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Serripes (Mollusca) from Japan and Saghalien

Hiroshi Noda

(With 4 plates, 1 table)

INTRODUCTION

The Genus *Serripes* which dates back to the middle Tertiary has been recorded as living in the Bering, Alaska, Kamtchatka Seas and circumboreal seas. Although the species of *Serripes* are more or less common in the Miocene and younger deposits of the Japanese Islands and Saghalien, their value in geology had been neglected because of the difficulty in obtaining good specimens, the thin external shell which is often not preserved and the specimens thus occur as casts or moulds in many cases, confusion in the taxonomy because of the few detailed descriptions and figures and also because of their variable shape.

In 1935, Otuka summarized the Japanese species of *Serripes*, but since then there has been published no comprehensive work concerning the genus. For this reason and also because of the frequent occurrence the writer has attempted to make a monograph of its species from the Japanese Islands.

In the Institute of Geology and Paleontology, Faculty of Science, Tohoku University and the Saito Ho-on Kai Museum both in Sendai City, there are stored numerous specimens of *Serripes*, fossil and Recent. These are from various localities in Japan, Korea and Saghalien and were studied by the writer supplemented with the materials collected from the Tertiary deposits distributed in Higashi-Kubiki-gun, Niigata Prefecture during the course of his geological survey in 1960.

The species to be described in this paper amount to 12, among which four species and one subspecies are determined to be new to science.

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SERRIPES IN JAPAN

Serripes squalidum described by Yokoyama in 1924 from the upper Oligocene Iwaki formation in Fukushima Prefecture is the first record of the Genus *Serripes* in Japan.

Since then *Serripes groenlandicus* was reported from the lower Miocene Kobana formation in Tochigi Prefecture by Hirayama in 1954, who at that time described as a

species new to science *Serripes expansus*. The latter occurs in association with many molluscs such as *Brachidontes*, *Chlamys*, *Atrina*, *Lucina*, *Lucinoma*, *Conchocele*, *Vasticardium* and *Dosinia*. *Serripes* during the Miocene age in Japan is distributed from the Nishikurosawa horizon up to the Kitaura horizon in Akita Prefecture but from the lower to upper Pliocene and the Pleistocene there seems to be no record of *Serripes* in Japan. As Recent, *Serripes groenlandicus*, the type species of *Serripes*, *Serripes laperousii* and *Serripes notabilis* are now living in the Bering Sea, off Alaska, around Kamtchatka and in the seas surrounding Japan.

Otuka (1943*b*) described the Sugota Fauna and Ukibuta Fauna, but *Serripes* was not recorded. These fauna correspond to the Nishikurosawa horizon which is characterized by *Eostegodon pseudolatidens* (Yabe), *Lepidocyclina*, *Miogypsina*, *Operculina* besides many molluscs. The Yoshino formation in Yamagata Prefecture which is equivalent to the Nishikurosawa formation yielded *Serripes groenlandicus* (Minakawa, 1960, 1961) in association with *Clinocardium shinjiense*, *Chlamys akitana*, *Chlamys* cf. *nisataiensis*, *Dosinia nomurai*, *Dosinia kaneharai*, *Nanaochlamys notoensis* and other mollusca.

Serripes groenlandicus occurs in abundance from the Onnagawa horizon in Hokkaido, the Takinoue formation, Magaribuchi formation and Chikubetsu formation; the latter formation yielded *Serripes japonica*. The Chikubetsu Fauna is characterized by *Yoldia notabilis*, *Mercenaria chitaniana*, *Mercenaria y-iizukai*, *Spisula onnechuria*, *Platyodon nipponica*, *Peronidae kotakea* and *Natica ezoana*, and all of which are rather cool-water indicators and shallow forms in boreal region.

Serripes groenlandicus rarely occurs from the Ogino formation in Fukushima Prefecture; this is correlated to the Onnagawa formation.

Serripes yokoyamai is abundant in Northern Honshu, being known from the Ginzan formation, Utsuno formation, Kusanagi formation. It is rare in Hokkaido being known only from the Wakkauenbetsu formation.

Serripes laperousii is also rare but has been described with *Serripes notabilis*, *Serripes yokoyamai* from the Hitosao formation, and *Serripes groenlandicus*, *Serripes japonica* from the Magaribuchi formation. However, *Serripes notabilis* is unknown from this horizon in Hokkaido.

Numbers of the species and individuals of the genus *Serripes* are very abundant in the Funakawa horizon and have been described from various localities in Northern Honshu and Hokkaido. The Funakawa horizon is also known to yeild the so-called Yama Fauna which is characterized with such marine molluscs as *Nucula akitana*, *Clinocardium iwashiroense*, *Lucinoma acutulineatum*, *Conchocele nipponica*, *Macoma optiva*, *Cultellus izumoensis*, *Mya cuneiformis*, *Phos iwakianus*, *Ancistrolepis mogamiense*, *Neptunea nomurai* and *Psephaea tokunagai*.

The formations that have yielded the Yama Fauna are the Kanomatazawa formation, Shimokurosawa formation, Furukuchi formation, Nobesawa formation, Utsutoge formation, Shiotsubo formation, Oborogegawa formation, Ogawa formation, Fujina formation, Shiogama formation and Teradomari formation.

Serripes makiyamai was described from this horizon as a new form, the Furukuchi formation, Ogawa formation and Teradomari formation. *Serripes hataii* Noda, n. sp. and *Serripes shiobaraensis* Noda, n. sp. are also restricted to this horizon. *Serripes laperousii* is common in this horizon but *Serripes groenlandicus* becomes less common.

Serripes groenlandicus, *Serripes laperousii*, *Serripes notabilis* and *Serripes yokoyamai* have all been recorded from the Kurosawa formation from where the following genera are known to occur, namely, *Conchocele*, *Lucinoma*, *Yoldia*, *Periploma*, *Neptunea* and fish-scales all of which indicate rather deep water muddy bottom dwellers but in association also recorded the following rather shallow water forms as *Thracia*, *Sanguinolaria*, *Panomya*,

Cultellus, *Mya* and *Macoma*. *Serripes yokoyamai* is also common in this horizon and from the Ajiri formation in the Shiogama district, the following marine molluscs have been recorded, that is, *Anadara* cf. *ninohensis*, *Acila divaricata*, *Clinocardium shinjiense*, *Trachycardium shiobaraensis*, *Cultellus izumoensis*, *Patinopecten kimurai tiganouraensis*, *Panope japonica*, *Dosinia nomurai*, *Cyclocardia siogamensis*, *Natica* sp., *Fulgoraria striata*, *Vicarya yokoyamai*, *Proclava atukoae*, *Sinum yabei*, *Phos iwakianus*, *Murex tiganouraensis* and *Dentalium yokoyamai* and other marine molluscs. The above mentioned genera and species from the Ajiri formation occur in an area far north of the present limits in distribution, while *Serripes* occurs as far south as the Fujina formation in Shimane Prefecture from where the following species are known such as *Cultellus izumoensis*, *Lyropecten kagamianus*, *Shichiheia yokoyamai*, *Clinocardium shinjiense*, *Macoma optiva*, *Sinum yabei*, *Fulugoraria striata* with *Serripes groenlandicus* and *Serripes laperousii*. These marine molluscs from the Fujina formation have been studied by Yokoyama (1923) and Nomura and Hatai (1939). It is thought that these fossils were buried in sediments at less than 50 fathoms in depth and water cooler than the present sea.

Recently Tai (1955) studied the minor foraminifers and noted that the Fujina formation may have been deposited in the outer neritic zone, 50 to 200 meters in depth.

Serripes in the Kitaura horizon becomes more restricted in geographic distribution but *Serripes triangularis* and *Serripes makiyamai nigamiensis* appear in this horizon and are restricted to it. This horizon is characterized by relic species from the Yama Fauna. The Hongo formation has yielded *Serripes groenlandicus*, *Serripes laperousii*, *Serripes notabilis* and *Serripes yokoyamai* but the occurrence of *Serripes* individuals become reduced compared with the Funakawa horizon. *Serripes japonica* occurs from the Onnagawa horizon in Hokkadio and extends upwards to this horizon but extinct.

In the Pliocene age, *Serripes* is rather rare in number of specimens and in distribution in Northern Honshu. *Serripes groenlandicus* in the Pliocene of Hokkaido is rather common being known from the Ebishima formation, Shisun formation, Shozanbetsu formation, Wakkanai formation among which the last mentioned yielded *Serripes notabilis*. It is considered from the above mentioned facts that the Miocene *Serripes* immigrated towards the north and is a relict fauna. The Maruyama sandy shale has yielded abundant *Serripes groenlandicus*. In Honshu, the following forms are recorded or illustrated from the respective formations of early Pliocene age, *Serripes laperousii* from the Tatenohara formation, *Serripes notabilis* from the Takezawa formation and *Serripes yokoyamai* from the Nishiyama formation. In the late Pliocene of Honshu, *Serripes notabilis* from the Kubo formation, *Serripes groenlandicus*, *Serripes notabilis* and *Serripes yokoyamai* from the Haizume formation and *Serripes yokoyamai* from the Togawa formation are also descriminated.

SOME ECOLOGICAL REMARKS ON THE GENUS *SERRIPES*

The Genus *Serripes* occurs abundantly from deposits of Miocene age, especially from the Yama Fauna (Otuka 1943*b*) or Funakawa horizon in Oga Peninsula, Akita Prefecture which is generally accepted as the standard sequence of the Tertiary deposits in the oil fields of the Japan Sea borderland.

During the Miocene age in the Japanese Islands the following genera of molluscs, namely *Acila*, *Anadara*, *Lyropecten*, *Nanaochlamys*, *Placopecten*, *Patinopecten*, *Chlamys*, *Macoma* and *Cultellus* are abundant in general and have wide distribution but in Northern Japan *Serripes* becomes common and is associated with other molluscs.

Choronologically, *Serripes* as already mentioned appears from the Late Oligocene, reaches its hemera during Funakawa-Onnagawa time and extends sporadically through the Pliocene to Recent. *Serripes groenlandicus*, *Serripes laperousii* and *Serripes notabilis*

now living in the Bering, Alaska, Kamtchatka and circumboreal seas is considered to be a relic of the Miocene form. *Serripes* seems to have entered the central part of the Japanese Islands in Miocene age through the Uetsu Geosynclinal sea. *Serripes hataii* Noda, n. sp. and *Serripes shiobaraensis* Noda, n. sp. become extinct in the Funakawa time and *Serripes japonica* Noda, n. sp. and *Serripes triangularis* Noda n. sp. disappear in the early Miocene, Kitaura time. Many fossil specimens occur from very fine grained sand or muddy sediments in association with the genera as, *Acila*, *Anadara*, *Macoma*, *Periploma*, *Cultellus*, *Clinocardium*, *Trachycardium*, *Chlamys* and *Dosinia* all which indicate rather cold temperature and rather shallow water.

Serripes is found at present in the sandy and/or muddy bottom prevailing with cold water. The pallial line is not sinous but slightly truncated behind and therefore *Serripes* is not a form burrowing deeply into the bottom materials, and lives near the bottom surface. It is influenced by wave currents, water temperature, salinity and other physical conditions as other epifauna.

According to Oyama (1952), the bathymetric ranges of *Serripes laperousii*, *Serripes notabilis* and *Serripes yokoyamai* are restricted between 50 to 200 meters.

NOTES ON THE MEASUREMENTS OF *SERRIPES*

In this paper, 12 species are described, namely, *Serripes expansus* Hirayama, *Serripes groenlandicus* (Bruguière), *Serripes hataii* Noda, n. sp., *Serripes japonica* Noda, n. sp., *Serripes laperousii* (Deshayes), *Serripes makiyamai* (Yokoyama), *Serripes makiyamai nigamiensis* Noda, n. subsp., *Serripes notabilis* (Sowerby), *Serripes shiobaraensis* Noda, n. sp., *Serripes squalidum* (Yokoyama), *Serripes triangularis* Noda, n. sp., and *Serripes yokoyamai* Otuka. *Serripes* sp. from the Shinano Province recorded by Kuroda (1931) is not described in this paper because of the lack of topotype specimens but it may represent a new species. Measurements were made on selected specimens of *Serripes*. These measurements show that *Serripes yokoyamai* has the highest ratio of Height to Length which ranges from 0.792 to 1.141 but the convexity is low with regard to the ratio of Height to Length. *Serripes notabilis* shows nearly a constant ratio in Height to Length, the range being from 0.818 to 1.020 and the convexity is higher compared with Height to Length ratio. Although *Serripes groenlandicus* resembles *Serripes laperousii*, the former has a higher ratio of Height to Length from 0.795 to 0.982 with an average of 0.875, while the latter ranges from 0.735 to 0.925 with an average of 0.811. The specimens measured are those preserved in the collections of the Institute of Geology and Paleontology, Tohoku University and in the Saito Ho-on Kai Museum in Sendai City. It may be added that other details of the shell were also measured but their statistics are omitted at this place.

SYSTEMATIC DESCRIPTION

Family Cardiidae
Genus ***Serripes*** Gould, 1841

Serripes Gould, 1814, p. 93 (*non vidi.*); Dall, 1900, p. 384; Oldroyd, 1924, p. 145; Grant and Gale, 1931, p. 313; Otuka, 1935, p. 601; Habe, 1951, p. 151; Oyama, Mizuno and Sakamoto, 1960, p. 176–177.

Type species: *Serripes groenlandicus* (Bruguière). Recent, Greenland.
Generic diagnosis: Valve smooth mesially, radially striate towards the ends; cardinal teeth obsolete; pallial line truncate behind, foot geniculate, compressed, serrate on the edge below (Dall, 1900).
Remarks: This boreal genus is readily distinguished by its obsolete cardinal teeth,

ornamentation with fine concentric growth lines and radiating ribs towards both sides of the shell, and indistinct sculpture in the middle part. Rather swollen beak which is rather prominent, incurved and situated anteriorly.

Geographic distribution : Boreal region of the Northern Pacific and Northern Atlantic Oceans.

Geologic distribution : Late Oligocene to Recent.

Serripes expansus Hirayama, 1954

Serripes expansus Hirayama, 1954, p. 66-67, pl. 4, figs. 1-2.

Remarks : Present species was originally described by Hirayama in 1954 based upon the specimens from near Nanatsuishi, Oyamada-shimogo, Oyamada-mura, Tochigi Prefecture. The locality belongs to the early Miocene Kobana formation and *Miogypsina* was also reported. According to Hirayama this unusually expanded species finds no similar forms among the Neogene species of Japan, but it is allied to *Serripes laperousii* by its rather rounded shape, broadly rounded ventral margin and nearly straight posterodorsal margin for a short distance.

Among the examined specimens of *Serripes laperousii* there are allied forms which have depressed and deformed shape.

Dimensions (in mm) according to Hirayama : -

Holotype : Length=120.0, Height=97.0, Thickness (intact)=54.0

Paratype : Length=101.0, Height=78.0, Thickness (intact)=40.0

Geologic occurrence and *age* : Only known from the Kobana formation, Early Miocene.

Serripes groenlandicus (Bruguière), 1789

Pl. 36, figs. 1–5, Pl. 37, figs. 1, 4a–4b, 5.

Cardium groenlandicus Chemnitz, 1789, p. 202, pl. 19, fig. 198; Bruguière, 1789, p. 222; Gmelin in Linnaeus, 1792, p. 3262; Gould, 1841, p. 93; (all *fide* Grant and Gale, 1931); Yokoyama, 1929, p. 390, pl. 73, fig. 3.

Cardium boreale Reeve, 1845, pl. 22, fig. 131 (*non* Broderip and Sowerby, 1829) (*fide* Grant and Gale, 1931).

Cardium (Serripes) groenlandicum Chemnitz, Dall, 1885, p. 183 (*fide* Grant and Gale, 1931).

Serripes groenlandicus "Beck", Dall, 1896, p. 844 (*fide* Grant and Gale, 1931).

Serripes groenlandicus, Dall, 1900, p. 174; Dall, 1904, p. 114, and 121; Dall, 1919, p. 28 A; Dall 1921, p. 40, (all *fide* Grant and Gale, 1931); Oldroyd, 1924, p. 145, pl. 8, fig. 3; Nomura, 1933, p. 6, pl. 1, fig. 8; Otuka, 1935, p. 601-602; Hirayama, 1954, p. 67–68, pl. 4, fig. 3; Kanno and Matsuno, 1960, pl. 5, fig. 3.

Cardium pauperculum Yokoyama, 1926, p. 243, pl. 30, fig. 3.

Remarks : The type locality of the species is the coast of Greenland. The present species described by Chemnitz seems to have been the first but from the International Code of Zoological Nomenclature and the discussion of the Commission, Bruguière is accepted as the author. He used the name in a strictly binominal manner three years prior to Gmelin (Grant and Gale, 1931). This species is variable in shape and is allied to *Serripes laperousii* but differs from the latter in having a longer shell, elongate posterior extremity and rounded front, broady rounded ventral border and rather prominent beak which is turned forwards.

However, there are shells of similar shape in the Bering Sea, these have both dorsal margin nearly straight, the ventral margin broadly arcuated, both extremities subrounded, the beaks swollen and situated in the middle part of the shell length, the surface ornamented with fine concentric lines of growth and radiating ribs on the anterior side but indistinct in the middle part, the inner surface smooth except for rude radiating

ribs corresponding to the surface ornamentation, and the pallial line is not sinuous but slightly truncate behind.

Serripes laperousii compared with the present species has a more higher shell with regard to shell length, straight posterior dorsal margin and more swollen beaks.

Serripes pauperculum (Yokoyama) was orginally described by Yokoyama from Kamiichiba, Shimane Prefecture in 1923, but in 1939 Nomura and Hatai refered it *Serripes groenlandicus*.

Serripes pauperculum is conspecific with *Serripes groenlandicus*, both being characterized by subrounded sides, rounded ventral margin and beaks which are rather prominent. The surface ornamentation is the same as *Serripes groenlandicus*.

Geologic occurrence: Maruyama sandy shale (Inai and Seki, 1937), Prumi bed (Yokoyama, 1929) in Saghalien; Chikubetsu formation (Kanno and Matsuno, 1960), Ebishima formation, Shisun formation (Imanishi, 1950), Syozanbetsu formation, Takinoue formation, Upper Okada bed (Yokoyama, 1932), Wakkanai formation (Yokoyama, 1926) all in Hokkaido; Takahoko formation (Aoki, 1959) in Aomori Prefecture; Kurosawa formation (Otuka, 1943*b*) in Akita Prefecture; Hongo formation, Utsutoge formation (Minakawa, 1960), Yoshino formation (Minakawa, 1960, 1961) in Yamagata Prefecture; Kanomatazawa formation (Akutsu, 1960, MS., Hirasawa, 1961, MS.), Kobana formation (Hirayama, 1954) in Tochigi Prefecture; Fujina formation (Yokoyama, 1923) in Shimane Prefecture; Haizume formation in Niigata Prefecture.

Geologic age: Early to late Pliocene and Recent. (Living in Bering Sea and Puget Sound also in the seas surrounding Japan).

Serripes hataii Noda, n. sp.

Pl. 37, fig. 3.

One right valve and several incomplate specimens were examined. Shell rather large, somewhat inequilateral, disc very rounded, both sides of shell broadly rounded, dorasl margin sloping into both extremities with nearly straight margin for a short distance. Another border more elongate than posterior one which sharply slopes into ventral margin. Ventral margin strongly rounded. Surface ornametation with concentric regular lines of growth but densely at ventral margin, faint radiating ribs cross above mentioned concentric lines at both sides of shell but the former stronger than the latter; radiating indistinct in middle part of shell. Beak swollen, rather stout, situated near center.

Dimensions (in mm): Holotype (IGPS coll. cat. no. 74593) 83.8 in length, 84.5 in height and 19.0 in depth.

Affinities and *Comparison*: This new species resembles *Serripes groenlandicus* now living in the boreal seas but differs from the latter in having more rounded shell, smaller angle between both dorsal margins and more acute apex and rather broadly arcuated ventral margin. *Serripes laperousii* has a more elongate shell and rather straight posterior margin. *Serripes yokoyamai* orginally described from the Miocene Hitosao formation in Fukushima Prefecture differs from the present species by its more convex and inequilateral shell, and more incurved beaks.

Remarks: The present new species once listed by Onodera (1957) as *Serripes iwaigawaensis* Hatai from the Shimokurosawa formation from where *Desmostylus* cf. *japonica* Tokunaga and Iwasaki was reported, is a manuscript name.

Type locality: Iwaigawa, Kamikurosawa, Hagihana-mura, Nishiiwai-gun, Iwate Prefecture. Nishikurosawa formation.

Geologic occurrence: Shimokurosawa formation (Lower part).

Geologic age: Middle Miocene.

Serripes japonica Noda, n. sp.
Pl. 39, fig. 4.

Serripes fujinensis, Otuka (*part.*), 1937, p. 168–169, pl. 16, fig. 9, *non* fig. 10; (*non* Yokoyama, 1923) Kanno and Matsuno, 1960, pl. 4, fig. 6, no description.

Shell rather large, convex inequilateral, with anterior side short and posterior side very long, disc ovately rounded in shape. Both sides of shell rounded, antero-dorsal margin slightly concave and short, postero-dorsal margin long and broadly arcuated, ventral margin concave and broadly rounded.

Posterior extremity more arcuated than anterior one. Surface ornamentation of rude concentric growth lines on whole surface, anterior side with faint radiating ribs, indistinct on posterior side. Beak swollen, prominent, directed foreward, almost touching and situated at one-third of shell length. Hinge margin evenly arcuated with lateral teeth. *Dimensions* (in mm): Holotype (IGPS coll. cat. no. 78680) 82.4 in length, 61.0 in height, 17.5 in depth.

Affinities and *Comparison*: The present new species resembles *Serripes makiyamai* described from Hanzogane, Tochio City, Niigata Prefecture by Yokoyama in 1928 but differs from the latter by the higher shell and more straighter ventral margin; the former has more elongate posterior margin and more concave anterior dorsal margin. Another allied species is *Serripes makiyamai nigamiensis* Noda, n. subsp., but it differs from the present new species by its more convex shell, longer and broadly arcuated posterior margin, and more acute and narrow posterior extremity. *Serripes laperousii* also differs from the present species by the shell outline.

Remarks: The present new species is characterized by its elongate posterior side and very short anterior one. In 1923, Yokoyama described *Mactra fujinensis* (= *Serripes fujinensis*) from the Miocene Fujina formation in Shimane Prefecture, but Yokoyama's *fujinensis* is conspecific with *Serripes laperousii*, a species living in the boreal seas. Some paleontologists have, hitherto, described and listed the forms as *Serripes fujinensis* but among which the above cited Otuka's (1937) and Kanno and Matsuno's (1960) specimens are considered to be conspecific with this new species.

Type locality: Mukai, Sakekawa, Mogami-gun, Yamagata Prefecture, Sakekawa formation.

Geologic occurrence: Magaribuchi formation, Chikubetsu formation, and Sakekawa formation.

Geologic age: Early to late Miocene.

Serripes laperousii (Deshayes), 1839.
Pl. 36, figs. 6a-6b, Pl. 37, figs. 2a-2b, 6, 7, Pl. 38, figs. 5, 6.

Cardium laperousii Deshayes, 1839, p. 360. (*non vidi.*)
Mactra fujinensis, Yokoyama, 1923, p. 5, pl. 2, figs. 2a–2b.
Serripes laperoussii, Nomura, 1935, p. 114, pl. 7, figs. 1–3; Otuka, 1935, p. 602, pl. 16, figs. 1–2; Habe, 1951, p. 151, text-figs. 339–340.
Serripes fujinensis, Otuka (*part.*), 1937, p. 168–169, pl. 16, fig. 10, *non* fig. 9.

Remarks: This species is now living in the Beirng Sea and ranges to the Japan Sea. The type locality is "Mers de California".

The present species is characterized by its ovately rounded, rather short anterior dorsal margin. Its ventral margin is broadly arcuated. The beaks are swollen and located anteriorly. The surface ornamentation is of concentric lines of growth and faint radiating ribs on both sides of the shell but indistinct in middle part.

Affinities and *Comparison*: The present species resembles *Serripes groenlandicus* in

having rather long shell but differs from the latter by its more swollen beak and the latter has more acute apex and long, straight or slightly arcuated posterior margin. *Mactra fujinensis* first described by Yokoyama from Kamiichiba in Shimane Prefecture is conspecific with the present species in having rather round shape, short antero-dorsal margin, rather straight posterior one and the ventral margin is broadly rounded. The beaks are rather swollen. But a part of *Serripes fujinensis* of Otuka (1937, fig. 7) and Kanno and Matsuno (1960, fig. 6) are conspecific with the writer's *Serripes japonica* as already mentioned.

Geologic occurrence: Magaribuchi formation (Otuka, 1937) in Hokkaido; Shimokurosawa formation (Onodera, 1957) in Iwate Prefecture; Kurosawa formation, Sakekawa formation in Akita Prefecture; Hongo formation (Yamagata, 1957), Matsuzawa formation, Oborogegawa formation, Utsutoge formation in Yamagata Prefecture; Kurikoma formation, Yamada formation in Miyagi Prefecture; Ogino formation (Nomura, 1935, Kobayashi, 1944, Yabe and Hatai, 1941), Shiotsubo formation, Tatenohara formation, Urushikubo formation all in Fukushima Prefecture; Tomioka formation (Fujimoto and Kobayashi, 1937) in Gunma Prefecture; Fujina formation (Yokoyama, 1923) in Shimane Prefecture.

Geologic age: Middle Miocene to early Pliocene and Recent. (Living in the Bering Sea and circumboreal seas).

Serripes makiyamai (Yokoyama), 1928

Mactra ? makiyamai Yokoyama, 1928, p. 360, pl. 69, fig. 3.
Serripes makiyamai, Nomura and Zinbo, 1935, p. 10–11, pl. 1 (1), fig. 13; Itoigawa, 1958, p. 261, pl. 1, fig. 11; Makiyama, 1959, pl. 67, fig. 3; Kanno and Tomizawa, 1959, p. 10–11, pl. 2, figs. 6a–b.

Remarks: The present species was first described by Yokoyama in 1928, based upon the specimens from the lower Pliocene Ushigakubi formation in Niigata Prefecture as *Mactra ? makiyamai* Yokoyama. In 1935 Otuka considered this species to be synonymous with *Serripes notabilis* described from the Miocene Kurosawa formation in the Yokote district in Akita Prefecture by Otuka (1934*b*). But Nomura and Zinbo (1935) who described *Serripes makiyamai* (Yokoyama) from the Miocene Furukuchi formation in Yamagata Prefecture, considered *makiyamai* as a valid form. Hatai and Nisiyama (1952), Itoigawa (1958) Makiyama (1959) and Kanno and Tomizawa (1959) also recognized *Serripes makiyamai* as a valid species. Although Itoigawa (1958) recognized that *makiyamai* is valid, he listed *Serripes notabilis* of Otuka (1935), in the synonymic list of *makiyamai* when he described *makiyamai* from the Miocene Teradomari formation in Niigata Prefecture. *Serripes makiyamai* differs from *Serripes notabilis* in having a higher shell, rather ovate trigonal form, short and concave antero-dorsal margin and nearly straight ventral margin while the latter has more convex, rounded quadrate shape, and the beaks are more turned forward and nearly touching. The radial ribs on the shell surface are more distinct in *Serripes makiyamai* than in *Serripes notabilis*, the former is ornamented with concentric growth lines and radiating ribs, usually on both sides of the shell but the latter is sculptured with concentric growth lines and indistinct in the middle part of the shell surface.

Type locality: Hanzogane, Tochio City, Niigata Prefecture. Ushigakubi formation.

Geologic occurrence: Teradomari formation (Itoigawa, 1958), Ushigakubi formation (Yokoyama, 1928) in Niigata Prefecture; Furukuchi formation (Nomura and Zinbo, 1935) in Yamagata Prefecture; Ogawa formation (Kanno and Tomizawa, 1959) in Nagano Prefecture; Urushikubo formation in Fukushima Prefecture; Kinseido in Korea.

Geologic age: Middle Miocene to early Pliocene.

Serripes makiyamai nigamiensis Noda, n. subsp.
Pl. 39, figs. 1a–1c.

Intact valves, an incomplete right valve and a well preserved left valve are in the collection. Shell large, very thin with convex, ovate trigonal, very inequilateral outline.

Anterior side very short, posterior side about three times longer than anterior. Antero-dorsal margin very short and concave, postero-dorsal margin very long compared with anterior one and broadly arcuated, sloping into ventral margin.

Both sides of shell rather acutely rounded, anterior extermiy narrowly arcuated and posterior one narrow and acutely rounded. Ventral margin nearly straight. Surface ornamented with very fine concentric growth lines. Low, rounded-squarish topped, radiating ribs extend from beak to ventral margin, indistinct in middle part but distinct on both sides of shell.

Beak rather swollen, incurved foreward, situated at one-fifth of shell length. Most convex part of shell dorsal to center, gradually decrease in convexity to ventral margin and sharply into beak. Cardinal teeth obsolete, lateral teeth especially posterior one developed. Although not large, lunule about one third of anterior dorsal length.
Dimensions (in mm): Holotype (IGPS coll. cat. no. 78684), 125.3 in length, 97.0 in height, 27.5 in depth.
Affinities and *Comparison*: Although the present new subspecies is allied to *Serripes makiyamai*, the former differs from the latter in having a more inequilateral shell, more arcuated posterior margin and characteristically incurved beak, while the latter resembles the former in its faint radiating striae in the middle part of the shell but has no lunule.
Type locality: Nigami, Ooshima-mura, Higashikubiki-gun, Niigata Prefecture. Shiiya formation.
Geologic occurrence: Shiiya formation.
Geologic age: Late Miocene.

Serripes notabilis (Sowerby), 1915
Pl. 38, figs. 1–4, 7a–7b.

Cardium (Serripes) notabilis Sowerby, 1915, p. 169, pl. 10, fig. 9.
Serripes notabilis, Otuka, 1935, p. 602, pl. 15, figs. 9–10, Taki in Hirase, 1960, pl. 31, fig. 1; Habe, 1961, p. 128, pl. 57, fig. 26.
Serripes notabilis nomurai, Otuka, 1943*b*, p. 231, pl. 3(2), fig. 10.

Remarks: The present species is characterized by the rather large, somewhat round-squarish shape, equivalve, inequilateral, longer than high and convex shell. The anterior margin is shorter than the posterior, and slightly concave, while the posterior is nearly straight for a short distance from the beak and truncated down to the posterior extremity meeting the ventral margin with acute angle. Ventral margin broadly arcuated.

Surface ornamentation is of dense, fine concentric growth lines and radiating ribs on both sides. The inner surface of the Recent specimen is smooth except for rude concentric threads corresponding to the outer ornamentations, and the muscular scar is rather large. The pallial lines is slightly truncate behind and round in front. The beaks are prominent, turned forward and nearly touching one another.

The cardinal teeth are obsolete, two and the lateral teeth are short. In the young stage, the present species is rather convex, the disc rounded being slightly longer than high, nearly inequilateral to equilateral, and somewhat rounded in front and truncated behind. The anterior margin is slightly concave near the beak but rounded and meeting the ventral margin gently, while the posterior one is slightly longer than the former but also rounded. The ventral margin is more rounded than in the adult specimen. Specimens of the young

stage are in our Institute, from the Haizume formation, Takezawa formation in Niigata Prefecture and Urushikubo formation in Fukushima Prefecture. However, an interesting specimen was collected from the upstream of the Puromai River, North Saghalien.

It is a subrounded small *notabilis* and seems to be a dwarfed form. At the same locality, *Serripes groenlandicus* occurs in association with the said interesting *notabilis* but the small sized ones are common.

Geologic occurrence: Wakkanai hard shale (Kanehara, 1937) in Hokkaido; Kurosawa formation (Otuka, 1943, Hayasaka, 1957) in Akita Prefecture; Kubo formation (Chinzei, 1959) in Iwate Prefecture; Hongo formation in Yamagata Prefecture; Hitosao formation in Fukushima Prefecture; Takezawa formation, Haizume formation in Niigata Prefecture.

Geologic age: Middle Miocene to late Pliocene and Recent. (Living in Bering Sea and in the seas near Japan).

Serripes shiobaraensis Noda, n. sp.

Pl. 39, fig. 5.

Only a right valve was examined. Posterior extremity broken. Shell rather large, ovate trigonal, inequilateral, posterior margin longer than anterior one. Anterior dorsal margin nearly straight and meets the neighbouring border with acute angles, while posterior margin slightly arcuated but for a short distance near beak straight. Ventral margin broadly rounded, antero-dorsal margin graded into dorsal margin with higher angle. Surface ornamentation with radiating ribs with wider furrows, flatly rounded on top external from beak to ventral margin. Radiating ribs 35–40, cross very strong concentric growth lines, somewhat elevated, and dense near ventral.

Beak rather swollen, small, very prominent, turned anteriorly and situated at one third of shell length. Most convex part of shell near center, and gradually lessening marginally.

Ligamental area long, not incised.

Dimensions (in mm): Holotype (IGPS coll. cat. no. 78687), length unknown but ther material, 90.5 in length, 79.5 in height, 28.5 in depth.

Affinities and *Comparison*: *Serripes yokoyamai* differs from the present species by its more rounded sides and the surface ornamentation differs from the latter being sculptured with radiating ribs on the whole surface and not with so broadly rounded ventral margin as the latter. *Serripes japonica* slightly resembles the present species in shell form but clearly differs from the latter in shape and radiating ribs. *Serripes groenlandicus* differs from the present species by its more rounded hinge margin. There are no similar species of *Serripes* known from the Japanese Tertiary deposits.

Type locality: Cliff facing the Hokigawa Electric Power Station along the Hoki River, Sekiya, Shiobara-machi, Shioya-gun, Tochigi Prefecture. Kanomatazawa formation.

Geologic occurrence: Kanomatazawa formation.

Geologic age: Middle Miocene.

Serripes squalidum (Yokoyama), 1924

Cardium (*Laevicardium*) *squalidum* Yokoyama, 1924, p. 16, pl. 3. fig. 1.

Serripes squalidum, Makiyama, 1957, pl. 13, figs. 1–1a; Oyama, Mizuno and Sakamoto, 1960, p. 177, pl. 55. figs. 6a-6b.

Remarks: The present species was originally described by Yokoyama in 1924 from the upper Oligocene, Iwaki formation at Dodaira, Misawa, Nakoso City, Fukushima Prefecture. This species is characterized by its moderate size, convex, suborbicular, inequilateral shell which is longer than high. The original description is "Shell rather moderate in size and thickness, convex, suborbicular, somewhat longer than high,

inequilateral; anterior border more bluntly rounded than posterior. Surface smooth, though with rude lines of growth. Beaks somewhat swollen, prominent".
Dimensions (in mm): Holotype (GT*, destroyed) length 50.0 height 47 depth 12.

The subcircular species *Serripes hataii* differs from this species by its dorsal margins being longer and nearly straight and by the beaks swollen and situated at the middle part of anterior margin.
Geologic occurrence: Iwaki formation.
Geologic age: Late Oligocene.

Serripes triangularis Noda, n. sp.
Pl. 39, figs. 2, 3.

Shell rather large, inequilateral, somewhat ovate triangular in shape and slightly convex. Anterior dorsal margin long but shorter compared with postero-dorsal one, nearly straight. Postero-dorsal margin long and nearly straight.

Ventral margin rounded, both sides of border rounded with slightly high angle. Surface of shell ornamented with radiating ribs which are wider than furrows, low, rounded, flat topped on both sides but radiating ribs in middle part of shell narrower than at sides. Radiating ribs cross faint concentric lines of growth. Beaks slightly swollen and situated in the middle of shell length. Dimension (in mm): Holotype (SHM*, Reg. No. 8410) 88.0 in length, 83.5 in height, 23.5 in depth.
Affinities and *Comparison*: The present new species differs from *Serripes shiobaraensis* in having higher shell compared with shell length, while the latter has more convex shell, stronger growth lines and more rounded ventral margin.

Serripes makiyamai resembles the present new species but differs from the latter which has straight anterior and posterior dorsal margins and beak not so turned forwards as the former and the beak is situated near the middle or somewhat anteriorly while the former has more inequilateral shell and the beak at one third or slightly anteriorly. *Serripes laperousii* is allied to this new species by its straight posterior margin but differs from the latter in having longer shell, more rounded shepe, and the beak is more incurved.
Type locality: Itanoki-sawa, Araki-mura, Mogami-gun, Yamagata Prefecture. Mitsumori formation.
Geologic occurrence: Mitsumori formation.
Geologic age: Late Miocene.

Serripes yokoyamai Otuka, 1935
Pl. 39, fig. 6.

Serripes yokoyamai Otuka, 1935, p. 603, pl. 16, figs. 3–6.

Remarks: The present species was first described by Otuka (1935) from light gray tuffaceous sandstone at Hagino, Yamanogo-mura, Yama-gun, Fukushima Prefecture, the Miocene Hitosao formation. The present species is characterized by its roundly triangular inequilateral shell, rounded front and truncated behind, with rounded ventral margin. Sometimes, the present species shows various shell forms, the species from the Miocene Kanomatazawa formation in Shiobara, Tochigi Prefecture is higher than long but in general, this species is longer than high. The surface is ornamented by concentric growth lines and radiating ribs on both sides especially the anterior side but is indistinct in the middle part of the shell surface.

The concentric growth lines are more distinct than the radiating ribs on the surface.

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* = Geological Institute, Faculty of Science, University of Tokyo.
** = Saito Ho-on Kai Museum in Sendai City.

The beak is rather swollen, pointed and curved forward, and situated in the middle part of the dorsal margin or near half to one third of the shell length. The present species is allied to *Serripes notabilis* but differs from the latter which has more inequilateral shell, more incurved beaks which are located at one third of the shell length. *Serripes groenlandicus* differs from this species in having more pointed beak and longer shell while the latter has more rounded sides.

Geologic occurrence: Wakkaenbetsu formation (Imanishi, 1957) in Hokkaido; Shimokurosawa formation (Onodera, 1957) in Iwate Prefecture; Kurosawa formation (Otuka, 1943*b*, Hayasaka, 1957) in Akita Prefecture; Ginzan Formation (Saito, 1960), Kusanagi Formation, Hongo formation, Matsumae formation, Nobesawa formation (Saito, 1960), Tazawa formation (Saito, 1960), Utsutoge formation (Minakawa, 1960, 1961, Takahashi, 1960), Yonago formation all in Yamagata Prefecture; Ishikura formation (Shibata, 1961), Hamada formation, Utsuno formation (Taguchi, 1960) in Miyagi Prefecture; Hitosao formation (Otuka, 1935), Ogino formation (Kobayashi, 1944), Urushikubo formation in Fukushima Prefecture; Kanomatazawa formation (Akutsu, 1960MS, Hirasawa, 1961, MS) in Tochigi Prefecture; Tokawa formation in Aomori Prefecture; Nishiyama formation, Haizume Formation in Niigata Prefecture.

Geologic age: Middle Miocene to early Pliocene.

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PLATE

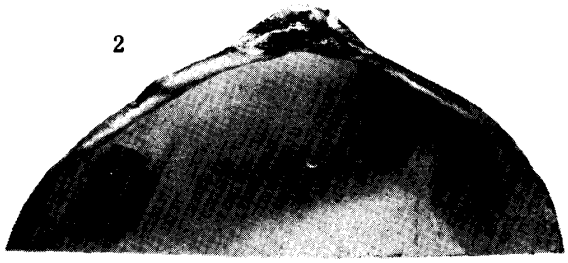
PLATE 36

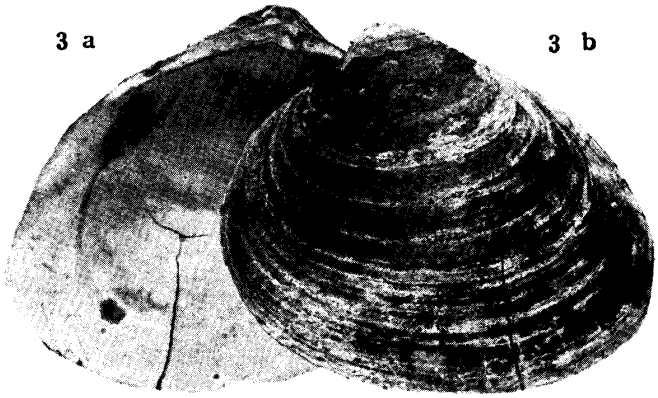
Figs. 1–5. *Serripes groenlandicus* (Bruguière). (p. 223).

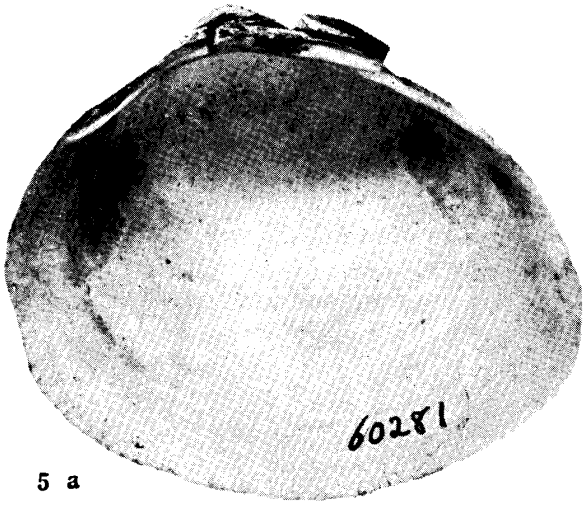
1. Right valve, ×1. IGPS coll. cat. no. 60281. Recent specimen from the Bering Sea, showing inner view and obsolete cardinal teeth.
2, Left valve, ×1. IGPS coll. cat. no. 60281. Recent specimen from the Bering Sea showing inner view.
3a. Left valve, ×2/3. SHM reg. no. 7321. Recent specimen from the Bering Sea, showing inner view.
3b. Left valve, same individual as fig. 3a. showing shell ornamentation.
4. Right valve, ×1. IGPS coll. cat. no. 17454a. Pliocene Prumi Bed, in North Saghalien, showing prominent beak and seems to be a dwarfed form.
5a. Left valve, ×1. IGPS coll. cat. no. 60281,. Recent specimen from the Bering Sea, showing pallial line without sinus.
5b. Left valve, same as fig. 5a.

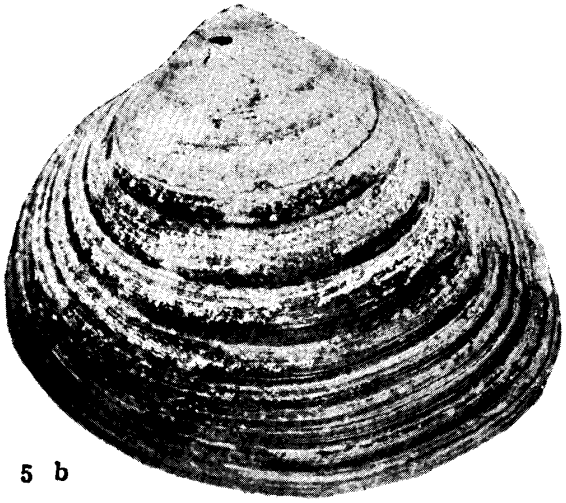
Figs. 6a–b. *Serripes laperousii* (Deshayes). (p. 225).

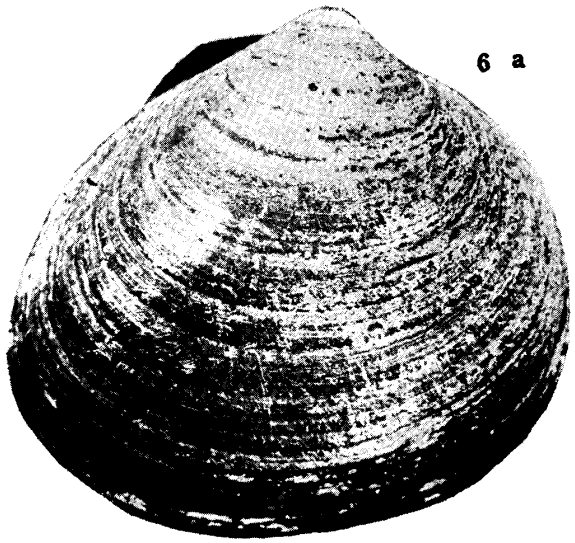
6a. Right valve, ×1. SHM reg. no. 18877. Recent specimen from the Bering Sea.
6b. Same specimen as fig. 6a, showing inner view.



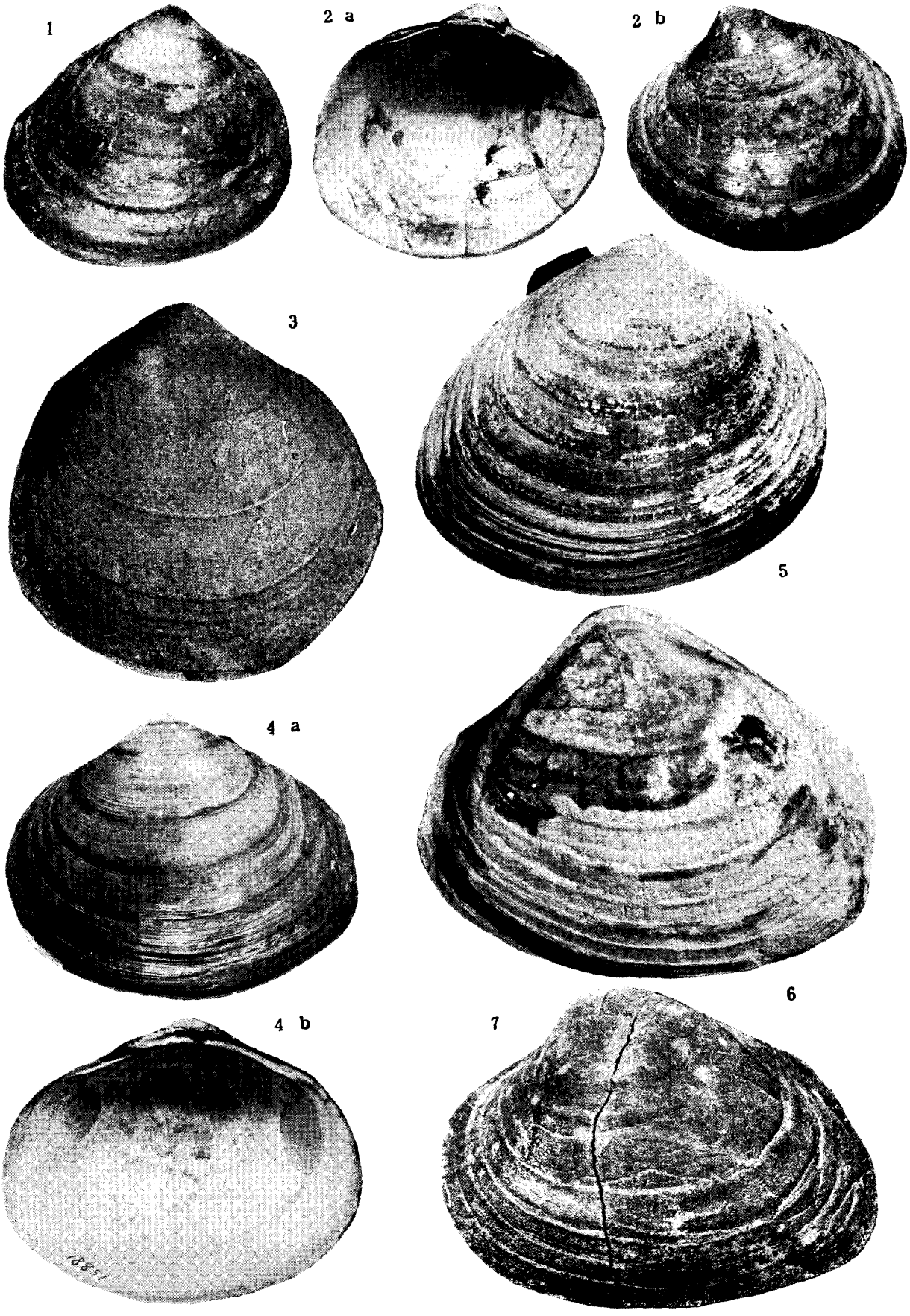








K. Kumagai photo.



K. Kumagai photo.

PLATE 37

Fig. 1. *Serripes groenlandicus* (Bruguière). (p. 223). Right valve, ×1. IGPS coll. cat. no. 17367a. Pliocene Prumi Bed in North Saghalien, showing small sized specimen seems to be a dwarfed form.

Figs. 2a–b. *Serripes laperousii* (Deshayes). (p. 225). Recent specimens from the sea off the western coast of Kamtchatka.

2a. Left valve, ×1. showing inner view and pallial line not sinous.

2b. Left valve same as fig. 2a.

Fig. 3. *Serripes hataii* Noda, n. sp. (p. 234). Left valve, ×2/3. Holotype, IGPS coll. cat. no. 74593. Loc. A cliff of River Iwai, Kamikurosawa, Hagihana-mura, Iwai-gun, Iwate Prefecture. Middle Miocene Shimokurosawa formation.

Figs. 4a–b. *Serripes groenlandicus* (Bruguière). (p. 223). Recent specimens from the Bering Sea.

4a. Left valve, ×2/3. SHM reg. no. 18851.

4b. Left valve, same as fig. 4a., showing inner view.

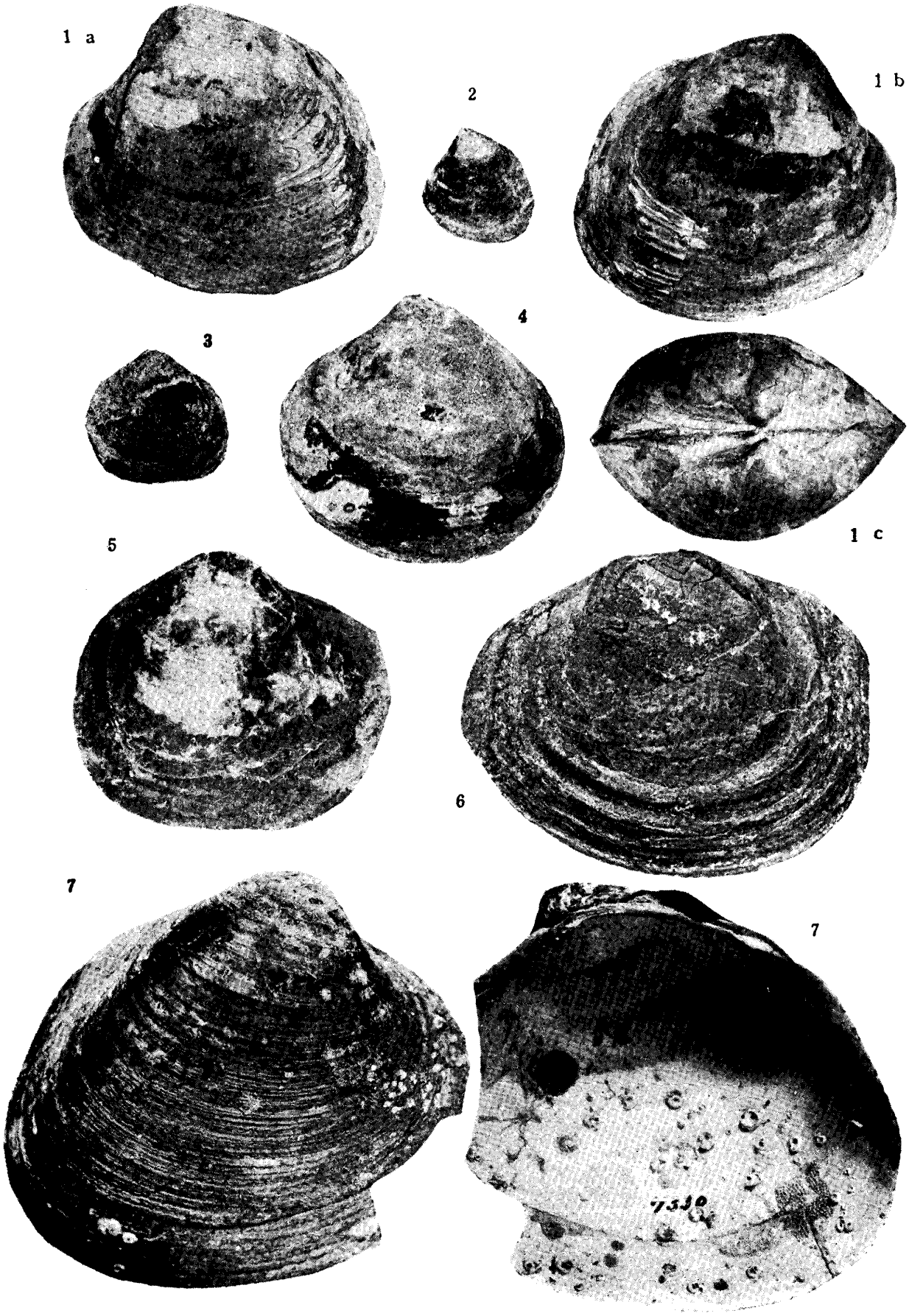
Fig. 5. *Serripes groenlandicus* (Bruguire). (p. 223). Right valve, ×1. IGPS coll, cat. no. 60281. Recent specimen from the Bering Sea.

Fig. 6. *Serripes laperousii* (Deshayes). (p. 225). Left valve, ×1. SHM reg. no. 2263. Oya tuffaceous sandstone menber, Hongo formation, in Yamagata Prefecture.

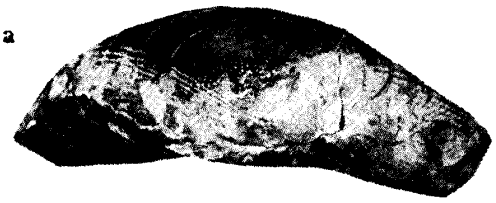
Fig. 7. *Serripes laperousii* (Deshayes). (p. 225). Left valve, ×1. IGPS coll. cat. no. 78682. Middle Miocene Kurosawa formation in Akita Prefecture.

PLATE 38

Figs. 1a–c, 2, 3, 4, 7a, 7b. *Serripes notabilis* (Sowerby). (p. 227).
1a—c. a. Left valve, b. Right valve, c. Apical view, ×1. SM reg. no. 2363a. Upper Miocene Oya tuffaceous sandstone member, Hongo formation in Yamagata Prefecture.
Fig. 2. Left valve, ×1. IGPS coll. cat. no. 17350f. Pliocene Prumi Bed in North Saghalien, showing small sized specimen, a dwarfed form.
Fig. 3. Left valve, ×1. IGPS coll. cat. no. 17350g. Pliocene Prumi Bed in North Saghalien, showing small sized specimen, seems to be a dwarf form.
Fig. 4. Left valve, ×1. IGPS coll. cat. no. 77072. Pliocene Takezawa formation in Niigata Prefecture, showing subrounded form, to be a specimen in young stage.
Figs. 7a–7b. Right valve, ×1. SHM reg. no. 7330. Recent specimen from the Bering Sea, a. showing shell surface, b. showing inner view.
Fig. 5. *Serripes laperousii* (Deshayes). (p. 225). Left valve, ×2/3. SM reg. no. 2363. Upper Miocene Oya tuffaceous sandstone member, Hongo formation in Yamagata Prefecture, showing depressed form alike with *Serripes expansus* Hirayama.
Fig. 6. *Serripes laperousii* (Deshayes). (p. 225). Left valve, ×1. IGPS coll. cat. no. 28438. Middle Miocene Kanomatazawa formation in Tochigi Prefecture, showing depressed form.



K. Kumagai photo.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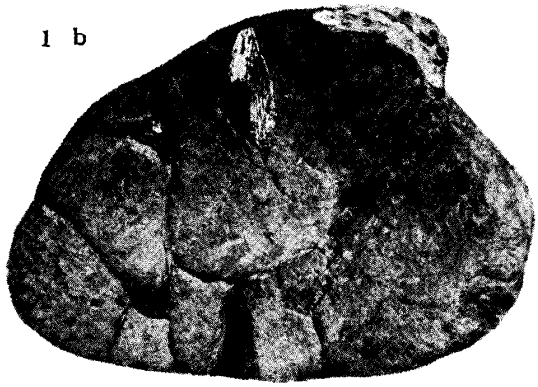
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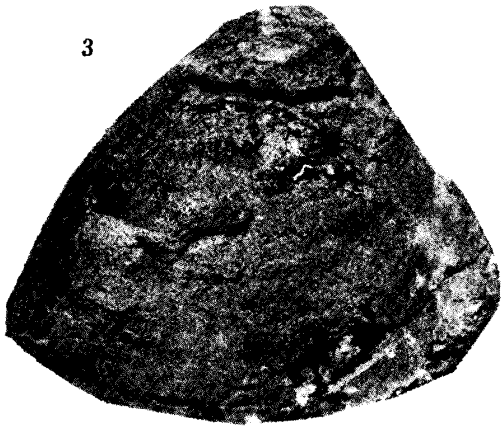
1 c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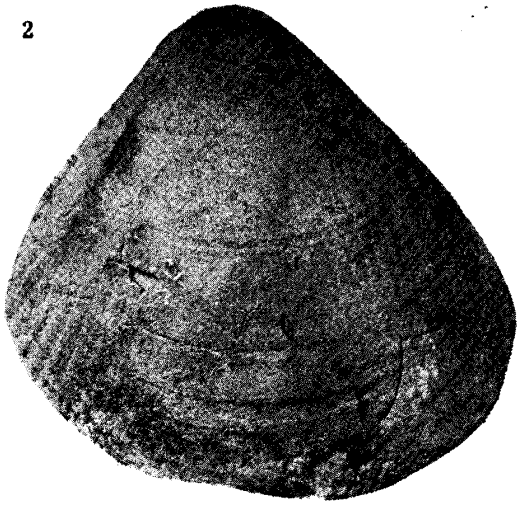
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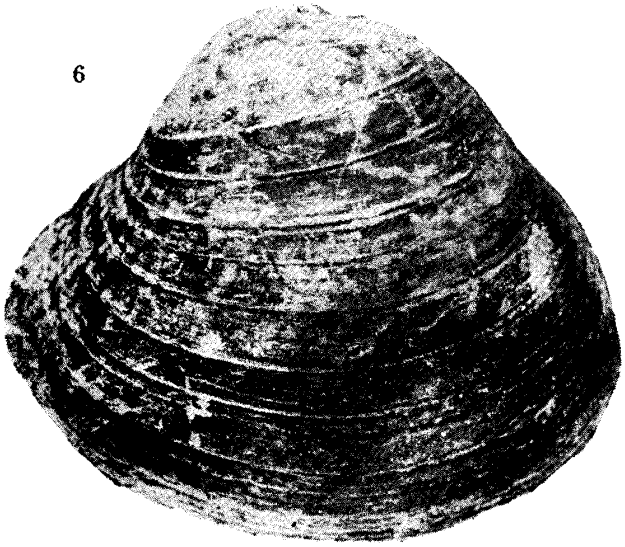
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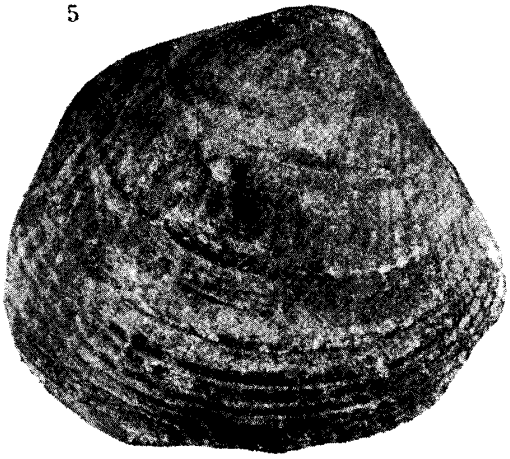
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K. Kumagai photo.

PLATE 39

Figs. 1a–c. *Serripes makiyamai nigamiensis* Noda, n. subsp. (p. 227). Left valve, ×2/3. Holotype, IGPS coll. cat. no. 78684. Loc. Nigami, Oshima-mura, Higashikubiki-gun, Niigata Prefecture, Upper Miocene Shiiya formation.

1a. Apical view, showing radial ribs in both sides.

1b. Showing inner view and strongly incurved beak.

1c. Left valve, showing shell surface.

Fig. 2. *Serripes triangularis* Noda, n. sp. (p. 229). Left valve, ×2/3. Holotype, SHM reg. no. 8410. Loc. Itanoki-sawa, Araki-mura, Mogami-gun, Yamagata Prefecture, Upper Miocene Mitsumori formation.

Fig. 3. *Serripes triangularis* Noda, n. sp. (p. 229), Right valve, ×2/3. SHM. reg. no. 9900. Formation unknown from Yamagata Prefecture.

Fig. 4. *Serripes japonica* Noda, n. sp. (p. 225). Right valve, ×2/3. Holotype, IGPS coll. cat. no. 78680. Loc. Mukai, Sakekawa-mura, Mogami-gun, Yamagata Prefecture, Upper Miocene Sakekawa formation.

Fig. 5. *Serripes shiobaraensis* Noda, n. sp. (p. 228). Right valve, ×2/3. Holotype, IGPS coll. cat. no. 78687. Loc. A cliff of the Hoki-river, opposits the Hokigawa Electric Power Station, Sekiya, Shiobara-machi, Shioya-gun, Tochigi Prefecture. Middle Miocene Kanomatazawa formation.

Fig. 6. *Serripes yokoyamai* Otuka. (p. 229). Left valve, ×1. IGPS coll. cat. no. 75792. Pliocene Tokawa formation in Aomori Prefecture.