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Some species of late Upper Devonian and lowest Carboniferous brachiopods from the Higashiyama district, Iwate Prefecture, North Japan.

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The late Upper Devonian Tobigamori and lowest Carboniferous Karaumedate formations are widely distributed in the northern part of Higashiyama-cho, Higashiiwai-gun, Iwate Prefecture.

This district is located in the southwestern area of the Kitakami Mountainland (approximately 141° 10′E, 39°N).

The Tobigamori formation consists of slaty rocks (in which most of the fossils are contained), conglomerate, sandstone as well as reddish sandstone and slate, but is entirely lacking in limestone and other calcareous rock. On the other hand, the Karaumedate is mainly composed of slate as well as conglomerate layers between the sandstone.

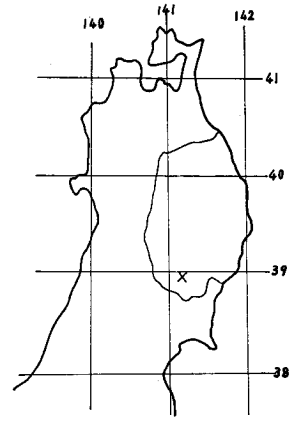

Fig. 1. ×.....Higashiyama-cho, Higashiiwai-gun, Iwate Prefecture.

The Tobigamori is characterized by *Cyrtospirifer*, *Tenticospirifer*, *Iwaispirifer*, *Athyris*, *Ptychomaletoechia*, *Chonetes*, *Rugosochonetes*, *Mesoplica*, *Ovatia*, *Buxtonia* (?), *Malloproductus*, *Schizophoria* and other brachiopods with pelecypods and gastropods. Besides these, plant remains including *Leptophloeum* are found. The Karaumedate contains *Cyrtospirifer* (?), *Prospira*, *Unispirifer*, *Iwaispirifer*, *Nodaea*, *Globispirifer*, *Syringothyris*, *Kitakamithyris*, *Tylothyris*, *Athyris*, *Cleiothyridina*, *Camarotoechia* (?), *Rhipidomella*, *Rugosochonetes*, *Productus*, and other brachiopods with *Conophillipsia* and plant remains including lycopods.

As already stated in the previous papers (Tachibana, 1950, 1952), the fossil contents of these two formations rather resemble to those of the Upper Devonian and Lower Carboniferous of Australia and Kazakhstan.

The Karaumedate formation is unconformably overlain by the Takozu formation in

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which *Linoproductus*, *Orthotetes*, *Rhipidomella* and *Chonetes* are contained and is roughly correlated with the Lower Visean. Furthermore the Takozu is covered by the Upper Visean Takezawa formation mainly consisting of limestone in which *Kueichouphyllum*, *Lithostrotion* and *Gigantoproductus* are found.

All the specimens are preserved in the state of internal and external moulds in the slaty and sandy rocks and are frequently deformed by the Ōshima orogenic movement of the Lower Cretaceous age. Accordingly most specimens are not necessarily well preserved, though the writer has collected them since 1949.

In the present paper, the writer described a large producted *Malloproductus pexus* n. gen., a small sized macrospiriferid *Iwaispirifer striatolamellosus* with *Athyris takozuensis* n. sp. from the late Upper Devonian, and *Nodaea okuboi* n. gen. et sp., a spiriferid of the Devonian type from the lowest Carboniferous.

Sometime in the future palaeontological studies will be published on fossils collected by the writer in a study of the Upper Devonian – Lower Carboniferous boundary.

Systematic Descriptions

Order Strophomenida Öpik, 1934
Suborder Productidina Waagen, 1883
Superfamily Productacea Gray, 1840
Family Sentosiidae McKellar, 1970
Genus *Malloproductus* n. gen.

Diagnosis: Shell medium to large sized; thin shell; concavo-convex; visceral cavity very thin; external surface of pedicle valve covered by densely crowded, very long hair-like spines; the median portion of brachial valve exterior marked by rather sporadically arranged and short recumbent spines, but the marginal portion marked by the same spines as those of the pedicle valve; bilobed, elongated cardinal process; lateral ridges long, parallel with the hinge margins and ornamented faintly by vertical striae; median septum very thin and rather high.

Remarks: *Malloproductus* differs from *Sentosia* Muir-Wood & Cooper, 1960 (*Krotovia praecursor* Stainbrook, the type species) by having a larger sized shell, much longer, radially arranged, curving hair-like spines on the surface of the pedicle exterior, a more elongated and narrower cardinal process, longer lateral ridges marked by faint vertical striae in the specimens of internal moulds, and a very thin, ridge-like septum.

Malloproductus is apparently similar to *Hamlingella* in having numerous, long, fine, hair-like spines. However, *Hamlingella* has a different internal structure of the brachial valve from that of *Malloproductus* as well as a distinct cardinal area.

This new genus was originally reported under the name *Nodella* (Tachibana, 1963), but was later found to be pre-occupied by Zaspelova (1952, P. 187-188, *Nodella svinrdensis Z.*) in the Upper Devonian ostracoda. Accordingly the new genus name, *Mallo-*

productus, was proposed as a substitute.

Type species : *Malloproductus pexus* (Tachibana).

Occurrence : Tobigamori formation. Late Upper Devonian age.

Malloproductus pexus (Tachibana), n. gen.
Pl. 1, figs. 1–11, and Figs. 2–3.
Productus nummularis Tachibana, 1953; Sci. Rep. Tokyo Bunrika Daigaku, Sec. C, Vol. 2, No. 13, p. 123–128, Pl. 1, figs. 1–10.
Nodella pexa Tachibana, 1963; Bull. Fac. Lib. Arts, Nagasaki Univ., Nat. Sci., Vol. 4, p. 42.

The shells are subcircular in outline, with rounded cardinal margins shorter than its greatest width situated at about mid-length of the shell.

The pedicle valve is moderately convex and the greatest convexity is situated near the umbonal region. The umbo projects a little beyond the hinge-line. There is no cardinal interarea. The brachial valve is slightly concave with a shallow concavity in the umbonal portion.

The entire surface of the pedicle exterior is ornamented by very long, exceedingly fine, hair-like spines. These spines extend posteriorly at the umbo and ears, and they

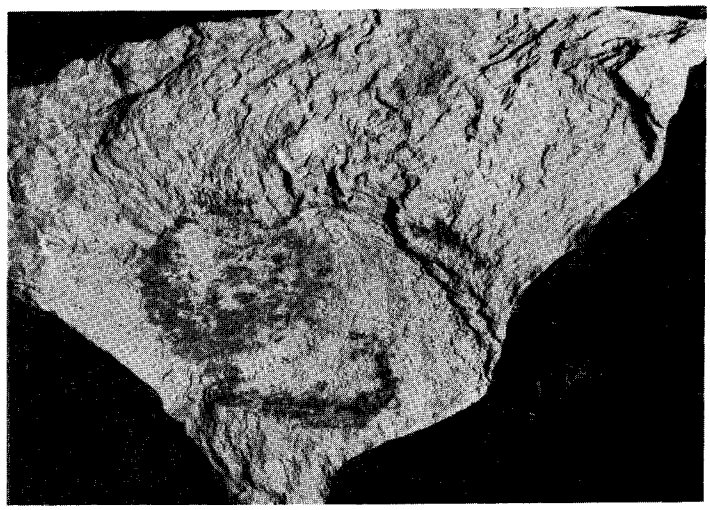

Fig. 2. *Malloproductus pexus* (Tachibana), n, gen.. ×1.
External mould of pedicle valve showing very long hair-like spines.

extend radially toward the lateral and anterior margins. The maximum length of these spines is 30mm. in immature shells and 50mm. or more in mature shells. Besides these, somewhat elongated spine bases and irregular concentric growth lines can be observed.

In the brachial valve, the median portion of the external surface is marked by sparsely arranged, short prostrate spines which extend antero-laterally, but in the marginal portion

the longer spines are numerous and crowded, being 10mm. or more in length. The surface is also ornamented by indistinct concentric growth lines and pits.

The pedicle interior is not well preserved on the internal moulds.

The brachial interior has a bilobed cardinal process which is narrow and elongated. Sometimes each lobe is sulcated posteriorly. The long lateral ridges from the base of the cardinal process extend along the straight hinge-margins to near the cardinal extremities. The median septum is very thin, rather ridge-like and slightly high, and it reaches to half the brachial valve length. On the interior surface of the brachial valve numerous pits and spine bases are observed. Musclar scars are not preserved.

Both the shell and the visceral cavity are very thin. As seen in the large specimen

Fig. 3. *Malloproductus pexus* (Tachibana), n. gen. ×1.
Large specimen showing natural casts of brachial internal mould at the median portion and pedicle external mould at the marginal portion. Late Upper Devonian.

(Figure 3) which is deformed and depressed, the natural casts of the internal and external moulds are preserved in this specimen.

Remarks: This species is characterized by having its much larger shell, very thin shell and visceral cavity, very long exceedingly fine, numerous hair-like spines, the elongated bilobed cardinal process and the long lateral ridges along the straight hinge margins.

Occurrence: This species is common in the late Upper Devonian, Tobigamori formation.

Order Spiriferida Waagen, 1883
Suborder Athyrididina Boucot, Johnson & Staton, 1964
Superfamily Athyridacea McCoy, 1844
Family Athyrididae McCoy, 1844
Subfamily Athyridinae McCoy, 1844
Genus *Athyris* McCoy, 1844

Athyris takozuensis n. sp.

Pl. 3, figs. 8-11, Fig. 4

The shells of this species are generally small. The average width is about 12mm. The outline of the shell is subovate or sub-pentagonal with the greatest width near the mid-length of the shell. A median sulcus and fold are generally observed at the anterior half of the shell. The sulcus usually originates from about the middle and becomes wider and deeper near the anterior margin and in some cases it may be extended forward in the form of a tongue. The fold is gently elevated along the median line of the valve and becomes anteriorly more convex to form a linguate extension. The pedicle interior has dental plates which are rather short and diverge slightly, extending along the deep delthyrial cavity. In the brachial interior there are distinct dental sockets, a hinge plate perforated by a visceral foramen and a very thin, faint median ridge which extends to the mid-length of the valve. In some specimens represented by internal moulds, the spiral cones forming the brachidium are preserved and its apices are laterally directed with 7 to 8 coils. It is especially characteristic that the posteriorly tapering cast of the visceral foramen is continuous with the fillings of the deep delthyrial cavity of the pedicle valve. The entire surface of both valves is ornamented by regularly spaced, numerous growth lamellae which become slightly spinose along the anterior edges and are marked by crowded concentric microstriae. Numerous short flat spines and fine radial striae are observed in some specimens, though these are not well preserved in most specimens.

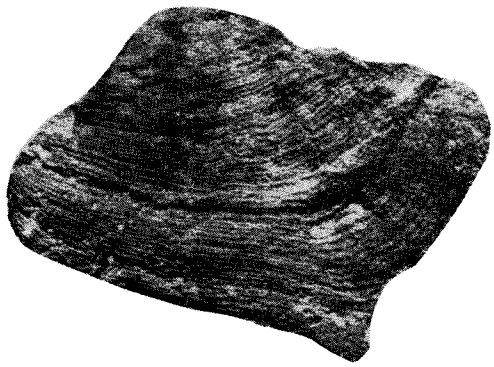

Fig. 4. *Athyris takozuensis* n. sp. ×3.5. External mould of pedicle valve, showing concentric growth lamellae on the external surface and median sulcus.

Remarks : This species resembles *Athyris sulcifer* Nalivkin from the Upper Devonian of Kazakhstan, but it is distinguishable from the Kazakhstan species by its smaller sized shell and less prominent median sulcus and fold.

Occurrence : Tobigamori formation. Late Upper Devonian age.

Suborder Spiriferidina Waagen, 1883

Superfamily Spiriferacea King, 1846

Family Mucrospiriferidae Pitrat, 1965

Genus *Iwaispirifer* Tachibana, 1963

Diagnosis : Shells of small size ; wider than long ; cardinal extremities alate to mucronate ; sulcus and fold nonplicate ; occasionally sulcus with a low median plica ; lateral slopes with 6 to 8 simple plicae on either side ; entire surface covered by distinct growth

lamellae and very fine radial striae ; dental plates rather short, frequently joined medially by secondary apical callus ; median ridge in pedicle interior ; brachial interior with striated cardinal process and shallow sockets forming anteriorly fulcral plates.

Remarks : *Iwaispirifer* is closely related to *Mucrospirifer* Grabau, 1913, *Eleutherokomma* Crickmay, 1950, *Acuminothyris* Roberts, 1963 and *Apousiella* Carter, 1972. But these genera can be distinguished by the larger sized shell, more numerous lateral plicae and exceedingly mucronate cardinal extremities. Especially *Eleutherokomma* has concentric micro-striae which are not found in *Iwaispirifer*. *Apousiella* lacks very fine external radial striae and internal dental plates.

Type species : *Iwaispirifer striatolamellosus* Tachibana.

Occurrence : Tobigamori formation. Late Upper Devonian age. Occasionally, this genus is also found in the lowest Carboniferous, Karaumedate formation. This Carboniferous species is hardly distinguishable from that of the Upper Devonian and has similar concentric growth lamellae crossed by radial striae on the entire surface of both valves and the small sized shell with less numerous lateral plicae.

Iwaispirifer striatolamellosus Tachibana

Pl. 2, figs. 1–10.

Iwaispirifer striatolamellosus Tachibana, 1963 ; Bull. Fac. Lid. Arts, Nagasaki Univ., Nat. Sci., Vol. 4, p. 42–43, figs. 4a–c.

The shells are small in size, the average width being about 17mm. This species is transversely sub-quadrangular in outline, and has the greatest width on the hinge line. The cardinal extemities are sharply alate and often mucronate. Each lateral slope on either side of the median sulcus has 6 to 8 simple plicae. The median sulcus and fold are non-plicated, but a single, narrow and low median plica is seen in the sulcus of some specimens, as in fig. 9 of Pl. 2.

The entire surface of both valves is ornamented by distinct concentric growth lamellae and by exceedingly fine radial striae. Concentric micro-striae are entirely lacking.

The deltyrium is open in some specimens, but it is often filled by an apical callus or covered by deltidium-like plate. The dental plates are short, diverging slightly and extending anteriorly to enclose the posterior half of the muscle area. The thin median ridge is observed in the pedicle interior, but it is not a true median septum. The cardinal process is multilobed or vertically notched with thin numerous lamellae. A low median ridge extends anteriorly from the base of the cardinal process to near the mid-length of the valve. Dental sockets bounded by socket plates are rather shallow and diverge anterolaterally, and have concave fulcral plates at their anterior ends.

Remarks : This mucrospiriferoid species is characterized by a small sized shell, less numerous lateral plicae and by the presence of fulcral plates at the anterior ends of the shallow dental sockets.

Family Spinocyrtiidae Ivanova, 1959

Genus *Nodaea* n. gen.

Diagnosis : Large sized shell with sub-rounded cardinal angles ; sulcus and fold nonplicate ; 5 to 6 low, rounded simple lateral plicae ; the delthyrium frequently covered by a flat plate near the apical portion ; delthyrial cavity deep ; dental plates subparallel and rather thin ; cardinal process striated ; dorsal adminicula short ; median septum absent in both valves; entire surface ornamented by very fine, numerous radial striae.

Remarks : *Nodaea* is especially characterized by micro-ornamentation consisting of fine radial striae on the entire surface of both valves, and at first sight resembles *Adolfia* Gürlich (1909), *Mauispirifer* Allan (1947), *Spinella* Talent (1956), *Pinguispirifer* Havlíček (1959) and *Eurekaspirifer* Johnson (1966).

In *Eurekaspirifer*, from the Lower Devonian of Nevada, the delthyrium is not covered by a delthyrial plate though short deltidial plates are developed along the margins of the delthyrium. It possess two separate cardinal processes as in *Spinella*, and the dental plates recurve to converge anteriorly. *Nodaea* is different in the surface micro-ornamentation from *Spinella* (the Middle Devonian, Victoria, Australia). *Spinella* is characterized by tear-drop shaped granules. However, *Spinella talenti* Johnson (Johnson, 1970) from the *Eurekaspirifer pinyonensis* zone of the Lower Devonian bears fine micro-ornamentation consisting of numerous, closely spaced, fine radial striae which are not observed in the surface of *Spinella*. According to Johnson's description, in *Spinella talenti*, "there is a slight thickening of shell material in the apex of the valve, but there is no transverse sub-delthyrial plate connecting the thickening of shell material on the medial edges of the dental lamellae near the hinge line" and the dorsal adminicula are not developed. Two separate cardinal processes which are characteristic of *Spinella* and *Eurekaspirifer* can not be observed in '*Spinella*' *talenti*. *Nodaea* seems to apparently resemble to this species, except for the internal structure of both valves. *Pinguispirifer* from the Middle Devonian of Bohemia also has well developed, fine, radial striae on the surface, but is distinguishable from *Nodaea* by having a well developed sulcus and fold. *Mauispirifer* from the Lower Devonian of New Zealand also has surface ornamentation consisting of well developed, fine, radial threads, but it has a straight hinge line which is equal to the greatest width of the shell and its dental plates are short and thin, diverging anteriorly. *Adolfia* from the Middle and Upper Devonian also resembles to *Nodaea*, but differs in having more numerous and angular lateral plicae, a median plica in the sulcus and differnt radial striae.

Type species : *Nodaea okuboi* n. gen. et sp.

The genus name, *Nodaea* is derived from Dr. Mitsuo Noda who first discovered the Upper Devonian species, *Cyrtospirifer* in this district of Japan.

Occurrence : Karaumedate formation. Lowest Carbouiferous age.

Nodaea okuboi n. gen. et sp.
Pl. 3, figs. 1–7.

The large sized shells are transversely subovate in outline, the average width being about 50mm. The valves are moderately biconvex. The cardinal angles are subrounded or form an obtuse angle. Maximum width is situated approximately at mid-length of the shell. The sulcus and fold are nonplicate. Simple, low and rounded radial plicae are 5 to 6 in number on each lateral side of the shell. The entire surface of both valves is covered by very fine numerous radial striae, and the concentric growth lines are mainly observed near the anterior half of the shell.

In the pedicle interior dental plates are rather thin and extend anteriorly to about one-third of the shell length and slightly recurve to enclose the posterior half of the muscle area. The delthyrium is closed by a flat apical plate in some specimens. The delthyrial cavity is deep. The median septum is lacking. The cardinal process is notched by numerous, thin vertical lamellae. The dorsal adminicula are short. No median septum is found in the brachial interior.

Remarks : This species resembles *Dimegelasma elegante* Maxwell (Maxwell, 1954) from the *Tenticospirifer* zone of early Tournaisian of the Mt. Morgan district, Australia in having radial striae on the entire surface, nonplicate median sulcus and fold, simple rounded lateral plicae, and distinct dental plates. But *Dimegelasma elegante* differs from *Nodaea okuboi* in having radial striae with fine granules or pustules and a median septum or ridge in the brachial valve, being smaller in size.

Dimegelasma Cooper, 1942 (*Spirifer neglectus* Hall, the type species) has a brachial interior with a short, distinct median septum supporting a well developed concave hinge plate and lacks the micro-ornamentation consisting of fine radial striae.

Though the figures of *Dimegelasma* in Maxwell's paper(1954) are shown by the pedicle valve only, it is doubtful to the writer whether these species belong to *Dimegelasma*.

The species is named after Dr. M. Okubo who contributed to the study of the Lower Carboniferous of this district.

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EXPLANATION OF PLATES 1–3

All photographic work was done by the writer. Stereophotographs are represented by the normal relief of specimens unless otherwise stated. But an inverted relief is marked by (I) in the explanation.

Plale 1

Figures 1–11. *Malloproductus pexus* (Tachibana). Late Upper Devonian, Tobigamori formation.

(1) internal mould of brachial valve, ×1.2, (**I**); (2) enlargement of fig. 1, ×3, (**I**); (3) internal mould of brachial valve, ×1, (**I**); (4) internal mould of pedicle valve, ×1; (5) external mould of pedicle valve, counterpart of the specimen of fig. 4, ×1; (6) external mould of pedicle valve, ×1, (**I**); (7) internal mould of brachial valve, showing bilobed cardinal process, lateral ridges marked by faint vertical striae and thin median septum, ×1; (8) cast of internal mould of brachial valve of fig. 7, ×1; (9) enlargement of fig. 7, ×2; (10) internal mould of pedicle valve, and natural cast of external mould of pedicle valve showing marginal, long hair-like spines, holotype, ×1; (11) external mould of pedicle valve showing long hair-like spines, immature shell, ×1.

Plate 2

Figures 1–10. *Iwaispirifer striatolamellosus* Tachibana. Late Upper Devonian, Tobigamori formation.

(1) internal mould of pedicle valve, ×1.2; (2) internal mould of brachial valve, showing a delthyrium filled by apical callus, short dental plates and muscle scars, ×2, (**I**); (3) internal mould of pedicle valve, ×1.2; (4) internal mould of pedicle valve, ×1; (5) internal mould of pedicle valve, ×1; (6) internal mould of brachial valve, ×2; (7) external mould of pedicle valve, showing concentric growth lamellae and fine radial striae near the anterior margin, ×7.5; (8) external mould of pedicle valve, showing radial striae and growth lamellae, ×6; (9) external mould of pedicle valve, showing a low and narrow median plica in the median sulcus and a surface ornamentation, ×2.5; (10) external mould of pedicle valve, showing surface ornamentation, ×2.5.

Plate 3

Figures 1–7. *Nodaea okuboi* n. gen. et sp. Lowest Carboniferous, Karaumedate formation.

(1) internal mould of brachial valve, ×1. (**I**); (2) enlargement of fig. 1, ×2.5, (**I**); (3) internal mould of brachial valve, ×1; (4) internal mould of pedicle valve, ×0.7, holotype; (5) internal mould of pedicle valve, ×0.8, (**I**); (6) brachial view of steinkern, ×1.2; (7) external mould of pedicle valve (fig. 4), showing radial striae on the surface and concentric growth lines near the anterior margin, ×3.5.

Figure 8–11. *Athyris takozuensis* n. sp. Late Upper Devonian, Tobigamori formation.

(8) internal mould of brachial valve, ×1; (9) internal mould of brachial valve, ×1; (10) external mould of pedicle valve, ×1; (11) enlargement of fig. 10, ×3.5.

PLATE 1

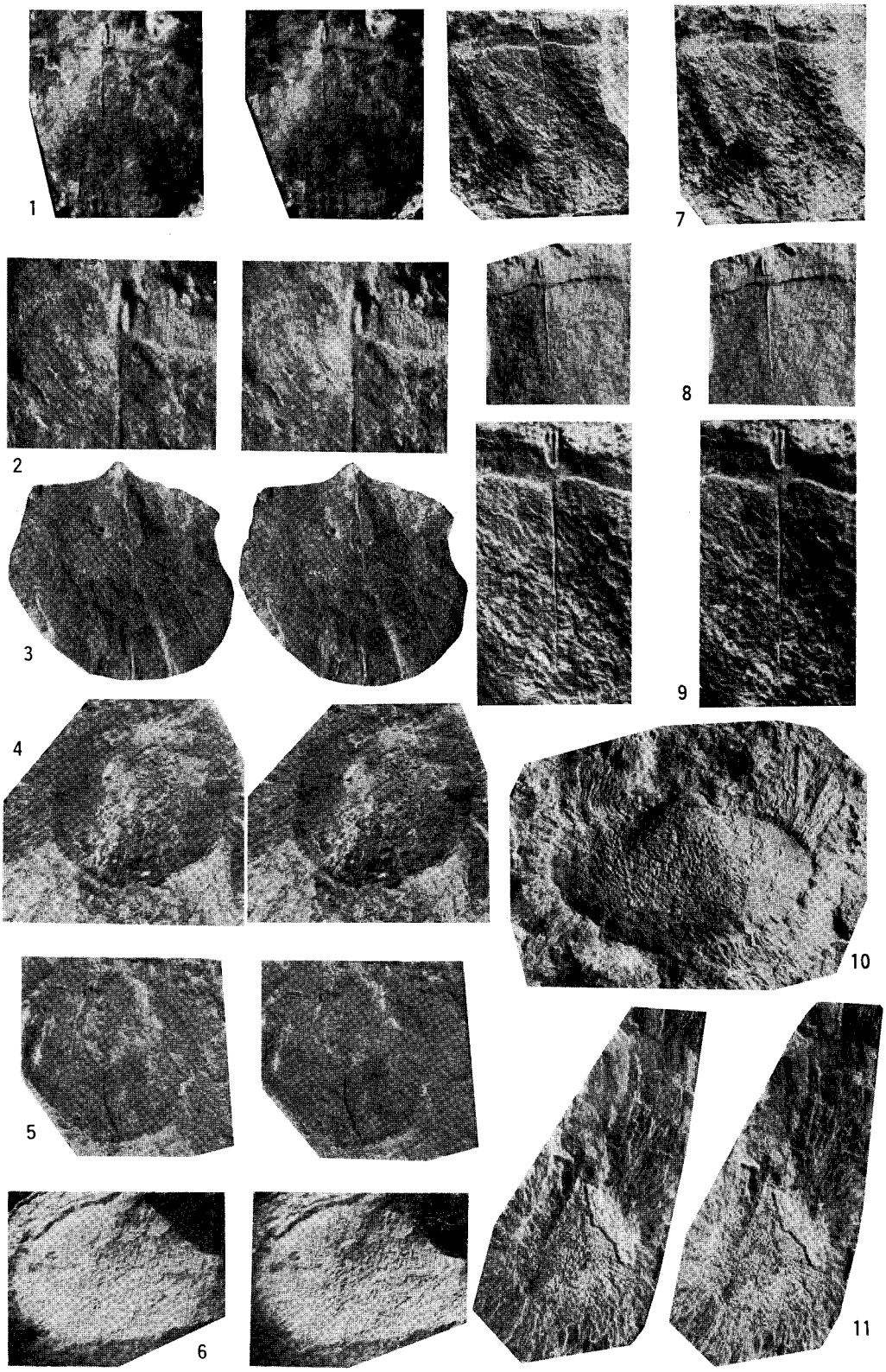

PLATE 2

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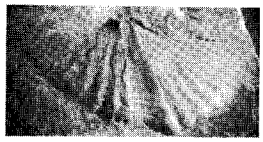

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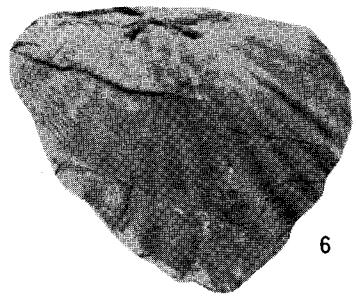

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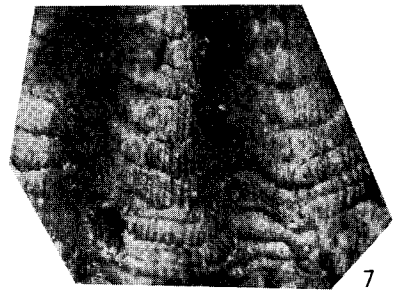

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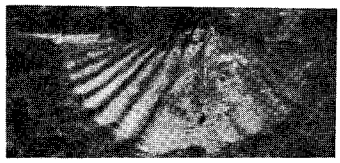

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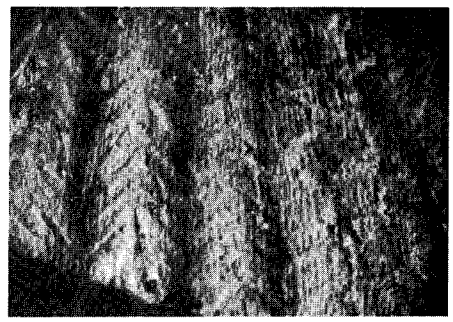

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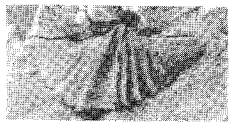

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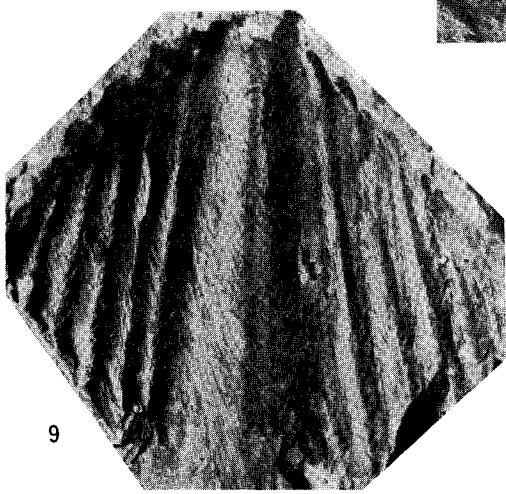

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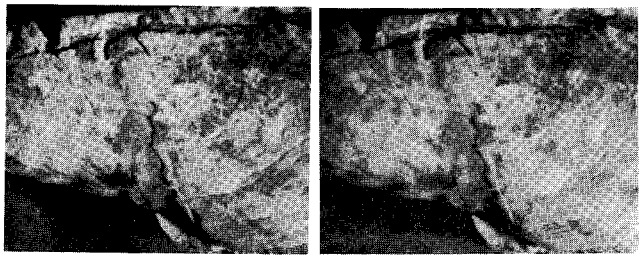
PLATE 3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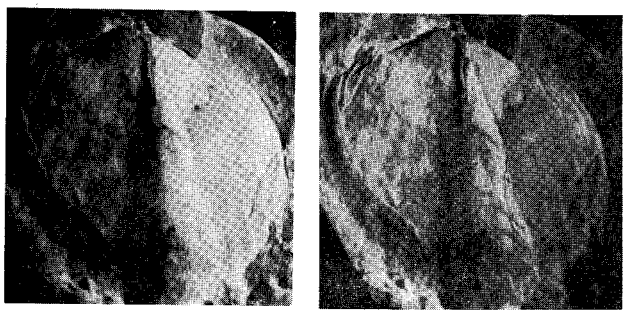
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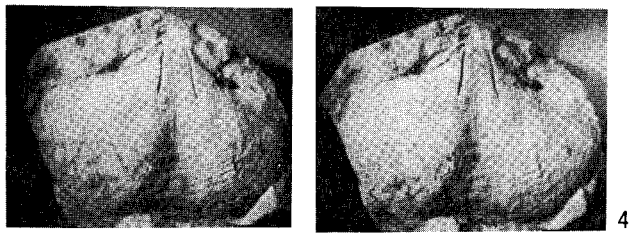
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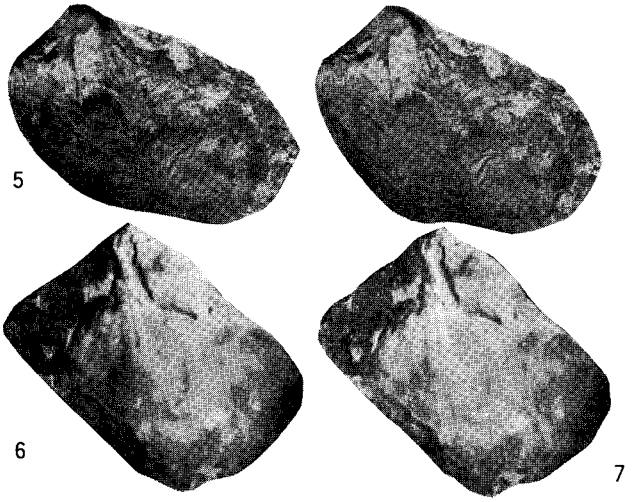
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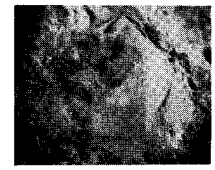
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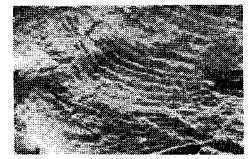
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