

REPORT OF THE BIOLOGICAL SURVEY OF MUTSU BAY
31. STUDIES ON CHITONS OF MUTSU BAY WITH GENERAL
DISCUSSION ON CHITONS OF JAPAN¹⁾

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(With Plates XIV-XXXIV and seven text-figures)

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INTRODUCTION

The zoological survey of Mutsu Bay carried out by the staff of the Asamushi Marine Biological Station chiefly during the years 1927-28, has yielded valuable material to increase our knowledge of chitons occurring in that region. The whole collection embraces 21 species as listed below, of which 4 species (6, 7, 13, 19) are new to science and 3 (3, 4, 5)

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the southernmost species and 2 (18, 21) the northernmost representatives of this group of animals.

1. *Lepidopleurus hakodatensis* THIELE
2. *L. assimilis* THIELE
3. *Tonicella lineata* (WOOD)
4. *T. ruber* (LINNÉ)
5. *T. submarmorea* (MIDDENDORFF)
6. *Spongioradsia foveolata*, nov. sp.
7. *Mopalia hirsuta*, nov. sp.
8. *Placiphorella stimpsoni* (GOULD)
9. *Acanthochiton rubrolineatus* (LISCHKE)
10. *A. achates* (GOULD)
11. *Cryptoplax japonica* PILSBRY
12. *Ischnochiton comptus* (GOULD)
13. *I. paululus*, nov. sp.
14. *Ischnoradsia hakodadensis* ('CARPENTER' PILSBRY)
15. *Lepidozona coreanica* (REEVE)
16. *L. albrechti* (SCHRENCK)
17. *L. mertensi* (MIDDENDORFF)
18. *Rhyssoplax kurodai* (IS. TAKI et IW. TAKI)
19. *R. tectiformis*, nov. sp.
20. *Liolophura japonica* (LISCHKE)
21. *Lucilina amanda* THIELE

According to THIELE's system the class Loricata is composed of 6 families and 43 genera, and the species listed above belong to 6 families and 11 genera, that is to say, they are distributed among all families of this class.

Of all the species collected from Mutsu Bay, 14 species (1, 3-5, 8-12, 14-16, 18, 20) are those found on the Pacific coast, 16 (1-6, 8-12, 14-16, 18, 20, 21) on the coast of the Japan Sea and 4 (6, 7, 13, 19) are peculiar to that locality. This means that the predominating species are common ones occurring along the coast of the main island of Japan and 2 species (2, 21) are those strictly confined to the Japan Sea and 1 (17) is that uncertain about its distribution in other regions of Japan. Therefore it is hard to say which faunistic region Mutsu Bay belongs to, because it does not show any feature of characteristic of its own. As the warm Tugaru current flows through the straits from the Japan Sea to the Pacific, the fauna of Mutsu Bay seems to be much influenced by that current. Thus *Lepidopleurus assimilis* (2) and *Lucilina amanda* (21) occur

in Mutsu Bay as well as in the Japan Sea. Furthermore in Mutsu Bay the number of species found in the Japan Sea excels that found in the Pacific coast by two species. It seems more reasonable to consider Mutsu Bay from the chiton fauna as a region of the Japan Sea than as that of the Pacific.

The chiton fauna of Mutsu Bay are composed of forms of the circumpolar, the northern Pacific, the temperate zone and the tropical regions. Of these elements *Tonicella ruber* (4) may be mentioned as the circumpolar species; the 2 species of *Lepidopleurus* (1, 2), the 2 species of *Tonicella* (3, 5), *Placiphorella stimpsoni* (8), *Ischnoradsia hakodadensis* (14) and the 2 species of *Lepidozona* (16, 17) may be regarded as peculiar to the northern Pacific; the 2 species of *Acanthochiton* (9, 10), *Cryptoplax japonica* (11), *Lepidozona coreanica* (15), *Rhyssoplax kurodai* (18), *Liolophura japonica* (20) and *Lucilina amanda* (21) are the temperate zone forms; *Ischnochiton comptus* (12) is a member of the tropical species. The remainders are endemic to this locality.

The genera *Lepidopleurus*, *Ischnochiton* and *Acanthochiton* are world-wide in their distribution, although the first is usually found in the deep seas, and the latter two are known as the representatives of the littoral forms. *Tonicella*, *Spongioradsia*, *Mopalia* and *Placiphorella* are only known from the circumpolar region; *Cryptoplax* appears to flourish better in the coral reef of tropical Australia; *Ischnoradsia* and *Liolophura* show the bipolarity in their distribution occurring in the temperate zones of the both hemispheres, and *Lucilina* is one of the representatives of the Indo-west-Pacific region and Mutsu Bay may be regarded as the northern boundary of its distribution.

The species of chitons described in the following pages were collected by the members of the Asamushi Marine Biological Station, supplemented by the specimens from other sources including those collected by my brother, IWAO TAKI.

I am greatly indebted to Prof. S. HÔZAWA, who has given me a rare privilege to work out the valuable material and to those gentlemen, Dr. K. KOKUBO, Dr. S. TAKATUKI, Mr. H. SATÔ, Mr. KAMADA and Mr. ITÔ, who collected the materials at Mutsu Bay. I must also express my hearty thanks to my friends too many to mention here, especially to Messrs. EDWIN ASHBY, KYÔZI AWAYA, KIKUTARÔ BABA, J. R. M. BERGENHAYN, DAVY J. DEAN, KEN'ITI EBINA, SIGEO EMURA, YOSINE HADA, KAZUITI HATAKEDA, SINTARO HIRASE, HUZIO HIRO, YOSIYASU HOSOYAMADA, MASARU HORI, ATUSI HUZITA, TADASI HUZITA, TAKEO IMAI, KEN'ITI INA-

ZAWA, TAKASI INO, TUNEITI KAMITA (and his pupils), TOSIHARU KAMOHARA, KÔITIRO KANDA, SUEO KANEKO, TADAO KANO, KANZAEMON KIKUTI, TORAITIRÔ KINOSITA, SIGEO KOBASI, HISAMATU KOHORI, TOKUBEI KURODA, DANIEL B. LANGFORD, JOHN S. MACKAY, MOITIRÔ MAKI, DENZABURÔ MIYAZI, TAKUÔ MIMURA, TAMEZÔ MORI, ZYUNITI MORITA, YAITIRÔ OKADA, KIYOSI OKAMOTO, SIRÔ OKUDA, KATURA ÔYAMA, TAKAHIDE SASAMORI, KAORU SASAMOTO, SYUHEI SONEHARA (and his pupils), RYÛSYÔ SUGIMOTO, D. THAANUM, KEIZÔ TAKAHASI, SADAË TAKAHASI, KITARU TAKAGI, SIGERU TAKAGI, KIYOSI TAKEWAKI, RYÛZÔ TANAKA, GENZÔ TOBA, TOMOE URITA, RENZI WADA, WASABURÔ YAGURA, TOMOSABURÔ YAMADA, HIROSI YOSIDA and Miss YAEKO YAMAMURA, whose incessant contributions to the collection of material have enabled me to get a general aperçu of the fauna of the western Pacific chitons. Besides the collection at the Museum of the Zoological Institute, Science Faculty, Tokyo Imperial University, other material came from the "Sôyô Maru" expedition, from the Oceanographical Institute, Tohoku Imperial University, Onagawa, from the Saitô Hôonkai Museum and from the Tokyo Science Museum.

Throughout the course of the present investigation suggestions were received from Drs. N. YATSU and S. TANAKA, to whom I gratefully acknowledge my indebtedness.

DESCRIPTION OF SPECIES

Class LORICATA

Order I LEPIDOPLEURIDA

Family LEPIDOPLEURIDAE

Genus LEPIDOPLEURUS RISSO 1826

1. *Lepidopleurus hakodatensis* THIELE 1909

Pl. XIV, fig. 1; Pl. XVI, figs. 1-4, 6-8, 14; Pl. XVII, figs. 6-8.

Lepidopleurus hakodatensis

THIELE (1909) Zoologica, Heft 56, S. 10-11, Taf. 1, Fig. 11-20.

Body small, elongate elliptical in outline, strongly vaulted at the back; valves of nearly equal breadth; girdle moderately wide and widest at the middle part of the body.

Head valve semicircular in outline, fairly elevated at the apex, ornamented with fine, flattened, round granules, tending to give a form of distinct radial riblets, especially emphasized at the periphery.

Median valves nearly equal in breadth, oblong in shape, exceedingly

wider than long, thin, fragile, not beaked, strongly arched at the back; lateral area not raised, but distinctly demarcated from the central area by the same sculpture as the head valve; central area with fine granular, longitudinal lirae, their anterior edges protrude a little, though never form distinct denticles; sutural laminae small, hyaline, triangular in shape; sinus wide, flat; interior of valves almost smooth; eaves narrow, a little porous in the tegmental portion.

Tail valve semicircular in outline, almost equal to the head valve in width; mucro nearly central, conspicuous, projecting posteriorly but neither raised nor pointed; central area fairly vaulted with sculpture similar to that of the median valves; posterior slope slightly concave, sculptured like the head valve, margins of tegmentum finely crenulate throughout.

Girdle not too much narrow, widest at about the middle of the body; perinotum scales exceedingly minute, flat, oval in shape, narrowing toward the tip, rounded at the base, with 4 to 6 feeble lines at the apical portion, measuring 72 to 84 μ in length, 45 to 46 μ in breadth; among these scales long, straight, more often slightly curved, smooth, pointed spines are interspersed, being 120 to 130 μ long, 16 to 24 μ thick (pl. XVI, fig. 6). Hyponotum narrow, with a covering of excessively minute, roughly pentagonal scales, often marked with 2 or 3 quite feeble striae near the apical portion, measuring 48 to 52 μ in length, 26 to 30 μ in breadth, showing a tendency to grow long toward the margin so as to form elongate, pointed, more distinctly striated spicules, measuring 100-120 μ in length, 20-30 μ in breadth; marginal spines small, straight, smooth, acute at the tip.

Radula small; central tooth broad, truncated at the front end with a well developed cusp, constricted a little near the base, slightly sinuated at the posterior end; centrolateral thin, divided into two lobes by a longitudinal ridge at about the middle, outer lobe shallowly notched at the anterior angle, smooth, sharp in front; inner lobe often extending anteriorly so as to form a small cusp; basal plate oblong; major lateral bicuspidate, outer one much thicker, longer than inner one; stalk thick, twisted strongly at about the middle; inner small-lateral squarish in outline; major uncinus long oar shape, dilated and cusped at the anterior edge; outer marginal oblong, much longer than wide.

All valves light yellow in colour, freckled here and there with easily removable coating of dark brown, although disarticulated valves nearly white; interior of valves also whitish; girdle brownish yellow.

Ctenidia, merobranchial adanal; gills 13 or 14 on one side, ranging

from the 6th to the tail valve.

Remarks: As pointed out by THIELE, the present species bears a close resemblance to *L. assimilis* in all features, the distinctive differences of these two species being found in the shape and the arrangement of the tegmental granulations, in the structure of radula. THIELE figured the radula of this species and stated that the wing-like process of the centro-lateral extends anteriorly so as to embrace the basal part of the major lateral, whereas such a broad expansion can not be detected in the material before me. What he observed may be some structure other than the radula.

Size: Head valve 3.5 mm; 4th valve 4 mm; tail valve 3.5 mm in breadth. Body 9 mm in length, estimated from the curled specimen.

Locality: 1 specimen, off Imabetu, Station 113, no. 2379, collected by S. HÔZAWA in July, 1929.

Distribution: Gulf of Amur; Hakodate (type locality, THIELE); Mutsu Bay; off Yokohama.

2. *Lepidopleurus assimilis* THIELE, 1909

Pl. XIV, fig. 2; Pl. XVI, figs. 5, 9-13, 15; Pl. XVII, figs. 9-11.

? *Chiton (Leptochiton) concinnus*

GOULD (1859) Proceedings of the Boston Society of Natural History, Vol. 7, p. 164

(not *Chiton concinnus* of SOWERBY, 1840).

— (1860) Otia Conchologica, p. 117.

? *Leptochiton concinnus*

CARPENTER, MS. p. 3, (fide PILSBRY)

SCHRENCK (1867) Reisen und Forschungen im Amur-lande, Bd. 2, S. 599.

DALL (1878) Proceedings of the United States National Museum, pp. 316, 318.

— (1878) Bulletin United States National Museum, Vol. 1, p. 100.

DUNKER (1882) Index Molluscorum Maris Japonici, p. 158.

? *Lepidopleurus concinnus*

PILSBRY (1892) Manual of Conchology, Vol. 14, p. 11.

— (1895) Catalogue of the Marine Mollusks of Japan, p. 113.

THIELE (1909) Zoologica, Bd. 22, Heft 56, S. 11-12.

Lepidopleurus assimilis

THIELE (1909) Zoologica, Bd. 22, Heft 56, S. 11-12, Taf. 1, Fig. 30-39.

Body small, oblong, nearly equal in width throughout the entire length; shell elevated, regularly arched, though not carinated; girdle very narrow, nearly equal in breadth in all parts; eaves comparatively broad, smooth, its tegmental portion brownish in colour.

Head valve crescentic in outline, rather flat at the apex with numerous, closely placed, radial series of minute, flattened, round granules, which

arranged rather irregularly near the apex, though forming distinct ribs at the periphery.

Median valves nearly oblong in shape, exceedingly wider than long, neither beaked nor carinated; jugum not defined; granules of central area nearly round, flat, distinctly separated from one another, arranged transversely as well as longitudinally, forming slight denticulations at the front edge; lateral area not elevated, though distinctly defined, sculptured like the head valve, while granules less regularly arranged at the dorsal region than those of the head valve, showing a tendency to form distinct radial riblets at the periphery; sutural laminae thin, small, triangular in outline, with a shallow sinus between them. Interior of valves almost smooth; lateral region shallowly dented, marked with feeble concentric lines of growth; pleural region covered with thick, smooth hypostracum, that makes it distinct from other adjacent regions; jugal region striated closely with short, fine, transverse lines except for the front region.

Tail valve semicircular in outline, somewhat broader than the head valve; central area sculptured like the median valves; posterior area slightly concave; mucro situated near the centre with an obtuse end; eaves rather broader than that of any other valve; interior of valve smooth, with a thick layer of hypostracum; there are 4 muscle impressions at the mucronal region.

Girdle very narrow, almost equal in width in all parts, covered with minute scales, which are generally oval shaped, bluntly pointed at the tip, slightly curved ventrally, marked distally with 10 to 14 strong striations on the dorsal surface, being 80 to 86 μ in length, 50 to 55 μ in breadth; marginal spine long, smooth, nearly straight or slightly curved, interspersed among the marginal spicules, measuring 156 to 165 μ in length, 21 to 23 μ in thickness; hyponotum scale elongate oval in outline, distinctly striated with 5 to 8 longitudinal lines, measuring 60 to 90 μ long, 30 to 40 μ broad, growing longer toward the margin passing over to an oblong marginal spicule, which has a length of 190 μ and a breadth of 33 μ , striated like the hyponotum scales.

Radula very small; central tooth of nearly oblong shape, narrowing anteriorly with obtusely pointed cusp at the tip, weakly bilobed at the posterior end; centro-lateral somewhat rolled inward on both edges, produced and cusped at the anterior edge, slightly notched on both sides of cusp, with remarkably small basal-plate at about the middle; major lateral much small, delicate, arranged closely with one another, stalk twisted at about the middle, having a broad extension at the base; cusp with a small

process on the outside near the pointed end; inner small-lateral squarish; major uncinus of long oar shape with a small basal plate; inner marginal oblong in shape, having a triangular extension at the middle part so as to cover the basal part of the major uncinus; middle marginal squarish in outline, bilobed a little at the posterior end, articulating with the anterior edge of the tooth situated immediately behind; outer marginal trapezoid in shape, much wider than long, becoming narrower distally.

All valves with pale orange-yellow or ochraceous-buff, usually fleckled here and there with a dark coating; girdle uniformly coloured with cream-buff.

Ctenidia, merobranchial, without a space between the last ctenidium and the anus, 9 (body length 9.5 mm) to 12 (body length 10 mm) on one side, reaching the tail from the 6th valves.

Remarks: THIELE described *L. hakodatensis* from a specimen collected by HILGENDORF at Hakodate and others from Yokohama and the Gulf of Amur. He then was of the opinion that the characteristic features of *L. concinnus*, reported by GOULD from Hakodate, do not agree well with those of *L. hakodatensis* and furthermore the name "*concinnus*" was applied already by SOWERBY to another species, so that even if this species be identical with GOULD's species, the new name must be proposed.

It is very difficult to determine decidedly GOULD's species from his rather insufficient description only. However careful examination of his descriptions seems to reveal that this form should refer to *L. assimilis*; for these two forms so well agree with each other in most features of shells, in the girdle and also in body size.

While entirely agreeing the descriptions and figures of *L. assimilis* given by THIELE with the specimens from Mutsu Bay except for the details of the radula, in which, contrary to his statements, the central tooth is oblong and becomes a little narrower anteriorly, truncated at the base; the centro-lateral is produced and distinctly cusped at the tip and never develops a thin plate in front so as to embrace the basal part of the major lateral. These differences concerning the structure of radula will be attributable to certain extent to the difficulty of observation, due to the fineness of the radula.

THIELE took a small accessory process on the inner side of the cusp in the major lateral for a residue of the connecting thread with the opposite side of the cusp in the radular sheath. However it may be more reasonable to consider it as a vestige of the inner cusp, which is often developed well in several other species of the genus.

Size

BODY		VALVES		
LENGTH	BREADTH	HEAD	TAIL	4TH
6.0mm	2.7mm	2.7mm	2.8mm	3.35mm
9.5	5.0	2.6	2.7	3.25
10.0	6.0	1.6	1.7	2.00
		2.25	2.25	2.50
		2.10	2.25	2.50

Locality: 1 specimen off Kamome-sima, 2 specimens off Kanida collected by S. TAKATUKI in July, 1927; 6 specimens collected by IWAOTAKI on August 11, 12 and 15, 1930, at the depth of about 30 m off Yunosima.

Distribution: Near Saghalien (P. SCHMIDT); near Vladivostok (P. SCHMIDT); Hakodate? (STIMPSON); Mutsu Bay.

Order II CHITONIDA

Family 1 LEPIDOCHITONIDAE

Subfamily A LEPIDOCHITONINAE

Genus TONICELLA CARPENTER 1873

3. *Tonicella lineata* (WOOD, 1815)

Pl. XIV, fig. 12; Pl. XVIII, figs. 9-15; Pl. XIX, fig. 2.

Chiton lineatus

WOOD (1815) General Conchology, or a description of shells arranged according to the Linnean system, p. 15, pl. 2, figs. 4, 5.

SOWERBY (1847) Conchological Illustrations, fig. 77.

REEVE (1847) Conchologia Iconica, Monograph of the genus Chiton, Vol. 4, pl. 7, fig. 33, species 33.

CARPENTER (1857) Report of the British Association for the Advancement of Science, 1856, pp. 208, 214, 223.

— (1864) Ibidem, 1863, pp. 523, 648, 684.

Chiton (Stenosemus) lineatus

MIDDENDORFF (1847) Mémoires l'Académie Impériale des Sciences de Saint-Petersbourg, Ser. 6, Tome 6, pp. 77, 82, 84, 86, 90, 91, 173, Taf. 12, Fig. 8, 9, (Malacologia Rossica, pp. 109-112).

Tonicia lineata

- CARPENTER (1857) Rep. Brit. Assoc. Adv. Sci., 1856, p. 317.
 CARPENTER (1864) Ibidem, 1863, pp. 648, 684.
 ADAMS, H. and ADAMS, A. (1858) The genera of recent Mollusca, Vol. 1, p. 474.
- Lepidochitona (Tonicella) lineata*
 DALL (1921) Smithsonian Institution United States National Museum, Bulletin 112, p. 188.
- Tonicella lineata*
 CARPENTER, MS., p. 38, (fide PILSBRY).
 DALL (1878) Proceedings of the United States National Museum, Vol. 1, pp. 296, 326.
 — (1878) Smithsonian Institution United States National Museum, Bulletin 1, pp. 78, 108-109, pl. 1, fig. 5.
 WOOD and RAYMOND (1891) Nautilus, Vol. 5, p. 58.
 PILSBRY (1892) Manual of Conchology, Vol. 14, pp. 42-43, pl. 11, figs. 25-28.
 — (1895) Catalogue of the Marine Mollusks of Japan, p. 114.
 WISSEL (1904) Zoologische Jahrbücher, Abt. Syst., Bd. 20, S. 592-594, Taf. 22, Fig. 1-4; Bare Island.
 BERRY (1917) Proceedings of the Californian Academy of Sciences, Ser. 4, Vol. 7, No. 10, p. 234.
 — (1922) Ibidem, Vol. 11, No. 18, pp. 433-435, pl. 2, figs. 1-5.
 PACKARD (1918) University of California Publications in Zoology, Vol. 14, No. 2, p. 292, pl. 34, fig. 3.
 CHACE, E. P. and CHACE, E. M. (1919) Loricinia, Vol. 2, No. 6, p. 43.
 THIELE (1909) Zoologica, Bd. 22, Heft 56, S. 4, Nr. 87.

Toniciella lineata

- THIELE (1893) Das Gebiss der Schnecken, Bd. 2, Lief. 8, S. 390, Taf. 32, Fig. 3.

Toniciella submarmorea

- THIELE (1893) Ibidem, S. 389, Taf. 32, Fig. 2.

Body of moderate size, oval in shape, broadest at about the posterior third of the entire length; shells fairly elevated, more or less carinated at the back; tegmental surface smooth, characteristically marked with dark-brown lines bordered above with white; girdle rather narrow, leathery.

Head valve of crescentic shape, smooth except for growth lines, solid, thick, straight at the posterior edge, with low but distinct apex, marked concentrically with somewhat irregular, rather zigzag or wavy, white lines upon the ground colour of light reddish; slits range from 8 to 10 in number; slit-rays radiated from the apex to the slits in correspondence with the number of the slits, provided with a series of small pores.

Median valves roundly arched or subcarinated, beaked, oblong in shape with smooth surface, having similarly coloured longitudinal lines; lateral area scarcely raised, indistinct, sloping obliquely backward; jugal area not defined in structure, though often marked with a narrow triangular, whitish line, or bordered with pink or reddish-brown; sutural laminae short, broad, white, thick, crescentic in shape, separated by a deep, narrow, angular sinus; eaves small, spongy; teeth short, but sharply cut with a shallow

slit on each side; slit-rays provided sparsely with small round pores, elongated and crowded near the slit; callus slightly elevated at the border between the central and the lateral areas; the greater part of the interior of valves nearly smooth except for the jugal area, which are striped with numerous faint, transverse, short lines.

Tail valve oval shaped, always smaller than the head valve, its tegmental margin with an indication of false beaking in front; mucro not elevated, blunt, much anteriorly situated; posterior area steep and nearly straight; sutural laminae oblong in shape with a shallow, rather wide sinus between them, having slits, 8 to 10 in number, coloured like the head valve.

Interior of valves tinged with rose colour at about the middle part and with white near the peripheral areas.

Girdle rather narrow, leathery with the ground colour of light brownish yellow, tessellated indistinctly with brownish; perinotum loosely beset with small, short, smooth, variously shaped, spinules, containing sometimes minute granules, having a length of 40 to 60 μ , a breadth of 12 to 20 μ , intermingling with minute, nearly straight, hyaline spicules, which are less in number than spinules, measuring 35 μ in length, 5 μ in thickness; hyponotum covered by thick, short, flat spinules, rather larger than that of the perinotum, obtusely pointed at the tip, faintly fluted distally with 4 to 5 striae, 70 μ long, 30 μ broad.

Radula: Central tooth elongate-oblong in outline, dilated at the anterior half with round end, faintly sinuated at the middle on the anterior edge, truncated at the posterior end; centro-lateral ridged axially at about the middle, bialate at the outer edge, basal plate thick, oblong in shape, obliquely placed and distinctly protruded outwardly, anterior edge smooth, sharp, not cusped, but a small extension at the middle, inner edge nearly straight; major lateral strongly developed, stalk thick, provided with a small wing at the anterior end on either side and two shallow axial grooves on the ventral side, base slightly twisted, truncated at the end; innermost of three cusps separated from middle one by a broad notch, while outer and middle ones divided by a shallow notch, outer one the thickest, to which middle one nearly equal in length or somewhat longer than it; inner small-lateral broad, roughly triangular in shape; peculiarities of major uncinus found in the remarkably long, triangular basal plate and considerably numerous fine cusps at the cutting edge, 50 or more in number, closely arranged along the edge; outer-marginal broad with a slight sinuation at the anterior edge, posterior edge protruding a little backward; middle-marginal oblong shaped, articulating closely with triangular inner-marginal.

Ctenidia, with a wide space between the last ctenidium and the anus, occupying almost entire length of the foot, but slightly separated from both ends of the foot, 16 on one side in the specimen 10 mm long, 25 or 26 in the specimen 30 mm long.

Remarks: The present species is one of the handsomest chitons found in the Pacific region. It has drawn much attention of many authors and was fully described by MIDDENDORFF (1847) and PILSBRY (1892) with respect to the characteristic features of the shell. DALL (1878) and THIELE (1893) figured respectively the radula of this species and WISSEL (1904) revised the results of the latter author, though all the figures and the descriptions are far from being satisfactory, THIELE's results agree better with the preparations before me than WISSEL's. The discrepancies of these results of the previous authors seem to be caused by the different angles from which the material is seen. The structure of this organ is shown in detail in Pl. XIX, fig. 2.

The animal usually grows over 35 mm in length, though the specimens under my examination are very small. Such individuals are never found in the littoral zone but are always collected at some depths.

It is interesting to note that the flatter the specimens, the farther south do they occur and that the specimens from Mutsu Bay agree well with forms from Alaska and northern Canada regarding the divergency of the shell.

Size and divergency

BODY		SHELL				AUTHORS
LENGTH	BREADTH	HEAD	6TH	TAIL	DIVERGENCE	
37.0mm	20.0mm	—	—	—	120°	PILSBRY
30.5	—	—	—	—	—	PACKARD
30.0	15.0	—	—	—	—	PILSBRY
30.0	—	—	—	—	120°	MIDDENDORFF
16.0	10.5	6.00mm	8.80mm	5.00mm	120°	TAKI (Mutsu Bay)
—	—	3.75	4.80	2.80	—	
—	—	3.30	4.40	2.75	100°	
5.4	—	2.50	3.10	1.90	—	

Locality: Off Kanida, 3 specimens (no. 1716) collected by S. TAKA-TUKI in July, 1927; 1 specimen at Yunosima by IWAO TAKI on August 15, 1930.

Distribution: Bering Straits south, on both coasts; from Japan and the Okhotsk Sea to the Bay of Monterey, California including whole the Aleutian Islands.

Bering Straits;

Norton Sound (BERRY), Aleutian Islands (PILSBRY).

Asiatic coast;

Siberia; Plover Bay (BERRY), Okhotsk Sea (DALL, PILSBRY).

Japan;

Hokkaidô, Okusiri-zima (T. KINOSITA), Honsyû, Mutsu Bay.

West coast of North America;

Alaska (DALL), Sitka; Unalaska (MIDDENDORFF), Forrester Island (BERRY).

Canada;

Vancouver (collection in the Museum, Tokyo Imp. Univ. Zool. Inst.).

U. S. A.;

Washington, D. C., California, Bonita Point, San Francisco Bay (WOOD and RAYMOND, PACKARD), Monterey Bay (PILSBRY, collection in the Museum, Tokyo Imp. Univ. Zool. Inst.), San Miguel Island, Santa Barbara (BERRY), San Diego (DALL), San Pedro (Pleistocene fossil, CHACE; BERRY).

4. *Tonicella ruber* (LINNÉ, 1767)

Pl. XIV, fig. 3; Pl. XVII, figs. 1-4; Pl. XVIII, figs. 1-5.

Chiton ruber

LINNÉ (1767) Systema Naturae, 12th ed. p. 1107.

LOWE (1825) Zoological Journal, Vol. 2, p. 101, pl. 5, fig. 2.

SOWERBY (1839) Conchological Illustration, Chiton, figs. 103, 103 a, 104.

GOULD (1841) Report on the Invertebrata of Massachusetts, p. 149, fig. 24.

REEVE (1847) Conchologia Iconica, Monograph of the genus *Chiton*, Vol. 4, pl. 26, fig. 175.

FORBES and HANLEY (1853) A List of British Mollusca and Their Shells, Vol. 2, p. 399, Pl. 59, fig. 6; pl. AA, fig. 6.

HANLEY (1855) The Shells of Linnaeus, Ipsa Linnaei Conchyliæ, p. 17.

JEFFREYS (1865) British Conchology, Vol. 3, p. 224.

— (1869) Ibidem, Vol. 5, p. 199, pl. 56, fig. 4.

BINNEY (1870) GOULD's Report on the Invertebrata of Massachusetts, 2nd ed., p. 260, fig. 523.

Chiton (Stenosemus) ruber

MIDDENDORFF (1848) Mémoires de l'Académie Impériale des Sciences de Saint-Petersbourg, Ser. 6, Tome 6, pp. 81, 83, 87, 88, 90, 92, 181-184, Taf. 12, Fig. 5; (Malacozologia Rossica, pp. 117-120): Eismeer Küste des Russischen Lapplandes: Grönlandische Küste: Norwegische Küste.

Leptochiton ruber

ADAMS, H. and ADAMS, A. (1858) The Genera of Recent Mollusca, Vol. 1, p. 473.

Chiton (Lepidopleurus) ruber

JEFFREYS (1865) British Conchology, Vol. 3, p. 210.

Boreochiton ruber

SARS, G. O. (1878) Mollusca Regionis Arcticae Norvegicae, p. 116, Tab. 8, figs. 4 a-1; Tab. 11, figs. 3 a-c; Northern seas, whole coast of Norway, low water to 40 fms.

Trachydermon ruber

CARPENTER (1873) Bulletin of the Essex Institute, Vol. 5, p. 153.
DALL (1878) United States National Museum, Bulletin 1, pp. 102-104; Kamchatka; in Alaska from the Pribiloff Islands to Attu and southward to Sitka; Bering Straits northward.
— (1878) Proceedings of the United States National Museum, Vol. 1, p. 320.
PILSBRY (1893) Manual of Conchology, Vol. 15, p. 65, pl. 15, fig. 25.

Ischnochiton (Trachydermon) ruber

PILSBRY (1892) Manual of Conchology, Vol. 14, p. 80, pl. 7, figs. 50-56.

Lepidochitona (Tonicella) ruber

DALL (1921) United States National Museum, Bulletin 112, p. 188. Arctic Ocean to Monterey, California.

Lepidochiton (Tonicella) ruber ruber

JOHNSON, C. W. (1934) Proceedings of the Boston Society of Natural History, Vol. 40, No. 1, p. 13; Labrador south to Connecticut, 1-80 fms.

Tonicella rubra

THIELE (1893) Das Gebiss der Schnecken, Bd. 2, Lfg. 8, S. 390, Taf. 32, Fig. 4.
— (1928) Fauna Arctica, Bd. 5, Nr. 2, S. 564; Helgoland, Port Wladimir.
ALLEN (1931) Plymouth Marine Fauna, 2nd ed., p. 236; New Grounds, Cawasand Bay, Wembury Bay, between tide-marks.
WINKWORTH (1932) Journal of Conchology, Vol. 19, No. 7, p. 218.

Tonicella ruber

SYKES (1894) Proceedings of the Malacological Society of London, Vol. 1, p. 36.
BALCH, F. N. (1906) Nautilus, Vol. 20, p. 62.
THIELE (1910) Zoologica, Bd. 22, Heft 56, S. 107.
BERRY (1917) Proceedings of the Californian Academy of Sciences, Ser. 4, Vol. 7, No. 11, pp. 231; Forrester Island, southeastern Alaska, 15-30 fms.
— (1927) Proceedings of the Malacological Society of London, Vol. 17, part 4, p. 160; Departure Bay, British Columbia.

Chiton cinereus

FABRICIUS (1780) Fauna Grönlandica, p. 423.
DILLWYN (1817) Catalogue of Recent Shells, p. 12.
LAMARCK (1836) Histoire Naturelle des Animaux sans Vertèbres, II édition, Tome 7, p. 505; les mers du nord de l'Europe.

Chiton minimus

SPENGLER (1797) Skrivter af Naturhistorie-Selskabet, Vol. 4, p. 1.

Chiton laevis

LOVÉN (1846) Index Molluscorum Lit. Scand., p. 28.
— (1846) Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar, Vol. 2, p. 160.
PENNANT (1877) British Zoology, Ed. 4, Vol. 4, p. 72, pl. 36, fig. 3.

Chiton latus

LEACH (1852) Molluscorum Britanniae Synopsis, p. 231.

Chiton puniceus

GOULD (1846) Otia Conchologica, p. 5.

Chiton incarnatus

REEVE (1848) Conchologia Iconica, Vol. 4, fig. 194.

Tonicella squamigera

THIELE (1909) Zoologica, Bd. 22, Heft 56, S. 18, Taf. 2, Fig. 44-50; Hakodate.

Body of medium size, oblong in outline; shell solid, elevated, sub-carinated at the back; girdle narrow, covered with minute elongate scales.

Head valve twice as long, crescentic in outline, with somewhat prominent apex; tegmental surface apparently smooth except for well-marked growth lines, under the microscope an excessively fine reticulation or series of minute granules visible; insertion plate having 8 to 11 slits; teeth sharp, smooth.

Median valves oblong, highly elevated, slightly keeled at the back, somewhat beaked; lateral slope a little concave; lateral areas slightly raised, having stronger concentric wrinkles than the central areas, ornamented likewise the head valve on the tegmental surface; jugum not defined; one slit on either side; sutural plate wide, smooth with sharp edge; sinus deep, narrow, angular.

Tail valve oval in outline with a sinuation at the middle of the anterior edge, mucro median, obtuse; posterior slope nearly straight, ornamented with minute granules like the head valve, slits 7-11 in number.

Colouration of valves very variable, usually light buff, marbled all over with orange-red in various patterns, or entirely suffused with reddish or whitish like *Tonicella marmorea* but the valves usually having a red dorsal stripe, bordered uniformly with dark red or nearly pure white; interior of the valves bright pink.

Girdle farinaceous, generally reddish-brown, dusted with alternate red and whitish patches, closely covered with minute scales, which are pyriform in shape, small at the base, obtuse at the tip, curved slightly inward with smooth surface, length more than twice the width, their cross sections oval in outline; long spines sparsely distributed among these scales, holding a small spinules at the tip; hyponotum scales very minute, hyaline, truncated at the base, pointed at the tip, faintly striped near the tip, growing longer toward the margin; marginal spicules long, lanceolate with

a chitinous base, marked with two sets of oblique striations.

Gills occupying the posterior half of the body, ctenidia 7 to 15 on each side.

Measurements :

BODY		VALVE				NUMBER OF GILL	LOCALITY
LENGTH	WIDTH	HEAD	4TH	TAIL	DIVERGENCY		
5.7mm	3.45mm	2.1mm	2.7mm	1.8mm	95°	7	Mutsu Bay
7.0	3.80	2.3	3.0	1.8	98°	10	
—	—	2.3	3.0	1.8	96°	—	Okusiri Id.
12.0	5.00	2.9	3.4	2.15	110°	—	
—	—	3.0	4.2	3.1	112°	—	Lubec, Me., U. S. A.
—	—	3.8	4.6	3.3	114°	—	
10.0	6.7	4.0	4.9	3.2	110°	12	Strömsund, Sweden
15.0	8.0	4.2	5.2	3.6	111°	—	
10.5	6.0	4.2	5.0	3.3	115°	12	Eastport, Me., U. S. A.
14.0	8.0	4.5	6.2	4.0	123°	15	
—	—	4.5	5.2	3.3	114°	—	Lubec
14.0	8.0	4.6	6.0	4.2	125°	14	Eastport
14.0	8.5	4.7	6.4	4.3	123°	13	
13.0	8.0	4.7	6.4	4.5	125°	13	
—	—	5.0	6.0	4.0	118°	—	Lubec
—	—	5.0	6.2	4.0	118°	—	
17.0	10.0	5.2	7.4	4.5	117°	—	Eastport
—	—	5.3	7.0	4.5	123°	12	
17.0	10.0	5.4	7.3	4.6	120°	15	
—	—	5.5	7.2	5.0	124°	14	
18.0	10.0	5.5	7.8	5.0	122°	14	
17.0	10.0	6.0	7.5	5.0	121°	—	
—	—	6.0	7.8	—	122°	—	North Pacific
—	—	6.15	8.0	5.3	127°	—	Eastport

BODY		VALVE				NUMBER OF GILL	LOCALITY
LENGTH	WIDTH	HEAD	4TH	TAIL	DIVERGENCY		
—	—	6.2mm	8.3mm	5.5mm	125°	—	Eastport
19.0mm	12.0mm	6.25	8.2	5.8	120°	13	
—	—	6.5	9.0	6.0	127°	—	North Pacific
—	—	6.5	9.8	7.0	123°	—	
—	—	6.6	9.8	7.0	134°	—	
20.0	12.0	—	—	—	—	—	(fide PILSBRY)
25.0	—	—	—	—	—	—	Alaska (PILSBRY)

Remarks: THIELE described a small species, *Tonicella squamigera*, collected from Hakodate by HILGENDORF, which is, according to him, easily distinguished from *T. ruber* in having more highly elevated shells, longitudinal wrinkles in the central area, oval scales and simple small spicules in the girdle, short pyriform central tooth and the peculiarly shaped centro-lateral tooth.

With careful comparison of the small specimens collected from Mutsu Bay and Hokkaidô, with the typical forms in my hand of *T. ruber* from Europe and North America there seems no specific distinction between these two as is shown below.

The tegmental surface of the central area of *T. ruber* is finely reticulated, while that of *T. squamigera* is wrinkled, in which the minute round pustules coalesce to form somewhat oblique lines in two different directions, that are crossing one another so as to give an appearance of a reticulation, and as it grows larger they are worn out leaving only the skeletal outline of reticulation, so that these are not essential but of subordinate features in respect to structure of the tegmental surface. Furthermore the valves are, as in other species of the genus, relatively higher in the young than in the old ones, that is to say, the shells become flatter as they grow older the divergency ranging from 110° to 130°.

The evidence afforded by *T. squamigera* is not strong enough to dissociate as distinct species. The difference in size as well as in shape in the girdle scales between these two forms is to be attributed to different stages of growth, because the characteristic scales of *T. squamigera* gradually pass over continuously to the other. The central tooth is pyriform in outline in an apical view, while it is elongate-oblong in a front view,

THIELE pointed out such differences as the distinguishing characters of these two species. Moreover the centro-lateral tooth of the two forms agrees completely with each other. Therefore it seems natural to treat *T. squamigera* as a synonym of *T. ruber*.

Locality: Off Imabetu, 2 specimens collected by S. HÔZAWA in July, 1929.

Distribution:

Atlantic Ocean; Norway, Sweden, England, North Sea, Greenland, Labrador south to Connecticut.

Arctic Sea; Russian Lappland,

Pacific Ocean;

Bering Sea, Alaska; Attu, Sitka, Forrester Island.

North America; Monterey Bay, California.

Kamchatka; Japan; Okusiri, Hokkaidô, Mutsu Bay.

5. *Tonicella submarmorea* (MIDDENDORFF, 1846)

Pl. XIV, fig. 16; Pl. XVIII, figs. 6-8; Pl. XIX, figs. 1, 3-8.

Chiton submarmoreus

MIDDENDORFF (1846) Bulletin de la Classe Physico-Mathématique de l'Académie de Saint-Petersbourg, Tome 6, No. 8; Tugurbusen; Schantarische Insel, süd Ochotskische Meer.

SCHRENCK (1867) Reisen und Forschungen im Amur-Lande, Bd. 2, S. 276-278; Castris Bay; Hakodate Bay, 20-38 feet.

Chiton (Platysemus) submarmoreus

MIDDENDORFF (1847) Mémoires de l'Académie Impériale des Sciences de Saint-Petersbourg, Ser. 6, Tome 6, pp. 82, 90, 162; (Malacozologia Rossica, pp. 18, 26, 98); Tugurbusen.

Chiton (Stenosemus) submarmoreus

MIDDENDORFF (1851) Reisen in den Norden und Osten Sibiriens, Bd. 2, Theil 1, S. 178-183, Tab. 14, Fig. 7-10; Tab. 15, Fig. 7, 8; Sitcha

Tonicella submarmorea

DALL (1878) Proceedings of the United States National Museum, Vol. 1, pp. 296, 327.
— (1878) United States National Museum, Bulletin 1, pp. 78, 109, pl. 1, fig. 7; The Aleutian Islands to Sitka and Juan de Fuca Straits.

— (1886) Proceedings of the United States National Museum, Vol. 9, p. 210.

PILSBRY (1893) Manual of Conchology, Vol. 14, p. 42, pl. 10, figs. 16-24.

— (1895) Catalogue of the Marine Mollusks of Japan, p. 113.

BERRY (1917) Proceedings of the Californian Academy of Sciences, Ser. 4, Vol. 7, No. 10, p. 234.

— (1917) Proceedings of the United States National Museum, Vol. 54, No. 2223, p. 3.

Lepidochitona (Tonicella) submarmorea

DALL (1921) Smithsonian Institution United States National Museum, Bulletin No. 112, p. 188.

Catharina submarmorea

DUNKER (1882) Index Molluscorum Maris Japonici, p. 159.

Chiton insignis

REEVE (1848) Conchologia Iconica, Monograph of the genus *Chiton*, Vol. 4, pl. 22, fig. 148, species 148.

Chiton sitchensis

MIDDENDORFF (1846) Bulletin de la Classe Physico-Mathématique l'Académie de Saint-Petersbourg, Tome 6, p. 121.

Chiton (Stenosemus) sitchensis

MIDDENDORFF (1847) Mémoires de l'Académie Impériale des Sciences de Saint-Petersbourg, Sér. 6, Tome 6, pp. 72, 87, 90, 176, (Malacozologia Rossica, pp. 8, 23, 26, 112); Taf. 13, Figs. 1, 2.

Tonicia sitchensis

DUNKER (1882) Index Molluscorum Maris Japonici, p. 157.

Tonicella sitchensis

PILSBRY (1892) Manual of Conchology, Vol. 14, p. 44, pl. 11, figs. 29-31.

THIELE (1909) Zoologica, Bd. 22, Heft 56, S. 18-19.

Lepidochitona (Tonicella) sitchensis

DALL (1921) United States National Museum, Bulletin No. 112, p. 188.

Body of small to medium size, oval in outline; shell rather depressed with subcarinated back; girdle narrow, apparently smooth, yellowish-brown in colour, usually tessellated with dark brown.

Head valve crescentic; apex low; tegmental surface provided with many excessively minute granules which are regularly and closely arranged in a series in two different directions and crossed diagonally with each other so as to form a fine reticulation; interior of the valve smooth, polished; slit lines not grooved with many round large pores; eaves short, porous; teeth thick, short, sharp, 5 in number.

Median valve oblong in outline, subcarinated at the back, posterior edge well beaked, anterior edge straight; lateral area scarcely distinguishable, finely granulated like the head valve; central area provided with fine pustules which are smaller and more sparsely scattered than that of the lateral area; sutural laminae thick, broad and round; sinus wide, angular; interior of the valve shining, callus-ridge thick and prominent; jugal area marked irregularly with several transverse short grooves; slit line similar to that of the head valve; slit deeply incised, one on each side; teeth short, sharp.

Tail valve small, oval shaped, mucro central; posterior slope nearly straight, sculptured like the head valve, central area with similar sculpture to that of the median valve, marked with distinct concentric lines of growth; interior of valve smooth with large slit-pores along slit lines; slits 5 in number.

Tegmental surface variously coloured, though usually rosy or yellowish-

white, closely painted with spots and flames of red colour, reduced in tone toward the periphery to reddish-white; divergency 115° to 130° in adult specimens.

Girdle apparently leathery, though under the microscope the entire surface is covered densely with very fine scales, which are pyriform, longer than wide, bluntly pointed at the tip, small at the base, yellowish-brown in colour; a few remarkably long, hyaline spines distributed sparsely among these scales; hyponotum scales hyaline, exceedingly minute, elongate conical in shape, rather pointed at the tip, with fine striations on the surface, growing longer toward the periphery; margin closely beset with brown long spines and large hyaline spicules.

Radula; central tooth elongate oblong, slightly dilated and angular at the anterior end, weakly sinuated at the middle of the tip, a little constricted near the base, cusp distinct, wide and sharp; centro-lateral squarish, strongly expanded at the outer edge, with a slight sinuation at the anterior margin, inner edge smooth, nearly straight, basal plate oblong, distinct; major lateral tricuspid, its inner cusp smallest and sharpest, middle one truncated at the edge, outer one as large as half the whole cusp; shaft thick, stout, having a small, half-round wing at the anterior angle

Measurements:

BODY		VALVE				GILL	LOCALITY
LENGTH	BREADTH	HEAD	4TH	TAIL	DIVERG- GENCY		
—	—	2.5 mm	3.0 mm	2.2 mm	104°	—	Mutsu Bay
—	—	2.6	3.1	2.1	113°	—	Okusiri Id.
—	—	2.8	3.2	2.1	108°	—	
23 mm	14 mm	6.5	8.5	6.3	138°	23	Akkesi
22	12	6.8	8.5	6.3	132°	24	Aniwa Bay
—	—	7.3	10.2	6.0	130°	—	Akkesi
—	—	8.0	10.6	7.0	140°	—	Aniwa Bay
—	—	8.2	11.4	7.8	136°	22	
—	—	9.0	11.2	7.0	133°	—	
10	6	—	—	—	130°	—	Sitka
38	24	—	—	—	115° – 130°	24	Okhotsk Sea

of the inner edge and smooth, nearly straight at the outer edge; inner small-lateral with oblong basal plate and a bifurcated strong ridges, protruding forward at the tip; major uncinus shaped like a spoon with fine, many regularly arranged cusps at the anterior edge, with a thick, stout shaft upon a small basal plate; inner marginal somewhat irregular oblong shape with a large process at about the middle; median marginal elongate octangular in outline; outer marginal squarish as broad as wide, with deep insertion groove at the inner edge.

Ctenidium: Merobranchial abanal, extending from the 3rd to the 7th valves and consisting of 22 to 24 gills on one side.

Remarks: The present species bears a much resemblance to *Tonicella marmorea*. Though it is distinguished from the latter by its more depressed and less carinated median valve, different colour-pattern on the tegmentum, much longer marginal spines and broad wing of the centro-lateral tooth.

Of these distinguishing characters, the divergency of valves, as already pointed out by SCHRENCK (1867), is not constant and does not always tally with the original values given by MIDDENDORFF, who seemed to be of the opinion that this is the most important feature in separating this species from *T. marmorea*. As a matter of fact the divergency is usually about 100° in young specimens and becomes larger as they grow older. Therefore the character like this is not peculiar to these two forms and does not seem to be an absolute distinctive feature.

Sometimes it is difficult to differentiate this species from *T. lineata*, as the shells are similarly coloured. Even in such a case its microscopical granulation on the tegmental surface serves very well as one of the most distinguishing characters.

T. sitchensis was described by MIDDENDORFF from a single specimen, and has not been found by any later collector. THIELE (1909) examined the type specimen of this species, belonging to the Petersburg Museum, and considered that it should be a small specimen of *T. submarmorea*. The results worked out by THIELE on the radula agree well with the preparations before me.

Locality: Off Kanida, one small specimen was collected by S. TAKA-TUKI in July, 1927 (specimen number 1716).

Distribution:

The Bering Islands (DALL); Nicolski, between tide-marks (BERRY).

The Aleutian Island (DALL).

Alaska; Sitka (WOSNESSENSKI coll.); Juan de Fuca Straits (DALL,

PILSBRY); Forrester Island, 15-25 fathoms, (BERRY).
 U. S. A.; Puget Sound (DALL).
 Okhotsk Sea; Tugurbusen, Schantarischen Inseln (MIDDENDORFF): Bay
 of Castries, 20-38 feet (SCHRENCK).
 Japan; Saghlien; Aniwa Bay (T. URITA)
 Hokkaidô; Akkesi (HADA and OKUDA coll.); Hakodate (collected
 by LINDHOLM, reported by SCHRENCK); Okusiri Island (T.
 KINOSITA coll.)
 Honsyû; Mutsu Bay.

This species was originally described by MIDDENDORFF from the southern Okhotsk Sea and later by different authors from the Bering Sea and other various places along the Pacific coast of north America.

This is peculiar to the northern Pacific in its distribution, as will be seen from the localities shown above, ranging from the Bering Sea to Puget Sound (about 48° N.) on the eastern coast and to Mutsu Bay (41° N.) on the western side, the latter locality probably being the southern limit.

It was recorded by MIDDENDORFF from the southern Okhotsk Sea near the tide-mark and by BERRY from Bering Island between tide-marks, while SCHRENCK collected it at the depth of from 6 to 12 m at the Bay of Castries and never found it at the depth more than 12 m, and from Forrester Island BERRY described it from the waters 27 to 45 m deep.

The young individuals always live deeper than 50 m and they seem to come up gradually into the shallow water as far as the tide-mark as they grow larger.

Subfamily B CALLOCHITONINAE
 Genus SPONGIORADIA PILSBRY 1893

6. *Spongioradsia foveolata*, nov. sp.

Pl. XIV, fig. 4; Pl. XX, figs. 1-10; Pl. XXI, fig. 1.

Body of small size, 6 mm in length, oval in outline, with well vaulted shells, dull purplish-red in colour; girdle nearly smooth, tinted with pale violet.

Head valve of crescentic shape, thick, spongy, very fragile, apex prominent, moderately raised, finely reticulated with minute elongate granules in quincunx pattern on the whole surface, punctulated by the numerous black dots of megalaesthetes near the apex; interior of the valve

nearly smooth, with the two low ridges near the posterior edge, hind parts of these two ridges rather regularly, coarsely pored; central callus much thickened posteriorly, having many transversely elongate pores; slit-rays never grooved, provided with a few large pores in rather irregular arrangement; insertion plate thick; teeth 15 in number, widely separated from one another, spongy in nature; eaves broad, spongy; posterior border of the tegmentum broadly reflexed.

Median valve oblong, slightly concave at the middle of the anterior edge, prominently beaked at the posterior end; surface smooth, slope nearly straight on either side, subcarinated at the ridge, lateral area not elevated, but trify distinctive by its peculiar pattern in the same manner as that of the head valve; megalaesthetes scattered quincuncially near the anterior border of this area; jugum not defined; central area broad, smooth, only roughened by several small pustules, arranged sparsely in a longitudinal series, traversed by some feeble lines of growth, foveolated near the outer corner except for the second valve, its whole surface finely woven by feeble threads in running longitudinally as well as transversely; central callus strongly developed in the middle of the interior of the valve, strikingly marked by a short groove at its front boundary; another callus distinct, bounding the anterior border of the lateral region with a shallow groove of the slit-rays in front of it; small area behind this callus provided with many, large, rather regularly arranged pores; two deep slits of the insertion plate widely separating teeth one from another; posterior border broadly reflexed; sutural laminae low, wide with round edge, continuous with each other; jugal sinus indistinct, very flat and narrow, divergency 130°.

Tail valve about semicircular in outline, its anterior edge nearly straight, but protruded a little at the middle; mucro prominent, not so much raised, directed anteriorly, situated at about the anterior third of the tegmentum, anterior area sculptured like a central area of the median valves; posterior slope straight, ornamented with elongate granules and black dots of megalaesthetes like the head valve. Mucronal region in the interior of the valve hollowed, with many pores in concentric arrangement; slit-rays shallowly grooved, provided several large pores; insertion plate thick, well developed, though very fragile, having 13 slits; sutural laminae low and flat, truncated at the anterior edge, connected with each other by a lamina, with a shallow sinus between them.

Tegmental surface of head valve, lateral areas of the median valves and posterior area of the tail valve equally tinted with flesh-pink; central

area marbled with longitudinal irregular lines of coral red on the ground colour of light-yellow; interior of valves all pinkish; perinotum of the girdle light-purplish-vanaceous or pale purple-drab in colour.

Perinotum of the girdle covered densely with long, sharply pointed spines of various length, brownish in colour with smooth surface, protruding at the periphery; hyponotum clothed with exceedingly minute scales of conic shape, obtusely pointed at the tip, strongly ridged in a longitudinal series of granules, standing upon the squarish, flat, thin basal plate with a shallow notch at the inner edge; small hyaline spinules seen at the periphery, distinctly striped with a few longitudinal lines.

Central tooth of radula oblong shaped, constricted a little near the tip, protruding at the anterior end, cusp with entire edge, base truncated, basal plate elongated triangular in shape; centro-lateral having a broad extension at the outer edge, slightly indented at the outer corner, somewhat sinuous at the anterior edge, inner edge almost straight with oblong basal plate; major lateral stout, tricuspidate, median cusp the strongest, shaft thickened at the tip with pointed process at the middle on the outside; inner small-lateral broad, delicate with low oblique ridge; major uncinus spoon shaped, cusped entirely, with stout, thick shaft on small basal plate; inner marginal elongate oblong, with well protruded central process; median marginal similarly shaped to the preceding one; outer marginal nearly squarish, truncated at the outer and the posterior edges.

Remarks: This species resembles much *Callochiton larvis* of Europe in many respects of the shell characters, in the girdle armatures and even in the colouration, though the latter has much more solid shells, more numerous slits in the insertion plate of the median valves, the distinctly raised lateral areas and sharply keeled shells.

It seems to me that *Spongioradsia aleutica* and *S. multidentata* are intimately related with each other in having very spongy eaves, two slits on each side of the median valves, the less elevated lateral area, the continuous sutural laminae, megalaesthetes on the surface of the valve and in small body size, while the present species is distinctive from the latter two in such characters as its well developed teeth of the valves, distinctly beaked median valves, position of the mucro in the tail valve, smoothness of girdle spines.

It seems to be natural to classify this species with the genus *Spongioradsia*, for the much fragile nature of the shell, very spongy eaves, number of slits of the median valves, though, it has, as noted above, some relationships to the genus *Callochiton*.

Spongioradsia was proposed by PILSBRY (1894) with the type of DALL's species *Trachyradsia aleutica* as a subgenus of the genus *Trachydermon* with some doubt in relation to the genus *Callochiton*.

THIELE (1929) ranked it as a subgenus of *Lepidochiton* under the subfamily Lepidochitoninae which is distinguished from Callochitoninae by the absence of the eyes on the shells, the separated sutural laminae and the comb-like cusp of the major uncinus.

It is easily recognized from the description of PILSBRY that the type of the group *Spongioradsia*, however, has numerous eyes on the shell and continuous sutural laminae, as he says that "the whole surface is obsoletely punctulated by the comparatively large megalaesthetes" and "the sinus, as in typical *Callochiton*, is bridged by a lamina extending across from one sutural lamina to the other". According to THIELE's system, as above mentioned, the group *Spongioradsia* is a member of the subfamily Callochitoninae, resembling *Callochiton* in having the continuous sinus, as pointed out by PILSBRY. Thus it seems to be reasonable to rank the group under the subfamily Callochitoninae.

Locality: Ôma Bay, Station 105, 1 specimen was collected by HÔZAWA, TAKATUKI and H. SATÔ in August, 1927, sp. no. 2196. Body length 6 mm.

Family 2 MOPALIIDAE

Genus MOPALIA GRAY 1847

7. *Mopalia hirsuta*, nov. sp.

Pl. XIV, fig. 11; Pl. XXI, figs. 2, 4-6; Pl. XXII, figs. 1-6; Pl. XXIII, figs. 12, 13.

Body small, elongate-oval in outline; shell strongly elevated with subcarinated ridge, coarsely reticulated on the whole surface; girdle narrow, setose with numerous, long setae, painted generally with brownish-red; it is one of the most beautiful species in the genus.

Head valve thin, smaller than the semicircle; apex indistinct; eight radiating series of regularly increasing tubercles arranged in correspondence with the slits; posterior edge wavy, but not strongly dentated by a similar series of tubercles; entire surface between these ray-ribs rather regularly sculptured by a reticulum of pitting and netting; all sculptures become obsolete toward the apex; eaves very short; teeth long and thick; slit deep, distinct, eight in number; interior of the valve smooth, shining without a callus; slit-rays not grooved, provided with a few minute pores.

Median valves oblong in shape, straight at the anterior edge, except

for the second valve, slightly beaked at the posterior border in the middle, much elevated, subcarinated at the dorsal ridge; side-slope straight; central area coarsely reticulated by radial and oblique riblets, which become obsolete toward the jugum; lateral area distinctly raised, bordered sharply from the central area by a strong diagonal rib, formed by the partial coalescence of large, somewhat elongate tubercles, sculptured with regular pittings and tubercles, arranged almost in a checker pattern, its posterior edge a little denticulated by tubercles; interior of the valve quite smooth, shining, without any distinct callus, but jugal region striated transversely by numerous fine threads; slit-ray grooved, provided with several small pores; tooth arising from short eaves, rather thin, well defined, but not sharpened at the edge; slit deep, rather narrow, one on each side.

Tail valve small, oval shaped, shallowly sinuated at the middle on both edges; mucro at about the posterior third of the tegmentum, slightly elevated, directed forward at the tip; diagonal ribs weaker than those of the median valves; front area sculptured more coarsely with relatively larger tubercles than in the intermediate valve; posterior area small with straight slope, strongly nodulose on the whole surface; interior of the valve strongly thickened at the posterior edge, at the central and the front calli, shallowly notched on either side; slit-rays inconspicuous, accompanied by a series of 4 or 5 elongate pores; jugal region marked with numerous transverse short lines; sutural laminae separated from each other by a deep narrow sinus, extending broadly forward, truncated sharply at the front edge.

Jugal and central areas of the tegmentum striped longitudinally with broad lines of sea-shell-pink or coral-red on the ground colour of light-buff; lateral area also similarly coloured except for the third valve, which retains alone the ground colour in correspondence with the light patches of the girdle, which is generally painted by salmon-colour or light-salmon-orange; interior of the valve light-sea-shell-pink at the central area, fading toward the periphery.

Girdle rather narrow, setose, deeply slit posteriorly; perinotum covered with numerous setae of various length, arranged with such regularity that the longest situated at the sutures and the ends of terminal valves, subsidiary setae placed at about the middle between the primary ones, and subsequent ones beset successively at the intermediate position between the preceding ones. Several long, slender, curved bristles imbedded nearly in their proximal half in a conchyolinous substance of the setae in a row for a fair distance from one another, tipped by a minute calcareous

spinules at distal ends, with small roots at the base. Solitary bristles found in a group near the margin of the perinotum, apparently at a young stage judging from its similarity to the long setae. Leathery surface of the perinotum composed of exceedingly minute, long, densely crowded scales, nearly cylindrical in shape with a small tip, strongly striated by a few longitudinal ribs; marginal spicules long, hyaline, smooth or obliquely striped on the surface with pointed tip; scales of the hyponotum elongate oval in shape, considerably minute, hyaline, striated with fine, rather irregular, longitudinal lines, having a tendency to become narrower toward the periphery.

Radula: central tooth with a broad, entire cutting edge at the tip, immediately behind of which strongly constricted, dilated at the middle, and again narrowing backwardly with a truncated posterior edge; centro-lateral broadly extended outwardly so as to form a conspicuous wing at the outer margin, straightened at anterior and inner edges, alated a little at the outer corner, basal plate oblong shaped; major lateral tricuspid, with the strongest cusp at the middle, the smallest at the out side, cusps all long and sharp at the tip; shaft thick, slightly dilated at the outer margin with a small process at the anterior end, ridged remarkably in two rows at the back; major uncinus long spoon shaped, with a broad, entire, sharp cutting edge and small basal plate; inner and median marginals elongate oblong in outline; outer marginal squarish, slightly longer than wide, straight at the front as well as at the outer edge, protruding at about the middle on the inner margin.

Ctenidia merobranchial abanal extending from the third valve to the eighth valve, with 24 gills on one side.

Size and divergency; Body length 9 mm, divergency 105°.

Remarks: This species is sufficiently distinct from *Mopalia middendorffi* in many particulars as having the coarse sculpture of the tegmentum, the denticulated posterior margin of the valves, an acute divergency of the median valves, a small calcareous tip of bristles in the girdle, a minute, strongly ridged scales on the perinotum and the more elongate body, and from *Mopalia schrencki*, *M. retifera*, *M. ciliata* and *M. wosnessenski* as having coarse sculpture and reddish colouration, an acute divergency of the median valves, although much related to *M. middendorffi* in colouration, in arrangement of bristles, in shape of the scales on the perinotum and also to *M. schrencki* in structure of the bristles.

As is seen from the above remarks, this can not be referred to any of the known species of the genus, and I do not hesitate to make it a

new species.

Locality: Off Syukunobe, in the line drawn between Benten and Kurosaki, station 63 (V); 1 specimen was collected by HÔZAWA and KOKUBO on August 10, 1926; sp. no. 669.

Genus PLACIPHORELLA (CARPENTER) DALL 1878

Placiphorella

DALL (1878) Proceedings of the United States National Museum, Vol. 1, p. 303, 306 (CARPENTER MS.).

Langfordiella

DALL (1925) Nautilus, Vol. 38, No. 3, p. 96.

8. *Placiphorella stimpsoni* (GOULD, 1895)

Pl. XIV, figs. 13, 17; Pl. XXI, figs. 3, 7-9; Pl. XXII, figs. 7-15.

Chiton (Molpalia) stimpsoni

GOULD (1859) Proceedings of the Boston Society of Natural History, Vol. 7, p. 165.
— (1860) Otia Conchologica, p. 118; Hakodate Bay.

Mopalialia stimpsoni

DUNKER (1882) Index Molluscorum Maris Japonici, p. 158; Loochoo.

Placiphorella stimpsoni

DALL (1886) Proceedings of the United States National Museum, Vol. 9, p. 210.
PILSBRY (1892) Manual of Conchology (1), Vol. 14, pp. 307-309, pl. 62, figs. 84-87.
— (1895) Catalogue of the Marine Mollusks of Japan, p. 115.
PLATE (1901) Zoologische Jahrbücher, Supplement-Band 5, Fauna Chilensis, Bd. 2, S. 300-307, Taf. 13, Fig. 321-327.
NIERSTRASZ (1905) Siboga-Expeditie, Monographie 48, S. 48.
PELSENEER (1906) Mollusca in LANKESTER'S Treatise on Zoology, Part 5, fig. 32 (figure after PLATE on page 49).
THIELE (1909) Zoologica, Bd. 22, Heft. 56, S. 4, 7.
BERRY (1917) Proceedings of the United States National Museum, Vol. 54, No. 2223, pp. 12-13, pl. 8, figs. 1, 2; pl. 9, figs. 1-8.
DALL (1921) Smithsonian Institution United States National Museum, Bulletin 112, p. 197; Bering Is.; Lower California.
THIELE (1929) Handbuch der systematischen Weichtierkunde, Teil 1, S. 11, Fig. 4.
KIKUTI, K. (1931) Toyamawan Nantaidôbutu Mokuroku (Catalogue of Mollusca of Toyama Bay), p. 1, no. 2.
YAGURA, W. (1932) Hyôgokensan Kairui Mokuroku (Catalogue of Mollusca of Hyôgo Prefecture), p. 20, no. 243.
TAKI, IWAÔ (1932) Memoirs of the College of Science, Kyoto Imperial University, Ser. B, Vol. 8, No. 1, pp. 33-42, Figs. 13-28, plate 2, figs. 4-6.
HIRASE, S. (1934) A Collection of Japanese Shells, pl. 55, fig. 2, p. 30.
KURODA, T. (1935) Miyazaki-Kensan Kairui Mokuroku (Catalogue of Mollusca of Miyazaki Prefecture), p. 39, no. 1.
TAKI, IWAÔ (1936) Onomiti Kinkai Nantaidôbutu Mokuroku (Catalogue of Marine

Mollusca around the Onomiti Marine Biological Station), p. 1, no. 4.

TAKI, ISAO (1936) Saitô Hô-onkai Hakubutukan Zihô (Proceedings of Saitô Hô-on-Kai Museum), No. 13, no. 10.

Placiphorella sp.

TAKI, ISAO (1924) Dôbutugaku Zassi (The Zoological Magazine), Vol. 36, no. 429, pp. 286-287, 1 text-figure.

HIRASE, S. (1927) Nippon Dôbutu Zukan (Figures and Descriptions of Japanese Animals), p. 1501, fig. 2885.

YAGI, S. (1931) Ehimeken Dôbutu Si (Catalogue of Animals from Ehime Prefecture), p. 67, no. 739.

ASANO, H. (1933) Bunrui Suisan Dôbutu Zusetu (Systematic Illustrations of Freshwater and Marine Animals), p. 253, fig. 351.

NOMURA, H. and H. TUNODA (1933) Saitô Hô-on-Kai Hakubutukan Zihô, special no. 3, p. 19, no. 195.

Langfordiella japonica (full grown form, without tail slits)

DALL (1925) Nautilus, Vol. 38, p. 96.

TAKI, ISAO (1928) Venus, Vol. No. 1, pp. 41-42.

THIELE (1929) Handbuch der systematischen Weichtierkunde, Teil 1, S. 11.

Placiphorella blainvillei BRODERIP } (incorrectly referred to)

Placiphorella petasus ADAMS et REEVE }

THIELE (1893) Das Gebiss der Schnecken, Bd. 2, S. 397, Taf. 32, Fig. 24, 25.

Body of large to medium size, broadly ovate in outline; shell depressed, subangular at the ridge, with straight side slopes; girdle of unequal breadth, being much extended anteriorly.

Head valve thick, stout, narrowly crescentic with an indistinct apex, concentrically striated on the tegmental surface, but lacking all radiating sculpture; interior of the valve smooth, unusually thickened anteriorly; slit-lays inconspicuous; teeth remarkably thick, short, strongly pectinated irregularly; slit 8 or more.

Median valve oblong in outline, exceedingly wider than long, subcarinated at the jugum, not beaked posteriorly, almost straight at the front edge; lateral areas usually distinct, slightly elevated, bordered by inconspicuous low diagonal and sutural ribs; the space between ribs smooth, slightly concave; interior of the valve smooth, not distinctly callused; slit-lays not defined; slit narrow; teeth thick and short, obtuse at the edge, slightly pectinated on the outer surface, rising from narrow eaves; posterior edge widely reflexed; sutural laminae very wide, thick, nearly straight and sharp at the front edge; incised by a shallow, v-shaped sinus.

Tail valve small, depressed, its greatest width, including insertion and sutural-plates, measuring hardly more than half the width of the widest median valves; anterior edge regularly arched with a slight sinuation at the posterior end in the middle; mucro lies near the posterior margin;

central area occupies the greater part of the tegmentum, flat but roughened by irregular lines of growth, bordered posteriorly by fairly prominent diagonal rim in the median valves due to its inward reflexion; insertion-plate very short, rising from a heavy callous rim, having one oblique slit on each side and faint waving along the posterior margin; sutural laminae broad, smooth, flat, sufficiently expanded anteriorly, truncated at the front edge, deeply cut into two halves by a narrow sinus.

Girdle unequal in breadth around the valves, being much wider anteriorly; perinotum sparsely beset with exceedingly minute spinules which are sharply pointed and deeply striated at the tip, measuring $30\ \mu$ in length; large bristles at the suture and the margin, intermingling a number of small ones; all the bristles composed of small spinules, which are pointed at the tip and with a small root at the base, light brownish in colour, densely arranged in oblique series around the axis like the arrangement of shoots of plants; marginal spines long, hyaline, sharp at the tip, faintly striped nearly throughout the entire length, with a small root at the base, measuring $130\text{--}160\ \mu$ in length; hyponotum having much developed pallial fold, deeply incised at the posterior end, extending forwardly so as to form several tentacular processes, its entire surface densely covered with hyaline, long, smooth, pointed spinules, measuring $80\text{--}100\ \mu$ in length, the peripheral ones being nearly equal to the marginal spines in length.

Radula typically mopalioid; central tooth oblong in outline, slightly sinuated at the middle on both sides, nearly straight at the front end with well developed cusp, trilobular at the posterior end; centro-lateral having very broad wing at the outer edge, slightly reflexed at the outer corner, weakly sinuated at the anterior edge, inner margin much curved, basal plate elongate-oblong; shaft of the major-lateral thick and stout, strongly ridged at the outer margin with a broad wing at the base, inner edge nearly straight and smooth, dorsal ridges forming two distinct processes, cusp small, cut into three denticles almost in equal size; inner small-lateral broad, very much elevated near the inner edge to articulate with the dorsal process of the major-lateral; major-uncinus spoon shaped, slightly curved at the base with a elongate basal plate, cusp arched, entire, sharp; inner-marginal elongate oval shape with a strongly developed triangular process at about the middle; median-marginal squarish in shape, slightly sinuate in front, protruding at the posterior edge.

Colouration of valve whitish along the middle, the side slopes mottled and streaked with greenish-yellow, olive and blue or olivaceous and orange-ash, thus giving a general effect of dark olivaceous; interior of the valves

bluish-green or nearly white on the whole surface.

Ctenidia holobranchial abanal, extending along the entire length of the foot, about 26 on each side; a specimen of 29 mm in length has 15 to 19 gills on one side.

Size

BODY		SHELL		
LENGTH	BREADTH	LENGTH	BREADTH	DIVERGENCY
18 mm	14 mm	13 mm	10 mm	128°
22	18	16.5	13	137°
27	22	19	15.5	138°
33	24	24	18	138°
36	24	26	19	134°
—	29	28	23	140°
—	29	28	23	137°
42	33	30	23	136°
56	32	34	24	140°

Remarks: GOULD first described this species under the name *Chiton stimpsoni* basing on the small specimens collected by STIMPSON from Hakodate Bay at the depth of 25 fathoms. THIELE figured the radula of this species under the erroneous name *Placiphorella blainvillei* and *P. petasus*, both collected from Japan, and later corrected the mistakes in his enormous work entitled "Revision des Systems der Chitonen". PLATE (1901) gave details of the anatomical structure of this species from the material taken from Hakodate, and the excellent descriptions are given of some characters of shell by PILSBRY (1892) and that of the girdle and the radula by BERRY (1917) from the study of the alcoholic specimens collected by the "Albatross" from Hakodate.

DALL established new genus *Langfordiella* with the type *L. japonica*. Examination of the type specimen, this species agrees completely with *Placiphorella stimpsoni* in all characters except for the slits of the tail valve. The young specimens of this species have a distinct slit on each side of the tail valve. But the slit dwindles as it grows older and moreover as the surface of the insertion plates becomes much wavy so as to form an

irregular pectination, the slit disappears into the waves. PLATE (1901, p. 301) states that the slit is not always present in the tail valve of this species. Therefore the presence or absence of the slit in the tail valve loses its significance as the criterion to distinguish these two forms.

In 1926 I sent the late Dr. DALL of Smithsonian Institution specimens collected from Ehime and Kanagawa Prefectures, asking his opinion as to whether his new species might be referable to *P. stimpsoni* of GOULD.

His reply was "it is evident from the specimens that you are right in identifying your species with GOULD's *P. stimpsoni*, and in showing (which my *Langfordiella* specimens did not do) the variation in the condition of the tail valve". DALL's new form and GOULD's species can not be denied to be synonymous.

THIELE (1929) ranked *Langfordiella* as a subgenus of *Placiphorella*, although it is much more reasonable to make the former as a synonym of the latter by reason of the evidence given above.

Locality

SP. NO.	STATION	LOCALITY	COLLECTOR	DATE	NUMBER OF SPECIMEN
671	74 (III)	off Karibazawa	KOKUBO and KAMADA	Aug. 22, 1926	1
677	45 (III)	off Tubakiyama	HOZAWA and TAKATUKI	Aug. 2, 1926	3
1730		off Kanida	TAKATUKI	July 23, 1927	2
1757		off Hiradate	TAKATUKI and SATO	July 24, 1927	1
2428	116	off Huzisima	HOZAWA	July 22, 1929	1
		Asamusi	IW. TAKI	Aug. 9, 1930	1
					Total 10

Distribution:

Pacific coast

Hokkaidô: Akkesi (collected by HADA and OKUDA). Hakodate (STIMPSON coll., GOULD described, PLATE, DALL, PILSBRY, DUNKER, BERRY). Tugaru Straits (PLATE, collection by the "Sôyô-maru", Station no. 654).

Honsyû: Hirotamura, Kesen-gun; Miyako; Sakiyamamura, Simohei-gun (collected by G. TOBA), Iwate-prefecture. Onagawa Bay (collection at the Onagawa Marine Laboratory), Miyagi-prefecture. Onahama (NOMURA and TUNODA; TAKI), Hokusima-prefecture. Minato

(SASAMOTO), Ibaragi-prefecture. Emi; Nemoto (DALL, LANGFORD); Hôzyô (Y. OKADA and K. BABA), Tiba-prefecture. Misaki (TAKI) Kanagawa-prefecture. Okitu (A. HUZITA coll.); Kawana, Tagata-gun (Y. OKADA coll.), Sizuoka-prefecture. Seto (IWAO TAKI coll.); Sirasaki-mura, Hidaka-gun (K. KANDA coll.), Wakayama-prefecture. Kyûsyû: Nangô (KURODA), Miyazaki-prefecture. Tomioka, Amakusa (Y. OKADA and BABA coll.), Kumamoto-prefecture.

Inland Sea:

Honsyû: Awazi (YAGURA, collected by TAKASE and MORITA); Settu; Harima (YAGURA), Hyôgo-prefecture. Onomiti (collection at the Onomiti Marine Laboratory). Hiroshima-prefecture.

Sikoku: Mitu (TAKI); Tikami (YAGI), Ehime-prefecture.

Coast of Japan Sea: Mutsu Bay, Aomori-prefecture. Sado (K. KIKUTI coll.), Niigata-prefecture. Himi; Abugasima (K. KIKUTI coll.), Toyama-prefecture. Torii-mura, Annô-gun, (TAKAGI coll.), Simane-prefecture. Hukuoka (K. BABA coll.), Hukuoka-prefecture.

Pacific coast of North America:

Bering Islands to Cerros Island, Lower California (DALL).

Family 3 CRYPTOPLACIDAE

Subfamily A ACANTHOCHITONINAE

Genus ACANTHOCHITON GRAY 1821 (ACANTHOCHITONA)

9. *Acanthochiton rubrolineatus* (LISCHKE, 1873)

Pl. XV, fig. 1; Pl. XXIII, figs. 1-6; Pl. XXIV, figs. 1-2; Pl. XXV, figs. 17, 18.

Chiton rubro-lineatus

LISCHKE (1873) Malakozoologische Blätter, Bd. 21, S. 24.

— (1874) Japanische Meeres-Conchylien, Teil 3, S. 73-74, Taf. 5, Fig. 12; Nagasaki.

Acanthochiton rubro-lineatus

DUNKER (1882) Index Molluscorum Maris Japonici, p. 160.

Acanthochiton rubrolineatus

THIELE (1893) Das Gebiss der Schnecken, Bd. 2, Lfg. 8, S. 399, Taf. 32, Fig. 32.

YAGURA (1932) Hyôgokensan Kairui Mokuroku, p. 20, no. 245; Awazi.

BERGENHAYN (1933) Kungl. Svenska Vetenskapsakademiens Handlingar, Bd. 12, No. 4, S. 45; Misaki, Sagami.

TAKI, IW. (1936) Onomiti Kinkaisan Nantai-Dôbutu Mokuroku, p. 1, no. 7; Onomiti.

TAKI, IS. (1936) Saitô Hôonkai Hakubutukan Zihô, No. 30, p. 1, no. 7; Matusima Bay; Matugahama; Kinkazan; Amizisima; Onahama; Yunosima, Mutsu Bay; Taneiti, Iwate Pref.

Acanthochites rubrolineatus

PILSBRY (1893) Manual of Conchology, Vol. 15, p. 18, pl. 2, fig. 50; Nagasaki.

- PILSBRY (1895) Catalogue of the Marine Mollusks of Japan, p. 115.
 NIERSTRASZ (1905) Die Chitonen der Siboga-Expedition, S. 50.
 THIELE (1909) Zoologica, Bd. 22, Heft 56, S. 46, Taf. 6, Fig. 14-17; Enosima, Sagami Bai; Hakodate; Nagasaki; Tsingtau; Tschifu.

Acanthochitona rubrolineata

KURODA (1935) Miyazakikensan Kairui Mokuroku, p. 39, no. 3; Aosima.

Acanthochiton zealandicus

THIELE (1893) Das Gebiss der Schnecken, Bd. 2, Lfg. 8, S. 399, Taf. 32, Fig. 33, Nagasaki.

Body oblong-ovate in outline; medium sized; shell rather small, convex at the jugum; girdle not so much broader than median valves, beset with 18 hair-tufts, generally dark blackish-green in colour.

Head valve larger than semicircular, regularly convexed with flattened apex, slightly waved at the anterior margin; posterior edge slightly sinuated at the middle, provided with numerous, closely set, flat, oval granules; interior of the valve smooth with a well developed callus in the middle; teeth long, slightly wrinkled on the outer surface, shallowly incised by 5 small slits; posterior margin broadly reflexed.

Median valve trapezoid in shape, its breadth much broader than length, nearly straight at the anterior edge, well beaked at the posterior edge, regularly arched on both sides; jugum not sharply demarcated from pleuro-lateral areas, sculptured with fine, longitudinal wrinkles; pleuro-lateral area ornamented with numerous small, oval granules; sutural laminae rather short, extending forwardly; sinus deep, moderately wide; teeth thick, long, having a slit on each side; interior of the valve smooth, thickened at the middle.

Tail valve nearly straight at the anterior margin, vaulted at the jugum, strikingly arched at the posterior margin; mucro lies a little behind the centre; central area sculptured like that of the median valves; posterior slope somewhat convexed, granulated likewise the head valve; sutural laminae short, truncated at the anterior edge; sinus wide, flat; posterior margin of insertion plate sinuated at the middle.

Girdle covered densely with brownish smooth spinules, 20-30 μ long, intermingling with long, slightly curved, finely striped, sharply pointed spines, measuring 350 μ or more in length; hair-tufts very marked; bristles long, acute, hyaline or dark brown, over 1.5 mm in length; marginal spicules straight, nearly smooth, hyaline or brownish, somewhat longer than those of perinotum (length 430 μ); hyponotum clothed with small, hyaline spinules, measuring 100 μ or more.

Radula: Central tooth oblong shaped, truncated at the anterior end,

serrated at the posterior end; centro-lateral square, with a small outer process at the anterior corner, a broad outer lamella at the posterior corner, weakly cusped at the anterior edge; the middle of three cusps of major lateral is the largest, its shaft stout with a short outer wing at the anterior end, a small outer process near the base; major uncinus moderately arched, with a small cusp at the front end; three marginals elongate oblong in shape; outer marginal strikingly thickened at the inner edge.

Ctenidia holobranchial with a small space between the posterior gill and the anus, ranging in correspondence with from the 4th to the tail valves, counted 21 or 22 branchiae on each side in a specimen measuring 27 mm in length.

Colouration: Shells of the type is fresh-gray coloured, maculated here and there with brown, nearly whitish on the 5th, 6th, 7th and a part of the 4th valves; much reddish on the 2nd valve; another valves are generally dark reddish-brown, having a wedge-shaped olive spot which is separated by a whitish longitudinal line in the middle of the 2nd, 3rd and 4th valves, and painted obliquely by longitudinal red lines.

There are many varigated specimens in this species, for example, the girdle is yellowish throughout with white hair-tufts, uniformly brownish, dark brownish or dark greenish, and the shells are brownish with the dark longitudinal bands on the lateropleural areas as well as at the boundaries of the jugum, freckled with dark brown on the pale ground colour, or painted thoroughly with dark green; the interior of the valves

Locality

SP. NO.	STATION	LOCALITY	COLLECTOR	DATE	NUMBER OF SPECIMEN
684	26 A (I)	Hutagozima	HOZAWA and ITO	July 9, 1926	3
1885		Tutiya	TAKATUKI and SATO	July 29, 1927	3
1921	26 (II)	Hutagozima	HOZAWA and KOKUBO	Aug. 10, 1927	1
2052	102	Takaisozaki	HOZAWA and TAKATUKI	Aug. 17, 1927	1
2477	117	Tappiobisima	HOZAWA	July 22, 1929	1
—	—	Asamusi	Iw. TAKI	Aug. 7, 1930	2
—	—	Aburamegasaki	Iw. TAKI	Aug. 8, 1930	14
—	—	Asamusi	Iw. TAKI	Aug. 9, 1930	8
—	—	Mourazima	Iw. TAKI	Aug. 10, 1930	10

is pale blue and dark at the middle.

Size: length 24 mm, breadth 20 mm (LISCHKE)
 „ 27 mm, „ 13 mm (MUTSU BAY)

Remarks: The specimen which had been kept in the Löbbeck Museum was lost. THIELE (1909), however, examined several specimens from Japan and single specimen, supplied by the same museum, which he considered to be the original specimen from the type locality. According to him the distinguishing characters of this species are that the median valve is much broader than long and is nearly equal in width to that of the girdle; the mucro of the tail valve is situated at about the middle, spines of the girdle are acute at the tip with fine striations over half the length.

Distribution:

Pacific coast

Hokkaidô: Muroran (1) (EMURA); Hakodate (2) (THIELE, IW. TAKI).
 Honsyû: Taneiti (3), Miyako (4) (TOBA), Iwate Pref. Onagawa (5) (IMAI); Kinkazan (6) (TAKI); Matusima Bay (7) (TAKEWAKI), Miyagi Pref. Onahama (8) (TAKI), Hukushima Pref. Hutomi (9) (HIRASE), Tiba Pref. Yokohama (10) (TAKI), Misaki (11) (TAKI, BERGENHAYN); Kamakura (12) (INAZAWA); Enosima (13) (THIELE, TAKI), Kanagawa Pref. Simoda (14) (KANEKO), Sizuoka Pref. Ôsima (15) (ÔYAMA, YAMAMURA). Toba (20) (MORITA YAMADA), Mie Pref. Seto (21) (TAKI); Kada (22) (KANDA), Wakayama Pref.
 Sikoku: Kasiwazima (25) (SUGIMOTO), Kôti Pref.
 Kyûsyû: Aosima (26) (KURODA), Miyazaki Pref. Natui, Sibusi Bay (27) (HARA); Kagosima Bay (28) (IW. TAKI), Kagosima Pref.

Inland Sea:

Honsyû: Awazi (30) (YAGURA, MORITA), Hyôgo Pref. Onomiti (31) (IW. TAKI); Uzina (32) (TAKI), Hiroshima Pref.
 Sikoku: Mitu (33) (TAKI), Ehime Pref.
 Kyûsyû: Sirako (34) (TAKAGI), Ôita Pref.

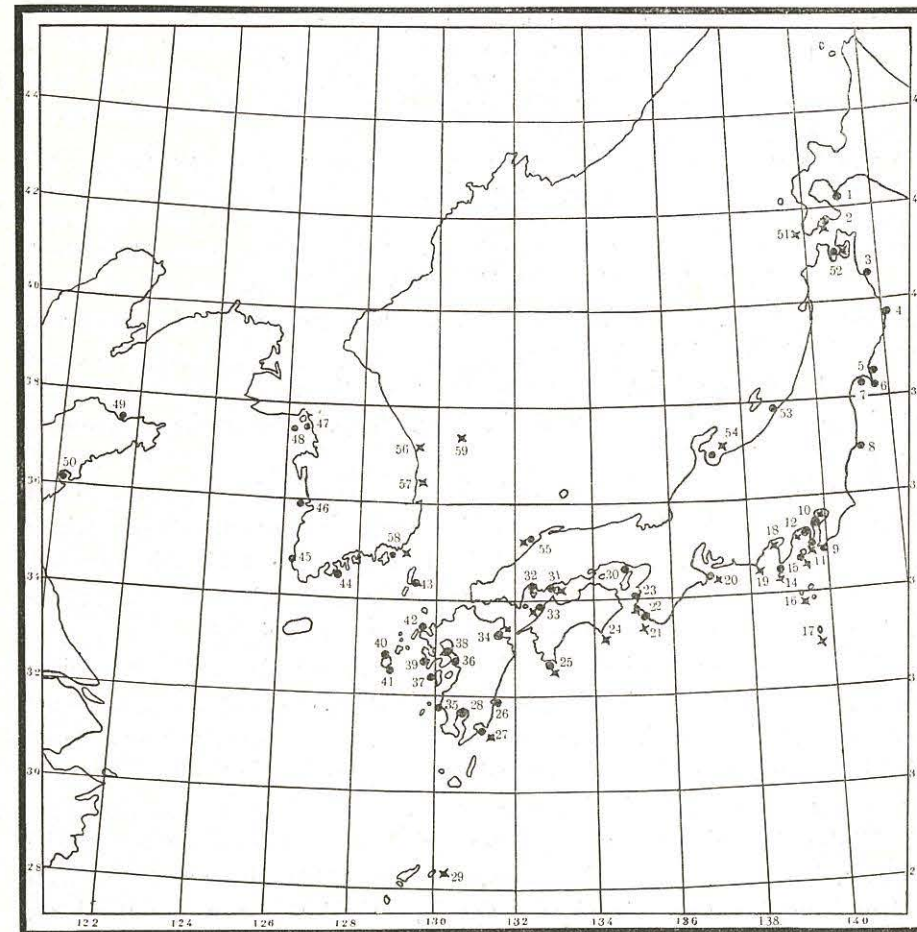
Western coast:

Kyûsyû: Akune (35) (MITUKURI), Kagosima Pref. Hyakkanisi (36) (IW. TAKI); Amakusa (37) (BABA), Kumamoto Pref. Nisiariie (38) (SIKI); Nagasaki (39) (LISCHKE, DUNKER, THIELE, SONEHARA); Kisyuku (40) (YOSIDA); Tomie (41) (ÔGA), Hukuezima; Sanri, Takanosima (42) (HIROYAMA); Ituhara, Tusima (43) (EGUTI); Nagasaki Pref.
 Tyôsen: Reisui (44) (OKUDA); Moppo (45) (RA); Gunzan (46) (OKUDA); Zinsen (47) (MORI, KAMITA); Tokutumisima (48) (KAMITA).

China: Tschifu (49), Tsingtao (50) (THIELE).

Japan Sea:

Honsyû: Mutsu Bay (52), Aomori Pref. Niigata (53) (EMURA), Niigata Pref. Toyama Bay (54) (KIKUTI), Toyama Pref. Toriimura, Annôgun (55) (TAKAGI), Simane Pref.
 Tyôsen (Korea): Husan (58) (YOSIDA).



Text-fig. 1. Geographical distribution of *Acanthochiton rubrolineatus* (LISCHKE) (•) and *Acanthochiton achates* (GOULD) (×).

10. *Acanthochiton achates* (GOULD, 1859)

Pl. XV, fig. 2; Pl. XXIII, figs. 7-11; Pl. XXIV, figs. 3-7.

Chiton (Acanthochaetes) achates

GOULD (1859) Proceedings of the Boston Society of Natural History, Vol. 7, p. 165.

— (1862) Otia Conchologica, p. 118; Kikaia and Hakodate Bay.

Acanthochiton achates

DUNKER (1882) Index Molluscorum Maris Japonici, p. 160.

Acanthochites achates

PILSBRY (1893) Manual of Conchology, Vol. 15, pp. 18-19.

— (1895) Catalogue of the Marine Mollusks of Japan, p. 115.

NIERSTRASZ (1905) Die Chitonen der Siboga-Expedition, S. 59.

THIELE (1909) Zoologica, Bd. 22, Heft 56, S. 46-47, Taf. 6, Fig. 18-23; Hakodate.

Acanthochites subachates PILSBRY, MS.

TAKI, Is. (1923) Dôbutugaku Zassi, Vol. 36, pp. 288-289, 1 text-fig.; Misaki, Sagami.

BABA (1929) Dôbutugaku Zassi, Vol. 41, p. 112, pl. 1, fig. 1. D.

Acanthochiton sagamicus

BERGENHAYN (1933) Kungl. Svenska Vetenskapsakademiens Handlingar, Bd. 12, No. 4, S. 43-45, Taf. 1, Fig. 14, Text-fig. 14; Misaki, Sagami.

Shell narrow, elliptical in outline; girdle wide, provided with short, unequal spines and bunches of spicules.

Head valve semioval, finely granulated on the surface, nearly straight at the posterior edge; teeth thick, long, sharp, roughened on the outer surface; slit deep, 5 in number.

Median valve trapezoid or scale-shaped, strongly beaked; jugum not so distinctly bordered, weakly provided with longitudinal striation which give a moniliform appearance near the boundaries on both sides; latero-pleural area finely ornamented with elongate oval granules; sutural laminae widely protruding anteriorly; sinus deep with rounded base.

Tail valve very small compared with the size of the body, elliptical in shape, exceedingly broader than long, nearly straight at the anterior edge; mucro flat, subterminal, posterior area small, steep; posterior margin of the articulamentum straight; sutural laminae large, strikingly extending anteriorly with truncated edge in front.

Girdle covered densely with large and small spines, large ones spindle shaped, hyaline or yellowish brown, sometimes blue or bluish green in colour, conspicuously striated near the tip, with chitinous cup at the base, measuring 420-500 μ in length; small spines smooth, sharply pointed at the tip, hyaline or yellowish brown, being 70-120 μ long; marginal spines straight, nearly smooth, usually hyaline, pointed at the tip with chitinous cup at the base, attaining 550 μ in length; spinules of hyponotum somewhat flattened spindle shape, hyaline, measured 60-120 μ in length; spicules

of hair-tuft thin, long, acute at the tip, hyaline or yellowish or bluish in colour, 1.2-1.8 mm in length.

Colouration: shell generally dark brown or sooty in colour; median valve having usually 1 or 3 whitish or yellowish streaks on the jugal tract, sometimes provided with small white freckles on the lateral regions; interior of valves glaucous, sometimes reddish or brownish at the middle; girdle usually dark brown or dark blue, sometimes variegated; hair-tufts white or yellowish or brownish in colour.

Radula: central tooth oblong, slightly constricted at the middle on both sides, roundly arched and slightly cusped at the anterior edge, somewhat pointed at the base; centro-lateral squarish, having small outer process at the anterior corner, exceedingly broad outer lamella and small cusp at the anterior edge; major lateral tricuspid, its shaft thick, with rounded inner wing at the anterior end, outer wing very small; major uncinus long, stout with small cusp and large basal plate; outer marginal oblong, thickened at the inner margin.

Ctenidia holobranchial with a small space between the gill and the anus, extending in correspondence with from the 3rd valve to the tail valve or occupying 5/6 the entire length of the foot, 30 gills on each side in the specimen measuring 27 mm in length, 35 in the specimen 30 mm long.

Size: length	22 mm,	breadth	12 mm.
	„ 27 mm,	„	15 mm
	„ 30 mm,	„	20 mm
	„ 31 mm,	„	17 mm
	„ 32 mm,	„	20 mm

Remarks: This species bears so strong a resemblance to *A. rubrolineatus* that even a sensible taxonomist sometimes fails to distinguish them. The following features may be a helpful guide to the clear distinction between them. In the present species, 1) the tegmental granulations are usually finer; 2) the median valves are much more beaked posteriorly; 3) the sutural laminae are longer and more protruded anteriorly; 4) the tegmental area of the tail valve is much smaller with a subterminal mucro; 5) spines of girdle are much thicker and longer, with distinct striations near the tip.

BERGENHAYN (1933) described *Acanthochiton sagamicus* from Misaki, Kanagawa Prefecture and myself (1923) reported a species under the manuscript name "*Acanthochites subachates*" from the same locality. Both forms would fall into *A. achates* of GOULD in all respects.

Locality: 5 specimens were collected by IW. TAKI at Mourazima on August 10, 1930.

Distribution:

Pacific coast

Hokkaidô: Hakodate (2) (GOULD, THIELE).

Honsyû: Miyako (4) (TOBA), Iwate Pref. Tôkyô Bay (10) (TAKI), Tôkyô Pref. Zyôgasima (11) (TAKI), Misaki (11) (TAKI, BERGENHAYN), Kamakura (12) (TAKI), Enosima (13) (TAKI), Kanagawa Pref. Simoda (14) (KANEKO); Okitu (18) (A. HUZITA); Omaezaki (19) (A. HUZITA); Sizuoka Pref., Ôsima (15) (YAMAMURA); Kamizusima (16) (MIYAZI); Hatizyôzima (17) (T. HUZITA), Izu Sinitô. Toba (20) (YAMADA), Mie Pref. Seto (21) (TAKI); Gobô (22) (OKAMOTO), Wakayama Pref.

Sikoku: Murotozaki (24) (HIRO); Kasiwazima (25) (SUGIMOTO), Kôti Pref.

Kyûsyû: Natui, Sibusi Bay (27) (MITUKURI).

Amami Syotô: Kikaizima? (29) (GOULD).

Inland Sea:

Honsyû: Onomiti (31) (TAKI), Hirosima Pref.

Sikoku: Mitu (33) (TAKI), Ehime Pref.

Kyûsyû: Sirako (34) (K. TAKAGI), Ôita Pref.

Japan Sea:

Hokkaidô: Hukuyama (51) (T. KINOSITA).

Honsyû: Mutsu Bay (52), Aomori Pref. Toyama Bay (54) (KIKUTI).

Tyôsen (Korea): Urutin (56) (TODA), Kôgendô; Kyûryûho (57) (HATAKEDA), Keisyôhokudô; Husan (58) (YOSIDA), Keisyônandô;

Uturyôtô (59) (SUGIYAMA).

Subfamily B CRYPTOPLACINAE
Genus CRYPTOPLAX BLAINVILLE 1818

11. *Cryptoplax japonica* PILSBRY 1901

Pl. XIV, fig. 15; Pl. XXIV, figs. 8, 9; Pl. XXV, figs. 1-5, 19-21.

? *Chitonellus fasciatus*

TAPPARONE-CANEFRI (1874) Zoologia del Viaggio Intorno al Globo della Regia Fregata Magenta, Malacologia, p. 178; Japan.

Chitonellus larvaeformis

THIELE (1893) Das Gebiss der Schnecken, S. 400, Taf. 32, Fig. 36; Hakodate (HILGENDORF).

Cryptoplax japonicus

PILSBRY (1901) Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 53, p. 204; Hirado (HIRASE).

HIRASE, Y. (1907) Catalogue of Marine Shells of Japan, p. 12, no. 1177 a; Hirado, Hizen.

TAKI, IS. (1924) Dôbutugaku Zassi, Vol. 36, No. 429, pp. 287-288, 1 text-fig; Misaki, Sagami.

— (1929) Venus, Vol. 1, pp. 108, 116, fig. 54.

BABA, K. (1929) Dôbutugaku Zassi, Vol. 41, No. 485, pp. 112-114, text-figs. III, 1-5.

KUSE, Y. (1930) Tatugahama Kinkaisan Kairui Mokuroku, p. 12, no. 181.

GISLÉN, T. (1931) Journal of the Faculty of Science Imperial University of Tokyo, Sect. 4, Vol. 2, Part 4, pp. 433, 441; Misaki.

BERGENHAYN (1933) Kungl. Svenska Vetenskapsakademiens Handlingar, Bd. 12, No. 4, S. 52-54, Taf. 1, Fig. 19, Text-fig. 17 a, b, d-f; Misaki, Sagami.

Cryptoplax japonica

THIELE (1909) Zoologica, Bd. 22, Heft 56. S. 4, 8, 54-55, Taf. 6, Fig. 95-96; Hakodate (HILGENDORF).

HIRASE, Y. (1910) Nippon Senkai Mokuroku, p. 23, no. 497; Hizen.

TAKI, IS. and IW. TAKI (1930) Venus, Vol. 2, No. 3, pp. 101, 103.

YAGI, S. (1931) Ehimeken Dôbutusi, p. 67, no. 729; Tikami.

KIKUTI, K. (1931) Toyamawan Nantaidôbutu Mokuroku, p. 2, no. 4; Takosima; Noto.

HIRASE, S. (1934) Collection of Japanese Shells, p. 55, fig. 4.

KURODA, T. (1935) Miyazakikensan Kairui Mokuroku, p. 39, no. 4; Aosima.

TAKI, IW. (1936) Onomiti Kinkaisan Nantaidôbutu Mokuroku, p. 1, no. 8.

Cryptoplax rhodoplax

PILSBRY (1901) Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 53, p. 20; Hirado (HIRASE).

HIRASE, Y. (1907) Catalogue of Marine Shells of Japan, p. 12, no. 1177 b; Hirado, Hizen.

— (1915) Conchological Magazine, Vol. 4, pl. 1, fig. 6.

THIELE (1909) Zoologica, Bd. 22, Heft 56, S. 55, Taf. 6, Fig. 90-94; Hirado (HIRASE); Hakodate (HILGENDORF); Enoshima (DÖDERLEIN); Nagasaki (BUNGE).

YAGURA (1916) Hyôgokensan Kairui Mokuroku, p. 2, no. 716, Awazi.

YAGI, S. (1931) Ehimeken Dôbutusi, p. 67, no. 730; Tikami.

YOKOYAMA (1931) Catalogue of Marine, Freshwater and Land Shells of Japan, p. 16, no. 467; Iyo.

Cryptoplax japonica rhodoplax

KANAMARU (1932) Venus, Vol. 3, No. 5, p. 237, no. 44; Simoda.

Body large, elongate vermiform, nearly equal in breadth throughout the entire length; four anterior valves usually, sometimes three anterior only imbricated, four posterior separated each other with short intervals, of which the spacing between the 5th and the 6th is the longest, between the 7th and the tail valve the shortest; girdle wide, brownish yellow in colour, banded transversely with dark brown.

Head valve: tegmentum somewhat longer than wide, ornamented with elongate tubercles, arranged densely in radial series, sometimes traversed by some lines of growth; teeth long, thick, smooth; slit deeply incised at

the front edge, 3 in number, interior of valve smooth, without slit lines.

Median valve: second valve oval shaped, shorter than tail valve, jugum defined, dilated and protruded anteriorly, sculptured with fine longitudinal lines; fourth valve having the tegmentum of about equal breadth to the second, being not so much protruded as the preceding one; latero-pleural area small, provided with 4 or 5 longitudinal series of tubercles, forming sometimes coarse riblets by their coalescence; interior of valve smooth; posterior edge strongly reflexed; sutural laminae small, protruded forward, separated by flat sinus.

Tail valve becoming narrower anteriorly, rounded posteriorly; mucro terminal, flat, blunt, inconspicuous, especially not protruded posteriorly in young specimens, but somewhat prominent in full grown ones; insertion plate short, thick, nearly vertical.

Girdle: perinotum clothed densely with spines of various size, brownish or hyaline, of which the larger ones slightly curved, smooth, sharply pointed at the tip, standing on small chitinous base, the smaller ones slightly curved or nearly straight, deeply grooved, moderately pointed at the tip; marginal spines much longer than those of perinotum, hyaline, smooth with acute tip; hyponotum densely crowded by small, curved, acute, hyaline spinules.

Colouration: Body coloured with brownish throughout, but usually tessellated rather irregularly with dark brown; tegmentum with dark brown; articulamentum whitish, bluish, greenish or bright rose coloured.

Radula: central tooth oblong shaped, rounded anteriorly, with strong cusp at the tip, slightly waved on both sides, bilobed at the posterior end; centro-lateral having broad outer wing at the posterior corner, notched at the anterior corner, nearly straight at the front edge; major lateral tricuspid, the median cusp is the longest, shaft nearly straight in both edges, with small wing at the anterior corner, strongly ribbed at the back; major uncinus long oar-shaped, subtruncated at the anterior end with small cusp; base large thick; outer marginal nearly square.

Gill: merobranchial, branchiae about 18 on each side, disposed in correspondence with the interval between the 7th and the 8th valve.

Size: The type specimen measured 28 mm in length in dried condition; body 57 mm in length (BERGENHAYN); the specimens of this species taken from Mutsu Bay are all very small and most of them are strongly curled; two uncurled specimens measured respectively 20 mm and 30 mm in length.

Remarks: The species which was reported by TAPPARONE-CANEFRI

(1874) from Japanese waters may be referred in all probability to PILSBRY's species.

THIELE (1893) figured and described the radula of this species as of *Chitonellus larvaeformis* and later he (1909) corrected the name and discussed at length the two forms which have been recorded by PILSBRY (1901) from Hirado. The conclusion he arrived at was that *Cryptoplax rhodoplax* should be conspecific with *C. japonica*. Since the Japanese species has the tegmenta of various sculptures and the differently coloured articulamenta, both sculpture and colour do not amount to an absolute criterion of the two species.

BERGENHAYN (1933) worked out on the species and pointed out the difference from the results of THIELE especially concerning the structure of radula and stated that the distinguishing character of this species is the median cusp of the major lateral which is exceedingly longer than the outer cusps. But that is not peculiar to the species but the feature characteristic of the genus, and moreover the length of the cusps varies with different position even in one and the same radula. It becomes, therefore, desirable to make a more careful study concerning the structure of tooth in the radula of this species.

Locality

Sp. No.	STATION	LOCALITY	COLLECTOR	DATE	NUMBER OF SPECIMEN
1744		Kanida	TAKATUKI and SATO	July 23, 1927	8
2045	102	Takaiso, near Sai	HOZAWA, TAKATUKI and SATO	Aug. 17, 1927	1
2054	102	"	"	"	1
2093	104	Ôma	"	Aug. 18, 1927	2
2164	104	"	"	"	1
					Total 13

Distribution:

Pacific coast

Hokkaidô: Hakodate (HILGENDORF).

Honsyû: Matusima Bay (TAKEWAKI), Miyagi Pref. Hutomi (HIRASE).

Tiba Pref. Misaki (TAKI, BERGENHAYN); Hayama (TAKI); Enosima (DÖDERLEIN), Kanagawa Pref. Simoda (KANAMARU, KANEKO); Enoura (HARA); Omaezaki (A. HUZITA), Sizuoka Pref. Wagu (T.

- YAMADA, A. HUZITA), Mie Pref. Seto (IW. TAKI); Sirasakimura (K. KANDA); Gobô (OKAMOTO); Tatugahama (KUSE), Wakayama Pref.
- Sikoku: Kasiwazima (SUGIMOTO), Kôti Pref. Yawatahama (TAKI), Ehime Pref.
- Kyûsyû: Aosima (T. KURODA), Miyazaki Pref. Sakurazima, Kagosima Bay (MITUKURI); Amamiôshima (MITUKURI), Kagosima Pref.
- Inland Sea:
- Honsyû: Awazi (YAGURA), Hyôgo Pref. Onomiti (IW. TAKI), Hiroshima Pref.
- Sikoku: Tikami (YAGI); Mitu (TAKI), Ehime Pref.
- West coast:
- Kyûsyû: Amakusa (BABA), Kumamoto Pref. Nagasaki (BUNGE); Hirado (PILSBRY, HIRASE, THIELE); Waniura (HARA); Tusima (MAKI), Nagasaki Pref.
- Tyôsen: Kanrin (OKUDA); Zyôzanho (KURIHARA), Saisyûtô.
- Japan Sea:
- Honsyû: Mutsu Bay, Aomori Pref., Toyama Bay (K. KIKUTI), Toyama Pref.

Family 4 ISCHNOCHITONIDAE
Genus ISCHNOCHITON GRAY 1847

12. *Ischnochiton comptus* (GOULD, 1859)

Pl. XIV, figs. 5, 10; Pl. XV, figs. 6, 7; Pl. XXV, figs. 9-16; Pl. XXVII, figs. 6, 7; Pl. XXIX, figs. 11-16.

Chiton (Leptochiton) comptus

- GOULD (1859) Proceedings of the Boston Society of Natural History, Vol. 7, p. 163; Oosima; Bonin and Liu-kiu Is.
- (1862) Otia Conchologica, p. 117.
- KURODA (1928) Catalogue of the Shell-bearing Mollusca of Amami-Ôshima, p. 20, no. 213.

Ischnochiton (Ischnochiton) comptus

- PILSBRY (1893) Manual of Conchology, Vol. 14, p. 117; Philippines (CUMING).
- (1895) Catalogue of the Marine Mollusks of Japan, p. 114.
- (1898) Nautilus, Vol. 12, pp. 50-51.
- NIERSTRASZ (1905) Die Chitonen der Siboga-Expedition, S. 24-27, Taf. 1, Fig. 10; Taf. 3, Fig. 77-85; West Lombok; West and North Celebes; Great Sangir Is.; Amboina Is.; Damma Is.; East Sumbawa Is., etc.
- THIELE (1910) Zoologica, Bd. 22, Heft 56, S. 111, 113, 114.
- KIKUTI, K. (1931) Toyamawan Nantaidôbutu Mokuroku, p. 2, no. 5; Abugasima.

- YAGURA (1932) Hyôgokensan Kairui Mokuroku, p. 20, no. 24; Tazima; Harima; Settu; Awazi.
- TAKI, IW. (1936) Onomiti Kinkaisan Nantaidôbutu Mokuroku, p. 1, no. 1.
- TAKI, IS. (1936) Saitô Hôonkai Hakubukan Zihô, No. 30, p. 1, no. 1; Onahama.
- Ischnochiton thaanumi*
- DALL (1926) Proceedings of the Biological Society of Washington, Vol. 39, p. 66; abstract, IS. TAKI (1928) Venus, Vol. 1, no. 1, p. 42; Nago, Okinawa Is. in Loochoo Islands.
- KURODA (1928) Catalogue of the Shell-bearing Mollusca of Amami-Ôshima, p. 20, no. 212.
- KUSE, Y. (1930) Tatugahama Kinkaisan Kairui Mokuroku, p. 12, no. 182 (part).
- Ischnochiton albrechti*
- THIELE (1893) Das Gebiss der Schnecken, S. 382, Taf. 31, Fig. 19; Hakodate (HILGEN-DORF).
- Ischnochiton (Ischnoradsia) hakodadensis*
- THIELE (1909) Zoologica, Bd. 22, Heft 56, S. 3.
- Ischnochiton* sp.
- TAKI, IS. (1924) Dôbutugaku Zasshi, Vol. 36, No. 429, p. 284, 1 fig.; Misaki.
- YOKOYAMA (1931) Catalogue of Marine, Freshwater and Land Shells of Japan, p. 16, no. 461; Iyo.
- YAGI, S. (1931) Ehimeken Dôbutu Si, p. 67, no. 735; Tikami.

Chiton of moderate size, shell thin, oval or elliptical in outline, dorsum not prominently elevated, entire surface finely granulated; girdle rather narrow, imbricated regularly with large, solid, smooth, somewhat convexed scales.

Head valve semicircular, with about 40 to 60 divaricate radiating, minutely beaded threads, of which the hindmost very broad, not traversed by the lines of growth, having 11 to 17 slits, usually 11 to 12 in number, arranged rather irregularly around the anterior margin; teeth short, sharp, weakly waved on the outer surface; eaves moderate in width; slit-lines distinct, whitish.

Median valve slightly mucronate, but not keeled; sutural line nearly straight, side slopes roundly arched; jugal area not defined; central areas having the lines of granules either parallel or bending toward the acute jugum, intersected by forwardly diverging series of grooves, forming a zigzag or ripple pattern; granules rather round on the jugal region, becoming elongate oval in shape toward the periphery; lateral areas somewhat elevated, having small radiating furrows, at first 3 to 5 in number, then splitting into 6 to 10, traversed deeply by three or more lines of growth; interior of the valves smooth, not strongly callused, having one slit on each side; sutural laminae moderately extended anteriorly with acute edge; sinus flat, wide; slit-lines rather grooved, provided with very small pores in a row.

Tail valve: mucro somewhat elevated, situated slightly in front of the middle; posterior area flat, a little concave, ornamented with about 40 to 50 delicate radial threads; slits 9 to 13, usually 11 in number.

Girdle: large scales of perinotum quite smooth, but sometimes marked transversely with numerous, very fine striations, irregularly pitted, usually pectinated at the tip, probably caused by erosion; peripheral scales very small, cylindrical or ovoidal in shape, narrowing slightly toward the tip, smooth on the surface, containing numerous minute granules; large marginal-spines thick, sharply pointed, finely striated; small marginal-spines rod-shaped, smooth with blunt end; marginal spinules claviform with acute tip, weakly striated at the distal end; hyponotum scales hyaline, oblong.

Colouration: it is generally light grey in colour with small round white maculations, though variation in colour is great, being (a) densely clouded with olive; (b) light clouded mottled with dark and lilac; (c) four central valves chestnut, the rest olivaceous; (d) brown with olive, with broad white streak down the centre; (e) light reddish-chestnut mottled; (f) the same as e, shading into olivaceous; (g) sixth and eighth valves dark olive-brown, the rest light ashy; (h) the whole light ashy; girdle alternately suffused in grey and whitish patches.

Radula: central tooth strongly cusped, slightly sinuated at the anterior end, base dilated on both sides; centro-lateral deeply cusped, straight at the front edge, shallowly sinuated at the outer edge, its basal plate nearly triangular in shape; major lateral bicuspidate, inner wing large, a little reflexed at the end, base expanded outwardly so as to form a triangular wing; major uncinus curving inwardly, dilated at the anterior end with a cusp, stalk stout, with a small, squarish base; median marginal bilobed at the posterior end; outer marginal pentagonal shape, directing forward the blunt end.

Gills nearly ambient, ctenidia 22 to 32 in number on each side.

Size: length 15 mm, breadth 10 mm (type).

„ 17.5 mm, „ 10 mm (CUMING)

„ 23 mm, „ 13 mm (pl. XV, fig. 7)

„ 18 mm, „ 11 mm (pl. XV, fig. 6)

„ 16 mm, „ 9.5 mm (pl. XIV, fig. 10)

Divergency: 120° (type), 110° (pl. XXV, fig. 13)

Remarks: Rather strange it is that GOULD (1859) placed this species in *Leptochiton*, since the scales are as large, solid and regular as in *Chiton*. Basing on this respect, PILSBRY (1893) treated it as a member of *Ischnochiton* s. str., stating that the median valves have one slit on each side.

As indicated in the diagnosis the insertion plates of this species have generally one slit on both sides, while sometimes two on one side and one on the other and very rarely two on both sides.

The most important distinguishing character of this species is in the girdle scales described by GOULD (1859) thus "the girdle is narrow and imbricated with small elongated grooved scales", and by CARPENTER from CUMING's beautiful specimens, "the girdle has large, solid imbricating scales, sometimes very slightly striated". PILSBRY (1893) remarked in examining the typical specimens, that "the striation of the scales can seldom be seen", and NIERSTRASZ (1905) referred the examples collected in the course of the Siboga-Expedition to Celebes, Lombok and other places, to this species notwithstanding their scales are smooth.

It is difficult to get a clear idea as to the characteristic features of scales whether they are evenly smooth or distinctly striated, as the type was differently described by different authors. NIERSTRASZ is right to refer the material of the Siboga-Expedition to this species, because the valves agree in most respects with those of the type. I think that the original specimens included two forms. Upon examination of numerous specimens collected from the type locality and from other places of Japan, I can clearly distinguish two forms, one of which has smooth and the other distinctly striated scales, both occurring almost always in the same habitat. I do not, therefore, hesitate to consider the specimens of smooth scales as *I. comptus* and that of striated scales as *I. boninensis* of BERGENHAYN (1933).

Since the identification of this form has been very difficult, I asked the late Dr. DALL's assistance in April, 1926 in sending notes and figures and in stating that "the present species seems to ally very closely to *I. comptus* of GOULD, but I can not decide whether or not it is the same species, because the original descriptions too meagre for identification. If this be a new species, I would call it *I. tenuitestus*". Dr. DALL's letter dated June 25, 1926 says that "*I. tenuitestus* is the same as a shell which I named *thaanumi* in a paper appeared in the Proceedings of the Biological Society of Washington (Vol. 39, p. 66) and your specimens differ only in colour". I was, however, not very much satisfied with his letter, because he did not give any notion as to how it should be distinguishable from *I. comptus*. I thought that the form with the striation on the scales was *I. thaanumi* and that with smooth scales *I. comptus*. Recently I have been delighted to have an opportunity of examining the cotype of *I. thaanumi*, kindly sent me by Mr. D. THAANUM of Hawaii. In examining

the cotype it became clear that there are no difference between *I. thaanumi*, and the smooth scaled species which I have hitherto treated as *I. comptus*, in other words, *I. thaanumi* is synonymous with *I. comptus*.

All too fragmentary or insufficient original descriptions often lead the later authors to confusion. For instance THIELE (1893) considered a form of *Ischnochiton* as *albrechti* of SCHRENCK, which was collected by HILGEN-DORF from Hakodate, and afterward he (1909) corrected the name to *I. hakodadensis*, and again he (1910) came to realize that this was neither *albrechti*, *hakodadensis*, *comptus* nor *mitsukurii*, for it had smooth, large, solid scales, though he has not given any further account of it. The radula of this form, figured and described in his work "Das Gebiss der Schnecken", agrees so well that of *I. comptus*, that THIELE's specimens can without a doubt be referred to this species.

Locality

Sp. No.	STATION	LOCALITY	COLLECTOR	DATE	NUMBER OF SPECIMENS
675	1, (A) (I)	Yunosima	—	—	2
1897	—	„	HOZAWA	Aug. 9, 1927	1
—	—	„	IW. TAKI	Aug. 15, 1930	6
2062	103	Sai Bay	HOZAWA, TAKA-TUKI and SATO	Jul. 17, 1927	1
1716	—	Kanida	TAKATUKI	Jul. 1927	8
—	—	Asamusi	IW. TAKI	Aug. 9, 14, 1930	10
4	—	—	—	—	1
5	—	—	—	—	1
					Total 30

Distribution

Pacific coast

Hokkaidô: Hakodate (THIELE)

Honsyû: Onagawa (TAKI); Matusima Bay (TAKEWAKI), Miyagi Pref. Onahama (TAKI), Hokusima Pref. Kominato; Hutomi, Tiba Pref. (HIRASE). Yokohama (TAKI); Misaki (TAKI, Y. ÔSIMA, TAKEWAKI), Kanagawa Pref. Simoda (KANEKO); Numatu (K. ÔYAMA); Omaezaki (A. HUZITA), Sizuoka Pref. Hatizôzima (UTIYAMA), Izusititô; Titizima (HIROTA), Ogasawara Islands. Seto (IW. TAKI); Gobô

(OKAMOTO); Sirasakimura (K. KANDA), Wakayama Pref.

Sikoku: Naruto (HIROTA), Tokushima Pref. Kasiwazima (SUGIMOTO), Kôti Pref. Yawatahama (TAKI), Ehime Pref.

Kyûsyû: Kagosima (IW. TAKI); Makurazaki (MITUKURI); Amamiôshima (GOULD, MITUKURI), Kagosima Pref.

Loochoo: Nago, Okinawa Pref. (LANGFORD & THAANUM).

Taiwan: Kiirun (TAKAHASI); Ôtei (S. TAKAHASI).

Philippines (CUMING).

East Indian Islands: Great Sangir Island; Kwandang Bay, North Celebes; Palos Bay, West Celebes; Amboina Is.; Damma Island; East Java; West Lombok Island; Sapeh Bay, Sumbawa Island; South Timor (Siboga-Expedition).

West coast:

Kyûsyû: Kamikosikizima (T. KURODA); Akune (MITUKURI), Kagosima Pref. Amakusa (BABA), Kumamoto Pref. Nisiarrie (SIKI); Kisyuku, Gotô (YOSIDA); Tusima (MAKI), Nagasaki Pref.

Tyôsen: Kanrin, Saisyûtô (S. OKUDA); Gunzan, Zenrahokudô (OKUDA).

Inland Sea:

Honsyû: Harima; Settu; Awazi (YAGURA), Hyôgo Pref. Onomiti (IW. TAKI), Hirosima Pref.

Sikoku: Mitu (TAKI); Tikami (YAGI), Ehime Pref.

Japan Sea:

Hokkaidô: Hukuyama (T. KINOSITA).

Honsyû: Mutsu Bay, Aomori Pref. Kawasaki, Sado (K. KIKUTI), Niigata Pref. Toyama Bay (K. KIKUTI), Toyama Pref. Nanao Bay (T. KURODA), Isikawa Pref. Miyazu Bay (A. IIZUKA), Kyôto Pref. Tazima, Hyôgo Pref. (YAGURA). Tazirimura (M. HORI), Tottori Pref. Toriimura (S. TAKAGI), Simane Pref.

Tyôsen: Husan (OKUDA); Ôzyôri (HATAKEDA), Keisyômandô.

13. *Ischnochiton paululus*, nov. sp.

Pl. XV, fig. 10; Pl. XXV, figs. 6-8; Pl. XXVI, figs. 6-12; Pl. XXVII, figs. 8, 9.

Body small, 5 mm in length; shell highly elevated with vaulted jugum, punctated all over in quincunx, light reddish purple in colour; girdle narrow, covered with finely striated scales.

Head valve evenly granulated in quincunx, slope steep, straight, smooth; interior of valve smooth, shining, pinkish coloured, not callused, having 10 or 11 slits at the periphery.

Median valve strongly raised at the jugum, but not carinated, side slopes roundly convex, posterior margin slightly beaked; jugum not defined; central area beset evenly with forwardly converging series of elongate, flat, granules, intersected by somewhat stronger forwardly diverging grooves; lateral area slightly elevated, diagonal line inconspicuous, entire surface cut into fine granulation, formed by intersection of two different series of oblique lines of rather rounded granules; interior of valve smooth; callus flat; slit shallow, 1 on each side; slit-line well defined; teeth short, thick, smooth on both surfaces; sutural laminae small, roundly arched at the front edge, widely separated by a flat sinus.

Tail valve very small; sutural line roundly arched; central area much more vaulted than in the median valves; mucro flat, inconspicuous, situated a little behind the middle; diagonal line low, not conspicuous; posterior slope small, steep, deeply concave; sutural laminae small, flat, nearly straight at the anterior edge; slits 9 to 12, arranged rather irregularly at the periphery.

Girdle: perinotum clothed with a little curved, finely grooved scales, grooves usually 15 in number in large scales, peripheral scales very small, strikingly ribbed, its base rhombic in shape; marginal spines long, hyaline, obliquely striated, with small root; marginal spinules very small, hyaline, smooth, pointed at the tip, intermingling sparsely with strongly ribbed, sharply pointed, globular scales; hyponotum scale hyaline, smooth, flat, oblong shaped with somewhat pointed end; peripheral scales bearing a much resemblance to marginal spine, but differing from it by its small size and its deep, longitudinal grooves.

Colouration: shells coloured generally with light reddish purple, pinkish colour predominating in the jugal region except for the median line where it is whitish, painted with dull yellow at the periphery; girdle pale blue, with somewhat regular brownish patches. In another specimen, shell light yellow, maculated with a few, small, brownish freckles; girdle also yellowish, regularly tessellated with dark brown.

Radula: central tooth oblong shaped, having small cusp at the tip, broadly dilate at the base; centro-lateral broad, weakly cusped, sinuated at the outer edge; major lateral bicuspidate, inner wing small, rounded, somewhat thickened at the tip, base exceedingly protruded inwardly; major uncinus long, broad, with weak cusp, its base small, squarish; outer marginal nearly square in shape, slightly protruded at the anterior edge; median marginal bilobed at the posterior end.

Gill: holobranchial, branchiae 13 on each side, extending along the

entire length of foot.

Size and divergency: Body length 5 mm, breadth 3 mm. Divergency 90°.

Remarks: This species resembles Japanese representatives of the genus, *Ischnochiton mitsukurii* and *I. melinus* in its small size, sculpture of valves, striated scales in the girdle and its much elevated shells.

I. mitsukurii has the elevated and carinated valves, the three or four radial sulci in the lateral area of the median valves, the straight posterior slope of the tail valve and the coarsely striated scales, whereas in this species the shell is much elevated, but not carinated, and lateral areas are evenly granular and sometimes weakly wrinkled on the surface, the posterior slope is deeply concave and the scales of the girdle are finely grooved.

I. melinus has a carinated jugum, evenly granulated lateral areas, a slightly concave posterior area and grooved scales, longitudinally striated marginal spines, not beaked median valves, the lateral areas, however, are not elevated, posterior slope of the tail valve is much broader and less concave and the girdle is more densely clothed with more coarsely striated scales than in this species.

From the young specimens of *I. comptus* it is easily distinguished by the strongly grooved scales and the peculiar features of the marginal armatures and the hyponotum scales. *I. boninensis* differs from the species by having radial sulci in the end valves and the lateral areas, the finely striated large marginal spines, the smooth, long, pointed, small marginal spines, the strongly ribbed marginal spinules and the oblong scales of hyponotum and much more flattened and non-beaked median valves.

Locality: Station 113, off Imabetu, 1 specimen was collected by HÓZAWA on July 21, 1929, sp. no. 2379; 2 small specimens were collected by TAKATUKI together with *Tonicella lineata*, *T. submarmorea*, *Lepidozona mertensi*, *Rhyssoptax kurodai* and *Lepidopleurus assimilis*, off Kanida, in July, 1927, sp. no. 1716.

Genus ISCHNORADSIA SHUTTLEWORTH 1853

14. *Ischnoradsia hakodadensis* ('CARPENTER' PILSBRY, 1893)

Pl. XV, fig. 8; Pl. XXVI, figs. 1-5; Pl. XXVII, figs. 1-5; Pl. XXVIII, figs. 19, 20.

Ischnochiton (Ischnoradsia) hakodadensis

CARPENTER, MS.

PILSBRY (1893) Manual of Conchology, Vol. 14, p. 147, pl. 19, figs. 64-66; Hakodate.

— (1895) Catalogue of the Marine Mollusks of Japan, p. 114.

BERRY (1917) Proceedings of the United States National Museum, Vol. 54, pp. 4-5, pl. 1, figs. 6-7, pl. 3, figs. 3-5, pl. 4, figs. 1-3; Hakodate; Muroran. (Albatross, 1906).

KIKUTI (1931) Toyamawan Nantaidôbutu Mokuroku, p. 2, no. 6; Abugasima.

TAKI, Is. (1936) Saitôhônkai Hakubutukan Zihô, No. 30, p. 1, no. 3, Aomori Bay; Onahama.

Ischnochiton hakodadensis

THIELE (1910) Zoologica, Bd. 22, Heft 56, S. 112, Taf. 8, Fig. 44.

A medium-sized chiton; shell oblong oval in outline, moderately elevated, roundly arched at the back; girdle covered densely with minute scales; shell buff in colour, maculated and striped with dark brown; girdle buff, weakly tessellated with slate blue.

Head valve sculptured with numerous, fine radiating riblets, cut transversely by some concentric growth sulci, having 15-20 slits at the periphery; teeth rather sharp, smooth, though sometimes slightly roughened on the outer surface; eaves short, narrow, solid.

Median valves: lateral area slightly raised, cut into 6 to 9 low, unequal riblets by radiating impressed lines; riblets made uneven by concentric wrinkles of growth; central area very minutely pitted over, formed between quincuncial granulations, arranged in zigzag successions; interior of valve blue-white, having 2-3 slits on each side.

Tail valve: mucro lies a little in front of the middle, rather prominent; posterior slope broad, slightly concave, sculptured radially like the head valve, having 14-15 narrow slits.

Girdle covered with small, solid, convex, very weakly striated, scales; marginal spines yellowish, smooth, rounded at the base with blunt tip, intermingling small marginal spinules, coloured similarly to the spines, strongly ribbed at the tip, with hyaline, oblong plates.

Radula: central tooth oblong, weakly cusped, rounded at the tip, truncated at the base, with square basal plate; centro-lateral weakly cusped, outer wing small, round, basal plate triangular; major lateral bicuspid, inner cusp exceedingly larger, longer than the outer; wing-like expansion very fragile, inserted on the shaft just beneath the cusps with small base; major uncinus long, spoon-shaped, broadly cusped, with small basal plate; outer marginal nearly squarish in outline.

Gills holobranchial, ctenidia 28-32 in number on each side.

Remarks: The specimens exhibit wide range of variability, not only in colour, but in number of ray-ribs on the lateral areas and of marginal slits. The beautiful zigzag sculpture of flattened, overlapping, pointed pustules, which covers the central areas of young specimens, is usually eroded to the pitted appearance characteristic of the adults.

The shell of this species has very much the aspect of *Ischnochiton comptus*, *I. boninensis*, *I. mitsukurii*, *I. zebrinus*, and *I. melinus* from Japanese waters, in the tegmental sculpture, however, from all species of the group *Ischnochiton* this is distinguished by its bicuspidate major lateral, by the presence of the round outer wing of the centrolateral in the radula, by its closely arranged, nearly smooth, convex girdle scales and by the plurality of side slits in the median valves.

Locality

Sp. No.	STATION	LOCALITY	COLLECTOR	DATE	NO. OF SPECIMEN
1	—	Yunosima	ITO	July 10, 1926	2
2	—	"	HOZAWA	"	1
3	—	"	ITO	"	2
1897	—	"	HOZAWA	Aug. 5, 1927	3
—	—	"	Iw. TAKI	Aug. 15, 1930	20
675	1 (I) A	"	HOZAWA and TAKATUKI	Aug. 5, 1926	1
668	4 (I)	Asamusi	TAKATUKI	May 9, 1926	3
—	—	"	Iw. TAKI	Aug. 9, 1930	20
—	—	"	"	Aug. 14, 1930	15
673	66 (V)	Tozawa	HOZAWA and TAKATUKI	Aug. 11, 1926	1
612	18 (I)	Mourazima	HOZAWA and TAKATUKI	July 17, 1926	1
—	—	"	Iw. TAKI	Aug. 10, 1930	1
1716	—	Kanida	TAKATUKI and SATO	July 23, 1927	20

Distribution:

Pacific coast

Saghalien: Ôdomari; Tôbuti (URITA), Aniwa Bay.

Hokkaidô: Akkesi (HADA, OKUDA). Muroran (BERRY); Hakodate (PILSBRY, BERRY).

Honsyû: Sakiyamamura; Miyako; Hirotamura (TOBA), Iwate Pref.

Onagawa (TAKI), Miyagi Pref. Onahama (TAKI), Hukushima Pref.

Coast of Japan Sea:

Saghalien: Maoka (S. MIKI).

Honsyû: Mutsu Bay, Aomori Pref. Toyama Bay (K. KIKUTI).

Genus LEPIDOZONA PILSBRY 1893

15. *Lepidozonia coreanica* (REEVE, 1847)

Pl. XIV, fig. 7; Pl. XXVIII, figs. 1-12; Pl. XXIX, fig. 10; Pl. XXX, figs. 1-5;
Pl. XXXI, figs. 6, 7.

Chiton coreanicus

REEVE (1847) Proceedings of the Zoological Society of London, part 15, p. 24; Korean Archipelago, under stones.

— (1847) Conchologia Iconica, Monograph of the genus Chiton, Vol. 4, pl. 26, fig. 128.

ADAMS, A. and REEVE (1850) The Zoology of the Voyage of H.M.S. Samarang under the commander of Captain BELCHER, Mollusca, pl. 15, fig. 9.

Chiton (Stenosemus) coreanicus

SCHRENCK (1867) Reisen und Forschungen im Amur-lande, Bd. 2, S. 281-282, Taf. 13, Fig. 1-6; collected by LINDHOLM at the Bay of Hakodate.

Lophyrus coreanicus

DUNKER (1882) Index Molluscorum Maris Japonici, p. 157.

Ischnochiton (Lepidozonia) coreanicus

PILSBRY (1892) Manual of Conchology, Vol. 14, pp. 129-130, pl. 27, fig. 50.

— (1895) Catalogue of the Marine Mollusks of Japan, p. 114.

YAGURA (1916) Hyōgokensan Kairui Mokuroku, p. 1; Awazi, Tazima.

KUSE, Y. (1930) Tatugahama Kinkaisan Kairui Mokuroku, p. 12, no. 183; Tatugahama, Wakayama Prefecture.

YOKOYAMA (1931) Catalogue of Marine, Freshwater and Land Shells of Japan, p. 16, no. 463; Iyo.

Ischnochiton coreanicus

HIRASE, Y. (1907) Catalogue of Marine Shells of Japan, p. 21; Teshiwo.

TAKI, IS. (1924) Dōbutsugaku Zassi, Vol. 36, No. 429, pp. 284-285, with 1 text-figure; Misaki.

BABA (1929) Dōbutsugaku Zassi, Vol. 41, No. 485, pp. 114-115, text-figs. IV, 5-8, (anatomy).

GISLÉN, T. (1931) Journal of the Faculty of Science Imperial University of Tokyo, Sect. 4, Vol. 2, Part 4, pp. 430, 433, 437, 440, 441; Misaki.

ASANO, H. (1933) Bunrui Suisan Dōbutu Zusetu, p. 523, fig. 352.

Ischnochiton sp.

YAGI, S. (1931) Ehimeken Dōbutu, p. 67, no. 736; Tikami.

Lorica (Lepidozonia) coreanica

KIKUTI, K. (1931) Toyamawan Nantaidōbutu Mokuroku, p. 2, No. 7; Abugasima.

YAGURA (1932) Hyōgokensan Kairui Mokuroku, (revised edition), p. 20, No. 242; Tazima, Harima, Settu, Awazi.

KURODA, (1935) Miyazakikensan Kairui Mokuroku, p. 39, No. 5; Nangō.

TAKI, IW. (1936) Onomiti Kinkaisan Nantaidōbutu Mokuroku, p. 1, No. 2; Onomiti.

Lepidozonia pectinella

BERGENHAYN (1933) Kungl. Svenska Vetenskapsakademiens Handlingar, Bd. 12, No. 4, S. 15-19, Taf. 1, Fig. 5; Taf. 2, Fig. 40, 41; Taf. 3, Fig. 42-44, 46; Text-fig. 5; Misaki; Bonin Is.

TAKI, IS. (1933) Venus, Vol. 4, No. 3, p. 194.

Shell thick, medium sized, oval in outline, rather elevated and keeled at the back, about twice as long as wide; tegmental surface of end valves and lateral areas of median valves radially grooved, central area longitudinally ridged; girdle narrow, tessellated, covered densely with minute scales; colouration brownish or dark greenish, never reddish.

Head valve: semicircular in outline, apex rather low, posterior edge shallowly incised at the middle; ray-ribs low, but prominent toward the margin, provided sparsely with solitary pustules; slits 10 to 17, generally 13 or 14 in number; teeth thick, short, rather acute, but finely roughened inside toward the edge; eaves solid, short; interior of valve smooth, shining, slit-rays indistinct, provided with numerous, small pores.

Median valve square, carinated, scarcely beaked, jugal and pleural areas distinct especially in the 2nd valve; anterior edge nearly straight except for the 2nd valve, elegantly scalloped; lateral area distinctly elevated, sculptured with 3 to 6 ray-ribs, interstices between them slightly concave; tubercles roundly elevated, sparsely spaced; pleural area longitudinally, very finely, granosely ridged, interstices between the ridges deeply hollowed, traversed by somewhat irregular grooves; sutural plate flat, rather truncated at the anterior edge, sinus wide and shallow; slit usually one, rarely two on one side; teeth smooth, short, acute; interior of valve smooth, shining, central region fairly thick at the posterior border; lateral region shallowly concave; slit-ray indistinct, provided with numerous, irregularly arranged pores; anterior edge of the articulamentum between the sutural plates weakly denticulated, usually 6 or 7 in number.

Tail valve: mucro nearly central, low, flat; jugum a little defined from the pleural, both sculptured like that of the median valves, anterior edge slightly arched; posterior area straight, gently sloped, provided with ray-ribs likewise the head valve; slits 12 to 15; teeth thick, short; anterior edge of jugal plate denticulated like that of the median valves; sutural plate flat, wide, truncated at the anterior edge.

Girdle covered densely with small scales which are finely ridged, provided with a small sprocess on the front edge; hyponotum covered with oblong, smooth, hyaline scales; margin ornamented with thick, obliquely striated, bluntly pointed spines, long, smooth, sharply pointed spines and small spinules.

Ctenidia holobranchial, along entire length of the foot, with a space between the last gill and the anus.

Colouration: shell generally yellowish brown or dark green, tubercles

yellowish, central areas yellowish, blotched and variegated with dark brown; in another specimen, whitish or light green, indistinctly mottled and spotted with dark green; girdle tessellated with dark and pale green; interior of valves whitish or pale blue with a wide dark green ray on each side near the posterior margin.

Radula: central tooth broad, well arched at the anterior edge, narrowing posteriorly, slightly bilobed at the posterior end; centro-lateral oblong, winged at the anterior outer corner, basal plate triangular in outline; major lateral well developed, unequally bicuspidate, outer cusp much weaker than the inner one, its shaft thick, with fairly long appendage at the anterior inner edge: major uncinus simple, broad, weakly cusped; outer marginal oblong shaped, about twice as long as wide.

Measurements are taken from 86 specimens collected from various localities. The correlation between the body length and the number of gills and the relation between the width of the end valves and the number of ray-ribs are shown in the following figures.

Graph showing the correlation between the body length and the number of gills

		Body length																								
		mm																								
Number of gills	mm	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
		27			1																					
	28			1	1	1																				
	29	1		2																						
	30	1	1		1	2				1																
	31		1				1	1	1																	
	32						1	1	1		1															
	33						1	1	1		4															
	34						1	1	1	1	1	1														
	35						1	2	2	1	1	2	4	3	1											
	36							1		2	2	1	2		1											
	37							1	1	2	2	1	1		1		1									
	38										3	2	2	1	1		1									
	39												1													
	40											1	1					1		1						1
	41																	1		1						1
	42																									1
	M	29.5	30.5	28.2	29.0	29.3	33.2	33.2	32.5	35.6	34.2	34.7	35.6	37.1	36.5	—	37.5	—	40.5	—	40.5	—	—	—	—	41

The largest example in hand attains 60 mm in length with about 41 gills on each side of the foot. The number of gills increases with the size of body, though it is not in direct proportion to the size; for example, an individual of 12 mm in length has about 30 gills, while that of 24 mm

about 33, that of 36 mm about 37, and that of 48 mm about 40 on each side. From this it will be seen that when the body becomes twice, three or four times in length, the gills increase in number by 12.5 per cent, 23.3 per cent and 33.3 per cent respectively.

It is the commonest in the littoral zone that individuals about 30 mm long are provided with 34 to 35 gills on each side.

Graph showing relation between the width of the head and tail valves and the number of their ray-ribs

		Width of valves														
		mm														
Number of ray-ribs	mm	4	5	6	7	8	9	10	11	12	13	14	15	16		
		10	II			I										
	12															
	14		1	III	I	I										
	16		1		1 VII	IV	IV	I								
	18			1	I	2 VI	III	IV	I							
	20				3	1	3 IV	IV	V	I						
	22				2	3	4	1	1 IV							
	24					1	3	5	2 I	I						
	26							1	1	3 II	2 III	1				
	28								2	4 I	3	2				
	30										3	1		I		
	32										4	2	I	1		
	34										1	1 I				
	36											1				
	38													1		
	40													2		
	42													1 1		

I...V, Tail valve; 1...5, Head valve.

It is obvious from the above table that the largest head valve measures 16 mm in width with 42 ray-ribs and the tail valve 15 mm in width with

Table showing width and number of ray-ribs of head and tail valves

[B] BREADTH OF VALVES (mm)	HEAD VALVE			TAIL VALVE		
	NUMBER OF RAY-RIB [R]	$\frac{R}{B}$	NUMBER OF INDIVIDUALS	NUMBER OF RAY-RIB [r]	$\frac{r}{B}$	NUMBER OF INDIVIDUALS
4				10.0	2.5	2
5	15.0	3.0	2	—	—	—
6	18.0	3.0	1	14.0	2.3	3
7	20.0	2.8	6	15.4	2.2	10
8	21.0	2.6	7	16.9	2.1	11
9	22.3	2.5	11	17.4	1.9	11
10	24.9	2.4	9	18.6	1.8	9
11	26.0	2.3	10	22.1	2.0	14
12	29.8	2.4	13	24.4	2.3	5
13	30.7	2.3	8	34.0	2.6	1
14	—	—	—	32.0	2.2	1
15	38.4	2.5	5	30.0	2.0	1
16	42.0	2.6	1			
		M=2.47	Σ=73		M=2.06	Σ=68

M=mean, Σ=totals.

30 ray-ribs. The mode in the table are individuals with head valve of 9 to 12 mm and the tail valve of 7 to 11 mm in width. The number of ray-ribs per one mm in width is 2.47 on an average in the head valve and 2.06 in the tail valve. The head valve is always larger and has more numerous ray-ribs per unit in width than the tail valve.

Remarks: REEVE was the first to describe this species basing upon the material collected from "Korean Archipelago, under stones", and afterwards this has been recorded or collected from various places of Hokkaidô, Honsyû, Sikoku, Kyûsyû, Korea and Formosa. In examining these numerous specimens, it was found that there are some examples which agree precisely with the original description and figure, while most of them differ in sculpture of valve as well as in colouration. Several forms of this group described from the adjacent waters of Japan seem to be identical with this single species. *Lepidozona cultrata* ('CARPENTER'

PILSBRY) (1892), recorded from Hakodate, seems to be a young form of this species. *Lepidozona craticulata* (GOULD) (1859) bears a close resemblance to this species in many respects, differing merely in having more numerous radii of the lateral area. BERGENHAYN (1933) described a new species *L. pectinella* from Misaki which was considered different from *L. cultrata* and *L. craticulata* without any reference to REEVE's works, whereas no difference can not be pointed out from *L. coreanica* in sculpture of the shells, in colouration, in structure of the radula and also in girdle armatures.

Locality

SP. No.	STATION	LOCALITY	COLLECTOR	DATE	NUMBER OF SPECIMENS
675		Yunosima		Aug. 5, 1926	1
1897		east shore of Yunosima	HOZAWA	Aug. 9, 1927	2
		between Yunosima and Utouzaki	Iw. TAKI	Aug. 15, 1930	5
1568		"	TAKATUKI	June, 11, 1927	1
		north shore of Biol. Labor.	Iw. TAKI	Aug. 14, 1930	3
		Mourazima	"	Aug. 10, 1930	4

Distribution:

Pacific coast

Hokkaidô: Hakodate (1) (SCHRENCK).

Honsyû: Miyako (3), Iwate Pref. Onagawa Bay (4); Matusima Bay (5), Miyagi Pref. Onahama (6), Hukushima Pref. Kominato (7); Hutomi (8), Tiba Pref. Titizima (22), Ogasawara (BERGENHAYN). Yokohama (10); Misaki (9), Kanagawa Pref. Simoda (11); Numazu (12), Sizuoka Pref. Ise Bay (13), Mie Pref. Seto (14); Gobô (15); Tatugahama (16); Wakayama Pref.

Sikoku: Yawatahama (52); Ehime Pref.

Kyûsyû: Nangô (18); Miyazaki Pref. Natui, Birôzima, Sibusi Bay (19), Kagosima (20); Kagosima Pref.

Taiwan (Formosa): Kiirun (21); Kôsyun (53) (TAKAHASI).

Inland Sea:

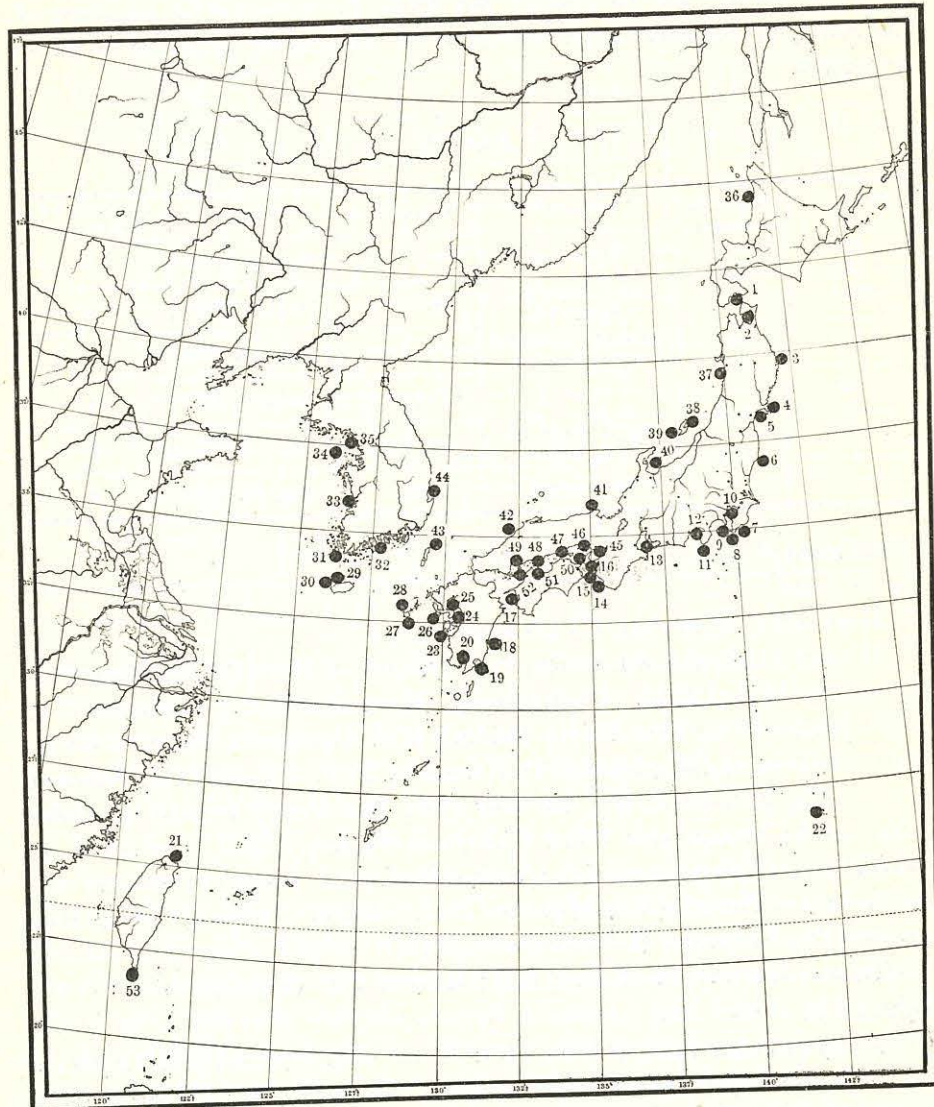
Honsyû; Settu (45); Harima (46); Awazi (50), Hyôgo Pref. (YAGURA). Kozima Bay (47), Okayama Pref. Onomiti (48); Hirosima (49), Hirosima Pref.

Sikoku: Tikami (51); Mitu (52), Ehime Pref.

West coast:

Kyûsyû: Amakusa (23); Hyakkanisi (24), Kumamoto Pref. Ariakekai (25); Nagasaki (26); Kisyuku (28); Tomie (27), Nagasaki Pref.

Tyôsen: Kinnei (29); Kanrin (30), Saisyû-tô. Korean Archipelago (31), (BELCHER). Reisui (32), Zenranandô. Gunzan (33), Zenrahokudô.



Text-fig. 2. Geographical distribution of *Lepidozona coreanica* (REEVE).

Tokutumisima (34); Zinsen (35), Keikidô.

Japan Sea coast:

Hokkaidô: Tesio (36).

Honsyû: Mutsu Bay (2), Aomori Pref. Kanaura (37), Akita Pref. Hutami (38); Kawasaki (39), Sado. Toyama Bay (40), Toyama Pref. Tazima (41), Hyôgo Pref. (YAGURA). Torii-mura (42), Simane Pref.

Tusima Straits: Waniura (43), Tusima.

Tyôsen (Korea): Hokô (44), Keisyôhokudô.

16. *Lepidozona albrechti* (SCHRENCK, 1863)

Pl. XIV, figs. 8, 9, 14; Pl. XXVIII, figs. 13-18; Pl. XXIX, figs. 7-9, 17, Pl. XXX, figs. 10-13; Pl. XXXI, figs. 1-5; Pl. XXXII, fig. 17.

Chiton albrechti

SCHRENCK (1863) Bulletin de l'Académie Impériale des Sciences de St.-Petersbourg, Tome 5, p. 551.

— (1863) Mélanges biologiques tirés de Bulletin de l'Académie Impériale des Sciences de St.-Petersbourg, Tome 4, p. 253.

— (1867) Reisen und Forschungen im Amur-Lande, Bd. 2, S. 283-288, Tab. 13, fig. 7-17; Hakodate.

Chiton (Lepidopleurus) albrechti

SMITH, E. A. (1875) Annals and Magazine of Natural History, Ser. 4, Vol. 16, p. 715; Endermo Harbour.

Ischnochiton (Ischnoradsia) albrechti

PILSBRY (1893) Manual of Conchology, Vol. 14, pp. 147-148, pl. 19, figs. 70-74; Hakodate.

— (1895) Catalogue of the Marine Mollusks of Japan, p. 114.

BERRY (1917) Proceedings of the United States National Museum, Vol. 54, no. 2223, p. 4; pl. 1, figs. 4-5; pl. 3, figs. 1-2; text-fig. 1; Muroran.

NIERSTRASZ (1905) Die Chitonen der Siboga-Expedition, Monographie no. 41, S. 22.

KINOSHITA, T. and ISAHAYA, T. (1934) Hokkaidôsan Kairui Mokuroku, p. 3, no. 1, pl. 1, fig. 1; Okusiri, Yoiti, Risiri.

Lorica (Lepidozona) albrechti

KIKUTI (1931) Toyamawan Nantaidôbutu Mokuroku, p. 2, no. 8; Takosima, Noto.

Lepidozona albrechti

TAKI, IS. (1936) Saitô Hôonkai Hakubutukan Zihô, No. 13, no. 5; Kamomezima, Aomori-Bay; Onahama, Hukushima Prefecture.

Body large, oval, elevated with acute dorsal ridge; entire surface of shells minutely punctated, reddish in colour, maculated with dark brown; girdle narrow, covered densely with imbricating scales.

Head valve having rather fine, low ray-ribs, bearing sparsely brown pustules; majority of ribs splitting into two toward the margin; teeth

short, acute, roughened on the outer surface; slits 14 or more in number.

Median valve square with nearly straight side slopes; jugum not defined except for the 2nd valve; central area with about 30 longitudinal lines of granules, in juvenile shells the area sculptured with longitudinal and transverse lines so as to form a fine reticulation, nodes of which remain in the adult shells as granules in a longitudinal series; lateral area scarcely elevated, having 4 to 6 in the juvenile, 10 to 12 radiating, sparsely granose riblets in the adult; in old shells entire surface non-granulated and distantly concentrically sulcated; sutural laminae short with regularly arched at the anterior edge; sinus very flat with narrow, denticulated lamina.

Tail valve smaller than head valve; mucro median, nearly flat; posterior area straight, gently sloped, ornamented with ray-ribs like the head valve; sutural laminae narrow, roundly arched; sinus flatter than in the median valves; interior of valve white, tinted with rays of reddish-brown; teeth thick, acute, sometimes rugose or lobed on the outer surface; slits deep, 12 in number.

Girdle moderately wide, reddish-brown or brownish-yellow, tessellated regularly with dark-brown, covered with convex scales which are weakly striated, usually 10 in number, bearing a small process at the front end, sinuated at the middle of the base; margin of girdle armed with long, smooth, acute bristles, striated thick spines and small striated acute spinules; hyponotum covered densely with hyaline, more or less elongated cylindrical scales.

Radula: Central tooth dilated and weakly undulated at the anterior edge, constricted at a trifle behind the middle with a little broadened base; centro-lateral square with a large appendage at the anterior outer corner; major lateral bicuspidate, cusp distinct in juvenile specimens, being stronger in the inner one, in adult specimen it looks sometimes like unicuspid the smaller one having worn out; stalk thick with a long appendage at the anterior end of the inner edge and a small process at the outer edge and dorsal processes; major uncinus long, stout, slightly cusped at the anterior edge; outer marginal oblong, being longer than wide.

Gills holobranchial with a small space between the last gill and the anus.

Remarks: PILSBRY (1893) treated this species as a member of the subgenus *Ischnoradsia* under the genus *Ischnochiton* and this was followed by BERRY (1917). As pointed out by SCHRENCK (1863) this species is closely related to *Lepidozonia coreanica* and the features characteristic of

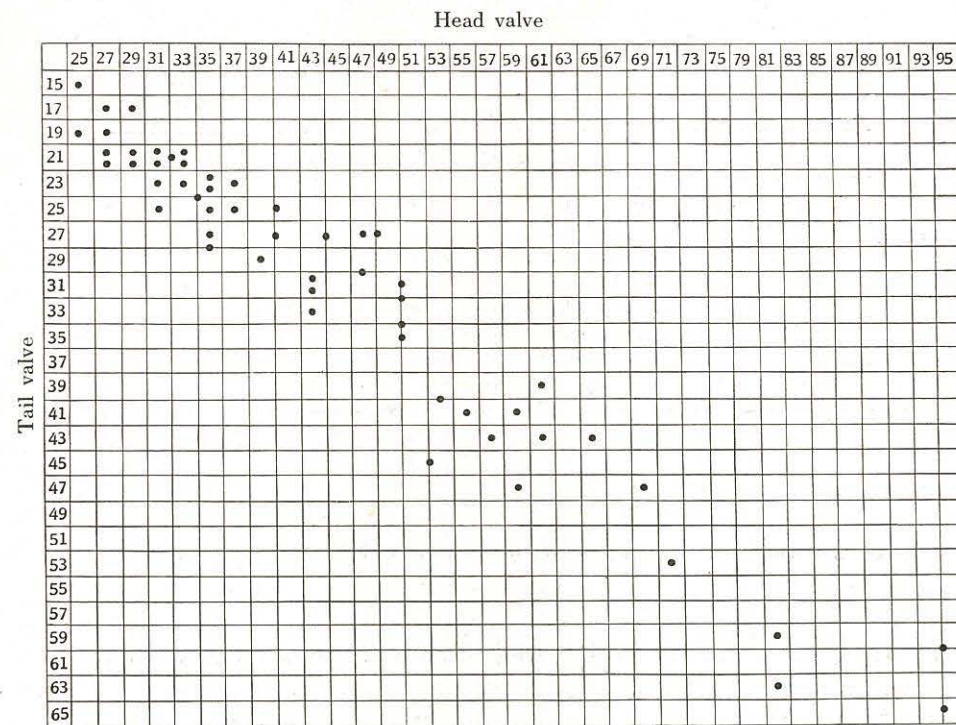
this species seem to agree with that of *Lepidozonia*. It is, therefore, more natural to consider this species as a member of *Lepidozoa* than as that of *Ischnoradsia*.

SMITH (1875) reported two large specimens from Muroran (Endermo Harbour), which measured about 65 mm in length and 28 mm in breadth in the central valves. These specimens are the largest, because it usually measures from 40 to 50 mm in length.

The ratios of the length to the width range from 1.56 to 1.83 and the mean ratio is 1.73 as shown in the following table:

Table showing length and width of body, and ratios of length to width

LENGTH	WIDTH	WIDTH LENGTH
22 mm	14 mm	1.56
33	20	1.65
44	26	1.69
42	24	1.76
46	26	1.76
46	26	1.76
50	28	1.78
48	27	1.77
49	28	1.75
55	30	1.83
		M=1.73



Text-fig. 3. Graph to show relation between head and tail valves respecting the number of ray-ribs.

In the above table it will be seen that the ratios increase with the length of the body and that the body becomes relatively narrower as it grows older.

The number of ray-ribs on the end valves increases regularly in proportion to the body size and is always more numerous in the head valve than in the tail one and its relation between both valves is plotted in text-fig. 3.

The number of slits ranges from 11 to 17 in the head valve and from 10 to 16 in the tail valve and is always more numerous in the former than the latter. Both valves have each about 14 and about 12 slits on an average. The following table shows the relation between the number of slits in the end valves.

NUMBER OF SLITS				
I	HEAD VALVE		TAIL VALVE	
	II	I×II	II	I×II
10			4	40
11	1	11	5	55
12	4	48	5	60
13	3	39	3	39
14	3	42	0	0
15	2	30	1	15
16	1	16	1	16
17	4	68		
Σ	18	254	19	225
M		14.1		11.8

I, number of slits; II, number of individuals; M, mean; Σ, totals.

SCHRENCK gives 112° in the divergency of the median valve. So far as the materials examined it varies from 100° to 123° and the mean is about 108°

The ctenidia extend along the practically entire length of the foot and the number of gills ranges from 25 to 50, being equal or nearly so on

DIVERGENCY	F	DIVERGENCY	F
100°	3	112°	2
102	2	113	1
105	1	114	1
106	2	115	1
108	1	117	1
110	3	123	1
		Σ=2065	=19
		M=108.63	

Table showing variation of divergency in median valves.
F, number of individuals; Σ, totals; M, mean.

mm	Body length																		
	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	
37	1																		
38	1																		
39																			
40																			
41																			
42							1			1									
43												1							
44							1												
45											1	2		1					
46										1			1						
47											1	1		1					
48													1	2				1	
49																			
50																			1

Text-fig. 4. Graph showing the relation between the body length and the number of gills.

each side and increases in proportion to the length of body as shown in the following table and graph.

NUMBER OF GILLS		F
LEFT	RIGHT	
26	26	1
28	28	1
29	29	1
25	30	1
30	30	3
32	30	1
31	31	2
31	32	1
32	33	1
33	33	1
35	37	1
37	38	1
40	40	1
41	41	1
44	42	1
45	43	1
45	47	1
45	48	1
46	42	1
47	45	1
48	46	1
47	48	1
48	50	1
Σ		26

F, number of individuals; Σ, totals.

BODY LENGTH	NUMBER OF GILLS	
	LEFT	RIGHT
22 mm	37	38
33	44	42
42	46	42
44	45	47
46	45	43
46	47	45
48	48	46
49	47	48
50	45	48
55	48	50

Table showing the relation between body length and number of gills on both sides.

Locality:

SP. No.	STATION	LOCALITY	COLLECTOR	DATE	NUMBER OF SPECIMENS
670	1 (I)	Ôsima, Asamusi	HOZAWA and ITO	July 12, 1926	1
672	83 (III)	Akimae	KOKUBO and KAMADA	Aug. 23, 1926	2
674	31 (I)	Itasaki	HATAI and HOZAWA	July 24, 1926	2
676	15 (I)	Ôsima	HOZAWA and TAKATUKI	July 16, 1926	1
678	76 (III)	Akimae	KOKUBO and KAMADA	Aug. 22, 1926	1
679	63 (V)	Syukunobe			5
681	21 (I)	Hanakuri, Nonai-mura	HOZAWA and TAKATUKI	July 19, 1926	2
683	—	—	—	—	3
686	23 (I)	Moura	HOZAWA and TAKATUKI	July 20, 1926	2
1639	—	Kamomezima	TAKATUKI	July 10, 1926	1
1722	—	Kanida	TAKATUKI and SATO	July 23, 1927	1
1897	—	Yunosima	HOZAWA	Aug. 9, 1927	1
—	—	„	Iw. TAKI	Aug. 15, 1930	10
—	—	Asamusi	„	Aug. 14, 1930	1
—	—	„	„	Aug. 9, 1930	1

Distribution:

Pacific coast

Hokkaidô: Akkesi (1) (HADA and OKUDA); Murooran (2) (SMITH, BERRY); Hakodate (3) (SCHRENCK, PILSBRY, K. ENDÔ).

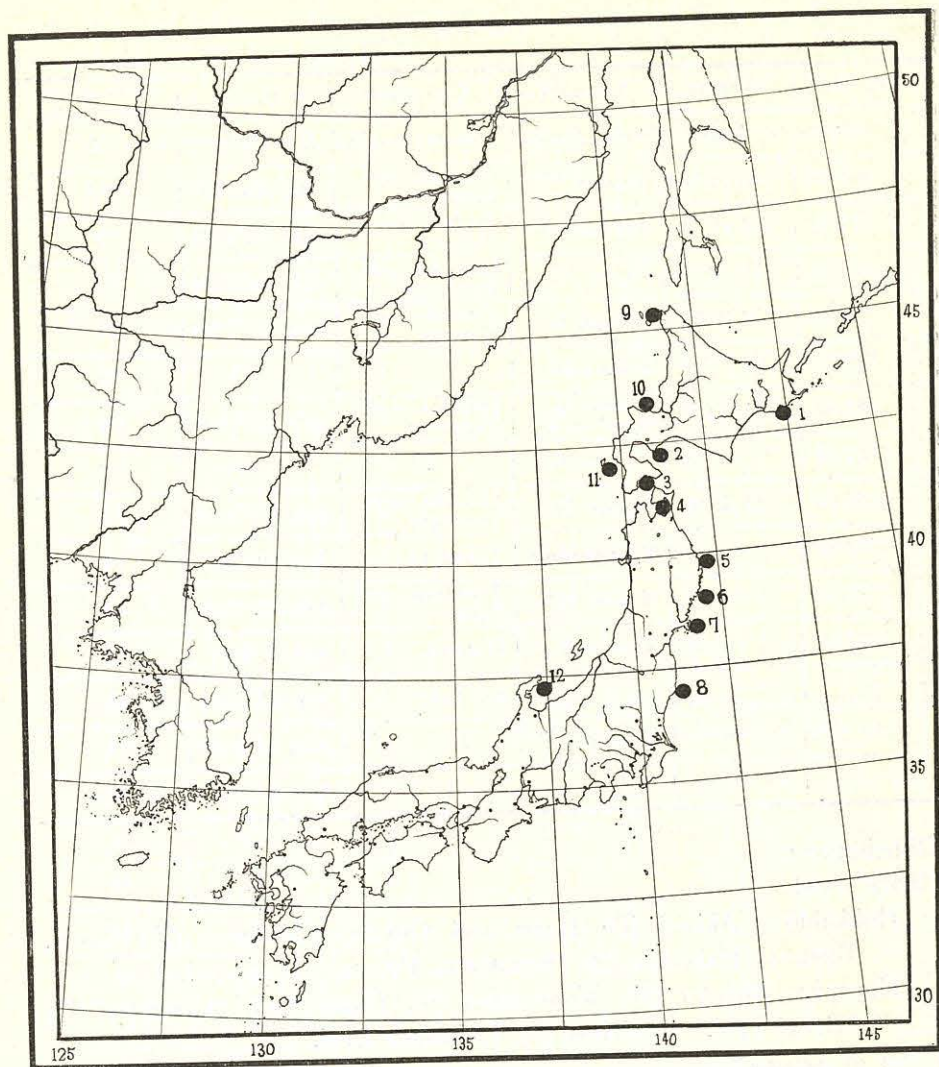
Honsyû: Miyako (5); Kesenuma (6), Iwate Pref. Onagawa (7), Miyagi Pref. Onahama (8), Hokusima Pref.

Coast of Japan Sea

Hokkaidô: Risiri-tô (9); Yoiti (10); Okusiri-zima (11) (KINOSITA and ISAHAYA).

Honsyû: Mutsu Bay (4), Aomori Pref. Toyama Bay (12) (KIKUTI), Toyama Pref.

This is one of the commonest species at the littoral zone of Hokkaidô and Honsyû with the southern limit in its distribution at about 37° N on both sides of Honsyû.



Text-fig. 5. Geographical distribution of *Lepidozona albrechti* SCHRENCK.

17. *Lepidozona mertensi* (MIDDENDORFF, 1846)

Pl. XIV, fig. 6; Pl. XXIX, figs. 1-6; Pl. XXX, figs. 6-9; Pl. XXXI, figs. 9, 10.

Chiton mertensii

MIDDENDORFF (1846) Bulletin de la Cl. Phys.-mathem. de l'Académie de St.-Petersbourg, Tome 6, p. 118.

Chiton (Stenosemus) mertensii

MIDDENDORFF (1847) Melacologia Rossica, pp. 34, 125-127, Tab. 14, Fig. 1-3; (1848)

Mémoires de l'Académie Impériale de Sciences de Saint-Petersbourg, Ser. 6, Tome 6, pp. 189-191; California, coll. by ROSS. MERTENS.

Leptochiton mertensii

ADAMS, A. and H. ADAMS (1854) Genera of Recent Mollusca, Vol. 1, p. 473.

DUNKER (1882) Index Molluscorum Maris Japonici, p. 158; Hakodate.

Lepidopleurus mertensii

DALL (1878) Proceedings of the United States National Museum, Vol. 1, pp. 297-332.

— (1878) Bulletin of the United States National Museum, Vol. 1, pp. 79, 114-115, pl. 2, figs. 18, 18 a. (radula), Sitka, south to Monterey.

Ischnochiton (Lepidozona) mertensii

PILSBRY (1892) Manual of Conchology, Vol. 14, pp. 125-126, pl. 26, figs. 20-26.

— (1895) Catalogue of the Marine Mollusks of Japan, p. 114.

BERRY (1917) Proceedings of the Californian Academy of Sciences, Ser. 4, Vol. 7, No. 10, p. 236; Forrester Island; Waterfall Cannery, Prince of Wales Island, Alaska.

DALL (1921) Smithsonian Institution United States National Museum, Bulletin 112, p. 192; Sitka, Alaska, to San Pedro, San Martin Island, Lower California, (cf. Addit. and emend. etc., Proc. U. S. Nat. Mus., Vol. 63, pp. 1-4).

BERRY (1922) Proceedings of the Californian Academy of Sciences, Ser. 4, Vol. 11, No. 18, pp. 475-476, pl. 10, figs. 7-12.

— (1926) American Journal of Science, Vol. 12, p. 456; Pleistocene of San Quintin Bay, Lower California.

— (1927) Proceedings of the Malacological Society of London, Vol. 17, p. 164; China Hat, Queen Charlotte Islands, British Columbia.

Ischnochiton mertensi

CHACE (1930) Nautilus, Vol. 44, pp. 7-8.

Shell oval, moderately thin, elevated with angular dorsal ridge; terminal and lateral areas radially pustulose; central area strongly lined; girdle narrow, covered densely with small scales.

Head valve ornamented with 25 to 35 ray-ribs, each bearing a series of rounded or pyriform pustules, the posterior series directed obliquely backward so as to dentate the suture; apex low, inconspicuous, interior of valve smooth; slit-ray distinct, without a pore; slits 9 to 11.

Median valve carinated at the jugum with straight side slope; lateral area distinctly raised, sculptured with radiating series of pustules, 5 or 6 in row; central area having acute, narrow, longitudinal riblets, interspace between them roughly latticed across, obsolete at the dorsal ridge, where the riblets have a tendency to diverge; jugal area distinct only in the 2nd valve, provided with diverging lirae with nearly smooth interspaces; sutural laminae low, wide, roundly arched at the edge, connected across the sinus by a dentate plate; teeth short, obtuse, usually roughened on the outer surface; eaves solid, wide; one slit on each side; sinus flat, angular at the base; interior of valve smooth; callus indistinct; slit-ray provided with numerous, fine, elongate pores.

Posterior area of tail valve straight, radially pustulose as in the head valve, central area roundly arched, sculptured with 20 to 24 sharply cut, longitudinal bars, traversed by numerous irregular grooves; mucro median, low, inconspicuous; slits 10 to 12.

Girdle firm, compactly covered with regular, solid scales, which are nearly squarish in outline, fairly curved inward, ornamented with about 10 longitudinal ribs, having a process at the front end; marginal armatures composed of three kinds of spines, the longest of which is hyaline, slightly curved, cylindrical of same diameter, sparsely beset among the thick, short, hyaline, striated spines; the smallest brownish in colour, sharply pointed at the end, strikingly striated near the tip; hyponotum covered densely with hyaline, oblong scales.

Colouration: Varying in colour from orange-red to claret-red, or even dark red-brown, either unicoloured or speckled and blotched with white; interior of valves generally white or blue-white; median valves showing broad red-brown rays posteriorly, tail valve tinted with crescents of the same colour at the middle; colouration of girdle similar to that of the shells, regularly or obscurely tessellated in two shades of dark brown.

Radula: Central tooth dilated anteriorly, slightly sinuated at the front edge, shallowly constricted on both sides; centro-lateral squarish in outline, having a large outer wing at the anterior end, a broad outer lamella at the posterior end; anterior edge slightly sinuated at the middle, though not cusped; major lateral bicuspidate, outer cusp much smaller than the inner one; outer process of the shaft remarkably protruded outside at about the middle, dorsal surface deeply channelled; major uncinus slightly curved inward with large basal plate; marginals oblong shaped, the outer one narrower anteriorly.

Gill rows take the space three-quarters of the foot, each containing about 40 branchiae.

Size: Length 20 mm, breadth 6 mm; divergency 100° (DALL)
 " 18 mm, " 12 mm; " 105°
 " 17 mm. " 11 mm; (contracted specimens).

Locality: Kanida, 5 specimens were collected by TAKATUKI in July, 1927; sp. no. 1716.

Distribution: On the Pacific coast of America, Sitka and vicinity, south to Lower California, on the Japanese coast, Hokkaidô and northern Honsyû.

American coast

Alaska; Forrester Island; Waterfall Cannery, Prince of Wales Island

(BERRY); Sitka (DALL).

British Columbia; China Hat, Queen Charlotte Islands (BERRY); Puget Sound Region (BERRY); Northern California (BERRY); Monterey Region (DALL, BERRY); Southern California (BERRY); San Pedro, San Martin Island (DALL, BAKER); San Quintin Bay (BERRY), Lower California (BERRY).

Japanese coast

Hokkaidô; Hakodate (DUNKER).

Honsyû; Mutsu Bay.

Family 5. CHITONIDAE

Subfamily A. CHITONINAE

Genus RHYSSOPLAX THIELE 1893

18. *Rhyssoplax kurodai* (Is. TAKI et IW. TAKI, 1929)

Pl. XV, fig. 5; Pl. XXXI, fig. 11; Pl. XXXII, figs. 1-7.

Chiton sp.

TAKI, Is. (1924) *Dôbutugaku Zassi*, Vol. 36, pp. 285-286, with 1 text-fig.; Misaki, Sagami.

YAGI (1931) *Ehimeken Dôbutusi*, p. 67, no. 737; Tikami.

Chiton kurodai

TAKI, Is. and IW. TAKI (1929) *Venus*, Vol. 1, No. 2, pp. 52-53, pl. 2, fig. 3, text-figs. 8-11; Iyo; Misaki; Seto.

KUSE (1930) *Tatugahama Kinkaisan Kairui Mokuroku*, p. 12, no. 185; Tatugahama, Wakayama Pref.

KIKUTI (1931) *Toyamawan Nantaidôbutu Mokuroku*, p. 2, no. 9; Abugasima, Toyama Bay.

YOKOYAMA (1931) *Catalogue of Marine, Freshwater and Land Shells of Japan*, p. 16, no. 468; Iyo.

YAGURA (1932) *Hyôgokensan Kairui Mokuroku*, p. 20, no. 246; Harima; Awazi.

Chiton (Rhyssoplax) kurodai

TAKI, IW. (1936) *Onomiti Kinkaisan Nantaidôbutu Mokuroku*, p. 1, no. 5, Onomiti.

TAKI, Is. (1936) *Saitôhônkai Hakubutukan Zihô*, No. 30, p. 1, no. 13; Onahama, Hukushima Pref.

Chiton (Clathropleura) bocki

BERGENHAYN (1933) *Kungl. Svenska Vetenskapsakademiens Handlingar*, Bd. 12, No. 4, S. 26-29, Taf. 1, Fig. 8, Taf. 3, Fig. 53, Text-fig. 9, a-f; Sagami Misaki.

Body oval or elongate oval in outline; shells well elevated, weakly carinated at the jugum, moderately beaked on the median valves; girdle rather narrow, densely covered with imbricating scales. It is one of the handsomest chitons in Japan.

Head valve thick, solid, generally smooth on the tegmental surface, it

is finely granulated in quinquax when seen under a microscope; anterior edge regularly arched; posterior edge straight, shallowly incised at the apex; interior of the valve smooth, shining, without a distinct callus; slits deeply incised, 8 to 9 in number; slit-lines shallow, distinct, provided with numerous small pores.

Median valves oblong shaped with an arched front edge and a well protruded beak; lateral area distinctly raised, smooth like the head valve; jugum not distinct, only defined by its smoothness from the pleural area, which is sculptured with 14 to 21 longitudinal lirae; sinus wide, flat, with pectinated laminae at the base; interior of valves polished with well developed callus at the middle; lateral region deeply concave; jugal region provided with numerous transverse, short lines; sutural laminae low, roundly arched, sharp at the front edge; teeth thick, solid, strikingly pectinated on the outer surface; slit distinct, one on each side; slit-line wide, provided with pores in double rows; posterior edge broadly reflexed.

Tail valve semicircular in outline, nearly straight at the front edge, regularly round posteriorly; mucro a little in front of the middle, distinct, though not raised; posterior slope slightly concave, sharply demarcated with diagonal lines from the central area, which is sculptured with 11 to 14 longitudinal lirae; jugum inconspicuous; interior of the valve smooth, without any callus; teeth thick, solid, well pectinated as in those of the median valves; slit-lines like those of the head valve; slits distinct, usually 9 to 12 in number; sutural laminae flat, wide, truncated at the front edge.

Perinotum of the girdle covered densely with smooth, regularly imbricating, strongly curved scales with rhombic base, generally from 16 to 18 in a diagonal row, tending to become smaller toward the edge; marginal spinules small, hyaline, lanceolate with somewhat flattened base; hyponotum covered with minute hyaline, oblong scales.

Teeth of the radula weak except for the major laterals; central tooth of much elongate oblong shape with a long, tapering cusp at the tip; centro-lateral rhombic shaped, with a remarkable folds in front, nearly straight on both inner and outer edges, slightly waved at the posterior edge, having a small appendage near the tip on the outer edge, its basal plate triangular, very much thickened at the inner edge; major lateral thick, stout, having a narrow outer wing and a small, oblong inner process, concave at the back near the tip, holding a large, entire, obtusely pointed cusp at the anterior end; major uncinus very small, broadly dilated at the tip so as to take the shape of a fan, stalk short, basal-plate small,

oval shaped; inner marginal small, oblong with inconspicuous central process, waved at the outer edge; middle-marginal larger than the former, elongate hexagonal shaped; outer marginal squarish in outline, slightly protruded at the posterior edge.

Ctenidia holobranchial abanal, gills about 27 on one side.

Remarks: *Chiton bocki* was described by BERGENHAYN (1933) basing on the material collected by SIXTEN BOCK at Misaki and was considered different from *Chiton canariensis* and *Ch. rhynchotus*, recorded from the Canary Islands and New Caledonia respectively, in having the smooth scales in the girdle and the denticulated jugal plate. No reference was made by him in his paper to the known Japanese species of the genus e. g., *Chiton aquatilis*, *Ch. densiliratus* and *Ch. kurodai*. The last species was reported by myself (1924) from Misaki, named by my brother and me (1929) basing on the material from Misaki, Seto and Mitu, and does not show any difference from *Ch. bocki* in all important features of the valves, the scales, the radula, the ctenidia and the colouration.

Locality: Kanida, two small specimens were collected by TAKATUKI in July, 1927 together with *Tonicella lineata*, *Tonicella submarmorea*, *Lepidozona mertensi*, *Lepidopleurus hakodatensis* and *Ischnoradsia hakodadensis*; sp. no. 1716. 15 specimens were collected by IWAO TAKI at Yunosima on August 13, 1930.

Distribution:

Pacific coast

Honsyû: Matusima Bay, Miyagi Pref. (TAKEWAKI). Onahama, Hukushima Pref. (TAKI). Misaki, Kanagawa Pref. (TAKI, BERGENHAYN). Kamizusima, Izusitô (MIYAZI). Simoda, Sizuoka Pref. (KANEKO). Seto (TAKI), Tatugahama (KUSE), Wakayama Pref.

Sikoku: Kasiwazima, Kôti Pref. (SUGIMOTO). Yawatahama, Ehime Pref. (TAKI).

Inland Sea

Honsyû: Harima; Awazi, Hyôgo Pref. (YAGURA). Onomiti, Hirosima Pref. (Iw. TAKI).

Sikoku: Imaharu (TAKI); Tikami (YAGI); Mitu (TAKI), Ehime Pref.

West coast

Kyûsyû: Simokosikizima, Kagosima Pref. (MITUKURI).

Tyôsen: Kanrin, Saisyûtô (OKUDA).

Japan Sea

Hokkaidô: Hukuyama, Ozima (KINOSITA).

Honsyû: Mutsu Bay, Aomori Pref. Tobisima, Akita Pref. (KURODA).

Abugasima, Toyama Bay (KIKUTI). Toriimura, Simane Pref. (S. TAKAGI).

19. *Rhyssoplax tectiformis*, nov. sp.

Pl. XV, fig. 4; Pl. XXXI, fig. 8; Pl. XXXII, figs. 8-13.

Body of small size; shell ovate in outline, strongly elevated at the jugum, central area weakly lired, other areas smooth; mucro subcentral; girdle covered with small scales, orange red in colour, tessellated with brownish red.

Head valve: apex bluntly prominent, posterior margin incised at the middle; surface generally smooth, but showing a very minute quincuncial pattern of granulation under the lens, marked faintly with concentric lines, maculated with reddish brown; interior of valve smooth, reddish brown in the middle, brownish yellow at the periphery; teeth thick, short, well pectinated on the outer surface, eaves solid, narrow; slits shallow, 9 in number.

Median valves strongly keeled at the jugum, much beaked at the posterior margin; front edge slightly sinuated at the middle; jugal area not well defined; whole surface minutely punctated like the head valve; central area ornamented with about 10 weak longitudinal lirae on each side of the keel, maculated irregularly with brownish red; lateral area very much raised, marked with a few concentric lines of growth; interior of the valves light pinkish in the pleural region, chestnut in the jugal region, brownish red in the lateral region; callus not thickened; slit-line shallowly grooved; teeth thick, short, well pectinated on the outer surface; slit one on each side; sutural laminae thin, short, rounded at the front edge; sinus wide, shallow, with small plate at the base, composed of five, small, wedge-shaped plates.

Tail valve: mucro prominent, situated at about two-fifths the entire length from the anterior edge; central area having 6 lirae on each side, separated by low ridges from the posterior area, which is slightly concave, sculptured like the head valve; sutural laminae short, wide, truncated at the front edge; interior smooth, brownish red at the middle, brownish yellow at the posterior margin, whitish anteriorly; slits at the periphery 11 in number.

Girdle: scales of perinotum squarish in outline, smaller ones more rounded with broad, rhombic base; surface smooth, though in large ones marked with fine, transverse lines; marginal spines small, hyaline, striated

obliquely, pointed bluntly at the tip, truncated at the base; scales of hyponotum hyaline, flattened rod-shape, blunt at the anterior end.

Radula: central tooth much elongated, strongly cusped at the front end, truncated at the base; centro-lateral broad, much undulated at the front edge, outer lamella protruded anteriorly, bearing a small wing at the outer surface near the tip; major lateral well developed, shaft stout, inner wing large, slightly reflexed at the end, cusp thick, simple, not acute at the edge; major uncinus small, fan-shaped, stalk thick, short with small basal plate; outer marginal much wider than long.

Gills: holobranchial, extending along the entire length of foot, 23 or 24 ctenidia on each side.

Size: body length 9 mm, breadth 6 mm (type).

 " " 10 mm, " 6 mm (cotype).

Head valve 3.25 mm, 2nd valve 3.7 mm, 3rd valve 4 mm, tail valve 2.8 mm in breadth (type).

Colouration: Orange red on the whole surface, the shells maculated with brownish red; in the cotype the second valve and the central area of the third valve are brownish yellow; the girdle finely tessellated.

Remarks: This species bears a much resemblance to *Chiton kurodai* in the texture of the shells, the sculpture of the central area, the shape of the scale in the girdle and of cusps in the radular teeth. This differs from it in having much coarser texture of shells, much less number of lirae in the central area, much more elevated and beaked valves, the smaller, striated marginal spines, the smaller cusp of the central tooth, much more developed inner wing of the major lateral, the transversely

CHARACTERS		SPECIES	
		<i>tectiformis</i>	<i>kurodai</i>
lirae	number	9-10	12-13
	shape	ridge	groove
beak		more beaked	less beaked
laminae of sinus		cut into five plates	denticulated
central tooth		cusps simple, small	tapering, long cusp
major lateral		wing large, cusped	wing small, not cusped
outer marginal		oblong	squarish
marginal spine		obliquely striated, small, hyaline, obtuse	smooth, large, brown, sharply pointed

elongate outer marginal. These differences are shown in the above table.

Locality: Ōma, 2 specimens were collected by HŌZAWA, TAKATUKI and SATŌ in August, 1927; station 104; specimen number 2076, 2077.

Subfamily B. ACANTHOPLEURINAE

Genus LIOLOPHURA PILSBRY 1893

20. *Liolophura japonica* (LISCHKE, 1873)

Pl. XV, fig. 3; Pl. XXXII, figs. 15, 16; Pl. XXXIII, figs. 1-8; Pl. XXXIV, figs. 1-4.

Chiton spiniger

SCHRENCK (1867) *Reisen und Forschungen im Amur-Lande*, Bd. 2, S. 275-276; Hakodate.

? *Chiton de-Filippii*

TAPPARONE-CANEFRI (1874) *Zoologia del Viaggio Intorno al Globo della Regia Fregata Magenta*, p. 77; Japan, not *Amycula de-filippii*.

Chiton japonicus

LISCHKE (1873) *Malakozoologische Blätter*, Bd. 21, S. 22.

— (1874) *Japanische Meeres-Conchylien*, Theil 3, S. 71, Taf. 5, Fig. 8-11; Nagasaki.

Chaetopleura japonica

DUNKER (1882) *Index Molluscorum Maris Japonici*, p. 158; Nagasaki.

Acanthopleura japonica

THIELE (1893) *Gebiss der Schnecken*, Bd. 2, Lfg. 8, S. 373, Taf. 30, Fig. 34; Enosima (DOEDERLEIN).

Acanthopleura (Liolophura) japonica

THIELE (1910) *Zoologica*, Bd. 22, Ht. 56, S. 3, 115.

NOWIKOFF (1907) *Zeitschrift für wissenschaftliche Zoologie*, Bd. 88, S. 153-186, Taf. 10, Fig. 2-4, 9, Taf. 11, Fig. 14.

Liolophura japonica

PILSBRY (1893) *Manual of Conchology*, Vol. 14, pp. 242-243, pl. 53, figs. 41-44; Enosima (STEARNS).

— (1895) *Catalogue of the Marine Mollusks of Japan*, p. 115, Enosima (STEARNS).

NIERSTRASZ (1905) *Notes from the Leyden Museum*, Vol. 25, p. 115, pl. 10, fig. 22; Japan.

— (1905) *Siboga-Expedition, Monographie 48*, p. 108; Japan, Enosima, Nagasaki.

HIRASE, Y. (1907) *Catalogue of Marine Shells of Japan*, p. 23; Hirado, Hizen.

— (1909) *Kairui Tebikigusa*, p. 69, fig. 68.

— (1910) *Nippon Senkai Mokuroku*, p. 30, no. 633; Hizen.

— (1914) *Hutū Kairui no Siori*, p. 1.

— (1915) *Conchological Magazine*, Vol. 4, no. 1, pl. 1, fig. 8.

YAGURA, W. (1913) *Nippon Kairui Syasin Tyō*, pl. 44.

— (1916) *Hyōgoken Kairui Mokuroku*, p. 2, no. 5; Awazi; Settu; Harima; Tazima.

TAKI, Is. (1924) *Dōbutugaku Zassi*, Vol. 36, No. 429, pp. 289-290, 1 text-fig.; Misaki, Sagami.

HIRASE, S. (1927) *Figuraro de Japanaj Bestoj*, p. 1503, fig. 2888.

BABA, K. (1929) *Dōbutugaku Zassi*, Vol. 41, No. 485, pp. 108, 115-116, text-figs. IV, figs. 1-4.

THIELE (1929) *Handbuch der systematischen Weichtierkunde*, S. 21.

KUSE, Y. (1930) *Tatugahama Kinkaisan Kairui Mokuroku*, p. 12, no. 186.

YAGI, S. (1931) *Ehimeken Dōbutusi*, p. 67, no. 733; Tikami.

KIKUTI (1931) *Toyamawan Nantaidōbutu Mokuroku*, p. 2, no. 10; Abugasima.

GISLÉN, T. (1931) *Journal of the Faculty of Science Imperial University of Tokyo*, Sect. 4, Vol. 2, Part 4, pp. 435, 436, 441; Misaki.

BERGENHAYN (1933) *Kungl. Svenska Vetenskapsakademiens Handlingar*, Bd. 12, No. 4, S. 39-40, Taf. 1, Fig. 12, Taf. 13, Fig. 60-67; Text-fig. 13, a-c; Misaki, Sagami.

ASANO, H. (1933) *Bunrui Suisan Dōbutu Zusetu*, p. 252, fig. 348.

KURODA, T. (1933) *Hukuikensan Kairui Mokuroku*, p. 179, no. 7; Nibu; Turuga; Onihu; Ōi.

SIBA, N. (1934) *Journal of Chosen Natural History Society*, No. 18, p. 12; Tyōsen.

KURODA, T. (1935) *Miyazakikensan Kairui Mokuroku*, p. 39, no. 6; Aosima.

HATAKEDA (1935) *Venus*, Vol. 5, No. 4, p. 233, no. 39; Asahimura; Kamizimasotomura; Kitakizimamura, Okayama Prefecture.

— (1936) *Venus*, Vol. 6, No. 2, p. 116, no. 27; Sikaimura; Kitauramura; Hukudamura; Yasudamura; Sakatemura; Nisimura, Syōdosima, Kagawa Prefecture.

Liolophura japonica tessellata

PILSBRY (1893) *Manual of Conchology*, Vol. 14, pp. 243-244, pl. 53, figs. 45, 46; Enosima.

— (1895) *Catalogue of the Marine Mollusks of Japan*, p. 115; Enosima (STEARNS).

NIERSTRASZ (1905) *Siboga-Expedition, Monographie 48*, p. 108.

YOKOYAMA (1931) *Catalogue of Marine, Freshwater and Land Shells of Japan*, p. 16, no. 469; Iyo.

YAGURA (1932) *Hyōgokensa Kairui Mokuroku*, p. 20, no. 247; Tazima; Harima; Settu; Awazi.

TAKI, Is. (1936) *Saitō Hōonkai Hakubutukan, Zihō*, No. 30, p. 1, no. 11; Akita; Yamagata; Miyagi Prefectures.

Body large, elliptical in outline; shell broad, moderately elevated, roundly arched, not carinated at the back, generally much eroded and encrusted; girdle medium in breadth, covered densely with numerous spines, more or less regularly tessellated with white and dark brown.

Head valve thick, solid, nearly semicircular in outline; apex not prominent; tegmentum ornamented with exceedingly minute granules, sparsely studded with numerous, black aesthetes on the whole surface, weakly wrinkled by indistinct furrows, giving a tendency to form radial riblets, intersected by strong concentric lines of growth; interior of the valve smooth, shining, weakly callused at about the middle, having 8 to 10 slits at the periphery; slit-lines indistinct without pores; teeth short, thick, strongly pectinated on the outer surface; posterior margin broadly reflexed.

Median valve oblong in outline, roundly arched at the jugum, slightly

sinuated at the middle of the anterior edge, much beaked but not pointed at the posterior edge; jugal area not well defined; lateral area hardly raised, scarcely defined by either a boundary rib or sculptures; tegmentum provided with numerous, fine, diagonally arranged granules on the whole surface; interior of the valve smooth, polished, with strongly elevated transverse callus at the middle; lateral and central regions deeply concave; slit small, one on each side; teeth thick, very short, pectinated on the outer surface; slit-line indistinct, without a pore; sutural laminae thick, broad, extending well forward, connected with each other by a small jugal lamina; sinus broad, deep, regularly arched.

Tail valve triangular in outline, nearly straight at the anterior edge, roundly arched on both sides; central area broad, flat, occupying a greater part of tegmentum, finely granulated likewise that of the median valve; mucro terminal, indistinct, bluntly produced posteriorly beyond and above the eaves; posterior area small, a little concave, lying under the central area; in place of insertion plate, crescentic ridge present, which is broad, flat, thick, smooth, a little wrinkled on the posterior surface, though not forming a distinct slit, becoming lower gradually passing over to the sutural lamina; central callus well developed in parallel with the crescentic ridge; central region strongly concave; sutural laminae extending remarkably forward to form a deep sinus between them, pectinated at the outer edge on the surface, bridged each other by jugal lamina; eaves broad, roughened by minute granules on the surface.

Colouration: tegmental surface of the valve without luster; blackish, generally showing a wide light stripe on each side of the black dorsal stripe; interior of the valves black, shining; sutural laminae black on both surfaces.

Girdle conspicuously varied with alternate patches of white and scorched brown or blackish, densely clothed with two kinds of numerous short, thick spines, becoming smaller toward the outer edge; upon the dark tracts of the girdle, spines reddish-brown or blackish, unicoloured or tipped with light brown or cream-white, nearly straight, obtusely pointed at the tip, much thickened at the base; upon the light tract, spines somewhat larger than the former, slightly curved, unicoloured white or light brown on the dorsal surface with dark-brownish on the ventral surface, somewhat flattened at the tip and nearly round in section at the base; marginal spine small, thin, hyaline, containing numerous minute granules, more or less pointed at the tip; hyponotum covered with minute, hyaline scales, which are coarsely striated on the surface, slightly smaller at the front

end, with squarish basal plate, near the peripheral region of this tract they are much elongated, faintly marked with a few striations.

Radula: central tooth remarkably long, slightly pointed, distinctly cusped at the tip; cutting edge slightly sinuated at the middle, both sides somewhat constricted; posterior end a little dilated, bilobed; basal plate rhombic shaped, situated at the middle of the tooth; centro-lateral broad, strongly cusped at the anterior edge, with a small triangular outer wing at the posterior corner, protruded posteriorly, slightly sinuated at the inner edge, basal plate broad, extending outside; major lateral thick, stout, unicuspidate, its cutting edge roundly arched, having a large wing at the inner edge of the shaft, bearing a strong cusp; outer edge protruded at the middle, broadly extended outside at the base, dorsal process well developed; inner small-lateral broadly protruded posteriorly, narrowing anteriorly; outer small-lateral thick, roundly lobed anteriorly with a small basal plate articulating with the outer edge of the preceding tooth, posterior lobe having a small process, directed outside to cover the basal part of the major uncinus; major uncinus having a broad cusp on the long stout shaft, erected from the small basal plate; inner marginal oblong in shape, having large triangular process at the middle, small denticle at the posterior edge, weakly waved at the outer edge; median marginal oval shaped, slightly bilobed at the inner edge, bluntly pointed posteriorly; outer marginal pentagonal in shape, somewhat longer than wide, shallowly sinuated at the anterior edge, protruded posteriorly.

Size: Length 35 mm, breadth 21 mm (type, LISCHKE).

„ 50 mm, „ 20 mm (PILSBRY, girdle excluded).

„ 36 mm, „ 26 mm (Mutsu Bay, somewhat contracted).

The largest specimen I have measured is 68 mm by 43 mm.

Remarks: A form of chitons collected by LINDHOLM from Hakodate, Hokkaidô was identified by SCHRENCK (1859) as *Chiton spiniger* which had been known only from tropical waters. The subsequent authors, such as SOWERBY (1930) and LELOUP (1933), quoted this locality as that of *Acanthopieura spiniger* (= *Acanthozostera gemmata*). SCHRENCK's note on this species is not altogether clear for me. This may be *Liolophura japonica* judging from its sculpture and colouration.

TAPPARONE-CANEFRI (1874) described *Chiton defilippii* from Japanese waters and distinguished it from *Chiton piceus* (= *A. gemmata*) by its peculiar features. But his diagnosis is not full enough for subsequent reference. PILSBRY examined the species and came to the conclusion that it is a synonym of *L. japonica*. His decision seems quite right.

LISCHKE (1893) described *Chiton japonicus* from Nagasaki, and PILSBRY (1893) quoted this in his manual under the genus *Liolophura* as the type and described its variety, *tessellata*, in which the girdle is much narrower and regularly tessellated with alternate patches of white and scorched brown or blackish and the spinelets are larger and more flattened than in the typical form. In observing numerous material of this species from the type locality and from other places of Japan, it was recognized that the girdle and the spinelets exhibit exceeding variation in size, colour and in width. I can not, therefore, distinguish *L. tessellata* from *L. japonica* from the features of the girdle.

The individual provided with narrow girdle, and rather small, uniformly coloured spinelets, figured by PILSBRY in plate 53, figures 41 and 42 in his manual, was considered by him as one of the typical form. It is, however, clearly distinguished from the type in all respects of the girdle.

At the same time, PILSBRY showed the type of CARPENTER's unpublished species, *Ornithochiton* (?) *caliginosus*, collected from China Sea and Hongkong, shown in figures 41-45 of plate 54 in his manual and believed to be identical with *L. japonica*, notwithstanding its sculpture of tegmentum and the most features of the girdle armatures and the insertion plate of the tail valve differ distinctly from those of *L. japonica*. It is undoubtedly different from CARPENTER's species.

HADDON (1886) reported *Acanthopleura incana* taken from Oosima, Japan during the voyage of "Challenger". NIERSTRASZ (1905) recorded 9 specimens of *L. japonica* var. *tesselata* [sic] from Molucca now in the collection of the Leyden Museum. The former of the two was identified by PILSBRY (1893) as *L. japonica*. It seems to me much proper to treat this form as identical with *L. loochooana* by its peculiar sculpture of valves, and the latter as an Australian species of the genus.

Distribution:

Pacific coast

Hokkaidô: Hakodate (SCHRENCK, IW. TAKI) (1).

Honsyû: Miyako (3); Hirota Bay (TOBA) (4), Iwate Pref. Ôsima (5); Karakuwamura (6); Kesenuma (7); Onagawa (8); Kinkazan (9); Ayukawa (10); Amizisima (11); Watanoha (12); Matusima Bay (TAKI) (13), Miyagi Pref. Hutomi (HIRASE) (14), Tiba Pref. Uraga (TAKI) (15); Misaki (TAKI, BERGENHAYN) (16); Enosima (THIELE, STEARNS, TAKI) (17); Manazuru (TAKI) (18); Kanagawa Pref. Ôsima (YAMAMURA, K. ÔYAMA) (19); Kamizusima (MIYAZI) (20); Izu Sinitô. Atami (TAKI) (21); Simoda (KANEKO) (22);

Enoura (HARA) (23); Omaezaki (A. HUZITA) (24), Sizuoka Pref. Wagu (T. YAMADA) (25), Mie Pref. Tanabe (Y. OKADA) (26); Seto (IW. TAKI) (27); Gobô (OKAMOTO) (28); Kada (R. TANAKA) (29), Wakayama Pref.

Sikoku: Murotozaki (HIRO) (30); Kôti (KAMOHARA) (31); Kasiwazima (SUGIMOTO) (32), Kôti Pref. Yawatahama (TAKI) (33), Ehime Pref.

Kyûsyû: Saganoseki (K. TAKAGI) (34), Ôita Pref. Aosima (KURODA) (35), Miyazaki Pref. Natui, Sibusi Bay (MITUKURI) (36), Kagosima Pref.

Inland Sea

Honsyû: Settu (YAGURA) (37); Akasi (R. TANAKA) (38); Awazi (YAGURA, Z. MORITA) (39), Hyôgo Pref. Nôzizima (IWAKAWA); Kônosimasotomura (HATAKEDA) (40); Asahimura (HATAKEDA) (83) Okayama Pref. Uzina (TAKI) (41), Hirosima Pref.

Sikoku: Siratori (Z. MORITA) (42); Syôdosima (HATAKEDA) (84) Kagawa Pref. Tikami (YAGI) (43); Mitu; Gogosima (TAKI) (44); Ehime Pref.

Kyûsyû: Siraki (K. TAKAGI) (45), Ôita Pref.

West coast

Kyûsyû: Akune (MITUKURI) (46), Kagosima Pref. Amakusa (BABA) (47), Kumamoto Pref. Nagasaki (LISCHKE, SONEHARA) (48); Nanatukamamura (Y. KÔNO) (49); Kurosemura (S. KINOSITA) (50); Sasamura (TAKAMASU) (51); Sisikimura (NISI) (52); Hirado (HIRASE) (53); Takasimamura (HIROYAMA) (54); Matoyama (SIRAKABE) (55); Kaminoura (SEGAWA) (56), Ôsima; Kisyuku (YOSIDA) (57), Gotô Rettô; Ituhara (EGUTI) (58); Nii (ABIRU) (59), Tusima, Nagasaki Pref.

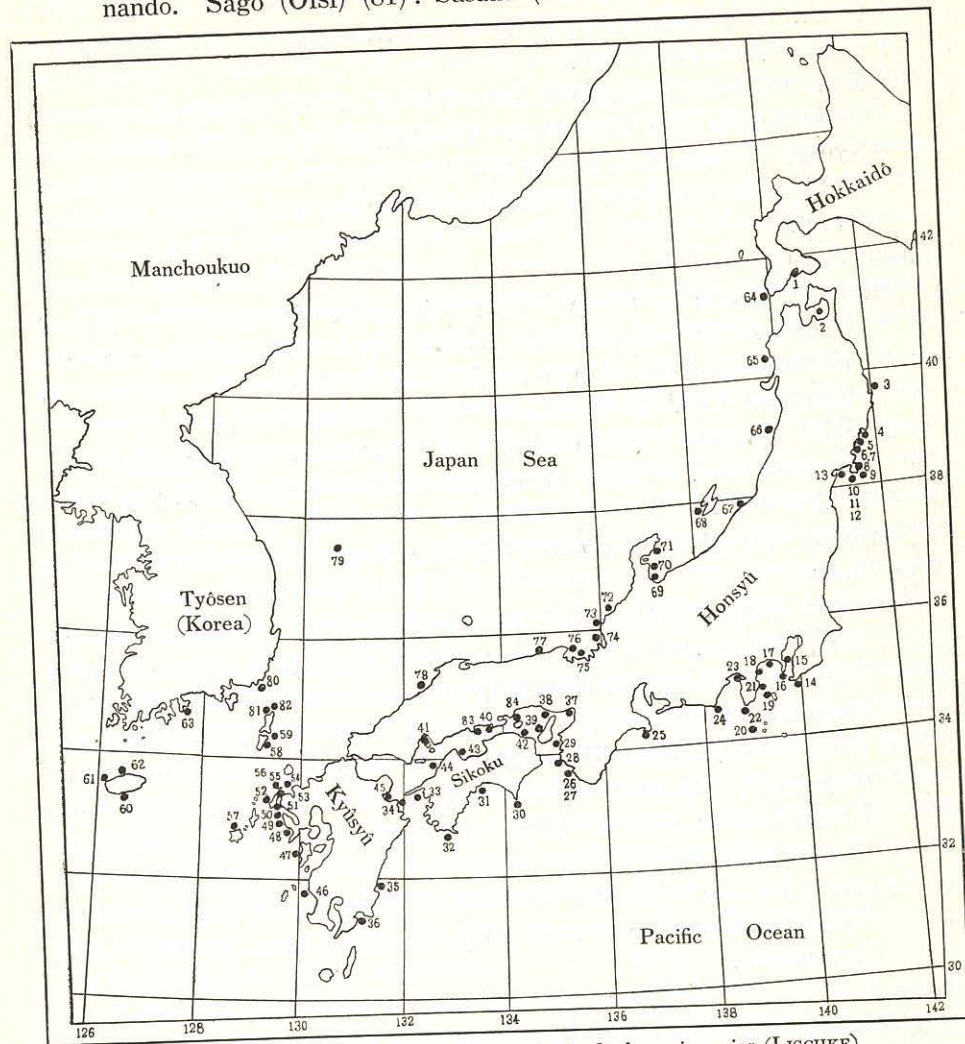
Tyôsen: Nisikiura (MAEDA, Y. YOSIDA) (60); Saisyû (OKUDA) (62); Zyôzanhô (KURIHARA, OKUDA) (61), Saisyûtô. Reisui (OKUDA) (63); Zenranandô.

Japan Sea

Hokkaidô: Hukuyama (T. KINOSITA) (64), Hakodate Pref.

Honsyû: Mutsu Bay (2), Aomori Pref. Iwadata (TAKI) (65), Akita Pref. Kamo (TAKI) (66), Yamagata Pref. Niigata (EMURA) (67); Hutami, Sado (EMURA) (68); Niigata Pref. Husiki (HARA) (69); Abugasima (K. KIKUTI) (70), Toyama Pref. Usyutu (HARA) (71); Isikawa Pref. Sakai (HARA) (72); Nibu (73); Turuga (74); Onihu (75); Ôi (KURODA) (76), Hukui Pref. Tazima (YAGURA) (77) Hyôgo Pref. Toriimura (S. TAKAGI) (78), Simane Pref.

Tyōsen: Uturyōtō (SUGIYAMA) (79); Husan (Y. YOSIDA) (80), Keisyō-nandō. Sago (ŌISI) (81): Sasuna (H. WATANABE) (82), Tusima.



Text-fig. 6. Geographical distribution of *Liolophura japonica* (LISCHKE).

Genus LUCILINA DALL 1882

21. *Lucilina amanda* THIELE 1910

Pl. XV, fig. 9; Pl. XXXIII, figs. 9-13; Pl. XXXIV, figs. 5-9.

Lucilina amanda

THIELE (1910) Zoologica, Bd. 22, Heft 56, S. 97, Taf. 10, Fig. 42-50; Westküste Japans bei Tago, in einer Tiefe von 75 m.

Body about 18 mm long, 10 mm broad; shells 7 mm in maximum width, rectangularly elevated at the jugum with rounded ridge, slightly arched on both sides, generally rose-red in colour.

Head valve ornamented with about 10 radial series of scaly granules and pits of aesthetes; teeth long, finely pectinated on the surface; slits 9 on the anterior margin; interior of valve smooth, not callused in the middle, with indistinct slit-lines.

Median valve: central area ornamented with longitudinal furrows, which are more or less shorter than the length of this area except for the outermost, that barely reaches the anterior edge; jugal area not distinctly defined, merely separable from other areas by its smoothness; sutural laminae short, triangular, pectinated at the outer edge; jugal articulation finely denticulated at the front edge; lateral area bordered anteriorly with a series of scaly granules, posteriorly coarsely granulated, interspace between them nearly smooth, slit one on each side.

Tail valve: mucro situated a little behind the middle, distinct, not elevated; posterior area bordered by distinct ridges, bearing radial series of aesthetes, steep, indistinctly sculptured, slits 9-11 on the posterior margin of articulation; sutural laminae flat, broad, somewhat pectinated on both outer edges.

Girdle: perinotum covered sparsely with small, pointed distally ribbed spinules, measuring $30\ \mu$ in length, $12\ \mu$ in breadth, cylindrical spines scattered among them, about $50\ \mu$ long, $5\ \mu$ thick; hyponotum armed with small scales, weakly ribbed, becoming smooth toward the periphery; marginal spines bluntly pointed, very slightly striated, measuring $70\ \mu$ in length, $15\ \mu$ in thickness.

Radula: central tooth small, dilated at both ends, with distinct cusp at the tip; centro-lateral exceedingly large, winged at the front end, never cusped, outer edge sinuated at the anterior corner, forming posteriorly a broad, angular lamella; major lateral bears 4 broad cusps, inner wing small, with reflexed tip; major uncinus broad, oval shaped, curved a little at the middle, stalk stout, short, with large basal plate.

Gills holobranchial, occupying about $5/6$ the entire length of the foot, branchiae 21 on one side.

Size: Body length 18 mm, breadth 10 mm (type).

„ „ 16 mm, „ 10 mm.

Head valve 6.5 mm, second valve 5.8 mm, fourth valve 6.7 mm, tail valve 5 mm in breadth.

Remarks: THIELE described this species from the single specimen

collected by DÖDERLEIN from the west coast of Japan near Tago (Tango?) at the depth of 75 m. The specimen before me seems to be referable to this species, as they fairly agree in most features of its characters except for the borders of the lateral areas, which are not demarcated by distinct ridges in the type specimen, but only distinguishable from other areas by its peculiar sculpture. In Mutsu Bay it was dredged from the depth of about 30 m, while the type from about 75 m. The fact seems to indicate that it occurs in deep waters of southern sea, whereas in much northern locality it lives in relatively shallow waters.

Locality: Ôma, station 104; one specimen was collected by HÔZAWA, TAKATUKI and SATÔ in August, 1927, together with *Rhysoplax tectiformis*; sp. no. 2076.

Distribution:

Japan Sea

Honsyû: Mutsu Bay, Aomori Pref. Tango (THIELE), Kyôto Pref., at the depth of 75 m.

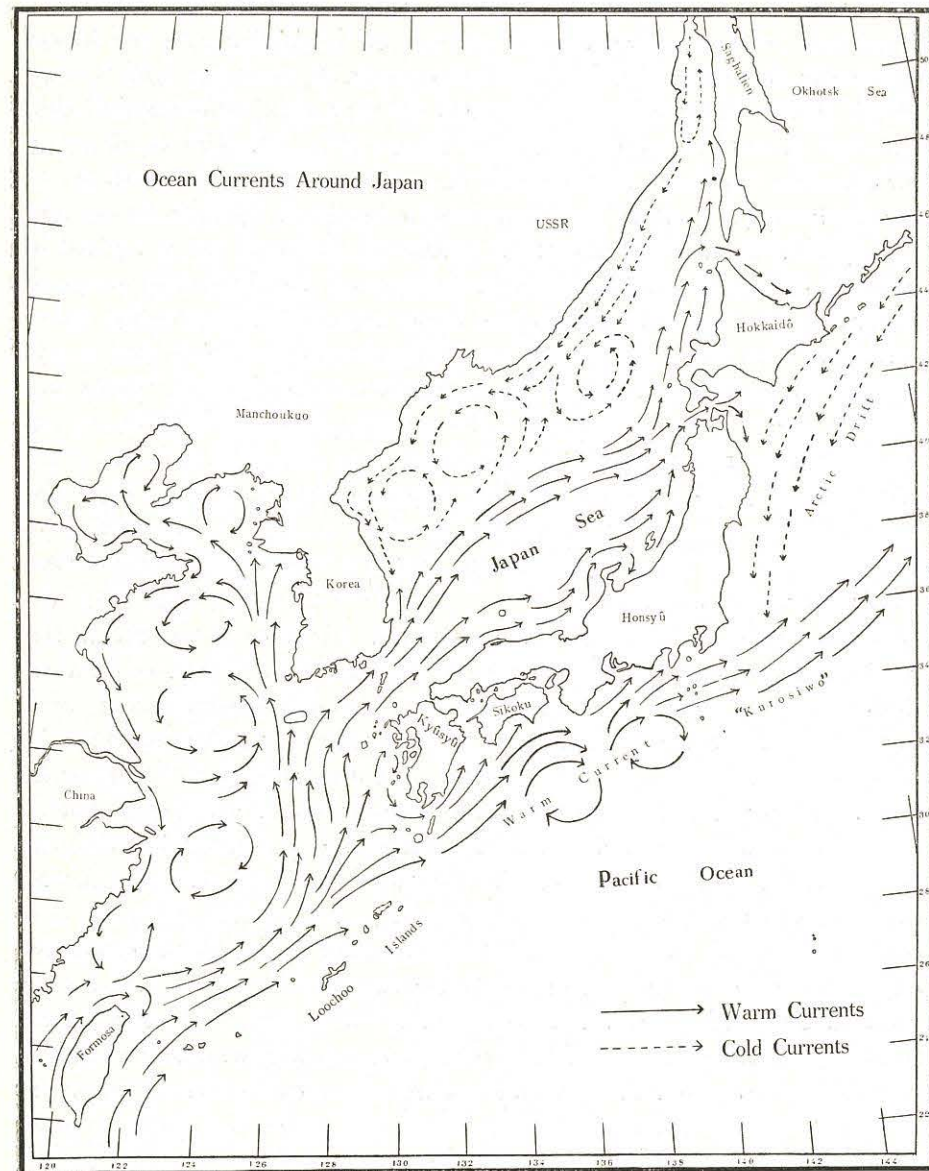
GENERAL COMMENT ON THE CHITONS OF JAPAN

I. INTRODUCTORY NOTE

The fauna of chitons in the northern Pacific has been investigated first by MIDDENDORFF (1847, 1851), and SCHRENCK (1867) reported several species from Alaska, the Aleutian Islands, the Okhotsk Sea and northern Japan. GOULD (1846, 1859) and DALL (1876-79, 1921) also described some species from the Aleutian and the Bering Islands. Later BERRY (1917, 1925-27, 1928) added the supplemental data to the previous results and gave a full account of the chiton fauna of these districts. Besides these authors, REEVE, TAPPARONE-CANEFRI, LISCHKE, PILSBRY, THIELE, BERGENHAYN, and myself together with my brother, described new species from the various places of Japan. The whole collection of chitons brought by the expeditions of the Challenger and the Siboga from Malay Archipelago and adjacent territories were worked out respectively by HADDON (1886) and NIERSTRASZ (1905). Australian and Neozelanic shores have long been famous for the wealth of their chiton fauna and furnished abundant material for the researches of many European authors, and a complete account concerning their fauna was given by recent workers such as ASHBY, IREDALE, HULL, MESTEYER, MACKAY.

Despite the fact that the taxonomic studies of chitons have been carried out fairly well basing upon the material collected from various parts of

the world except for the greater part of Chinese coasts, little attention has so far been directed to the problem of their distribution.



Text-fig. 7. Ocean Currents around Japan.

II. THE FAUNAL AREAS OF CHITONS

The distribution of chitons of the western Pacific Ocean may be roughly divided in three regions; I. The first region extends from the Kurile Islands to Formosa along the entire coast of the Pacific with the Inland Sea as its subregion. II. The second region is the west coast of Kyûsyû and Korea including adjacent islands and the Gulf of Liantung and Pechili and also the Yellow Sea on the Chinese side. III. The third region includes the whole shore of the Japan Sea from the Mamiya straits to the Tusima straits, which is bounded by a line drawn through Husan and Simonoseki, embracing the northern coast of Tusima. As is noticed in other marine animals, among the factors determining the faunal region of chitons in the western Pacific, the most important may be the ocean currents. The warm current "Kurosiwo" sweeps along the eastern coasts of Luzon and Formosa and the southern coasts of Kyûsyû, Sikoku and Honsyû, giving off a branch along the western coast of Kyûsyû beyond the boundary of this region to the Japan Sea along the northern coast of western Honsyû. The Arctic drift from the Bering straits washes the entire northern coast of Japan and is checked at about the middle part of Honsyû by the warm current, flowing farther to the south and submerges under the current.

From these considerations it seems much advisable to demarcate the northern from the southern subdivision by an oblique plane formed between the two ocean currents. Both currents differ in temperature and carry faunas peculiar to them, which may be determined by isothermal lines in different level. Thus it will be found that the chitons which occur in shallow waters of the northern sea often extends to relatively deep waters of much southern localities¹⁾. *Lucilina amanda* was dredged from Mutsu Bay at about a depth of 30 m, while from off Tango, Japan Sea, it was obtained at 75 m in depth.

Although both the western coast of the main island of Japan and the Japan Sea receive a branch of the warm current, the former has a pronounced tidal difference, while the latter has hardly any. This fact seems to influence considerably the faunal difference, working with other factors, between the two regions. *Acanthochiton rubrolineatus* thrives better on

¹⁾ A similar mode of occurrence is found in boreal forms of gastropods: thus *Fusitriton oregonensis* was discovered in abundance at about 100 m in depth of the Kurile Islands, Saghalien and Hokkaidô, at about a depth of 300-400 m in Kumanonada and Tosa Bay on the Pacific side and at 300 m in Toyama Bay and off Tazima in the Japan Sea.

the entire western coast, whereas *A. achates* is not found in this region, but occurs in abundance in the Japan Sea and on the Pacific coast of Honsyû, Sikoku and Kyûsyû.

The warm current has little influence on the fauna of the Inland Sea, where no peculiar genera or species of chitons are found. *Onithoplax hirasei* does not live in the Inland Sea, while it is widely distributed extending from Formosa to Matusima Bay on the Pacific coast and to Sado in the Japan Sea. A related form, *Lucilina interplicata* is met with on the Pacific coast from Formosa to the Bôsô Peninsula as well as in various localities of the Inland Sea.

It may also be mentioned here that the specimens of *Liolophura japonica* collected from the southern coasts of Kyûsyû and Sikoku have long, fairly thick calcareous spines on the girdle, while they are very delicate in those from the Inland Sea. The same thing may be said of the girdle scales of *Ischnochiton comptus* and of the tegmental granulations of *Acanthochiton rubrolineatus*.

III. ELEMENTS OF THE CHITON FAUNA OF THE WESTERN PACIFIC

The faunal components of the western Pacific may best be considered vertically as well as horizontally.

(A) Horizontal distribution

1. Continuous horizontal distribution.

They consist of the circumpolar, the northern Pacific, the temperate zone and the tropical forms.

a) The circumpolar elements. The genera or species which have been regarded as peculiar to the Arctic Ocean, especially to the northern Atlantic, often extend to the lower latitudes on both sides of the Pacific. Thus the European species *Tonicella marmorea* and *T. ruber* were collected from the American coast as well as from northern Japan. The latter species was found in Mutsu Bay, the southernmost limit in its distribution in Japan; *Hanleya* was also found in Sagami and Tosa Bay and certain places of the northern Japan Sea at about the depth of 200 m.

b) The northern Pacific components. As the northern Pacific genera may be mentioned *Schizoplax*, *Spongioradria*, *Mopalia*, *Placiphorella*, *Nuttalina*, *Katharina*, *Amicula*, *Cryptochiton* and *Lepidozona*. *Schizoplax*, a most striking genus of all chitons with shells divided along the median line, has a limited range in its distribution from Puget Sound to the southern coast

of Saghalien through the Aleutian Islands and the Okhotsk Sea. Of the species endemic to the area, the following live in northern Japan: *Tonicella submarmorea*, *T. lineata*, *Spongioradsia foveolata*, *Mopalia middendorffi*, *M. ciliata*, *M. wosnessenski*, *M. schrencki*, *M. hirsuta*, *Cryptochiton stelleri*, *Amicula amiculata*, *Stenoradsia lindholmi*, etc. Besides these, *Ischnoradsia hakodadensis* and *Lepidozona albrechti* range from northern Japan to Onahama on the Pacific coast and to Toyama Bay in the Japan Sea. Mutsu Bay is the southern boundary of the distribution of *Tonicella submarmorea*, *T. lineata*, *T. ruber* and *Lepidozona mertensi*.

c) The elements of the temperate zone. The chiton fauna of the area consists of a mixture of the genera characteristic of both the boreal and the tropical regions, though the majority of species are endemic and flourish evenly on the entire coast of Honsyû, Sikoku, Kyûsyû and Korea. Among the boreal genera the following species may be mentioned: *Mopalia retifera*, *Placiphorella stimpsoni*, *Lepidozona coreanica*; and among the species of the tropical groups are *Cryptoplax japonica*, *Rhysoplax kurodai*. *Ischnochiton* and *Acanthochiton* are cosmopolitan. *Ischnochiton boninensis*, *I. comptus*, *Acanthochiton rubrolineatus*, *A. achates* may be enumerated as our representatives. Of the indigenous components which show the sporadic occurrence are *Ischnochiton melinus*, *I. paululu*, *I. mitsukurii*, *Stenoplax venustus*, *Lepidozona iyoensis*, *L. interfossa*, *L. amabilis*, *Callistochiton jacobaeus*, *Ikedaella conica*, *Rhysoplax komaiianus*, *Lucilina amanda*, *Acanthochiton dissimilis* and *Cryptoplax propior*.

d) The tropical elements. *Cryptoplax*, *Rhysoplax*, *Notoplax*, *Acanthozostera*, *Squamopleura*, *Onithoplax* and *Lucilina* are peculiar to the tropical region. *Cryptoplax* is very rich in species in the coral reefs of northern Australia and Malay Archipelago. A few representatives of the genus occur also in Japan, *C. japonica* being found from Kyûsyû to Mutsu Bay or Hakodate. *Acanthozostera gemmata* is by far the most abundant of the littoral chitons in all the localities, where the majority of *Cryptoplax* thrives and reaches as far north as the Yaeyama Islands, which is its northern limit. *Notoplax*, comprising *N. dalli*, *N. döderleini*, *N. thielei*, *N. stewartiana* and others in our waters, may be regarded as a characteristic genus of the Indo-west-Pacific region. A striking range of meridional distribution is found in *Ischnochiton comptus*, which occurs from Malay Archipelago to Mutsu Bay or Hakodate. *Lucilina interplicata* and *Onithoplax hirasei* live from Formosa to the middle part of Honsyû. The former is found exclusively on the Pacific coasts, while *L. amanda* is the only member in the Japan Sea and the most northern species of the genus.

The latter species is on either side of Honsyû and limited in the north by a line drawn between Sado and Matusima Bay, that is very near 39° N. *Acanthochiton dissimilis* is obtained on both coasts of about the middle of Honsyû. *Acanthochiton defilippi* has the similar in range habitat with that of *Onithoplax hirasei*, though it goes as far south as the southern coast of Kyûsyû. *Liolophura loochooana* extends from Formosa and *L. caliginosa* from the Loochoo Islands to the Kii Peninsula.

2. Bipolarity or discontinuous meridional distribution.

In the west Pacific the genera of chitons show occasionally meridional discontinuity in their distribution, that may be called bipolarity. *Ischnoradsia hakodadensis* is found in abundance on the shores of the northern half of Japan and other species of the genus are known from Alaska and California, while four species of the genus have been recorded from Queensland, New South Wales, Victoria, South Australia and Tasmania. Three species of *Icoplax* have been reported from the eastern shores of Australia, ranging from Queensland to Tasmania and four species of the same group from New Zealand, while *I. septemcostata*, the only representative in the northern hemisphere, was collected from Sagami Bay at the depth of 150 m. Three species of *Lorica* were described from the eastern coast ranging from New South Wales to Tasmania and one from New Zealand, while a member of the genus was dredged in Tosa Bay, off Simoda and off the Bôsô Peninsula at about the depth of 200 m. *Liolophura* is known from Australia and Japan, in the former locality two species have been distributed in the range between 20° and 35° S. on the eastern coast, while in the latter three species occur with the range from Formosa (22° N.) to Mutsu Bay or Hakodate Bay (41°-42° N.); *Squamopleura* ranges in its distribution between 10°-23° S. on the shores of Australia, New Caledonia, New Guinea and Malay Archipelago, while a northern representative occurs in Kôtôsyô, Formosa (22° N.); *Amphitomura* occurs on the shores of the western Indian Ocean and the Bonin Islands with an enormous intervening distance. *Onithoplax*, *Lucilina*, *Rhysoplax* are very rich in species in the southern tropics of the Indo-west-Pacific and a few representatives occur also in our waters, from Formosa to Mutsu Bay, Honsyû.

(B) Vertical distribution

1. Bathymetrical distribution.

The chitons may be grouped in three divisions according to their bathymetrical distribution, viz. the littoral, the shallow water and the abyssal

zones. The second extends between the *Laminaria* zone and the 150 m line and the third is the inhabitants of waters over 150 m.

a) The littoral zone has numerous species of heterogeneous groups in systematic position, such as *Acanthochiton*, *Ischnochiton*, *Ischnoradsia*, *Lepidozona*, *Placiphorella*, *Mopalia*, *Callistochiton*, *Cryptoplax*, *Lepidopleurus*, *Liolophura*, *Onithoplax*, *Schizoplax*. *Cryptoplax japonica* and *Lepidopleurus hirasei* are always found under stones or pebbles near the low water mark, *Schizoplax brandti* under rocks or on the leaves of *Zostera* at fairly low tides.

b) The shallow water division. Notwithstanding its abyssal characters, a few members of *Lepidopleurus* are occasionally found in shallow water. *L. latidens* was dredged from 2-3 m in Sagami Bay. *L. hakodatensis* and *L. assimilis* from the *Laminaria* zone and from the depth of 30 m. *Tonicella submarmorea*, *T. lineata*, *Spongioradsia foveolata*, *Lepidozona mertensi*, *L. iyoensis*, *Ischnochiton melinus* and *I. paululus* occur at about the depth of 20-50 m. *Lucilina amanda* was collected from 75 m in depth, while *L. interplicata* from the *Laminaria* zone. *Lepidozona interfossa* and *L. amabilis* were taken from 80 m and *Thaumastochiton* from 100 m in Sagami Bay.

c) The abyssal division. As the majority of chitons are littoral, the deep-water forms are not many. To the abyssal division belong the genera *Lepidopleurus* and *Hanleya*. *L. aequispinus* occurs at 300 m, *L. japonica* at 160 m, *L. diomedae* at 500 m; *Hanleya* at 200 m; *Lepidozona pilsbryana* at 400 m; *L. pallida* at 600 m.

2. Ontogenic migration.

Any one who tries to collect chitons at the shore, will soon find the fact that young ones are very rare there. So far no adequate explanation to account for this fact has been put forth. Neither has anybody full account of where and how chitons spend their young stages. The larvae of chitons are of course free swimming. Then they go down from the surface to their favorable depths to begin their bottom life. Afterward they gradually migrate toward the shore only to find at length their congenial home at the littoral zone. The following evidence seems to support the above account. Small specimens of *Ischnochiton comptus*, measuring 6-10 mm in length, were dredged at the depth of 20-30 m. The juvenile forms of similar sizes of *Lepidozona coreanica*, *L. albrechti*, *Ischnoradsia hakodadensis*, *Acanthochiton rubrolineatus*, *A. achates*, *A. defilippi*, *Onithoplax hirasei* and *Rhyssoplax kurodai* were also found at the depth of 20-80 m.

On the whole tendency has been noticed that the nearer the shore, the larger the specimens become. In his "Notes on West American Chitons" BERRY (1917) states about *Tonicella lineata* that "it is interesting to note that all the dredged specimens²⁾ run very much smaller than those taken between tides. It may be mentioned also that whereas there are no large specimens among the dredged material, I have on the other hand seen no smaller ones from the shore". And my opinion seems to be substantiated by the above remarks. However it is certain that the deep-water forms do not change the habitat during their growth period as their littoral congeners do, since specimens of various ages can be dredged from one and the same depth.

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²⁾ It was dredged from the depth of 10 to 30 fathoms at Forrester Island, Alaska.

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EXPLANATION OF THE PLATES

PLATE XIV.

- Fig. 1. *Lepidopleurus hakodatensis* THIELE, length 9 mm.
 Fig. 2. *Lepidopleurus assimilis* THIELE, length 8 mm.
 Fig. 3. *Tonicella ruber* (LINNÉ), length 6.5 mm.
 Fig. 4. *Spongioradsia foveolata*, nov. sp., length 6 mm.
 Fig. 5. *Ischnochiton comptus* (GOULD), length 23 mm.
 Fig. 6. *Lepidozona mertensi* (MIDDENDORFF), length 17 mm.
 Fig. 7. *Lepidozona coreanica* (REEVE), length 35 mm.
 Fig. 8. *Lepidozona albrechti* (SCHRENCK), length 37 mm.
 Fig. 9. *Lepidozona albrechti* (SCHRENCK), length 45 mm.
 Fig. 10. *Ischnochiton comptus* (GOULD), length 16 mm.
 Fig. 11. *Mopalia hirsuta*, nov. sp., length 9 mm.
 Fig. 12. *Tonicella lineata* (WOOD), length 16 mm.
 Fig. 13. *Placiphorella stimpsoni* (GOULD), length 25 mm.
 Fig. 14. *Lepidozona albrechti* (SCHRENCK), length 47 mm.
 Fig. 15. *Cryptoplax japonica* PILSBRY, length 30 mm.
 Fig. 16. *Tonicella submarmorea* (MIDDENDORFF), length 6.5 mm.
 Fig. 17. *Placiphorella stimpsoni* (GOULD), length 46 mm.

PLATE XV.

- Fig. 1. *Acanthochiton rubrolineatus* (LISCHKE), length 27 mm.
 Fig. 2. *Acanthochiton achates* (GOULD), length 27 mm.
 Fig. 3. *Liolophura japonica* (LISCHKE), length 36 mm.
 Fig. 4. *Rhysoplax tectiformis*, nov. sp., length 9 mm.
 Fig. 5. *Rhysoplax kurodai* (IS. TAKI et IW. TAKI), length 17 mm.
 Fig. 6. *Ischnochiton comptus* (GOULD), length 18 mm.
 Fig. 7. *Ischnochiton comptus* (GOULD), length 23 mm.
 Fig. 8. *Ischnoradsia hakodadensis* ("CARPENTER" PILSBRY), length 32 mm.
 Fig. 9. *Lucilina amanda* THIELE, length 16 mm.
 Fig. 10. *Ischnochiton paululus*, nov. sp., length 5 mm.

PLATE XVI.

- Figs. 1-4, 6-8, 14. *Lepidopleurus hakodatensis* THIELE.
 1. Front view of the 4th valve, breadth 4 mm.
 2. Marginal spinules, length 70 μ -76 μ .
 3. Dorsal view of the 4th valve, breadth 4 mm.
 4. Tail valve, breadth 3.5 mm.
 6. Girdle spines, length 120 μ -130 μ ; thickness 16 μ -24 μ .

7. Peripheral scales of hyponotum, length 100-120 μ ; breadth 20-30 μ .
 8. Scales of hyponotum, length 48-52 μ ; breadth 26-30 μ .
 14. Tegmental surface. $\times 65$
 Figs. 5, 9-13, 15. *Lepidopleurus assimilis* THIELE.
 5. Hyponotum scales, length 60-90 μ ; breadth 30-40 μ .
 9. Head valve, breadth 2.7 mm.
 10. Tail valve, breadth 2.8 mm.
 11. Front view of the 4th valve, breadth 3.5 mm.
 12. Dorsal view of the 4th valve.
 13. Interior of the 4th valve.
 15. Sculpture of tegmental surface. $\times 50$

PLATE XVII.

- Figs. 1-4. *Tonicella ruber* (LINNÉ).
 1. Hyponotum scales. $\times 600$
 2. Radula. $\times 400$
 3. Marginal spinal. $\times 600$
 4. Girdle scales. $\times 600$
 Fig. 5. Marginal spines of *Lepidopleurus assimilis* THIELE, length 156-165 μ ; thickness 21-23 μ .
 Figs. 6-8. *Lepidopleurus hakodatensis* THIELE.
 6, 7. Girdle scales, 72-84 μ in length; 45-46 μ in breadth.
 8. Radula. $\times 300$
 Figs. 9-11. *Lepidopleurus assimilis* THIELE.
 9. Girdle scales, length 80-86 μ ; breadth 50-55 μ .
 10. do.
 11. Radula. $\times 500$

PLATE XVIII.

- Figs. 1-5. *Tonicella ruber* (LINNÉ).
 1. Head valve, breadth 2.3 mm.
 2. Fourth valve, front view, divergency 98°.
 3. Tegmental surface of the 4th valve.
 4. Fourth valve, dorsal view, breadth 3 mm.
 5. Tail valve, breadth 1.8 mm.
 Figs. 6-8. *Tonicella submarmorea* (MIDDENDORFF).
 6. Spine of girdle. $\times 250$
 7. Scales of hyponotum. $\times 250$
 8. Girdle scales. $\times 600$
 Figs. 9-15. *Tonicella lineata* (WOOD).
 9. Head valve, breadth 6 mm.
 10. Fourth valve, front view, breadth 9 mm.
 11. Spinules of perinotum, length 40-60 μ ; breadth 12-20 μ .
 12. Fourth valve, dorsal view.
 13. Interior of the 4th valve.
 14. Hyponotum scales, length 70 μ ; breadth 30 μ .
 15. Tail valve, breadth 5 mm.

PLATE XIX.

- Figs. 1, 3-8. *Tonicella submarmorea* (MIDDENDORFF).
 1. Marginal spicule. $\times 600$
 3. Radula. $\times 200$
 4. Spine of girdle. $\times 460$
 5. Fourth valve, dorsal view, breadth 3 mm.
 6. Interior of the same valve.
 7. Front view of the same, divergency 104° .
 8. Tegmental surface of the median valve. $\times 50$
 Fig. 2. *Tonicella lineata* (WOOD), radula. $\times 200$

PLATE XX.

- Figs. 1-10. *Spongioradsia foveolata*, nov. sp.
 1. Interior of tail valve. $\times 30$
 2. Head valve. $\times 30$
 3. Interior of head valve.
 4. Scales of hyponotum. $\times 1000$
 5. Tail valve. $\times 30$
 6. Left side of tail valve. $\times 30$
 7. Fourth valve. $\times 30$
 8. Interior of the fourth valve.
 9. Marginal spicules. $\times 1000$
 10. Spines of perinotum. $\times 250$

PLATE XXI.

- Fig. 1. *Spongioradsia foveolata*, nov. sp., radula. $\times 450$
 Figs. 2, 4-6. *Mopalia hirsuta*, nov. sp.
 2. Radula. $\times 250$
 4. Marginal spines. $\times 400$
 5. Scales of hyponotum. $\times 400$
 6. Scales of perinotum. $\times 700$
 Figs. 3, 7-9. *Placiphorella stimpsoni* (GOULD).
 3. Marginal spines, 130 μ , 160 μ in length.
 7. Spinules of perinotum, length 30 μ .
 8. Hyponotum spinules, length 80, 95, 110 μ .
 9. Radula. $\times 150$

PLATE XXII.

- Figs. 1-6. *Mopalia hirsuta*, nov. sp.
 1. Head valve. $\times 18$
 2. Fourth valve, front view. $\times 18$
 3. Fourth valve, dorsal view. $\times 18$
 4. Fourth valve, interior. $\times 18$
 5. Tail valve. $\times 18$

6. Interior of tail valve. $\times 18$
 Figs. 7-15. *Placiphorella stimpsoni* (GOULD).
 7. Tail valve, breadth 7 mm.
 8. Interior of tail valve.
 9. Left side of tail valve.
 10. Part of bristle of perinotum. $\times 250$
 11. Head valve, breadth 10.7 mm.
 12. Interior of head valve, breadth 10.7 mm.
 13. Fourth valve, front view, breadth 12.5 mm.
 14. Same, dorsal view.
 15. Interior of 4th valve.

PLATE XXIII.

- Figs. 1-6. *Acanthochiton rubrolineatus* (LISCHKE).
 1. Head valve, breadth 4.8 mm.
 2. Tail valve, breadth 4.7 mm.
 3. Fourth valve, front view, breadth 5.5 mm.
 4. Hyponotum spinules, length 100 μ , 120 μ .
 5. Fourth valve, dorsal view.
 6. Spines of girdle, length 120 μ , 320 μ , 350 μ .
 Figs. 7-11. *Acanthochiton achates* (GOULD).
 7. Head valve, same magnification as fig. 1.
 8. Tail valve, same magnification as fig. 2.
 9. Hyponotum spinules, length 60 μ , 120 μ .
 10. Fourth valve, dorsal view.
 11. do., front view.
 Figs. 12-13. *Mopalia hirsuta*, nov. sp.
 12. Seta of perinotum. $\times 60$
 13. Bristle of seta. $\times 1000$

PLATE XXIV.

- Figs. 1, 2. *Acanthochiton rubrolineatus* (LISCHKE).
 1. Radula. $\times 100$
 2. Spicules of hair-tuft, length 1.5 mm, 1 mm.
 Figs. 3-7. *Acanthochiton achates* (GOULD).
 3. Radula. $\times 100$
 4. Marginal spine, length 540 μ .
 5. Large spine of perinotum, length 490 μ .
 6. Small spines of perinotum, length 70 μ , 120 μ .
 7. Spicules of hair-tuft, length 1.2 mm, 1.8 mm.
 Figs. 8, 9. *Cryptoplax japonica* PILSBRY.
 8. Fourth valve, front view.
 9. Radula. $\times 100$

PLATE XXV.

- Figs. 1-5. *Cryptoplax japonica* PILSBRY.

1. Head valve.
2. Second valve.
3. Fourth valve.
4. Tail valve, side view.
5. Same, dorsal view.

Figs. 6-8. *Ischnochiton paululus*, nov. sp.

6. Marginal spine. $\times 600$
7. Marginal scales. $\times 1000$
8. Marginal spinules. $\times 1000$

Figs. 9-16. *Ischnochiton comptus* (GOULD).

9. Large marginal spines. $\times 600$
10. Marginal spinules. $\times 600$
11. Small marginal spines. $\times 600$
12. Head valve, breadth 6.8 mm.
13. Fourth valve, front view, breadth 8.5 mm.
14. Fourth valve, dorsal view.
15. Tail valve, breadth 6.5 mm.
16. Hyponotum scale. $\times 650$

Figs. 17, 18. *Acanthochiton rubrolineatus* (LISCHKE).

17. Marginal spine, length 430 μ .
18. Spines of perinotum, length 33 μ , 18 μ .

Figs. 19-21. *Cryptoplax japonica* PILSBRY.

19. Spines of hyponotum, length 70 μ , 77 μ .
20. Spines of perinotum, length 120 μ , 330 μ .
21. Marginal spine, length 500 μ .

PLATE XXVI.

Figs. 1-5. *Ischnoradsia hakodadensis* ('CARPENTER' PILSBRY).

1. Head valve, breadth 7.8 mm; body length 22 mm.
2. Fourth valve, front view, breadth 9.6 mm.
3. Same, dorsal view.
4. Same, interior.
5. Tail valve, breadth 7.9 mm.

Figs. 6-12. *Ischnochiton paululus*, nov. sp.

6. Scales of perinotum. $\times 600$
7. Tail valve, dorsal view, breadth 2.8 mm.
8. Same, left side.
9. Hyponotum scale. $\times 1000$
10. Peripheral hyponotum scale. $\times 1000$
11. Fourth valve, front view, breadth 3.6 mm.
12. Peripheral scales of perinotum. $\times 1000$

PLATE XXVII.

Figs. 1-5. *Ischnoradsia hakodadensis* ('CARPENTER' PILSBRY).

1. Radula. $\times 150$
2. Marginal scale of hyponotum. $\times 600$

3. Marginal spinules. $\times 600$
4. Scales of hyponotum. $\times 600$
5. Marginal spine. $\times 600$

Figs. 6, 7. *Ischnochiton comptus* (GOULD).

6. Radula. $\times 200$
7. Major uncinus, major lateral. $\times 250$

Figs. 8, 9. *Ischnochiton paululus*, nov. sp.

8. Cusp. $\times 1000$
9. Central part of radula. $\times 1000$

PLATE XXVIII.

Figs. 1-12. *Lepidozona coreanica* (REEVE).

1. Head valve.
2. Second valve.
3. Fourth valve, dorsal view.
4. Interior of the same.
5. Same, front view.
6. Tail valve.
7. Same, interior.
8. Same, left side.
- 9-11. Small marginal spines, length 100 μ , 102 μ , 115 μ .
12. Tegmental surface of pleural area.

Figs. 13-18. *Lepidozona albrechti* (SCHRENCK).

13. Marginal spinules. $\times 600$
14. Tegmental surface of the second valve of juvenile specimen, breadth 6.5 mm.
15. Head valve, breadth 12.5 mm.
16. Tail valve, breadth 11 mm.
17. Same, left side.
18. Same, interior.

Figs. 19, 20. *Ischnoradsia hakodadensis* ('CARPENTER' PILSBRY).

19. Scale of perinotum, apical view.
20. do, dorsal view.

PLATE XXIX.

Figs. 1-6. *Lepidozona mertensi* (MIDDENDORFF).

1. Head valve, breadth 6.5 mm.
2. Fourth valve, front view.
3. Scales of hyponotum. $\times 250$
4. Interior of the 2nd valve, breadth 7.5 mm.
5. Fourth valve, breadth 8 mm.
6. Tail valve, breadth 5.5 mm.

Figs. 7-9. *Lepidozona albrechti* (SCHRENCK).

7. Fourth valve, front view, divergency 130°.
8. Same, dorsal view, breadth 15 mm.
9. Scales of hyponotum. $\times 250$

Fig. 10. *Lepidozona coreanica* (REEVE). Scales of hyponotum, 30 $\mu \times 80 \mu$.

- Figs. 11-16. *Ischnochiton comptus* (GOULD).
 11-13. Scales of perinotum. $\times 150$
 14-16. Peripheral scales of perinotum. $\times 700$
 Fig. 17. *Lepidozonia albrechti* (SCHRENCK), interior of the 4th valve, breadth 15 mm.

PLATE XXX.

- Figs. 1-5. *Lepidozonia coreanica* (REEVE).
 1. Large marginal spine. $\times 200$
 2. Perinotum scale of juvenile specimen, breadth 30 μ .
 3. Radula. $\times 150$
 4. Perinotum scale of full grown specimen, side view, height 280 μ .
 5. Same, dorsal view, breadth 280 μ .
 Figs. 6-9. *Lepidozonia mertensi* (MIDDENDORFF).
 6. Marginal spines. $\times 400$
 7. Large marginal spine. $\times 400$
 8. Marginal spinules. $\times 400$
 9. Radula. $\times 150$
 Figs. 10-13. *Lepidozonia albrechti* (SCHRENCK).
 10. Large marginal spine. $\times 230$
 11. Cusp of major lateral of full grown specimen. $\times 150$
 12. Cusp of major lateral of juvenile specimen. $\times 150$
 13. Radula. $\times 150$

PLATE XXXI.

- Figs. 1-5. *Lepidozonia albrechti* (SCHRENCK).
 1. Perinotum scale of full grown specimen, 270 $\mu \times 310 \mu$.
 2. do., 450 $\mu \times 740 \mu$.
 3. Peripheral scale of perinotum of juvenile specimen, 140 $\mu \times 220 \mu$.
 4. Perinotum scale of full grown specimen, apical view, breadth 450 μ .
 5. Perinotum scale of juvenile specimen, 140 $\mu \times 200 \mu$.
 Figs. 6, 7. *Lepidozonia coreanica* (REEVE).
 6. Marginal spinules. $\times 600$
 7. Perinotum scale of juvenile specimen, 130 $\mu \times 135 \mu$.
 Fig. 8. *Rhysoplax tectiformis*, nov. sp., radula. $\times 300$
 Figs. 9, 10. *Lepidozonia mertensi* (MIDDENDORFF).
 9. Perinotum scale. $\times 400$
 10. do., apical view. $\times 400$
 Fig. 11. *Rhysoplax kurodai* (Is. TAKI et Iw. TAKI), radula. $\times 150$

PLATE XXXII.

- Figs. 1-7. *Rhysoplax kurodai* (Is. TAKI et Iw. TAKI).
 1. Head valve, breadth 5.3 mm.
 2. Second valve, front view, breadth 5.8 mm.
 3. Fourth valve, dorsal view, breadth 6.5 mm.
 4. Tail valve, breadth 4.7 mm.

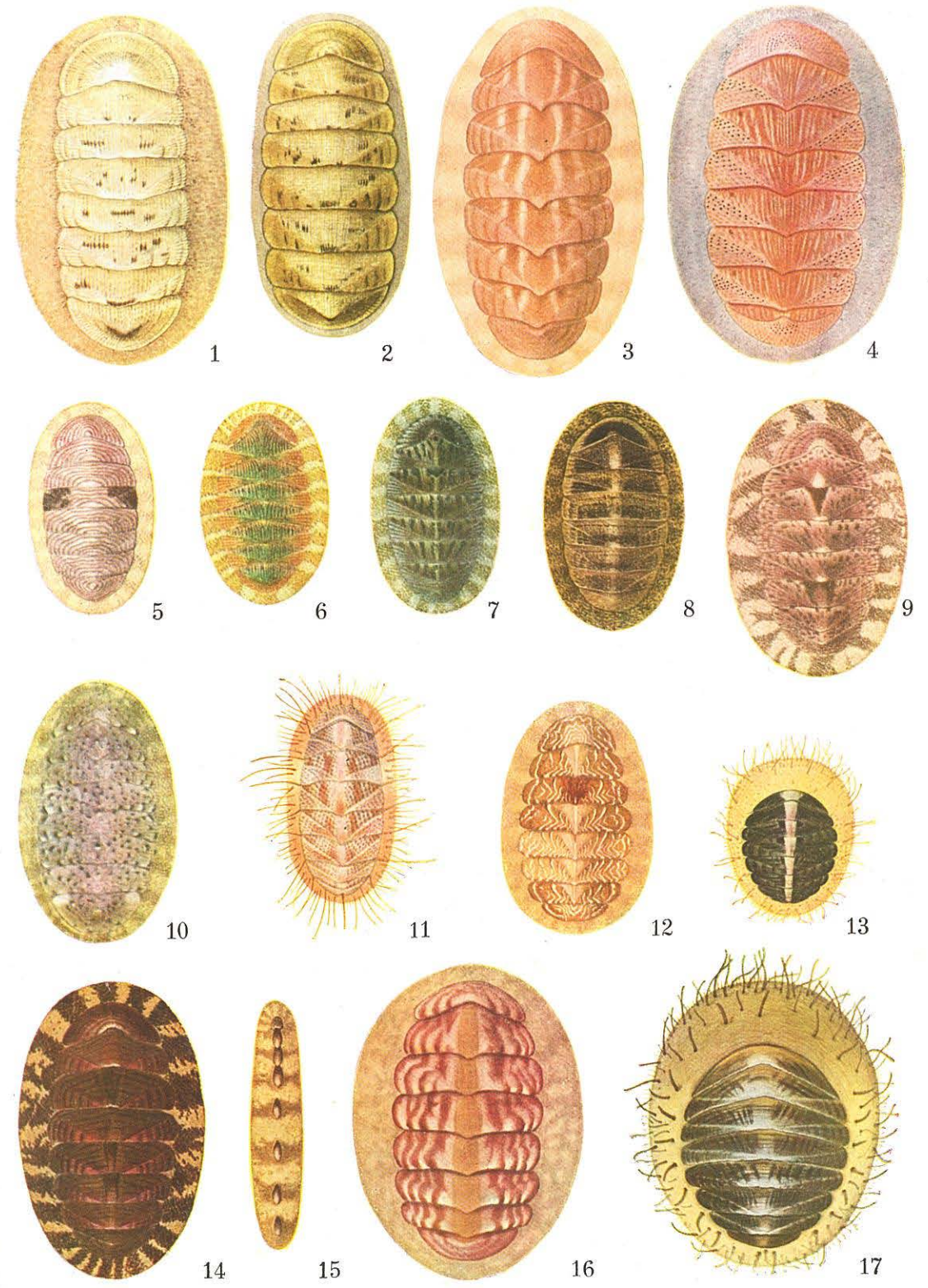
5. Scales of girdle. $\times 200$
 6. Marginal spines. $\times 250$
 7. Scales of hyponotum. $\times 250$
 Figs. 8-13. *Rhysoplax tectiformis*, nov. sp.
 8. Head valve, breadth 3.25 mm.
 9. Second valve, front view, breadth 3.7 mm.
 10. Third valve, dorsal view, breadth 4 mm.
 11. Tail valve, breadth 2.8 mm.
 12. Scales of hyponotum. $\times 600$
 13. Marginal spine. $\times 600$
 14. Scales of girdle. $\times 350$
 Figs. 15-16. *Liolophura japonica* (LISCHKE).
 15. Peripheral scale of hyponotum. $\times 300$
 16. Hyponotum scale. $\times 300$
 Fig. 17. *Lepidozonia albrechti* (SCHRENCK), marginal spines. $\times 600$

PLATE XXXIII.

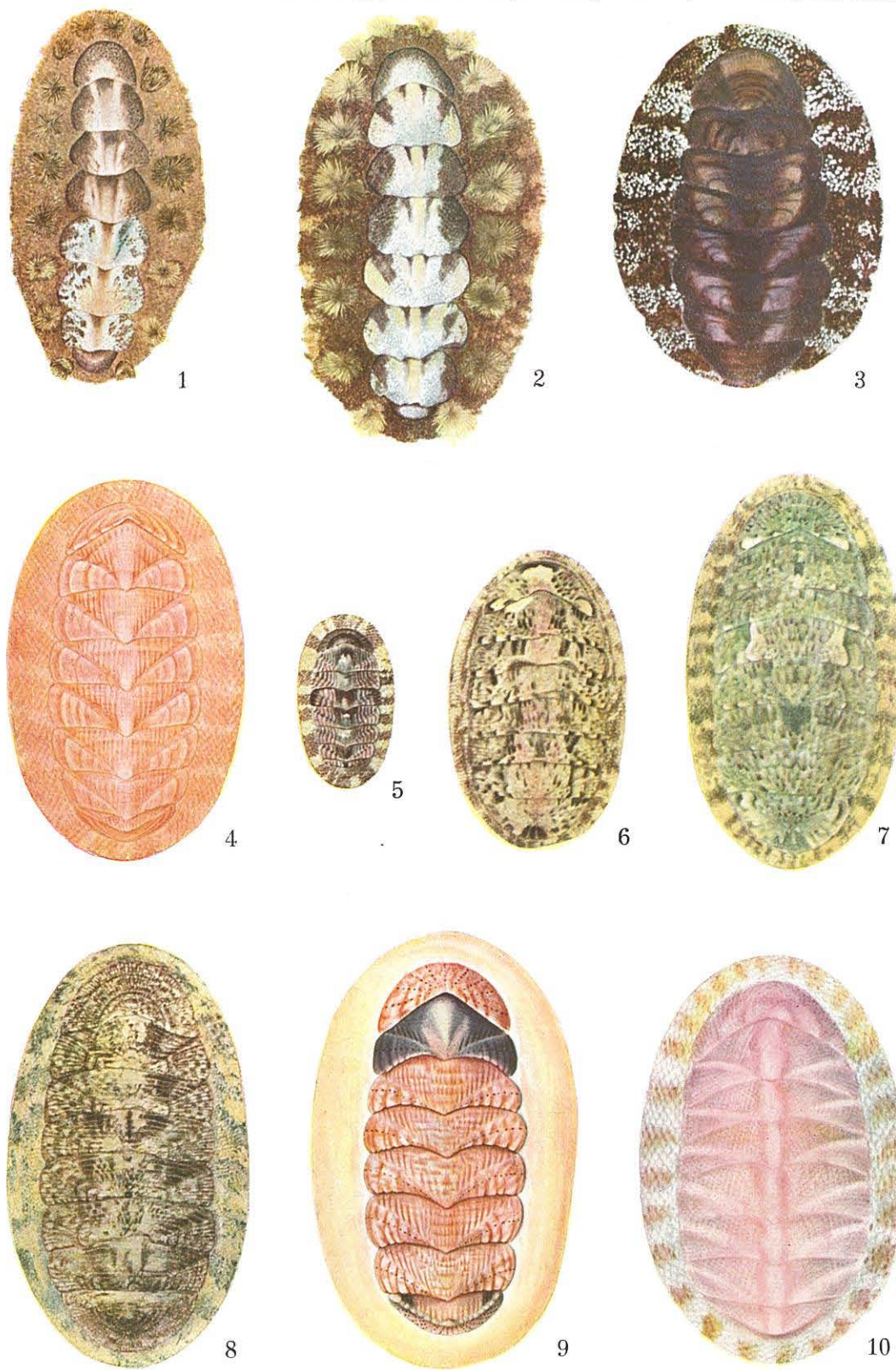
- Figs. 1-8. *Liolophura japonica* (LISCHKE).
 1. Tail valve, dorsal view, breadth 11 mm.
 2. do., left side.
 3. do. interior.
 4. Head valve, breadth 13 mm.
 5. Interior of head valve.
 6. Fourth valve, front view, breadth 15 mm.
 7. Same, dorsal view.
 8. Interior of the same.
 Figs. 9-13. *Lucilina amanda* THIELE.
 9. Second valve, front view, breadth 5.8 mm.
 10. Fourth valve, dorsal view, breadth 6.7 mm.
 11. Spines of perinotum. $\times 1000$
 12. Head valve, breadth 5.6 mm.
 13. Tail valve, breadth 5 mm.

PLATE XXXIV.

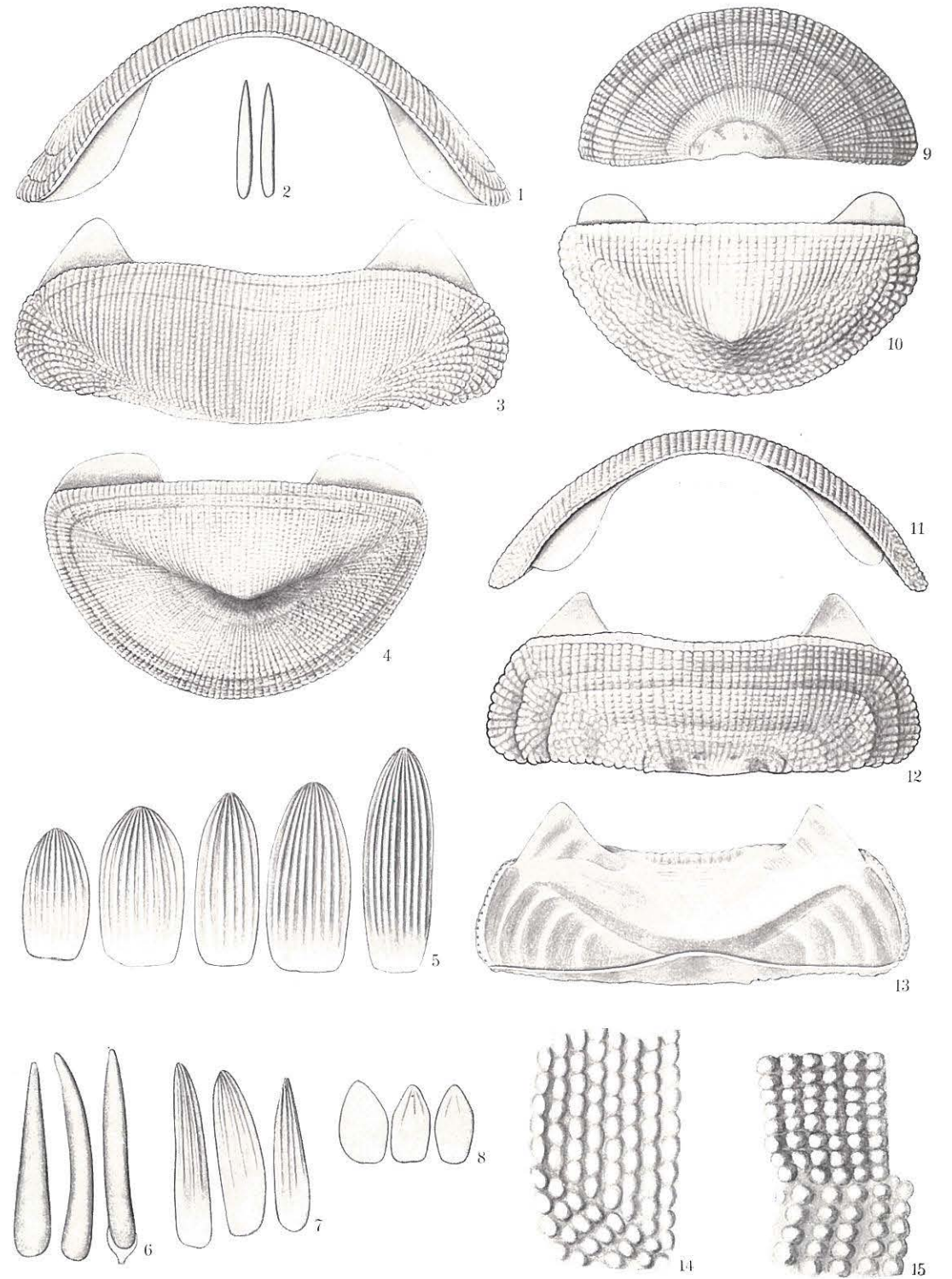
- Figs. 1-4. *Liolophura japonica* (LISCHKE).
 1. Marginal spines. $\times 250$
 2. Cusp of major lateral. $\times 150$
 3. Radula. $\times 150$
 4. Calcareous spines of perinotum. $\times 40$
 Figs. 5-9. *Lucilina amanda* THIELE.
 5. Spinules of perinotum. $\times 1000$
 6. Peripheral part of radula, including inner small-lateral, outer small-lateral, major uncinus, inner marginal. $\times 250$
 7. Cusp of major lateral. $\times 250$
 8. Central part of radula. $\times 250$
 9. Marginal spine. $\times 600$



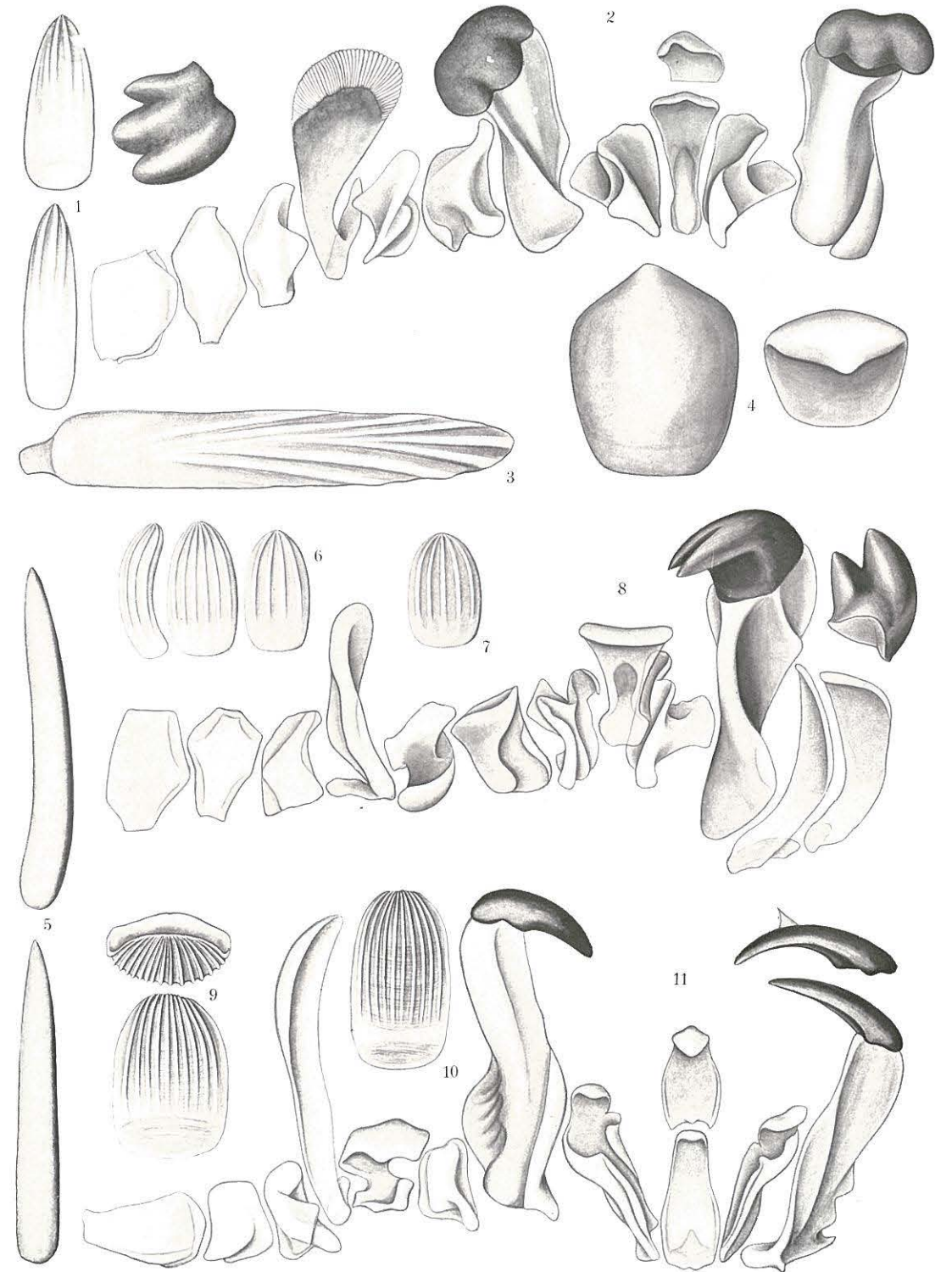
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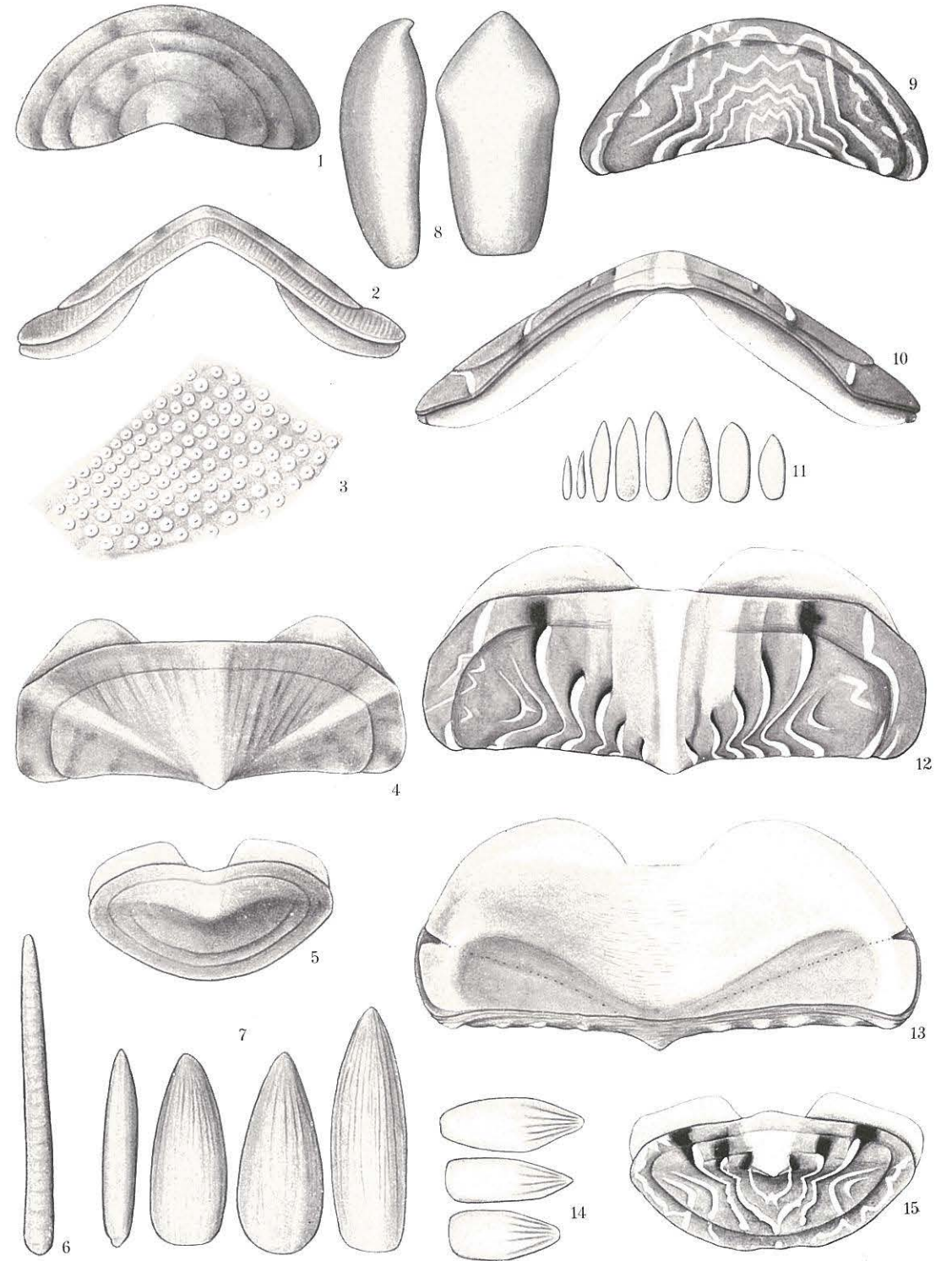
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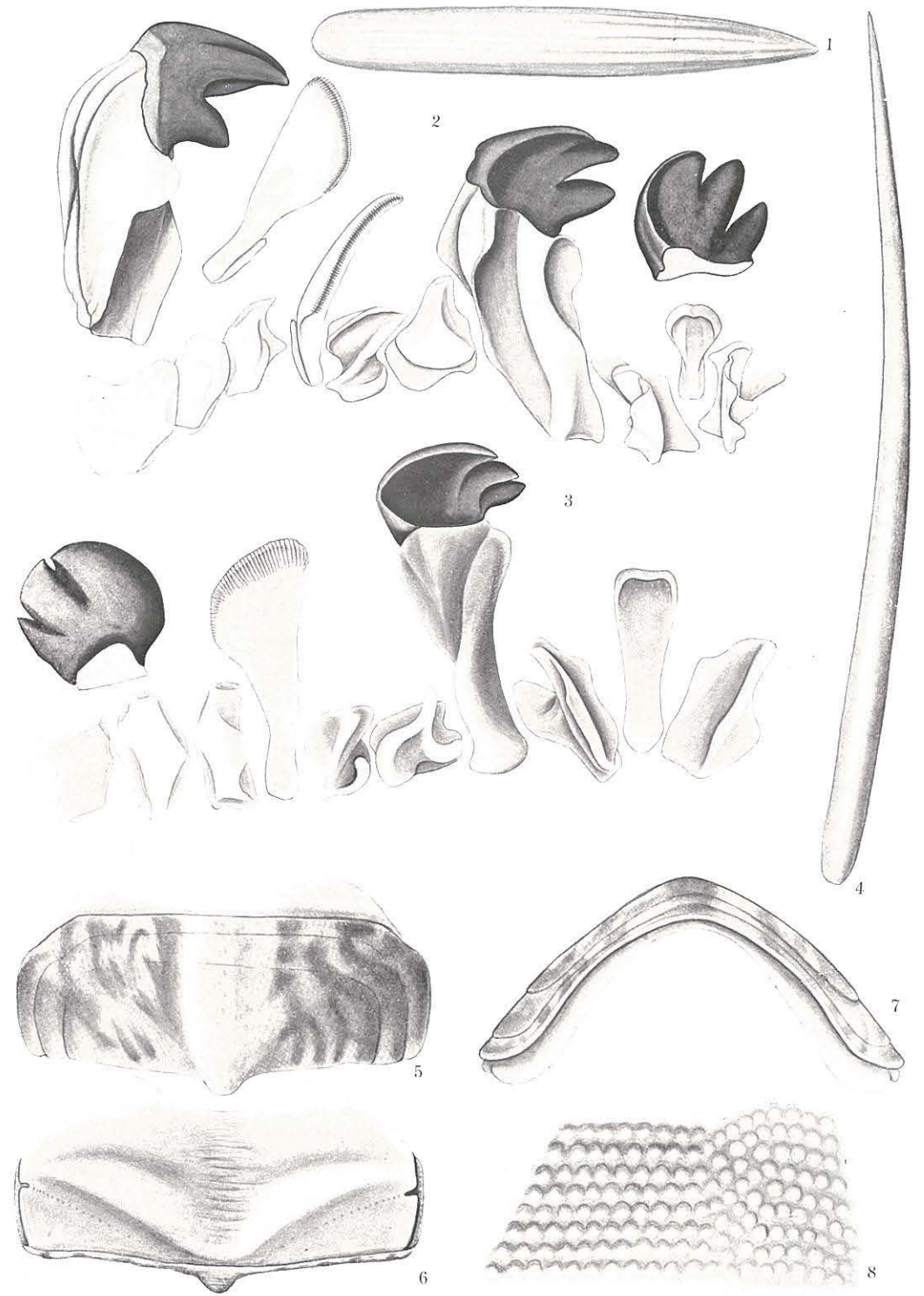
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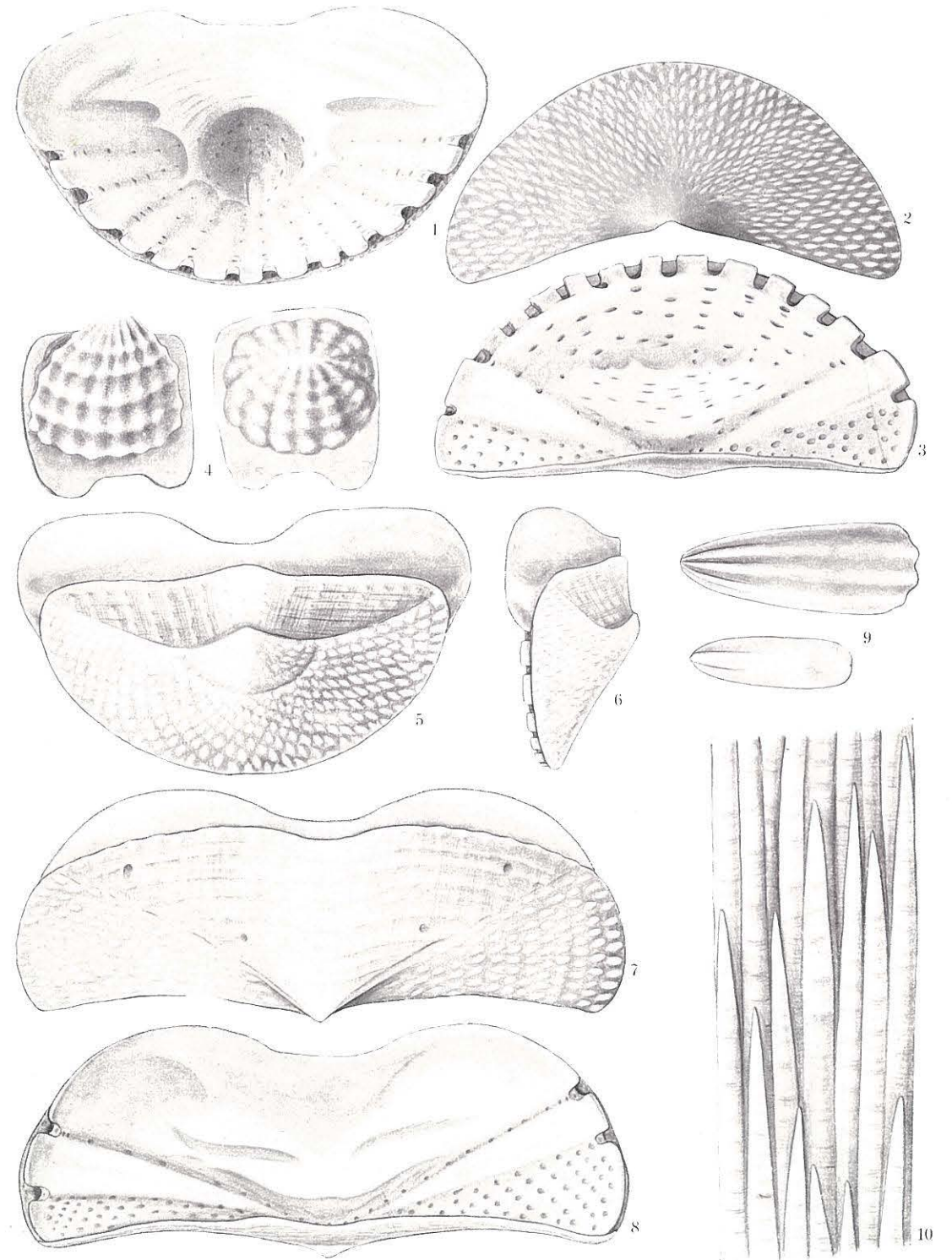
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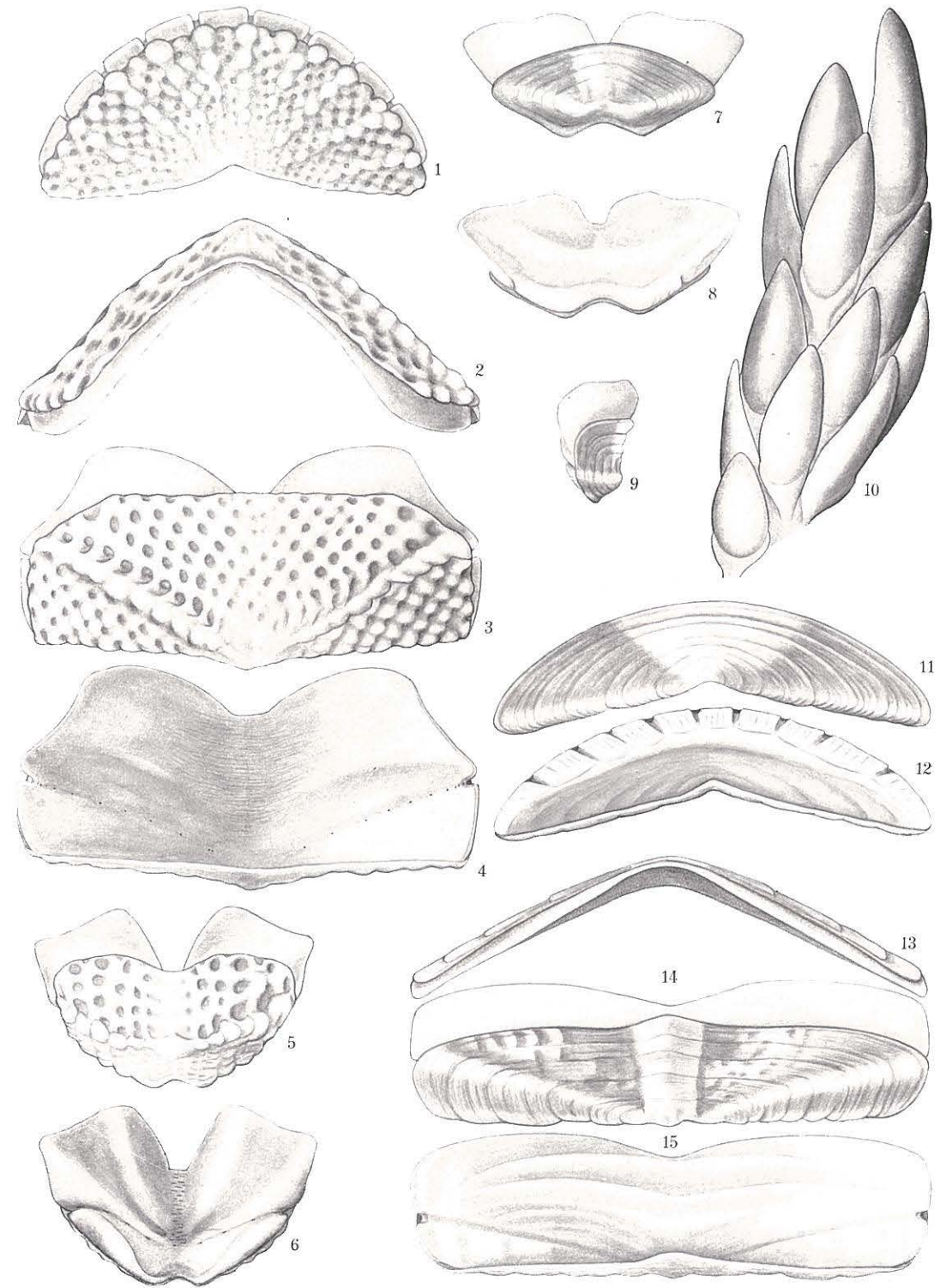
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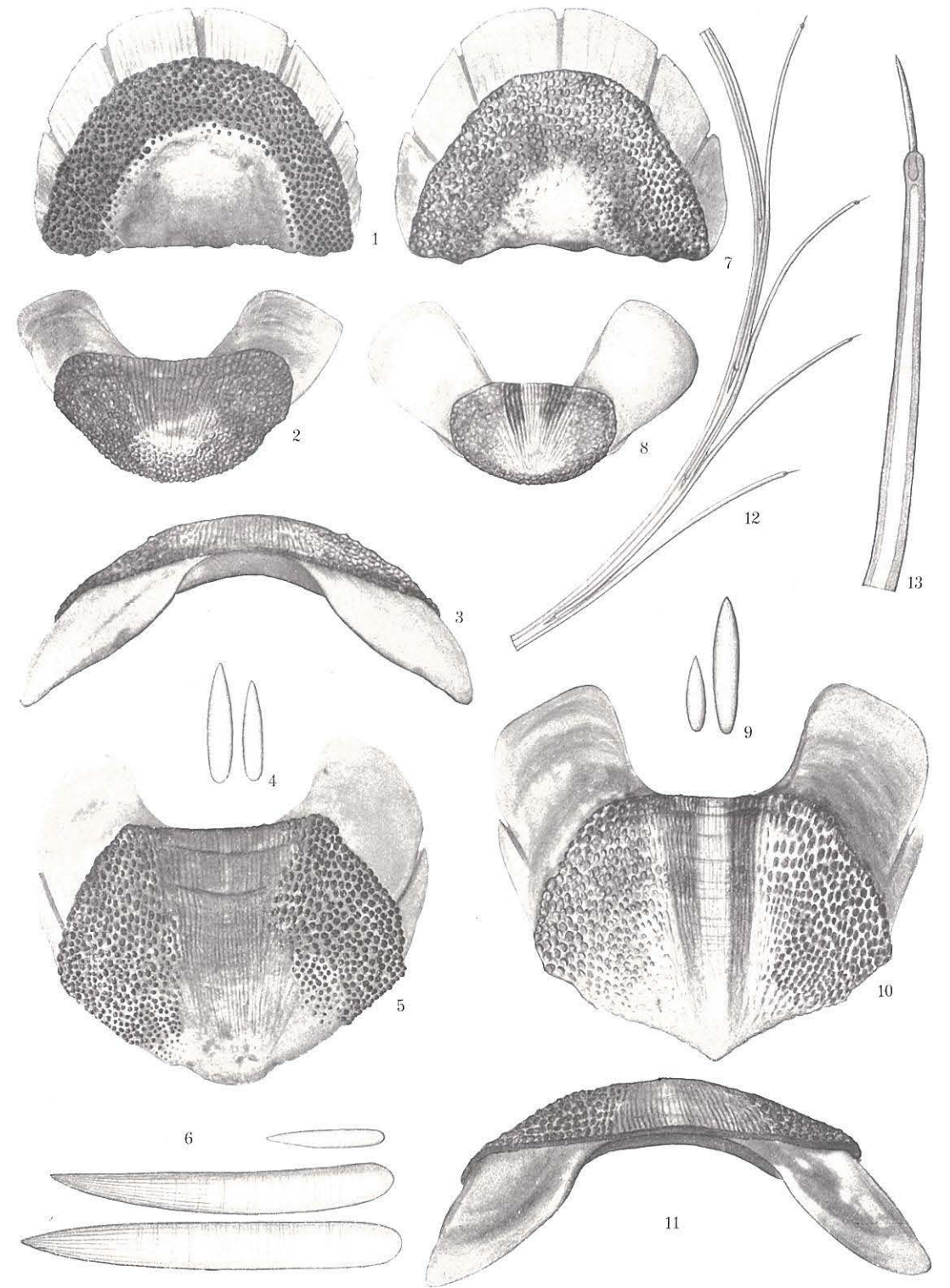
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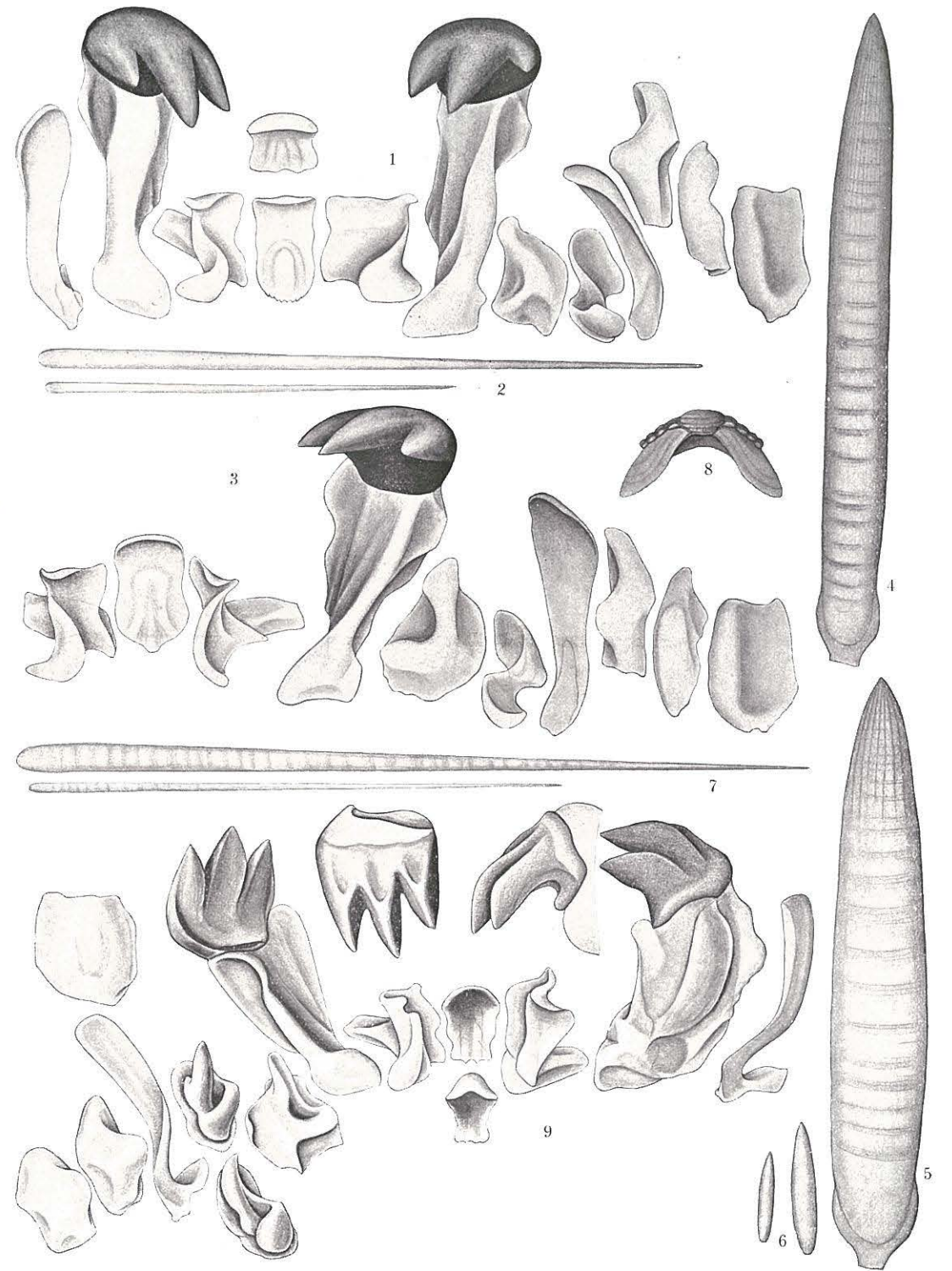
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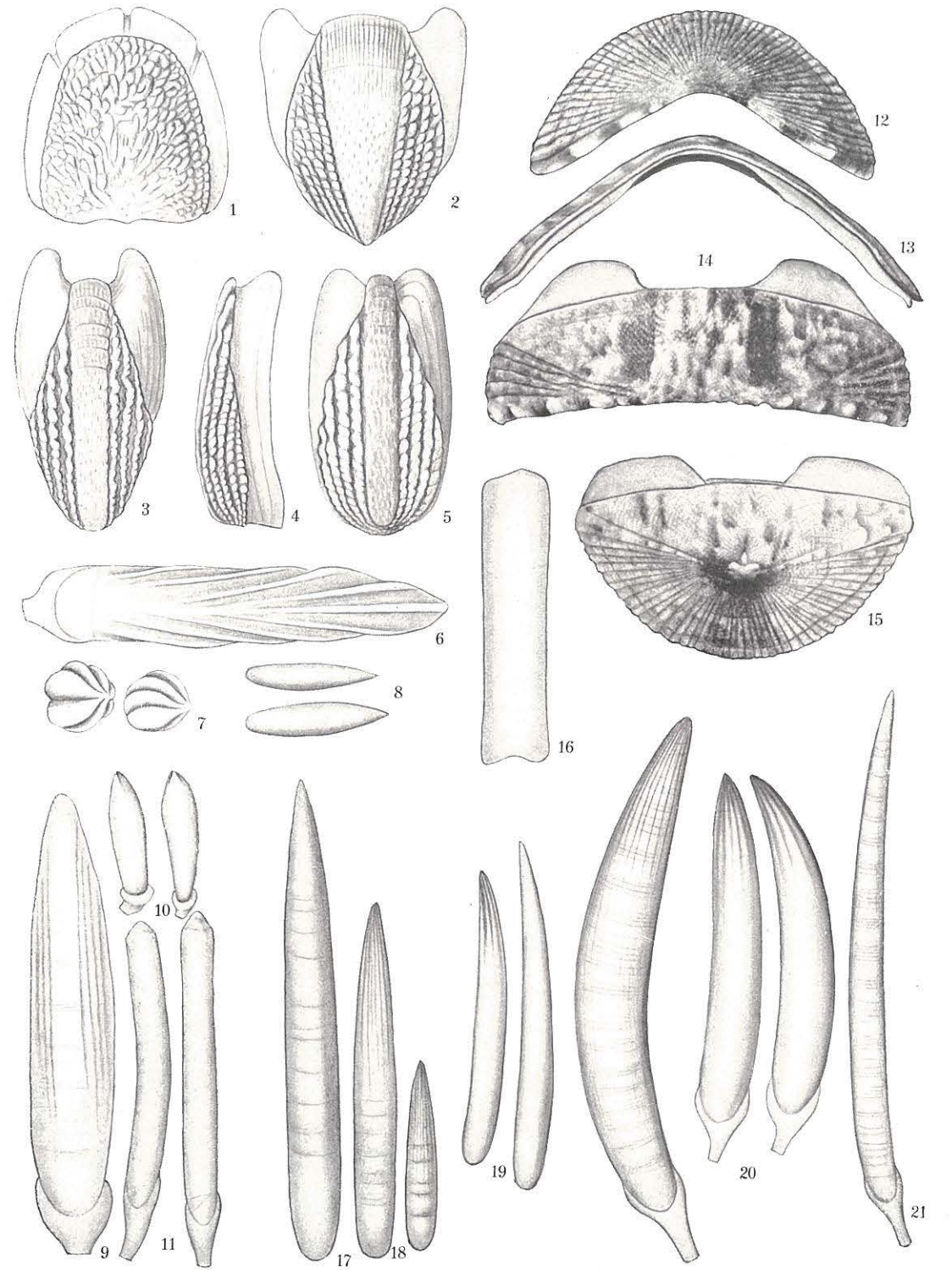
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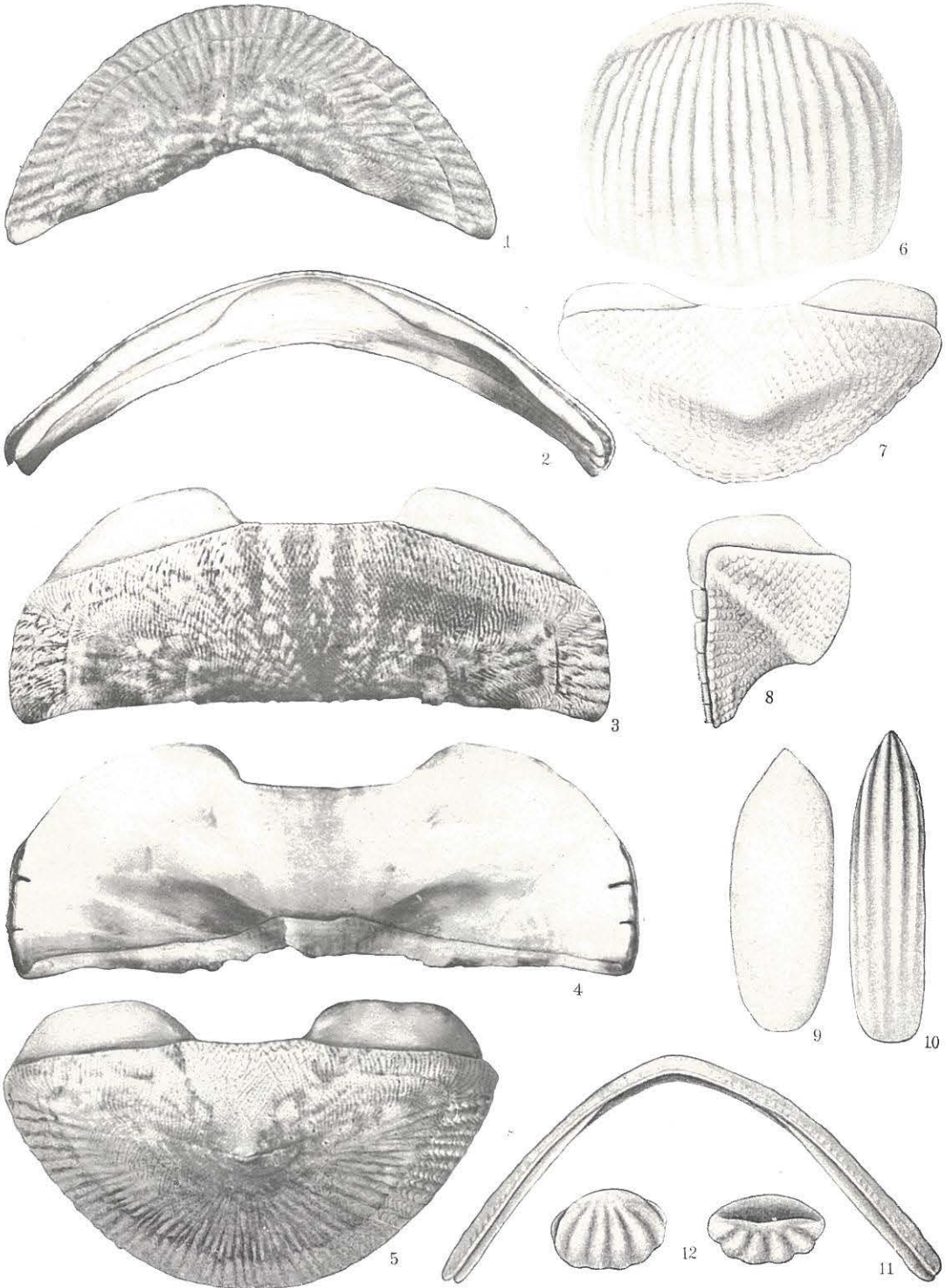
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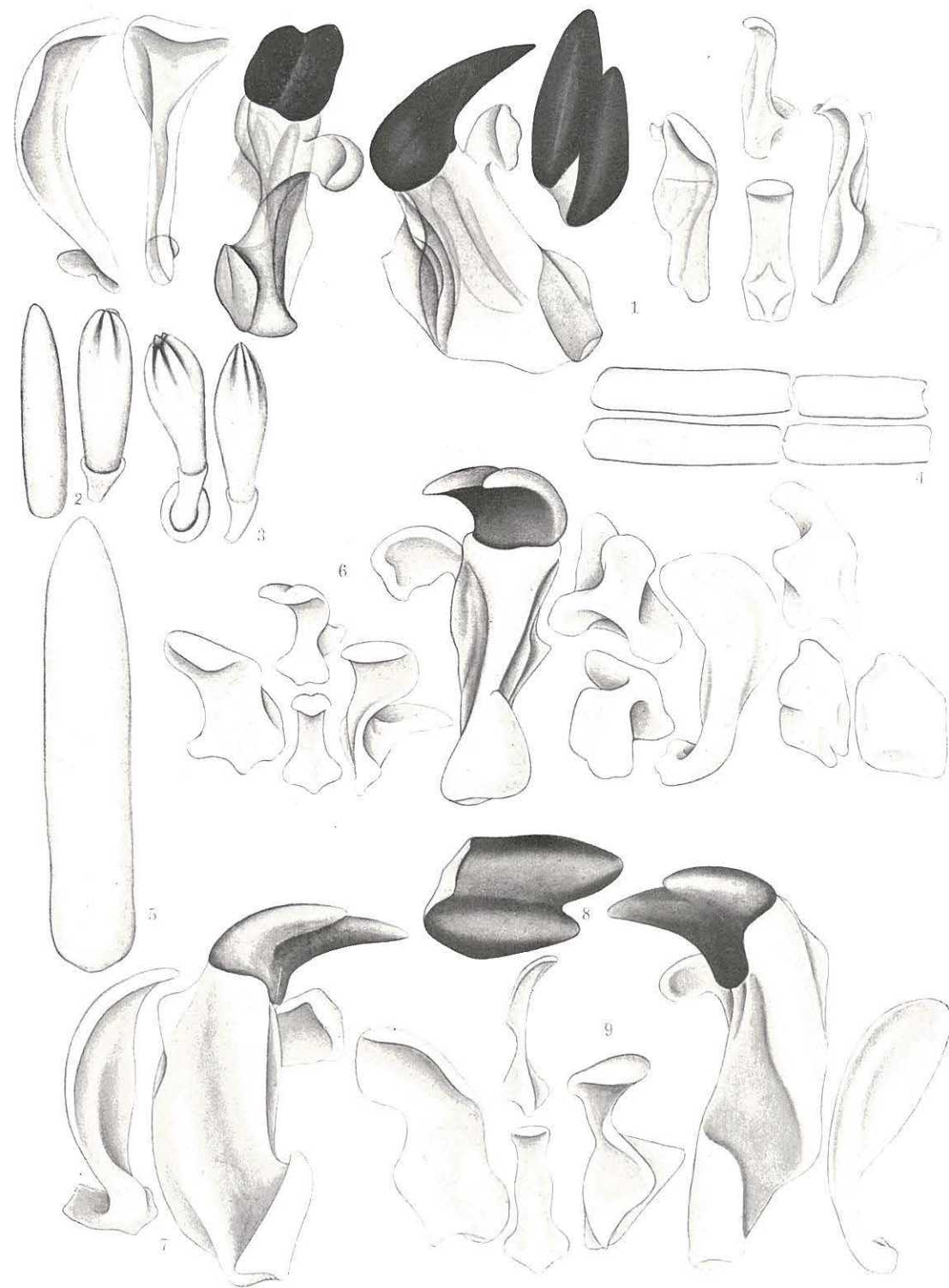
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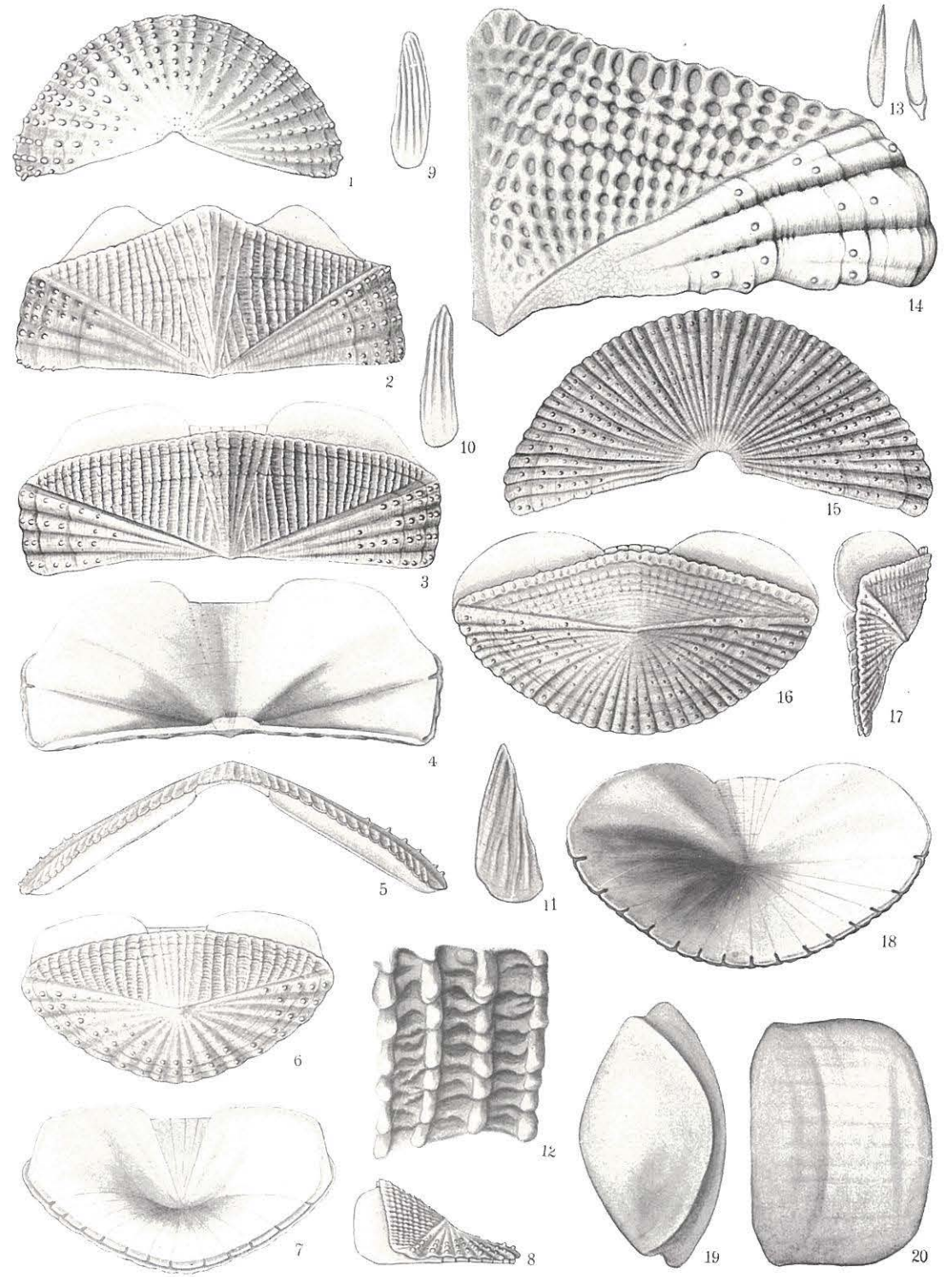
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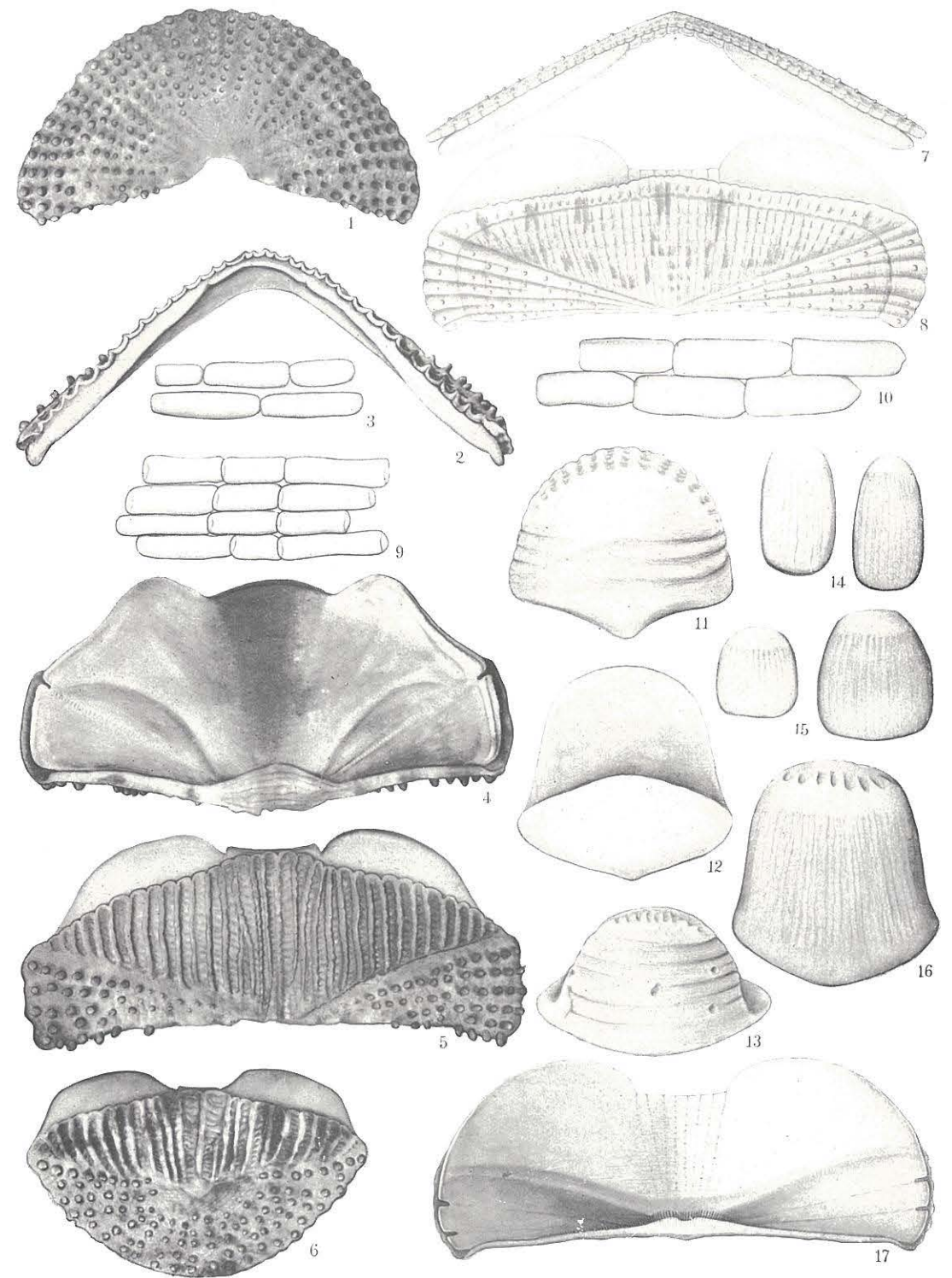
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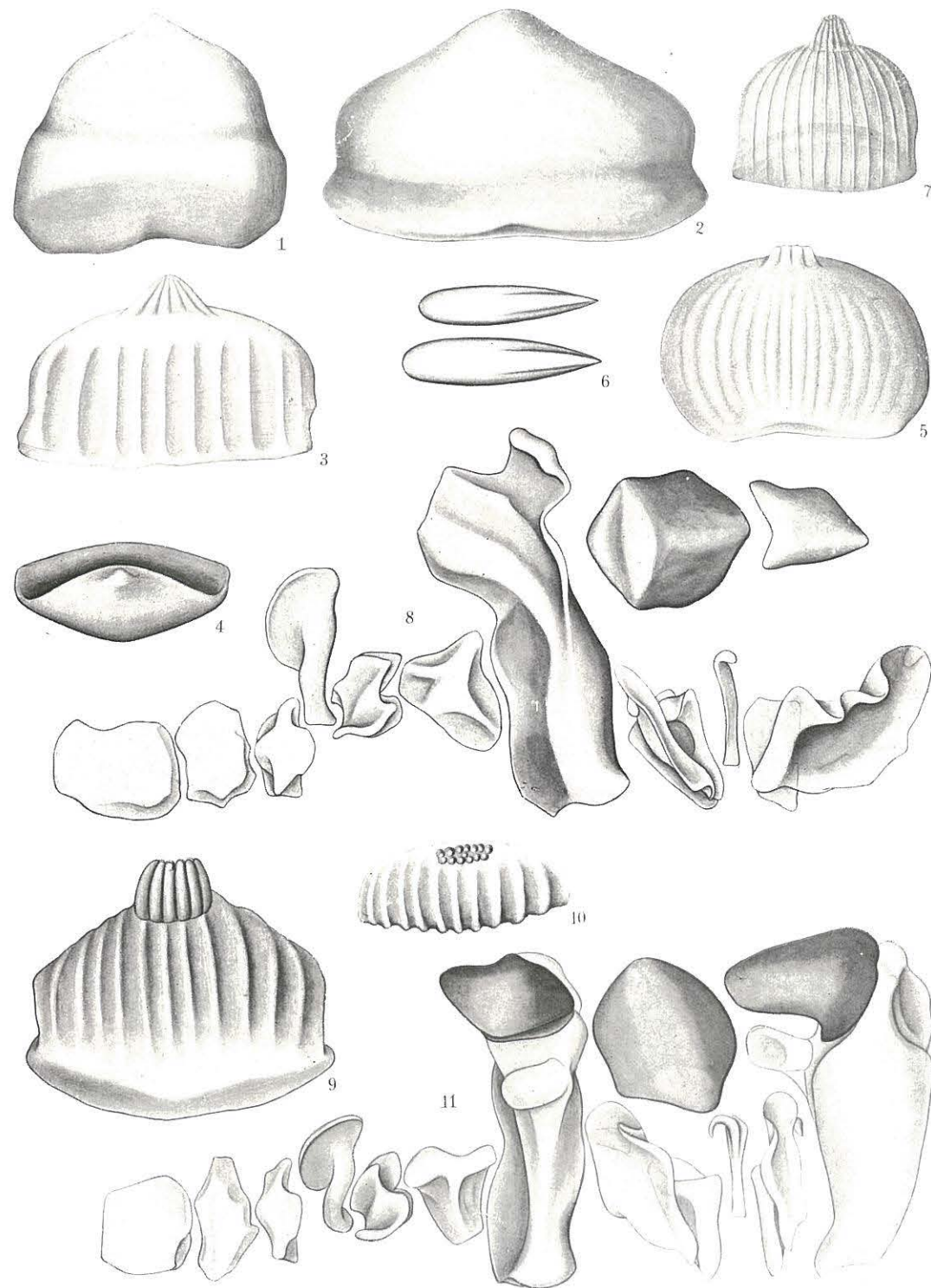
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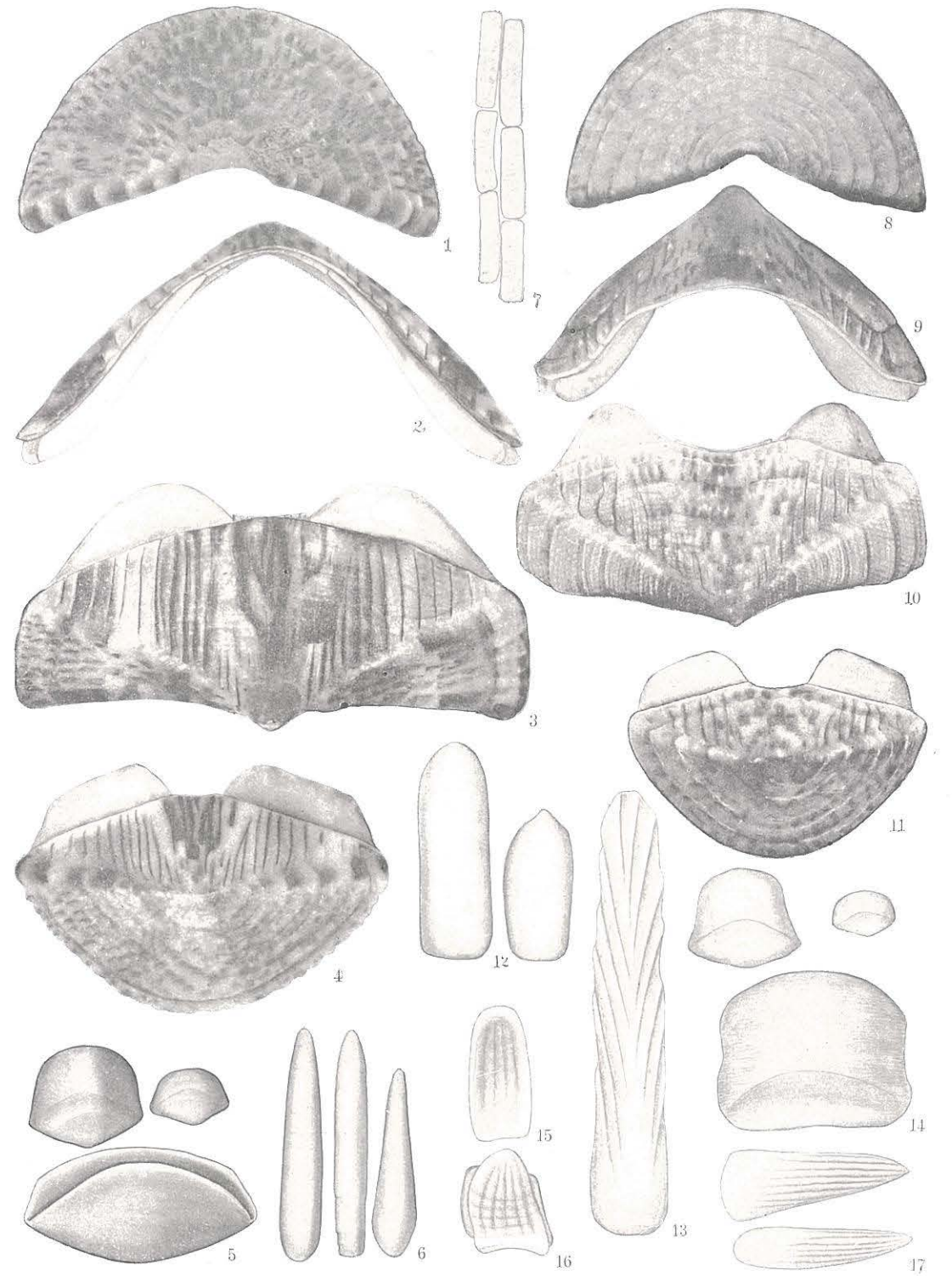
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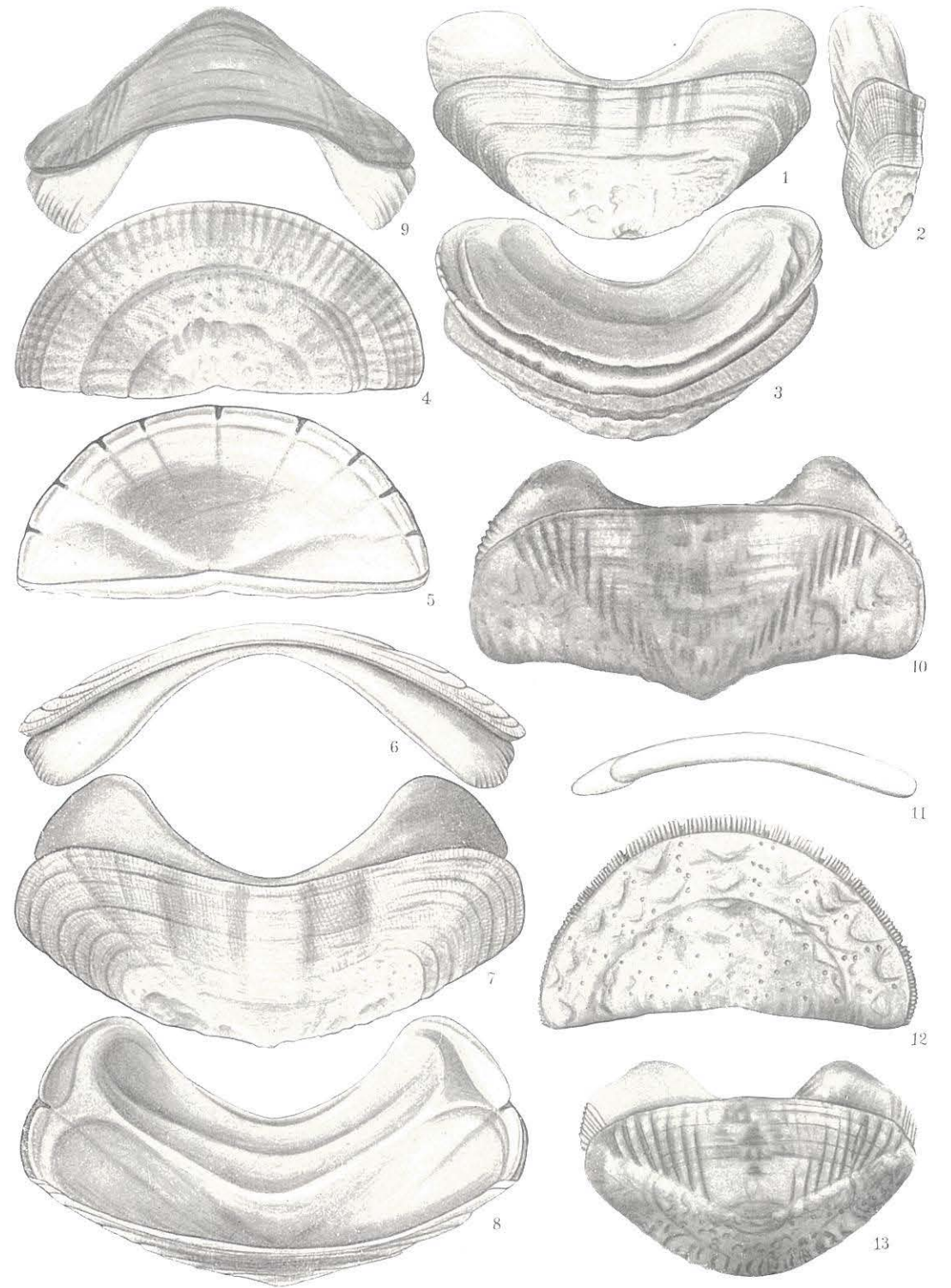
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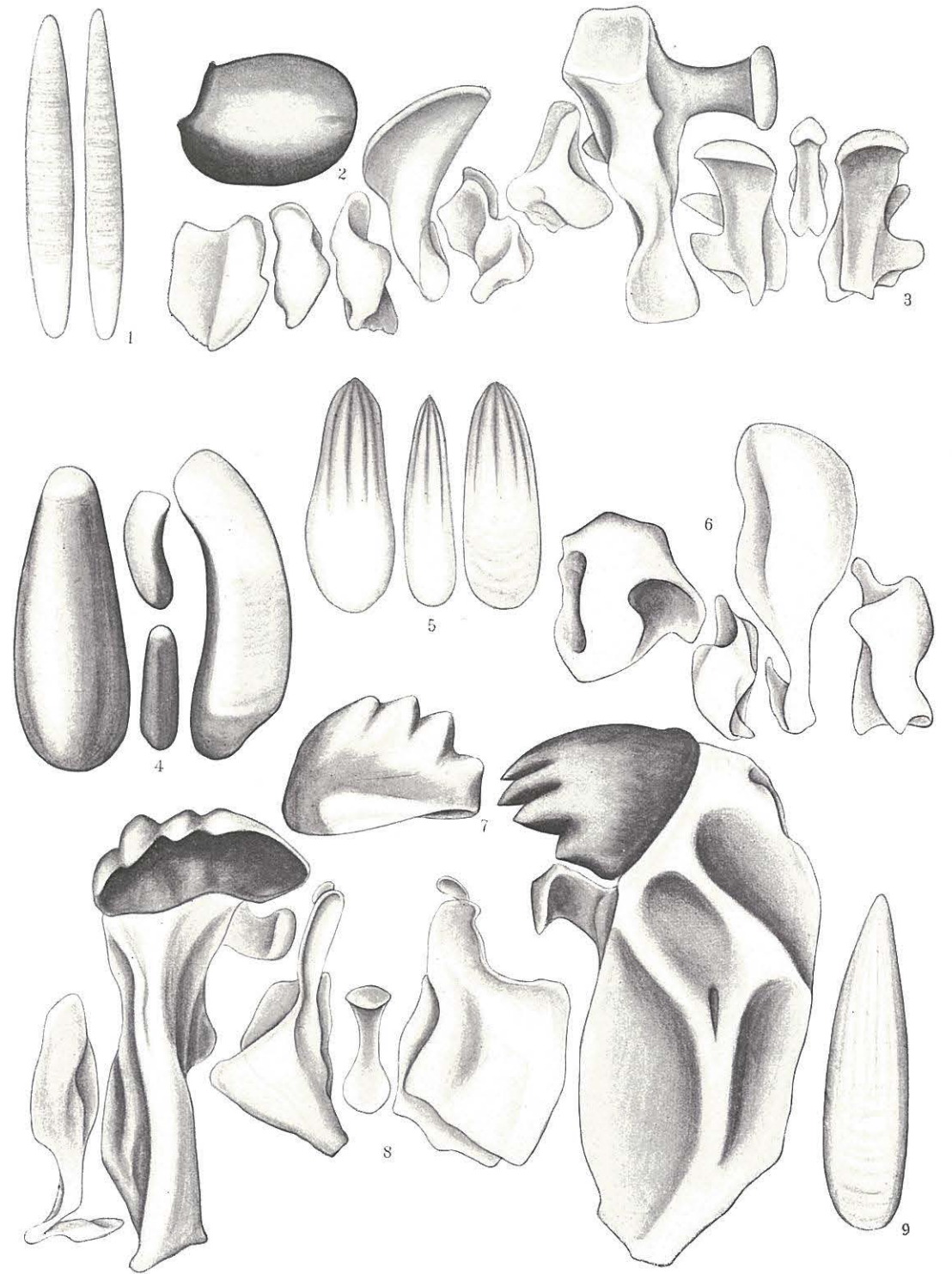
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