and considerably wider than long. Strong ribs cover the frontal margin of both valves.

Ventral valve is considerably curved in longitudinal direction, but laterally its curvature is rather flat. A wide and round sinus occurs at the middle of the valve and becomes more wider to the frontal margin. It forms at the front a subrectangular lobe with the frontal part of the opposite valve, and also with both lateral wings. Three round and low ribs occur in the sinus, they are rather obvious in the middle of the shell and almost obsolete near beak.

Dorsal valve is considerably curved in both lateral and longitudinal directions, especially it curves more strongly and regularly in longitudinal direction. Laterally its curvature is regular in the middle part and then steeply curves down towards both lateral wings in rather straight line. Consequently, a remarkable fold occurs in anterior half. Four or three round ribs cover the fold, they commence from the middle part and most strong on the frontal margin. They are round topped and separated by rather wide round valleys. Two weak ribs found on lateral wings. Shoulder is

slender and almost straight and forms a triangular shape of the shell, with a plane formed by frontal margins of the fold and both wings.

Internally, a median septum are found in the anterior part of the dorsal valve and also two diverging sharp dental plates in the apical part of the ventral valve.

Measurements of this species are as follows (in mm.):

Length of the shell	12.5	10.5
Width of the shell	17.0	15.7
Thickness of the shell	8.0	6.5

Remarks: This species is characterized by its subtriangular outline with extended lateral wings. This species is confirmable with *Wellerella saxatilis* (REED) described above, but our species is distinguished from the latter by its outline, extended wings and rather thin shell form. Beak of this species is also not so prominent as the REED's species. *Wellerella nucula* (SCHELLWIEN) is so much inflated rather than above two species. These species are not so different, but their outlines are somewhat variable each other, then they may be originated from one group of *Wellerella*.

Dielasma nummulus WAAGEN

Pl. 5, figs. 13-15; fig. 25.

1883 *Dielasma nummulus* WAAGEN. Salt Range Fossils, Pal. Indica, Ser. XIII, Vol. I, pt. 4, p. 344, Pl. XXV, fig. 9.

1933 *Dielasma* cf. *nummulus*, HUANG. Late Permian Brachiopoda of Southwestern China, Pt. II, Pal. Sinica, Ser. B, Vol. IX, fasc. 2, pp. 82-83, Pl. XI, figs. 6-7.

General outline of this species is nearly circular, a very little elongated with somewhat prominent beak. The frontal end has a short straight line in the middle and makes appear a somewhat pentagonal appearance to the whole outline. Both valves are slightly inflated, the ventral one is rather much inflated than the other.

The ventral valve is regularly vaulted longitudinally and also curves transversely. The curvature is rather strong transversely. The curve is rather abrupt from the end of the beak to about the upper one thirds of the valve, and from there it gradually tapering to the frontal line. The beak is rather pointed and somewhat bent over the hinge line, which is hardly observable. The area of this valve is separated from the lateral parts of the shell by indistinct and round ridges which diverges from the pointed umbo. For the ill preservation of this part, the minute structure is not observable.

The dorsal valve is more flattened than the opposite valve and is nearly quite circular in its outline. The apex is not clearly preserved. This valve is almost flat on almost part of the middle, with somewhat vaulted marginal

parts. Its curve is rather abrupt on both soulders, on the other, frontal marginal end forms flattened slope, which spread a little beyond the comisure line and seems to be sinus-like broadning.

The line in which the two valves meet is nearly straight all round the valve, except a small part of the frontal end.

The surface of the shell is entirely smooth, and no minute striations are observed. No internal structures can be seen.

Measurements of this species are as follows (in mm.):

Length of the shell	18.5
Length of the dorsal valve	15.5
Breadth of the valve	14.5
Thickness of both valves	8.5

Remarks: This species somewhat resembles to *Dielasma elongatum* SCHLOTHEIM in shape, but distinguished from it by more circular outline and almost obsolete sinus on the dorsal valve. The outline of this species is much similar to that of *Dielasma nummulus* WAAGEN from the middle Productus Limestone of the Salt Range. This species has somewhat tapered and less bent beak than the WAAGEN's species. On these respects, this species belongs to WAAGEN's species. *Dielasma bekhensis* TSCHERNYSHEV is comparable with this species on circular outline and somewhat prominent beak, but its much inflated shape distinguishes it from this species. *Dielasma ellipticum* is also distinguished from this species by its more inflated form and less prominent beak.

Dielasma cf. *biplex* WAAGEN

Pl. 5. figs. 16-18.

cf. 1882 *Dielasma biplex* WAAGEN. Productus Limestone Fossils, Pal. Indica, Ser. XIII, Vol. I, Pt. 4, pp. 349-351, Pl. XXV, fig. 3.

This species is presented by one ill-preserved specimen. Its general shape is somewhat pentagonal or elliptical in outline. It is eleongated longitudinally. This species is characterised by strongly inflated ventral valve and distinct two folds on the dorsal valve, and corresponding one fold on the opposite valve.

The ventral valve is regularly arched in the longitudinal direction, and also strongly curved in the transverse direction. But the frontal marginal part is somewhat flattened and makes a straight frontal line. Laterally the valve is strongly arched, but not so regular. Near the unbo, lateral sides of this valve strongly curve forming a large triangular area, but it is not so distinctly marked from the other part of the valve. The beak is not long, tolerably thick and distinctly bent over. It is pierced by a rather large foramen. On the marginal part, a low fold is hardly observed, but it is

rather obscure for ill-preservation of the shell.

The dorsal valve is nearly quite straight in longitudinal direction, and only slightly vaulted at umbonal and frontal parts. It is strongly bent transversely, especially on lateral two margins and almost part of the middle is rather flat or excavated. From apex two straight and rather round fold commence and diverge towards front and becomes more broad and low near marginal front line. Between these two folds exists a shallow and broad sinus, which is rather deep in the middle and becomes rather shallow on the margin, forming an slightly arched frontal line.

The internal structure of this species is not known.

Measurements of this species are as follows (in mm.):

Length of the shell	17.8
Length of the dorsal vave	16.0
Breadth of the shell	16.0 ?
Thickness of the shell	9.3

Remarks: This specimen in hand is ill-preserved, especially on its lateral side is broken, but general outline of ths shell is comparable to WAAGEN's *Dielasma biplex* from the middle Productus Limestone of the Salt Range. Two straight folds on the dorsal valve and corresponding one fold on the opposite valve are very remarkably represent specific characters. In our specimen, fold of the ventral valve is indistinct than those of original ones, but Indina species has many variations in form and some of them has rather indisinct fold on the ventral valve. In respect to the general outline, our specimen most resembles to WAAGEN's rather short specimen (Pl. XXV, fig. 3).

Athyris subtriangularis (REED)

Pl. 5, figs. 7-12.

1927 *Composita (Spirigerella) subtriangularis* REED. Palaeozoic and Mesozoic Possils from Yunnan, Pal. Indica, N. S., Vol. X, No. 1, p. 103, Pl. xvi, fig. 4.

1933 *Athyris subtriangularis*, HUANG. Late Permian Brachiopoda of Southwestern China, Pt. II, p. 74, Pl. X, figs. 25-26.

This species is subtriangular in outline and widest anteriorly. Both valves are slightly and nearly equarly inflated.

The ventral valve is convex and regularly curved in both directions, and somewhat flattened anteriorly with very weak traces of swollen median groove, but not marginally sinuated. The flattened end makes the shell appears subpentagonal outline. Beak is rather inflated but slender, somewhat prominent and not noticeably incurved. A median sinus is entirely absent.

The dorsal valve is slightly transverse than the ventral valve. It is regularly and equally convex both in the longitudinal and the transverse directions. The beak is low, small and partially concealed by the ventral

valve. A median fold is not developed. The surface characters are not shown for their ill-preservation.

Internally, the ventral valve possesses with sub-parallel dental plates. Interior of the dorsal valve with low median ridge.

Measurements of the speices are as follows (in mm.):

Length of the shell	7.4	7.3	7.9
Length of the dorsal valve	6.7	6.8	7.4
Width of the shell	6.8	6.7	6.9
Thickness of the shell	4.5	4.6	5.2



Fig. 3 Apical sections of *Athyris subtriangularis* (REED)

Remarks: This species is closely similar with *Composita (Spirigerella) subtriangularis* REED from the Permo-Carboniferous of Yunnan. They are identified as the same species by their outline, curvature and internal structure. Present species has a flattened part on anterior end of the ventral valve, and it makes an arched frontal line. Chinese specimen described by HUNG from the Upper Permian has more larger size than our and original specimens. The outline of this species somewhat resembles to that of *Athyris subtilia* HALL, but is distinguished from the latter by its more inflated both valves.

Athyris sp.

Pl. 5, figs. 19-24.

Outline of this species is elongate triangular and somewhat rounded, longer than wide. The valves are not much inflated and very little different in size, the dorsal one is smaller.

The ventral valve is slightly larger than the dorsal one with rather elongated, thick and round beak. Longitudinally it is strongly vaulted in the apical region, but it curves regularly almost part of the shell, and steeply bent down near the frontal line. Transversely, the curve ascends rather rapidly from the margin of the valve, but it forms a flattening in the middle of the shell. No sinus nor sulcus is found clearly. The beak is strongly bent down on the opposite valve and areal part is concealed by it. The front line bends up towards the dorsal side, forming an arch of line, but it not forms any sinus nor sulcus in the margin.

The dorsal valve is smaller than the ventral valve, with sub-elliptical or sub-triangular outline and widest anteriorly. This valve is regularly and

almost equally inflated as the opposite valve. Longitudinally, the curve is very strong in the apical region, and somewhat flattened towards the front. Transversely the curve is regular. The apex is not prominent and very strongly bent over and so, no areal part is observed.

On the both valves of this species, no minute characters is preserved. Internal structures are also not observed.

Measurements of this species are as follows (in mm.):

Length of the shell	8.5	8.2
Length of the dorsal valve	8.1	7.0
Width of the shell	7.1	6.8
Thickness of the shell	4.9	5.3

Remarks: The outline of this species resembles to *Orthis insiciva* WAAGEN and the writer had tentatively compared them, but our species has more thick and round umbo than the WAAGEN's species. The present species is rather confirmable to *Athyris subtriangularis* REED or *Athyris subtilita* HALL, but distinguished from them by its elongated outline and thick and round umbo. Internal structures are not shown and the species is tentatively grouped in *Athyris*,

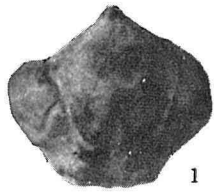
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Explanation of Plate 4

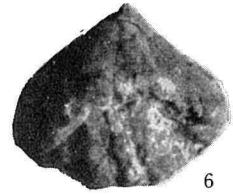
- Figs. 1-5. *Wellerella nucula* (SCHELLWIEN) $\times 2$
fig. 1 dorsal, fig. 2 ventral, fig. 3 lateral, fig. 4 frontal and fig. 5 apical views.
- Figs. 6-7. *Wellerella nucula* (SCHELLWIEN) $\times 2$
fig. 6 dorsal and fig. 7 ventral views.
- Figs. 8-12. *Wellerella saxatilis* (REED) $\times 2$
fig. 8 ventral, fig. 9 dorsal, fig. 10 lateral, fig. 11 frontal and fig. 12 apical views.
- Figs. 13-15. *Wellerella saxatilis* (REED) $\times 2$
fig. 13 dorsal, fig. 14 ventral and fig. 15 apical views.
- Figs. 16-18. *Wellerella* sp. A $\times 2$
fig. 16 lateral, fig. 17 dorsal and fig. 18 ventral views.
- Fig. 19. *Wellerella* sp. B $\times 2$
frontal view.



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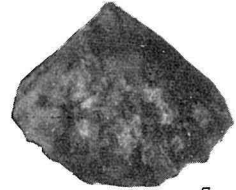
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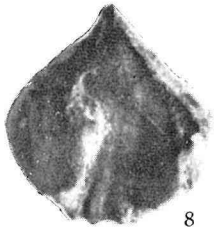
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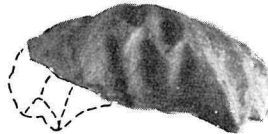
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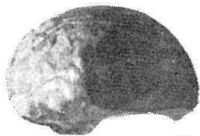
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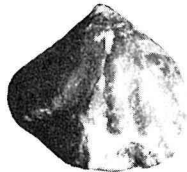
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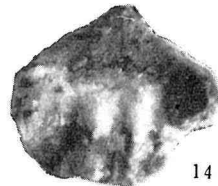
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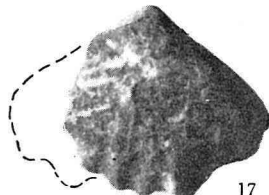
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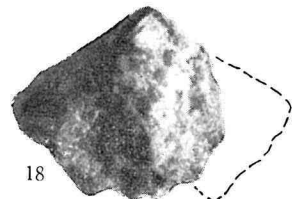
14



16



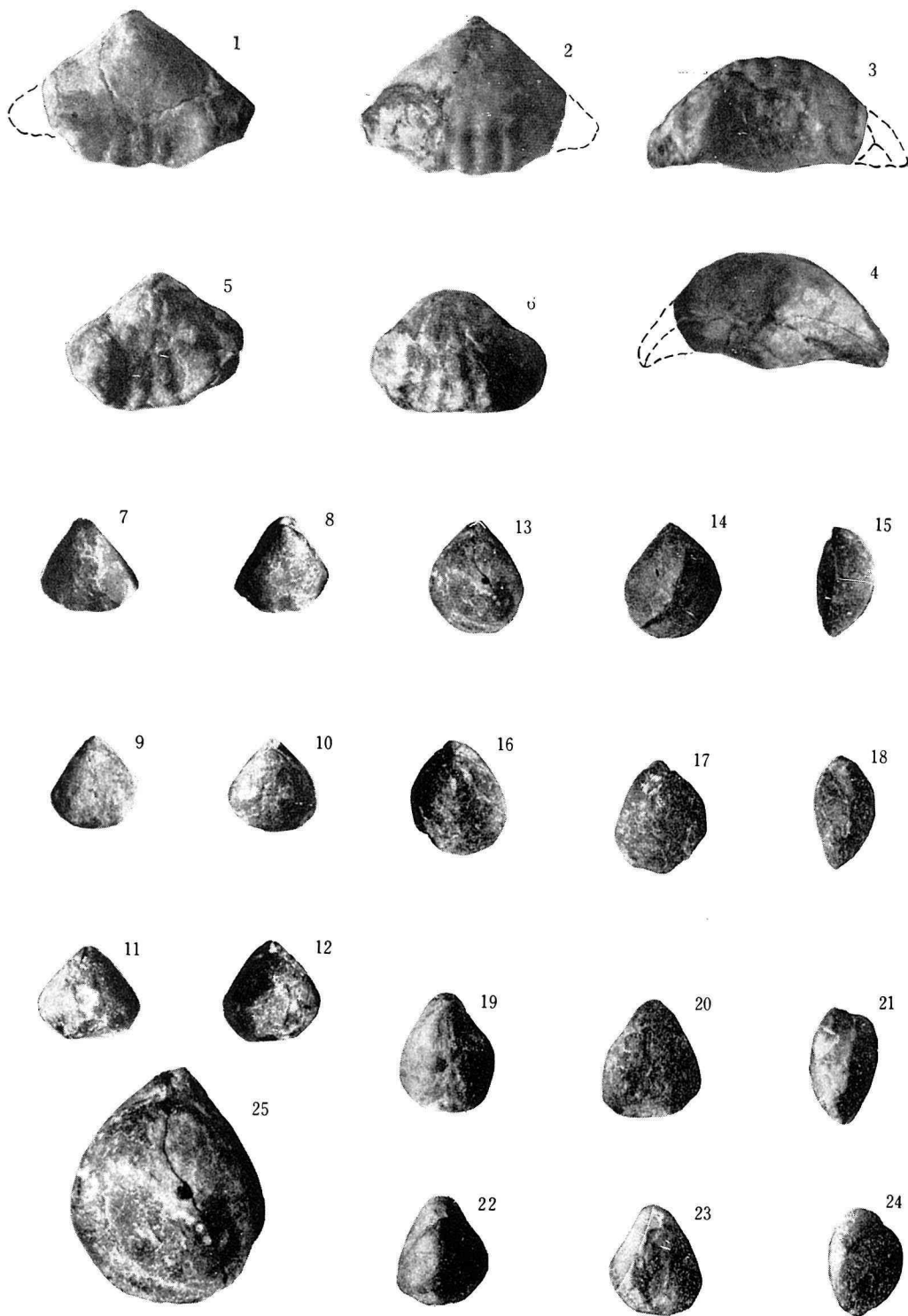
17



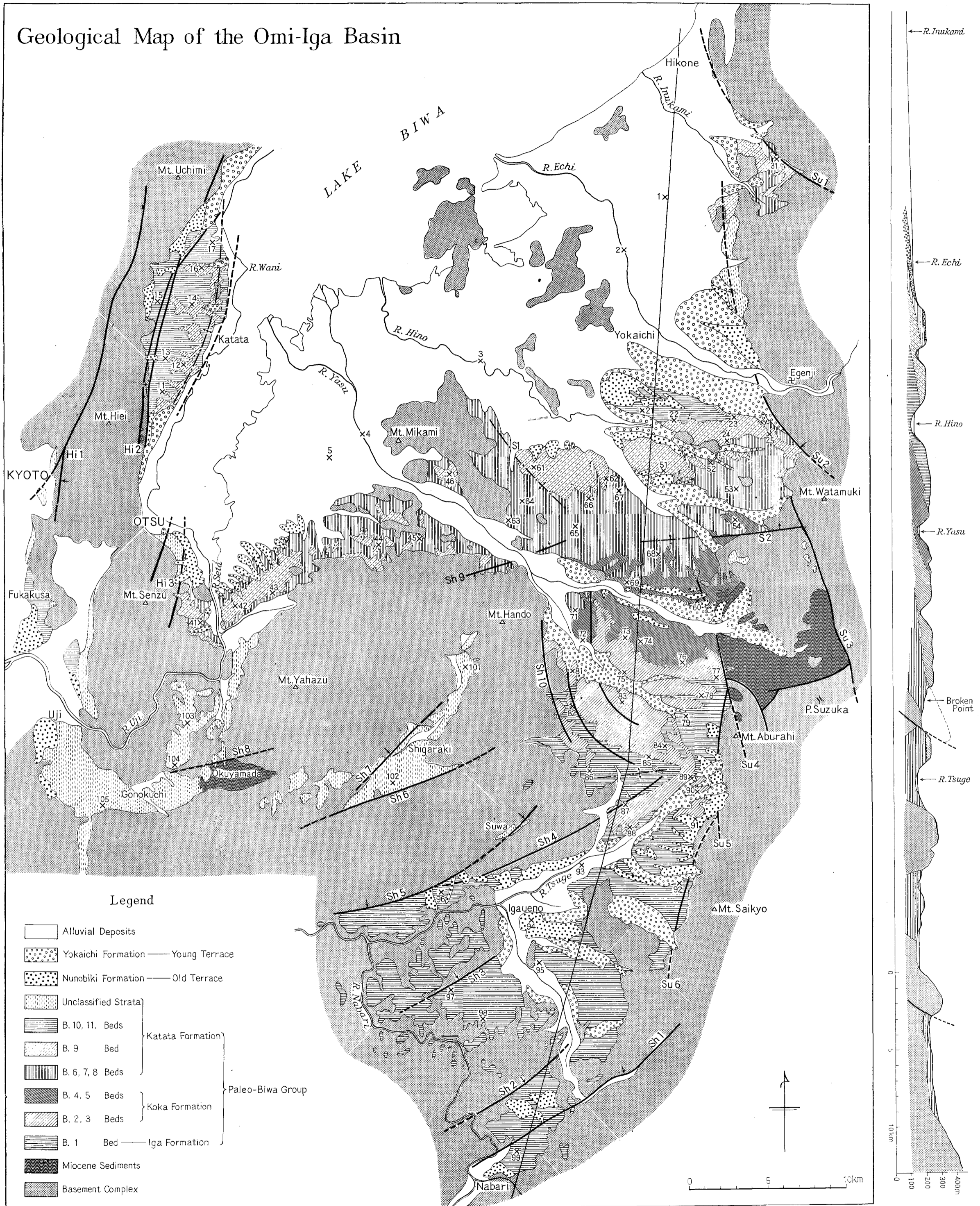
18

Explanation of Plate 5

- Figs. 1-4. *Wellerella* sp. B $\times 2$
fig. 1 ventral, fig. 2 dorsal fig. 3 frontal and fig. 4 apical views.
- Figs. 5-6. *Wellerella* sp. B $\times 2$
fig. 5 ventral and fig. 6 dorsal views.
- Figs. 7-8. *Athyris subtriangularis* (REED) $\times 2$
fig. 7 ventral and fig. 8 dorsal views.
- Figs. 9-10. *Athyris subtriangularis* (REED) $\times 2$
fig. 9 ventral and fig. 10 dorsal views.
- Figs. 11-12. *Athyris subtriangularis* (REED) $\times 2$
fig. 11 ventral and fig. 12 dorsal views.
- Figs. 13-15. *Dielasma nummulus* WAAGEN $\times 1$
fig. 13 dorsal, fig. 14 ventral and fig. 15 lateral views.
- Figs. 16-18. *Dielasma* cf. *biplex* WAAGEN $\times 1$
fig. 16 dorsal, fig. 17 ventral and fig. 18 lateral views.
- Figs. 19-20. *Athyris* sp. $\times 2$
fig. 19 dorsal, fig. 20 ventral and fig. 21 lateral views.
- Figs. 22-24. *Athyris* sp.
fig. 22 dorsal, fig. 23 ventral and fig. 24 lateral views.
- Fig. 25. The same as Fig. 13 $\times 2$



Geological Map of the Omi-Iga Basin



Legend

- Alluvial Deposits
- ▨ Yokaichi Formation — Young Terrace
- ▩ Nunobiki Formation — Old Terrace
- ▧ Unclassified Strata
- ▦ B. 10, 11. Beds } Katata Formation
- ▥ B. 9 Bed } Katata Formation
- ▤ B. 6, 7, 8 Beds } Katata Formation
- ▣ B. 4, 5 Beds } Koka Formation
- ▢ B. 2, 3 Beds } Koka Formation
- B. 1 Bed — Iga Formation
- ▩ Miocene Sediments
- ▧ Basement Complex

Notice: For "Basement Complex" of the area to the southwest of Uji read "Alluvial Deposits".