

Silurian Brachiopods from the Kesen District of the Kitakami Mountainland, Northeast Japan

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The Silurian rocks in the Kesen district are made up of two members, an upper, which is named the Takainari, and a lower the Kawauchi and are unconformably overlain by the Lower Devonian Ono series (Onuki, 1938 and 1969).

All specimens of the Silurian brachiopods studied in this paper have been collected by the writer since 1966 from loose blocks of limestones on the slope of the eastern side of Kusayami-zawa, about 1.5 km. west of Choanji, Hikoroichi-machi, Ofunato City, Iwate Prefecture (Fig.1). The blocks are undoubtedly derived from the limestones of the Silurian Kawauchi series as shown in Pl. 6, fig. 12.

The Kawauchi series is consisted mainly of fossiliferous limestones intercalated with black slates and has so far been studied by many geologists and palaeontologists.

Especially Sugiyama (1940) described many species of corals and stromatoproids from the limestones of the Kawauchi series, and considered the faunas to be of Middle Silurian age.

Sugiyama classified the fossil horizons of the Kawauchi series in descending order as follows:

- 5 *Solenopora* limestone
- 4 *Encrinurus* bed
- 3 *Halysites* limestone
- 2 *Clathrodictyon* limestone
- 1 *Favosites* limestone

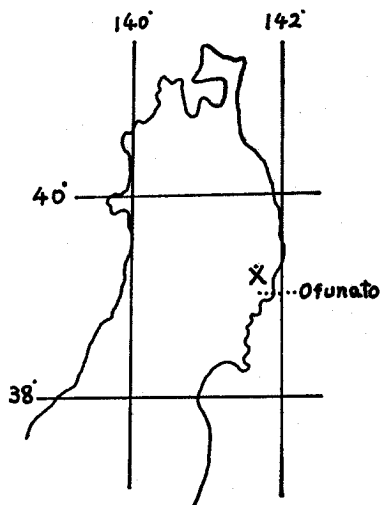


Fig. 1. × —Silurian brachiopod locality.

Of these fossil horizons the brachiopods from the Kawauchi series have not hitherto been studied excepted with two brachiopods, namely *Pentamerus* ? sp. indet. and *Plectambonites* ? sp. indet., listed by Sugiyama from the lower part of *Encrinurus* bed. Although these brachiopods were not described in his paper, *Plectambonites* ? sp. indet. seems to be probably related to *Aegiria sugiyamai* n. sp. in this paper. Accordingly the horizon of the brachiopods described in the present study may be assigned to the lower part of Sugiyama's *Encrinurus* bed.

On the other hand, Hamada (1958 and 1961) referred the age of the Kawauchi series to the Middle ? to Upper Silurian on the basis of the presence of *Schedohalysites kitakamiensis* (Sugiyama), *Falsicatenipora japonica* (Sugiyama) and *Encrinurus kitakamiensis* Sugiyama.

Concerning the stratigraphy of Kawauchi series, it has generally been regarded to be intruded by the Hikami granites since Onuki's study. However recently Murata and others (1974 and 1975) state that a part of the Hikami granites is rather unconformably overlain by arkose sandstones of the basal part of the Kawauchi. In addition they separated the Takainari series as distinct from the Silurian, and placed it in the lowest part of the Lower Devonian Ono series.

Although the Takainari series is generally baren of fossils, it is characterized by purple to reddish slates and tuffs, and considerably contains boulders and pebbles of granites evidently derived from the underlying Hikami granites.

In this paper the writer considers unconformable relationships between the Takainari series and the Kawauchi. The stratigraphic succession of these rocks in Kusayami-zawa is shown in Fig. 2.

The following brachiopods have been identified in the Silurian limestones of the Kawauchi series.

Skenidioides kitakamiensis n. sp.

Salopina onukii n. sp.

Aegiria sugiyamai n. sp.

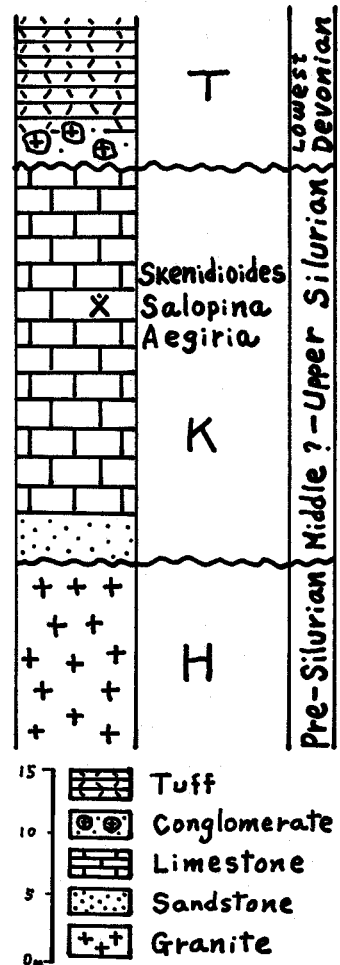


Fig. 2. Stratigraphic sequence through the Silurian Kawauchi series in Kusayami-zawa. T—Takainari series. K—Kawauchi series. H—Hikami granite.

The list is not complete, and the collection contains other brachiopods which have not yet been determined. The ranges of three genera, *Skenidioides*, *Salopina* and *Aegiria* within the Kawauchi series are shown in Fig. 3. The fossil content of

	Ordovician	Silurian			Devonian		
		Lower	Middle	Upper	Lower	Middle	Upper
<i>Skenidioides</i>		—————					
<i>Salopina</i>		—————			—————		
<i>Aegiria</i>		—————					

Fig.3. Ranges of the genera of *Skenidioides*, *Salopina* and *Aegiria* in the Silurian Kawauchi series.

the brachiopods is of Silurian age and seems to probably indicate the Upper Silurian as stated by Kobayashi and Hamada (1974).

Most specimens in the collections studied by the writer are usually silicified, but specimens contained in the black slates are preserved as internal and external moulds.

The specimens are distorted in some degree in shape, size and convexity of the valves as in the Palaeozoic fossils of the Kitakami Mountainland, and this deformation of the fossils has been considered to be due to the Oshima orogenic movement of Lower Cretaceous age.

All figures in the Plates 1-7 were photographed by the writer. .

DESCRIPTION OF SPECIES

Superfamily ORTHACEA Woodward, 1852

Family SKENIDIIDAE Kozłowski, 1929

Genus *Skenidioides* Schuchert & Cooper, 1931

Skenidioides kitakamiensis Tachibana, n. sp.

Pl. 1, figs. 1-21

Exterior: The shell is small and subpyramidal in shape. A hinge line is straight, usually being slightly shorter than the greatest width situated at the middle of the shell. The surface of both valves is marked by rounded, coarse radiating costellae which increase by intercalation toward the front. 20 to 25 costellae separated by narrow grooves are counted at the periphery of the shell. Concentric growth lines are frequently visible on the entire surface of the shell. The pedicle valve is somewhat deeper than the brachial one with a high convexity along the median line of the shell, but it rarely bears a very faint median depression at the frontal margin as seen in the specimen illustrated in Pl. 1. fig.13. The brachial valve is characterized by a broad, shallow, distinct median sulcus.

The pedicle interarea is almost catacline, considerably high, flattish but slightly concave. The delthyrium is long and open, including an angle of about 20°. The brachial interarea is low, flat and anacline, being divided by a short, open notothyrium, in which a cardinal process is partly observed from the valve exterior.

Interior of pedicle valve: The pedicle valve is characterized by the presence of a spondylium. The delthyrium is filled by the long, broad spondylium in mature specimens, but in young specimens the spondylium is short, being observed only in an upper part of the delthyrium. The spondylium is apically fused to the valve floor uniting with a posterior part of the low, broad median ridge which extends at the middle of the shell, and its anterior edge is free from the valve. The teeth occur at the corners of the delthyrium and are small but strong. Internal costellae corresponding to external grooves are preserved on the lateral and anterior margins in young specimens, but in mature specimens the internal surface tends to be smooth.

Interior of brachial valve: A simple, thin, linear cardinal process joins anteriorly with an elevated and thick median septum which extends almost to the anterior margin with a maximum height at about the middle of the shell. The long and slightly divergent brachiophores have pointed extremities and are supported by two transversely striated concave plates which form a cruralium and unite with a posterior extremity of the median septum. The dental sockets on the outside of the brachiophores are small and shallow, but are well defined by fulcral plates. The brachial adductor scars are scarcely observed on either side of the median septum (Pl.1, fig.19). The lateral and anterior margins are ornamented in a manner similar to that of the opposite valve.

Dimensions (in mm.)	Length	Width
Conjoined valves, holotype, (Pl. 1, figs. 1-3)	6	6
Pedicle valve (Pl. 1, figs.12-13)	5	4
Brachial valve (Pl. 1, figs. 14-15)	3.5	4.5

Remarks: The specimens are generally distorted in some degree, but *Skenidioides kitakamiensis* resembles *Skenidioides lewisi* (Davidson) from the Wenlockian of the Europe, from which the Japanese species is discriminated by having a low, broad median ridge in the pedicle interior and by differences in shape and ornamentation.

Superfamily ENTELETACEA Waagen, 1884
 Family SCHIZOPHORIIDAE Schuchert & Le Vene, 1929
 Subfamily DRABOVIINAE Havlíček, 1950
 Genus *Salopina* Boucot, 1960
Salopina onukii Tachibana, n. sp.

Pl. 1, figs. 22-26; Pl. 2, figs. 1-23; Pl. 3, figs. 1-20; Pl. 4, figs. 1-23; Pl. 6, figs. 1-2,
7-11; Pl. 7, figs. 1-2; Text-figs. 4a-g.

Exterior: The shell is relatively small and subequally biconvex. The shape and lateral profile of the specimens are considerably variable. The profiles of the specimens are shown in Fig. 4. In the slightly depressed specimens of Pl. 7, figs. 1-2

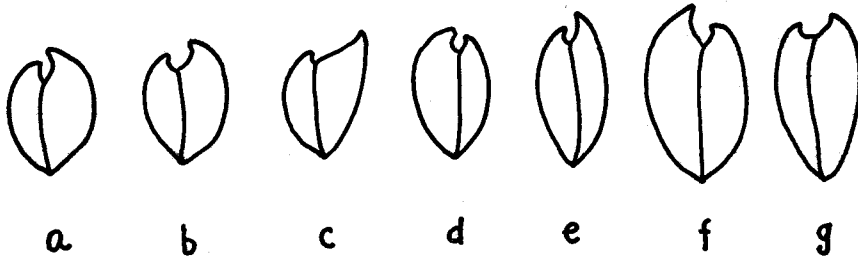


Fig. 4a-g. *Salopina onukii*, n. sp.; Profiles of specimens illustrated in Plates
2-3. $\times 3.3$

and Pl. 2, figs. 21-22, the length exceeds the width. But this species is generally subcircular to transversely sub-elliptical in outline. The hinge line is straight and is generally equal to about three fifths of the maximum width which is near the mid-length of the shell. Cardinal angles are somewhat obtuse and the anterolateral margins are generally rounded. The radial ornament consists mainly of characteristic hollow costellae (Pl. 6, figs. 1-2; Pl. 7, fig. 1), which are relatively coarse and increase in number and size anteriorly by intercalation and by bifurcation. The number of the costellae is about 40 at the anterior and lateral margins of the shell. The costellae are crossed by closely to coarsely spaced growth lines. The pedicle valve is generally slightly more convex than the brachial valve with the maximum elevation along the mid-line of the valve. Although the brachial valve bears a variably developed sulcus between individuals, it is usually gently to faintly sulcate, being broadly defined on the anterior portion of the valve. Occasionally the brachial valve flattens out over the central and anterior portions of the valve, and it is rarely almost nonsulcate in some specimens. The pedicle interarea is generally rather high, either flat or slightly concave and apsacline, being usually longer than the brachial one. Although one specimen of this species illustrated in Pl. 2, figs. 10-12 bears a somewhat higher brachial interarea, in most shells the brachial interarea generally is very low, flat, sometimes weakly concave and anacline. The pedicle beak is small, slightly pointed, being somewhat incurved in some specimens. The delthyrium and notothyrium are open.

Interior of pedicle valve: The deep delthyrial cavity is bounded laterally by short, medially concave dental lamellae extending anteriorly as low muscle bounding ridges. The elongate muscle area extending to about one third of the

shell length is consisted mainly of two narrow, expanding diductor scars, being anteriorly divided by a low, broad, distinct median raised area which becomes wider anteriorly and extends almost to the anterior margin. Adductor scars are generally not seen in the muscle area of our specimens. The triangular teeth are small, thick and slightly projected, being supported by dental lamellae. A small plate frequently occurs inside the apex of the delthyrium. The lateral cavities are small but deep. The anterior half of the internal surface is crenulated by the impress of the external costellae. The vascular markings are occasionally preserved in the pedicle interior (Pl.7, fig.2).

Interior of brachial valve: The adductor muscle area is subquadrate and extends anteriorly a half to three-quarters of the valve length. It is distinctly encircled by slightly elongate raised peripheral ridges and is divided into posterior and anterior adductors by a faint transverse ridge normal to oblique to a median ridge. The posterior adductors are usually smaller than the anterior adductors. The low and broad median ridge is somewhat variably developed, and especially varies in length and width. However it generally extends anteriorly from the delthyrial cavity to mid-point to three-quarters of the valve. It is frequently long, and reaches occasionally near the anterior margin. The anteriorly divergent brachiophores are strong and relatively long, with pointed extremities. A simple cardinal process with a fairly long shaft is present between the base of the brachiophores and is revealed in the open notothyrium from the valve exterior. Deep dental sockets are laterally bounded by low fulcral plates and by brachiophore.

Dimensions (in mm.)		Length	Width
Conjoined valves	(Pl.1, figs. 22-26)	5	5
Conjoined valves, holotype	(Pl.2, figs.1-5)	5	6
Conjoined valves	(Pl.2, figs. 13-15)	7	6
Conjoined valves	(Pl.2, figs. 16-20)	5	5

Remarks: Although there is considerable variation between the numerous specimens collected from one locality in pedicle interarea, shape, lateral profile and size, this is probably variation within a single species. The specimens of *Salopina onukii* are generally characterized by a small-sized shell and coarse costellae, and they are different from other salopinids in having a small plate in the apex of the delthyrium and the distinct median raised area in the pedicle valve, and in having the relatively long adductor muscle area surrounded by the distinctly raised peripheral ridges, broad and relatively long median ridge, long and pointed brachiophores in the brachial valve.

Salopina onukii most closely resembles *Salopina tubulata* (Lindström) from the Ludolovian of Gotland in having a relatively small-sized shell and coarse costellae. But a raised median area in the pedicle interior is very faint in *Salopina tubulata* and a median ridge and raised peripheral ridges bounding adductor muscle

field are not developed in the brachial valve of the latter species.

In the writer's collections this species occurs relatively commonly in the limestones of the Kawauchi series.

The species is named from Dr. Y. Onuki who first discovered the Silurian rocks from the Kitakami mountainland in Japan.

Superfamily PLECTAMBONITACEA Jones, 1928

Family SOWERBYELLIDAE Öpik, 1930

Subfamily AEGIROMENINAE Havlíček, 1961

Genus *Aegiria* Öpik, 1933

Aegiria sugiyamai Tachibana, n. sp.

Pl. 5, figs. 1-24; Pl.6, figs.3-6; Pl.7, fig.3; Text-figs. 5-8.

1940 *Plectambonites* ? sp. indet.; T.Sugiyama, p.90.

Exterior: Most of the available specimens of this species are transversely semicircular in outline, and have the greatest width at the hinge line, being concavo-convex in lateral profile. Cardinal extremities are generally at right angles, but they are occasionally alate. The valve surface is ornamented by parvicostellae. There are 6-7 primary costellae on the surface of both valves and equally to subequally fine costellae bearing an average of 4 costellae per mm. are inserted between the coarser primary costellae near the anterior margin. The pedicle interarea is apsacline, and is relatively low, nearly flat, very broadly equilaterally triangular in outline, being higher than the brachial one which is linear, flat and anacline. The pedicle valve is usually deeply convex, with a maximum convexity at the middle. The brachial valve is moderately to gently concave. The short triangular delthyrium in the pedicle valve is open anteriorly, but it is

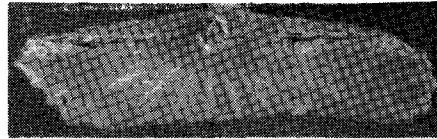


Fig.5. *Aegiria sugiyamai* n. sp. ;
Enlargement of Pl.5, fig.22,
showing interareas and pseudo-
deltidium. $\times 8$

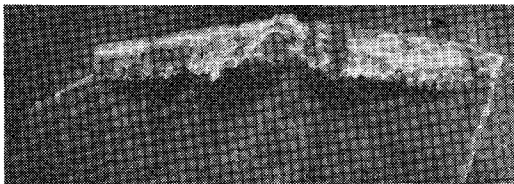


Fig.6. *Aegiria sugiyamai* n. sp. ; Enlargement
of Pl.6, fig.5, showing pseudodeltidium
and hinge. $\times 8$

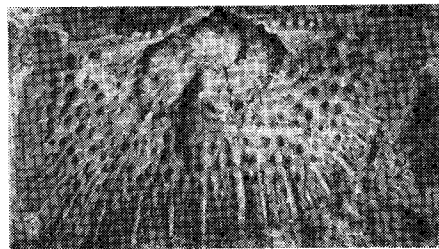


Fig.7. *Aegiria sugiyamai* n. sp. ; Enlar-
gement of Pl.5, fig.1, showing
lophophore platform and hinge. $\times 8$

apically to completely closed by a distinctly medianly arched pseudodeltidium. The hingeline of both valves seems to be denticulated (Fig.6 and Fig.7). The concentric marking is not almost observable in the specimens.

Interior of pedicle valve: The widely divergent dental lamellae are short but strong, merging anteriorly with the low muscle bounding ridges at the posterolateral part of the muscle scars. The deeply impressed muscle area is medially bisected by a strong median septum. In the delthyrial cavity a slightly protruded process from the valve floor is well preserved, and it bears a very deep hollow at its apex, and anteriorly continues the median septum having posteriorly medianly sulcate narrow groove. This process is surrounded by the teeth, dental lamellae, and pseudodeltidium. The posterior portion of the pedicle interior is shown in Fig. 8. The internal surface is marked by the external radial ornament of the

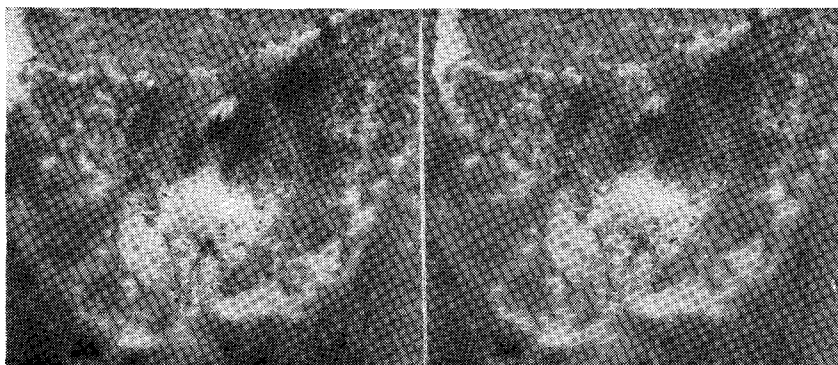


Fig.8. *Aegiria sugiyamai* n.sp.; Posterior portion of pedicle interior. $\times 8$

valve exterior, and furthermore somewhat closely arranged, short, strong pustules and endospines are radially or sporadically scattered over the posterior half of the interior surface.

Interior of brachial valve: A most characteristic feature is a lophophore platform which is distinctly elevated above the level of the interior surface of the brachial valve. The cardinal process is posteriorly projected from the hingeline and there is a deep, well developed alveolus anterior to the cardinal process. Socket plates along the posterolateral side of the lophophore platform are short and strong. The short median septum is very prominently high at the central portion of the valve interior, where the exterior of the brachial valve bears the greatest concavity, and the apex of the median septum is frequently pointed and sticks far into the pedicle interior. The internal surface is marked by the external radial ornament of the valve exterior, and the endospines and pustules are also distributed outside the lophophore platform in the brachial interior, and a few strong pustules are arranged also along the inside of the hinge line in some specimens.

Dimensions (in mm.)	Length	Width
Conjoined valves, holotype (Pl. 5, figs. 20-21)	4	7.5
Pedicle valve (Pl. 5, fig. 15)	4.5	6.5
Brachial valve (Pl. 5, fig. 1)	4	6
Brachial valve (Pl. 5, fig. 10)	6	8.5
Pedicle valve (Pl. 5, fig. 18)	4.5	7

Remarks: *Aegiria sugiyamai* seems to be comparatively common brachiopod associated with *Salopina onukii* in the Kawauchi series. Although this species was listed by Sugiyama as *Plectambonites* ? sp. indet. as stated above, it is distinctly different from *Plectambonites* on the internal structure of either valve. *Aegiria sugiyamai* is also different from *Aegiria thomasi* Talent from the Ludlovian of Australia in having a pronounced lophophore platform in the brachial valve. *Aegiria garthensis* (Jones) from the Llandovery of Wales closely resembles *Aegiria sugiyamai* in having a well defined lophophore platform, but John's species is represented by only two specimens of the brachial valve, and therefore a comparison upon the pedicle valve between the two species is impossible. According to Cock's description, the hinge line of the brachial valve in *Aegiria garthensis* is said to be smooth, but in *Aegiria sugiyamai* the denticulation along the hinge line seems to be recognized.

The species is named from Dr. T. Sugiyama who first described the Silurian Kawauchi fauna in the Kesen district.

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EXPLANATION OF PLATES

PLATE 1

All figures $\times 3,3$

Figures 1-21—*Skenidioides kitakamiensis* n. sp.

(1-3) Posterior, brachial and pedicle views of conjoined valves, holotype; (4) interior of pedicle valve showing interarea and spondylium; (5) interior of pedicle valve; (6) posterior view of pedicle interior showing high interarea and short spondylium; (7) posterior view of pedicle interior showing spondylium seen in the upper half of delthyrium; (8) exterior of pedicle valve showing radial ornament; (9) interior of pedicle valve showing spondylium and internal ornament; (10) posterior view of pedicle interior; (11) interior of pedicle valve showing spondylium; (12-13) interior and exterior of pedicle valve showing well developed spondylium and faint median depression near the external anterior margin; (14-15) interior of brachial valve and its posterior view showing cardinal process, cruralium, dental sockets, brachiophores and median septum; (16) interior of brachial valve showing two strong brachiophores, cruralium and median septum which is broken in this specimen; (17) brachial interior showing high median septum; (18) interior of brachial valve showing cruralium and median septum; (19) internal mould of brachial valve showing distinct median septum, dental sockets, cardinal process and adductor scars; (20) exterior of brachial valve showing median sulcus; (21) posterior view of brachial exterior showing slightly wider hinge line and median sulcus.

Figures 22-26—*Salopina onukii* n. sp.

(22-26) Pedicle, brachial, posterior, anterior and lateral views of conjoined valves showing median sulcus of brachial valve and coarse costellae.

PLATE 2

All figures $\times 3,3$

Figures 1-23—*Salopina onukii*, n. sp.

(1-5) Brachial, pedicle, posterior, anterior and lateral views of conjoined valves, holotype; (6-9) pedicle; brachial, posterior and lateral views of conjoined valves showing high pedicle interarea; (10-12) pedicle, lateral and posterior views showing relatively high brachial interarea; (13-15) pedicle, posterior and lateral views of slightly larger conjoined valves; (16-20) brachial, pedicle, posterior, anterior and lateral views of conjoined valves; (21-22) brachial and lateral views of slightly depressed conjoined valves; (23) brachial view of conjoined valves showing median sulcus in brachial valve.

PLATE 3

All figures $\times 3,3$

Figures 1-20—*Salopina onukii*, n. sp.

(1) Interior of brachial valve showing brachiophores, muscle bounding ridges and median ridge; (2) interior of brachial valve showing cardinal process, dental sockets, median and transverse ridges and muscle bounding ridge; (3) interior of pedicle valve showing high pedicle interarea; (4) interior of pedicle valve showing dental lamellae and median raised area; (5) interior of pedicle valve; (6) interior of pedicle valve showing dental lamellae and teeth; (7) interior of pedicle valve; (8) exterior of pedicle valve (fig.7); (9) interior of pedicle valve showing dental lamellae and teeth; (10) interior of pedicle valve; (11) interior of distorted pedicle valve showing dental lamellae; (12) interior of pedicle valve showing teeth, dental lamellae and median raised area; (13) interior of pedicle valve showing dental lamellae and median raised area; (14) interior of pedicle valve showing small plate in the apex of delthyrium; (15) interior of pedicle valve showing strong teeth; (16) interior pedicle valve showing dental lamellae; (17) interior of pedicle valve showing strong teeth; (18) interior of pedicle valve showing dental lamellae; (19) interior of pedicle showing small plate in the apex of delthyrium; (20) interior of pedicle valve showing teeth, dental lamellae and a small plate in the apex of delthyrium.

PLATE 4

All figures $\times 3,3$

Figures 1-23—*Salopina onukii*, n. sp.

(1) Interior of brachial valve showing two strong brachiophores, fulcral plates, dental sockets and muscle bounding ridges; (2) interior of brachial valve showing cardinal process and muscle bounding ridges; (3) interior of brachial valve showing brachiophores, cardinal process and muscle bounding ridges; (4) interior of brachial

valve showing fulcral plates, dental sockets and low, broad median ridge; (6) interior of brachial valve showing cardinal process, brachiophores and raised muscle bounding ridges; (7) interior of brachial valve showing brachiophores, transverse ridge and raised muscle bounding ridges; (8) interior of brachial valve showing cardinal process, raised muscle bounding ridges and brachiophores; (9) interior of brachial valve showing long brachiophores, median ridge and raised muscle bounding ridges; (10) interior of brachial valve showing long brachiophores, muscle bounding ridges and transverse ridge; (11) interior of brachial valve showing median ridge and muscle bounding ridges; (12) interior of brachial valve showing brachiophores, cardinal process, dental sockets, fulcral plates, median ridge and transverse ridge and muscle bounding ridges. Interior structure of this species is well represented in this specimen; (13) interior of brachial valve showing relatively long muscle area; (14) interior of brachial valve showing dental sockets, median ridge and muscle area; (15) interior of brachial valve showing long muscle area; (16) interior of brachial valve showing long brachiophores; (17) interior of brachial valve showing long muscle bounding ridges; (18) interior of brachial valve showing long muscle area and median ridge; (20) interior of brachial valve showing anterior adductor scars surrounded by raised muscle bounding ridges and long median ridge; (21) interior of brachial valve showing transverse ridge and adductor scars; (22) interior of brachial valve showing anterior adductor scars and median ridge; (23) interior of brachial valve showing long brachiophores and long muscle scars.

PLATE 5

All figures $\times 3,3$

Figures 1-24—*Aegiria sugiyamai*, n. sp.

(1) Internal mould of brachial valve showing lophophore platform, median septum and denticulate hinge; (2) brachial view of steinkern showing lophophore platform, socket plates and short median septum; (3) brachial view of steinkern showing lophophore platform and short median septum; (4) brachial view of steinkern; (5-6) external and internal views of brachial valve; (7) interior of brachial valve showing lophophore platform, alveolus and cardinal process; (8) interior of brachial valve showing strong socket plates, lophophore platform and pustules; (9) internal mould of brachial valve showing lophophore platform and short, high median septum; (10) internal mould of brachial valve showing short, high median septum, lophophore platform and internal ornament; (11-12) internal and external views of brachial valve; (13-14) external and internal views of pedicle valve; (15) internal mould of pedicle valve; (16) pedicle view of steinkern showing dental lamellae and muscle scars; (17) pedicle view of steinkern; (18) internal mould of pedicle valve; (19) external mould of brachial valve and interareas; (20) exterior of brachial valve and interareas; (21) exterior of pedicle valve (fig. 20); (22) exterior of brachial valve and interareas; (23) brachial view of conjoined valves; (24) posterior view of pedicle interior showing interarea and pseudodeltidium.

PLATE 6

Figures 1-2—*Salopina onukii*, n. sp.

(1) Enlargement of external ornament showing hollow costellae, $\times 8$; (2) enlargement of external ornament showing hollow costellae, $\times 12$.

Figures 3-6—*Aegiria sugiyamai*, n. sp. All figures $\times 3.3$

(3) Interior of brachial valve showing cardinal process, socket plates, alveolus, high median septum, endospines and pustules; (4) internal mould of brachial valve showing lophophore platform, high median septum and internal ornament; (5) part of interior of pedicle valve; (6) interior of pedicle valve.

Figures 7-11—*Salopina onukii*, n. sp. All figures $\times 3.3$

(7) Pedicle view of steinkern showing median raised area and dental lamellae; (8) brachial view of steinkern; (9) brachial view of steinkern showing cardinal process, brachiophores and muscle bounding ridges; (10) brachial view of steinkern showing cardinal process and muscle bounding ridges; (11) brachial view of steinkern showing raised muscle bounding ridges and median septum.

Figure 12—Outcrops of the Silurian Kawauchi series in Kusayami-zawa, Hikoroichi-machi, Ofunato City, Iwate Prefecture. T —Takainari series (Lowest Devonian) unconformably resting upon the Kawauchi series. K.— Kawauchi series (Middle ? to Upper Silurian) which is composed of fossiliferous limestone (lms) and basal sandstone (s.s). Gr.— Hikami granites (Pre-Silurian), which are unconformably overlain by the Kawauchi series. \times —fossil localities.

PLATE 7

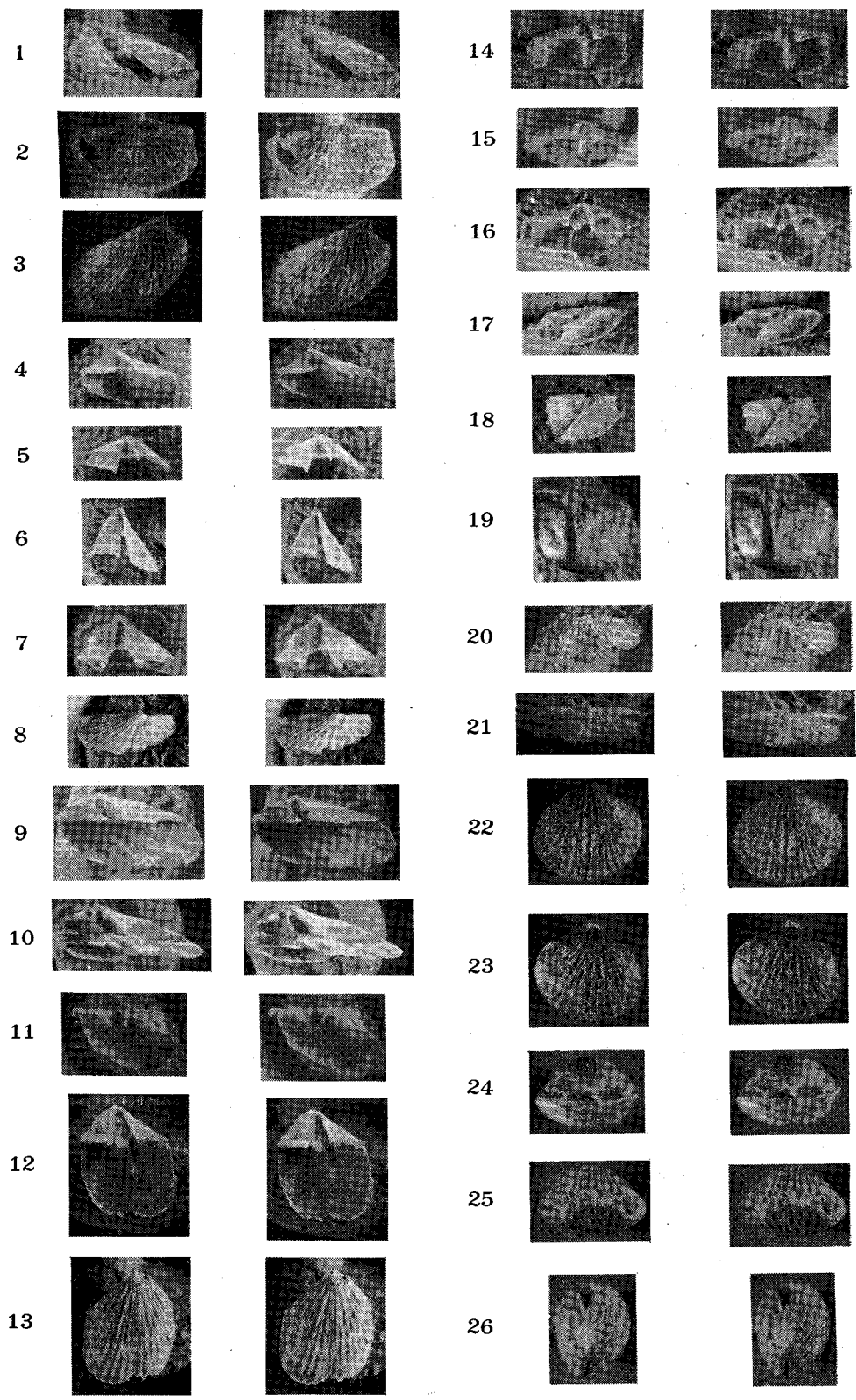
All figures $\times 8$

Figures 1-2 *Salopina onukii*, n. sp.

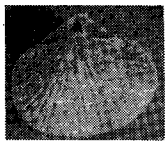
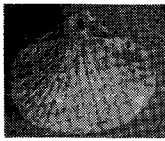
(1) Exterior of pedicle valve showing hollow costellae and external ornament; (2) interior of pedicle valve showing teeth, dental plates, median raised area vascular markings and open delthyrium with a small plate in the apex.

Figure 3—*Aegiria sugiyamai*, n. sp.

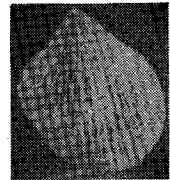
(3) Enlargement of Pl. 6, fig. 6 showing pedicle interarea and hinge.



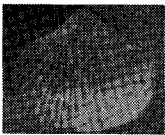
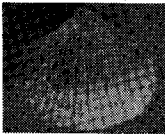
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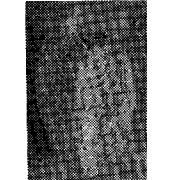
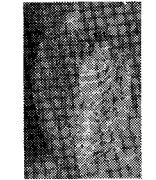
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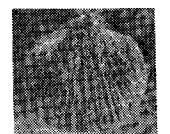
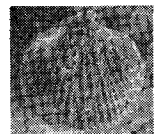
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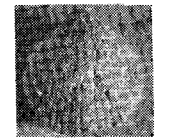
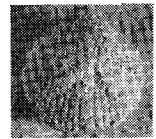
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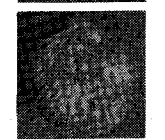
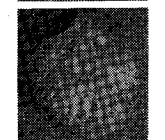
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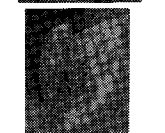
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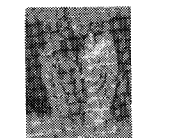
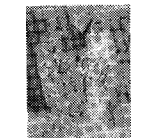
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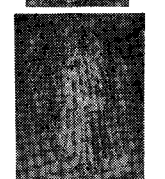
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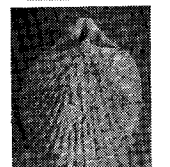
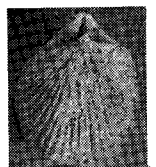
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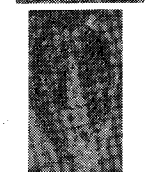
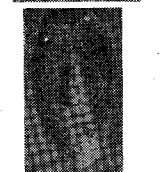
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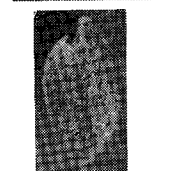
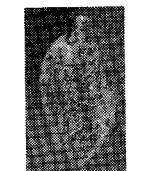
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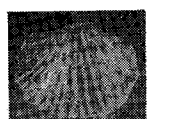
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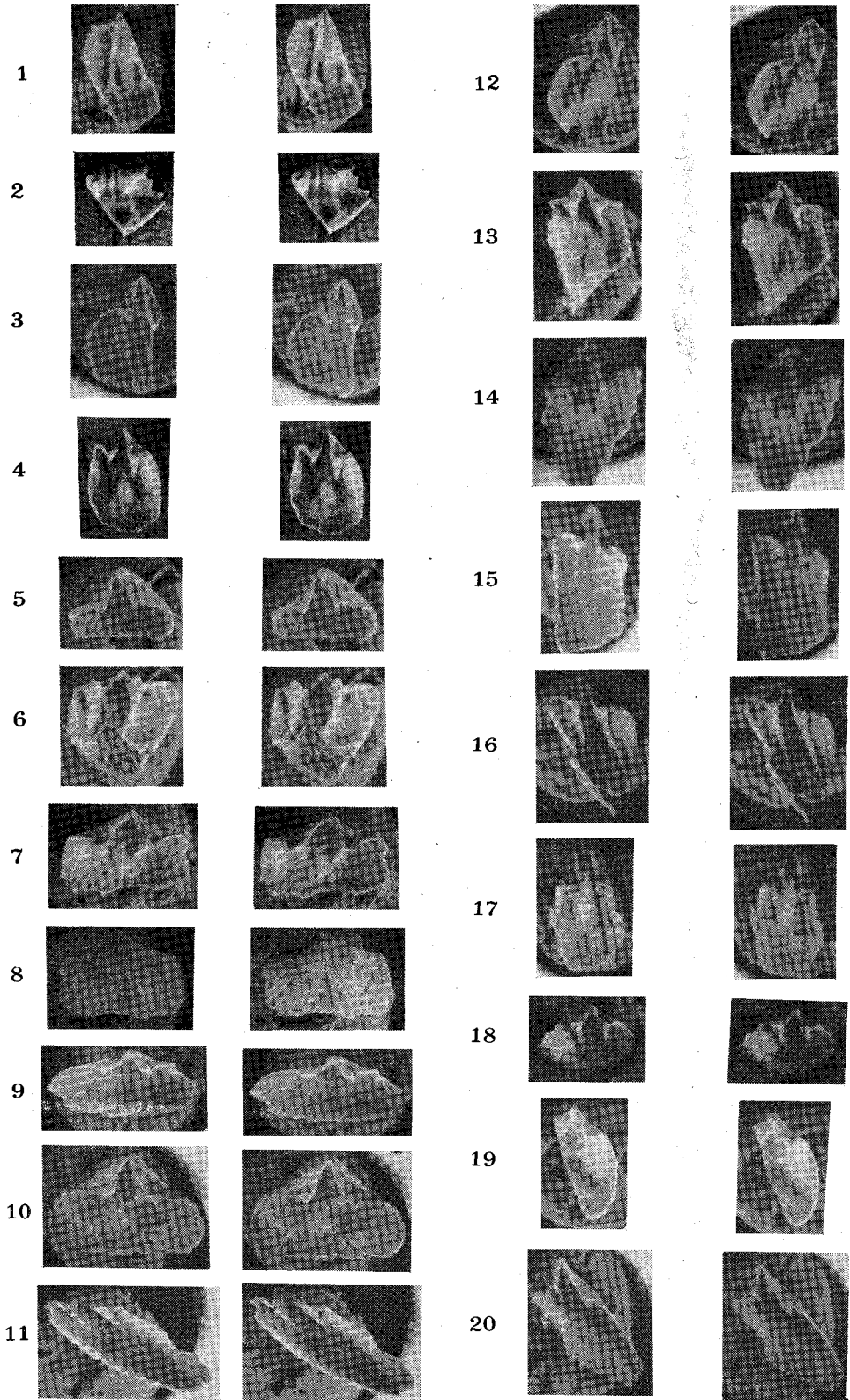


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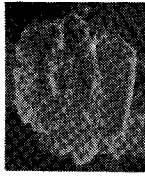


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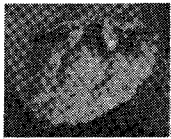
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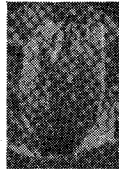
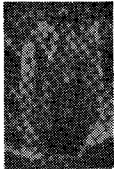
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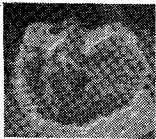
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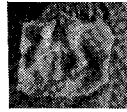
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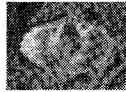
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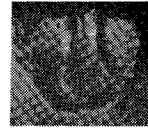
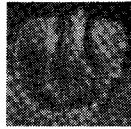
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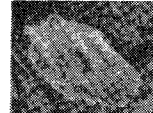
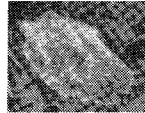
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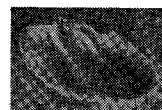
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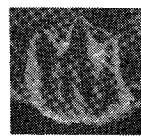
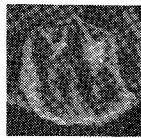
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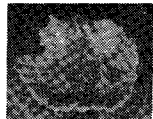
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