

Some Cretaceous Echinoids from Japan

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Abstract: This paper describes seven selected species of Cretaceous echinoids from Japan. They are assigned to the genera *Trochotiara*, *Pygurus*, *Pseudananchys* (?), *Toxaster*, *Hemiaster* and *Niponaster*. Five out of the described species are new, one is a heretofore known Japanese species, and another is provisionally comparable with but distinct from a certain foreign species. The species of *Pygurus* and *Toxaster* came from the Lower Cretaceous and the rest from the Upper Cretaceous. It should be noted that a new species of *Toxaster* shows specialized features in its ambulacra in spite of the occurrence in the Berriasian.

Introduction

Echinoid fossils occur in the Cretaceous strata in various areas of Japan, though sporadically. I have described and illustrated selected species of them. The main object of this report is to describe some additions which have been collected by myself and other persons. The material available came from various areas from northern Hokkaido southwards to eastern Kyushu and covers various ages from Berriasian to Maastrichtian. The species described herein include three Lower Cretaceous ones assigned to the genera *Pygurus* and *Toxaster* and four Upper Cretaceous ones belonging to the genera *Trochotiara*, *Pseudananchys* (?), *Hemiaster* and *Niponaster*. Among them, *Trochotiara* and *Pseudananchys* are genera first reported from Japan, being represented by a new species respectively. Three other new species are assigned to *Pygurus*, *Toxaster* and *Hemiaster*.

The repositories of the material for this study are the Geological Survey of Japan (GSJ), Tsukuba; the National Science Museum (NSM), Tokyo; the Yokosuka City Museum (YCM); and the MIYAUCHI Collection (MNH), Wakkanai.

Before going further, I wish to express my sincere gratitude to Professor Emeritus Tatsuro

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Systematic Descriptions

Order Hemicidaroida BEURLIN, 1937

Family Pseudodiademmatidae POMEL, 1883

Genus *Trochotiara* LAMBERT, 1901

Trochotiara kiiensis sp. nov.

Pl. I, Figs. 1–2; Pl. II, Fig. 5; Text-fig. 1

Material:—Holotype, GSJ F6073A, B (A, internal mould; B, incomplete external mould of aboral surface), from loc. T-900, about 500 m northeast of Ikadachi, Kanaya-cho,

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Arida-gun, Wakayama Prefecture (Kii Province), probable upper part of the Matsubara Formation of HIRAYAMA and TANAKA (1956), probably Coniacian (coll. K. TANAKA); paratype, GSJ F6074, imperfect internal mould, from the same locality (coll. K. TANAKA). One comparable specimen, GSJ F6171, from the same locality was also examined.

Diagnosis:—Test small, round in outline, low; aboral surface flattened; oral surface depressed around the peristome; margin rounded. Apical scar large, pentagonal in outline, longer than wide, somewhat extending to the posterior interambulacrum.

Ambulacra straight, somewhat more than half as wide as the interambulacra, not abruptly narrowed above the ambitus; ambulacral plates compound, trigeminate; some plates quadrigeminate at the ambitus; poriferous zones superficial, straight, widened at the peristome; pore pairs in a straight series throughout. Median space of the interambulacra naked, more or less sunken near the apical scar.

Primary tubercles on the ambulacra and interambulacra perforate, crenulate, faintly scrobiculate, forming a vertical series in each column, increasing gradually in size towards the ambitus, at least on the aboral surface encircled with partial rings of small tubercles by which the rows are separated. Primary ambulacral tubercles somewhat smaller than the primary interambulacral ones, covering the main part of three components, not abruptly decreasing in size above the ambitus. Interambulacral plates with one large primary tubercle in a vertical series, which is bordered on its outer side by one much smaller but distinct secondary tubercle forming a short row in the ambital region; secondary tubercles increasing gradually in size towards the

ambitus where they do not reach about the size of the primary ones.

Measurements:—The specimens available are secondarily deformed so that their original dimensions are hardly estimated. Nevertheless, the holotype roughly measures about 17 mm in longitudinal diameter for the internal mould and probably attains to at least 5 mm in height for the external mould.

Remarks:—The holotype is much depressed secondarily. In the holotype the interambulacra possess ten primary tubercles in each column.

Comparison:—This new species closely resembles *Trochotiara ornata* (DESOR) (COTTEAU, 1861–67, p. 480, pl. 1115, figs. 1–12) from the Cenomanian of France, West Germany and England. But it differs from that species in having a larger and more distinctly notched peristome and a smaller number of secondary interambulacral tubercles.

The present species is similar to *Trochotiara russoi* LAMBERT (1931–32 (1932), p. 27, pl. 1, figs. 20–21) from the Cenomanian of Morocco. However, it is distinguished from that species by its straight arranged pore pairs, less developed secondary interambulacral tubercles, more numerous small tubercles and by its primary tubercles being encircled with partial rings of small tubercles.

Occurrence:—Arida Valley east of the Yuasa area, Wakayama Prefecture; probable upper part of the Matsubara Formation, sandy siltstone, probably Coniacian. In the type locality two small kossmaticeratid ammonites were discovered.

Order Cassiduloida CLAUS, 1880

Family Clypeidae LAMBERT, 1898

Genus *Pygurus* L. AGASSIZ, 1839

Subgenus *Pygurus* L. AGASSIZ, 1839

Pygurus (Pygurus) posteroexpansus sp. nov.

Pl. I, Fig. 3; Text-fig. 2

Material:—Holotype, GSJ F6076A, B (A, internal mould; B, external mould of aboral surface), from loc. O-S01, about 1.5 km east-southeast of Nakaosaka, Mie-machi, Ono-gun,

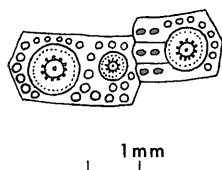


Fig. 1. Ambulacral and interambulacral plates of *Trochotiara kiensis* sp. nov., holotype, GSJ F6073.

Oita Prefecture, upper part of the Haidateyama Group, Upper(?) Barremian (coll. Hitoshi TANAKA).

Diagnosis:—Test large, shield-shaped with angular outline, nearly as long as wide, widest well behind the midpoint, rounded in front without an anterior notch, nearly straight at the antero-lateral margins, truncated at the postero-lateral margins, not rostrated at the posterior end, low. Aboral surface broadly convex, highest at the apical system, more or less steeper in front than behind; oral surface concave around the peristome, somewhat pulvinate with inflated interambulacra and depressed ambulacra, less inflated in the antero-lateral interambulacra than in the others. Apical system near the centre, small, with a large central madreporite.

Ambulacra all alike, superficial, straight, petaloid; petals moderately large, broad, lanceolate, closed apically, slightly open distally. Frontal petal extending about three-fourths the way to the margin, longer and narrower than the paired petals which extend about two-thirds the way to the margin; anterior paired petals nearly as long and wide as and more divergent than the posterior ones. In all the petals, the poriferous zones broad, interporiferous zones very wide and tapering distally; pores somewhat elongated transversely in the inner row, long slit-shaped in the outer row; pores of each pair opposite, widely set, conjugate; successive pore pairs in each poriferous zone separated by a row of granules the number of which is about eight in the middle part of the petals: near the ambitus pore pairs minute, round, obliquely set. Ambulacra on the oral surface lodged in furrows.

Peristome somewhat anterior, pentagonal, depressed; bourrelets distinct, elongated; phyllodes conspicuous, rather short, greatly widened, depressed, with two series of double pores in each half-ambulacrum; pore series close together. Periproct small, longitudinally oval, inframarginal, placed in an oval marked area, not visible from above. Tubercles small and crowded on the aboral surface.

Measurements:—The specimen is secondarily deformed, especially its height being lowered.

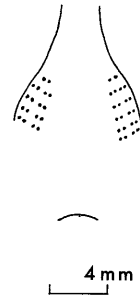


Fig. 2. Diagrammatic sketch of a preserved portion of the phyllode of *Pygurus (Pygurus) posteroexpansus* sp. nov., holotype, GSJ F6076.

Nevertheless, the holotype measures about 59 mm in length, about 60 mm in width and about 9.5 mm in height for the internal mould.

Remarks:—Because of unfavourable preservation, the detailed structure of the apical system and tuberculation on the oral surface are not known. Moreover, it is not ascertained whether buccal pores are absent from the phyllodes in the specimen.

Comparison:—As regards the occurrence of *Pygurus (Pygurus)* in the Cretaceous of Japan, only one species, *P. (P.) complanatus* TANAKA (1965, p.128, pl.15, figs. 1–2), has been known from the western Sanchu Graben, Nagano Prefecture. This species was reported to occur in the strata presumably belonging to the Ishido Formation (Upper Hauterivian—Barremian). However, in the light of recent investigations (TAKEI *et al.*, 1977; MATSUMOTO *et al.*, 1982) the echinoid horizon is now to be referred to the upper part (Aptian) of the Sebayashi Formation superjacent to the Ishido, although it has not yield any diagnostic fossils. The new species described herein resembles *Pygurus (Pygurus) complanatus*. But it differs from that species in that the test is much larger, widest more posteriorly and not protruded at the posterior end, the apical system is more posterior and in that the periproct is longitudinally oval.

This new species distinctly differs from *Pygurus (Pygurus) montmollini* (AGASSIZ) (D'ORBIGNY, 1853–60 (1856), p. 305, pl. 916, figs. 1–3, pl. 917, figs. 1–4; LORIOL, 1873, p. 285, pl. 23, fig. 2, pl. 24, fig. 5; KIER, 1962,

p. 45, pl. 2, fig. 1, chart 3, fig. h) from the Neocomian of France and Switzerland. In *P. (P.) montmollini* the test is emarginate in front and prolonged at the posterior end, the apical system is anterior and the periproct is very large.

The present species is easily distinguishable from *Pygurus (Pygurus) impar* GAUTHIER (COTTEAU *et al.*, 1873-91 (1875), p. 74, pl. 12, figs. 68-69) from the Upper Neocomian of Algeria by its less rounded test outline and much shorter and much narrower petals.

Occurrence:—Northwest of the Haidateyama area, Oita Prefecture; upper part of the Haidateyama Group, fine-grained sandstone, Barremian (probably Upper Barremian).

Order Holasteroida DURHAM and
MELVILLE, 1957

Family Holasteridae PICTET, 1857

Genus *Pseudananchys* POMEL, 1883

Pseudananchys (?) *tumida* sp. nov.

Pl. I, Fig. 4; Pl. II, Fig. 1; Text-fig. 3

Material:—Holotype, YCM. U611-1, external cast (the test being partly stripped off), from loc. U-611, Higashimachi, Urakawa-cho, Urakawa-gun, Hokkaido, Unit U₃ of KANIE (1966), lower part of the Chinomigawa Formation, Upper Yezo Group, Middle Campanian (coll. KANIE); paratype, YCM. U611-2, fragmentary external cast, from the same locality (coll. KANIE).

Diagnosis:—Test large, ovoid in outline, conical-shaped, more or less constricted behind, somewhat longer than wide, widest slightly in front of the midpoint, very high; frontal sinus short, very shallow, rather wide, disappearing near the apical system, expanding towards the ambitus; anterior notch faint. Aboral surface very much inflated with steeply inclined sides and without a flattened top, highest slightly behind the apical system, rather abruptly truncated posteriorly; margin rather broadly rounded. Apical system fairly anterior, elongate.

Frontal ambulacrum short, narrow, gradually open towards the ambitus, very shallowly

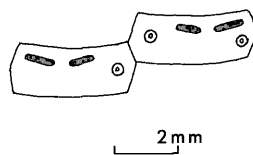


Fig. 3. Ambulacral plate of left anterior ambulacrum in *Pseudananchys* (?) *tumida* sp. nov., paratype, YCM. U611-2.

sunken, subpetaloid. Paired ambulacra rather long, narrow, more or less wider than the frontal ambulacrum, gradually widened distally, superficial, subpetaloid, somewhat distant from each other at the apical system. Anterior paired ambulacra shorter and more divergent than the posterior ambulacra, gently curved with forward concavity; posterior paired ambulacra slightly curved, concave backwards. All petals nearly alike, extending nearly to the margin; ambulacral plates relatively low, about one-fourth as high as the adjoining interambulacral plates except above the ambitus where they are about two-thirds; poriferous zones of each ambulacrum diverging, decreasing in width near the ambitus, narrower than the interporiferous zone which widens towards the ambitus. Pores slit-shaped, longer in the outer row than in the inner row; pores of each pair rather close together, slightly in circumflex and not conjugate. Interambulacra broad; interambulacral plates about 2.5 as wide as the adjoining ambulacral plates above the ambitus.

Periproct small, longitudinally oval, inframarginal. Tubercles small, rather homogeneously and widely scattered on the aboral surface; interporiferous zones dotted with tubercles; numerous granules between tubercles. No fascioles.

Measurements:—The holotype, though somewhat deformed, probably attains to about 70 mm in length, about 67 mm in width and about 60 mm in height. The test is relatively thick, being a little over 2 mm in the paratype.

Remarks:—These specimens are probably referable to the genus *Pseudananchys* on the basis of the general features of the test, although neither the structure of the apical system nor that of the plastron is uncertain. The oral

surface, except its posterior ambital region, is not preserved and accordingly, a peristome is not seen. The interambulacra consist of some dozen plates in each column, except near the apical system.

Comparison:—This new species resembles *Pseudananchys stephensoni* COOKE (1953, p. 26, pl. 9, figs. 6–9), probably from the Austin Chalk (Coniacian—Lower Campanian) of Texas. But it differs from that species in its more strongly inflated test and higher ambulacral plates on the aboral surface (higher ratio of the ambulacral to the adjoining interambulacral plates).

The present species is similar to *Pseudananchys rydzewski* KONGIEL (1936, p. 4) from the Maastrichtian of Poland, in the height of ambulacral plates and number of interambulacral plates on the aboral surface. But it is separated from that species by its larger and higher test and longitudinally oval periproct. Moreover, the new species has slit-shaped pore pairs in all the poriferous zones as against slightly oval in the above Polish species.

Occurrence:—Urakawa area, southern Hokkaido; lower part of the Chinomigawa Formation, Upper Yezo Group, calcareous concretion in siltstone, Middle Campanian.

Order Spatangoida CLAUSS, 1876

Suborder Toxasterina FISCHER, 1966

Family Toxasteridae LAMBERT, 1920

Genus *Toxaster* D'ORBIGNY, 1853

Toxaster priscus sp. nov.

Pl. II, Figs. 2–3; Text-figs. 4–5

Material:—Holotype, GSJ F6185A, B (A, internal mould; B, incomplete external mould), from loc. So-69-05, Yamashita, Kashimamachi, Soma-gun, Fukushima Prefecture, middle or upper part of the Koyamada Formation, Soma Group, Berriasian (coll. TAKIZAWA); paratype, GSJ F6134, represented by an external mould of the aboral surface, from loc. D-15, Yokone, islet of Ajishima, Oshika-cho, Oshika-gun, Miyagi Prefecture, lower part of the Kobiwatashi Sandstone and

Shale Member of TAKIZAWA *et al.* (1974), Ayukawa Formation, Oshika Group, Berriasian (coll. TAKIZAWA).

Diagnosis:—Test rather small, ovate in outline, somewhat heart-shaped, slightly emarginate in front, longer than wide, widest somewhat in front of the midpoint, constricted behind, relatively low; frontal sinus broad, moderately deep, more or less widening towards the ambitus with constant depth, extending to the peristome; anterior notch shallow. Aboral surface rather flat-topped, highest somewhat behind the apical system, sloping gently anteriorly, abruptly truncated posteriorly; oral surface slightly raised on the plastral area, depressed around the peristome. Apical system small, somewhat posterior, ethmophract, with four gonopores arranged in a quadrate form which is not elongate longitudinally; posterior genital plates mutually contiguous; left anterolateral ocular plate inserted between the left antero-lateral and postero-lateral genital plates.

Frontal ambulacrum wide, moderately sunken throughout its length, longer and much wider than the paired ambulacra, subpetaloid; pteroloid part extending nearly to the ambitus, each poriferous zone about half as wide as the interporiferous zone; pores oval to elongate oval in the inner row, much longer, slit-shaped and acuminate inwards in the outer row; pores of each pair opposite, rather widely set, not conjugate.

Paired ambulacra unequal in length, narrow, flexuous, shallowly sunken, subpetaloid. Anterior paired ambulacra nearly as long as the frontal ambulacrum, longer and less divergent than the posterior paired ambulacra; petaloid parts long, extending nearly to the ambitus, open distally; anterior poriferous zones much narrower than the posterior zones; interporiferous zones broader than the anterior poriferous zones, narrower than the posterior zones; pores in the anterior poriferous zones round to oval, close together in each pair; posterior zones consisting of elongate oval inner pores and slit-shaped outer pores acuminate inwards, pores of each pair opposite, rather close together and not conjugate. Posterior paired ambulacra shorter and more or less

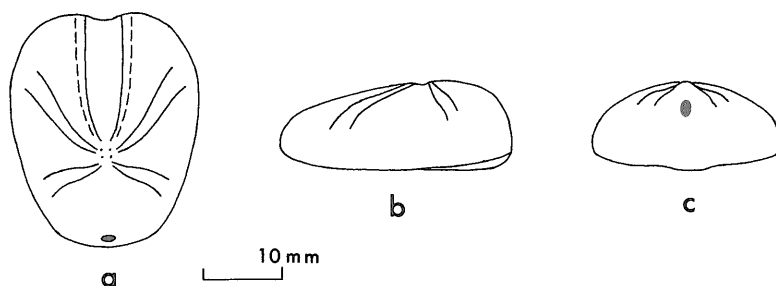


Fig. 4. Suggested figure of *Toxaster priscus* sp. nov. a, Aboral view. b, Left lateral view. c, Posterior view. Restored from the holotype and paratype.

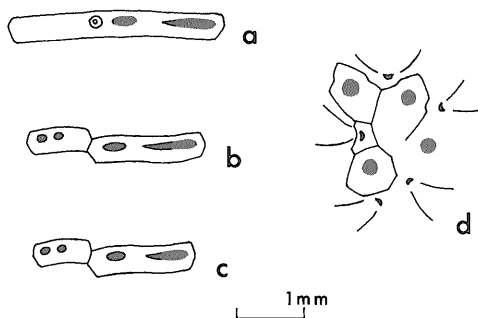


Fig. 5. *Toxaster priscus* sp. nov., paratype, GSJ F6134. a, Frontal ambulacrum. b, Right anterior ambulacrum. c, Right posterior ambulacrum. d, Apical system.

narrower than the anterior; petaloid parts extending about halfway to the margin, open distally; anterior poriferous zones much narrower than the posterior zones; pores in the anterior poriferous zones round, close together in each pair; pores in the posterior zones oval in the inner row, elongate comma-shaped in the outer row, pores in each pair opposite, rather close together and nonconjugate.

Peristome anterior, small, shallow, pentagonal. Periproct small, oval, vertically elongate, high up on the posterior truncate surface, visible from above. Tubercles perforate, crenulate, scrobiculate, closer and more or less larger on the oral surface than on the aboral, crowded on the plastron; interporiferous zone of the frontal ambulacrum dotted with smaller tubercles. No fascioles.

Measurements:—The holotype, though secondarily somewhat deformed, measures about 29.5 mm long, about 23.5 mm wide and about 9.5 mm high.

Remarks:—In the holotype neither an apical system nor a periproct is observed. They, however, are seen in the paratype.

Comparison:—As to the toxasterid echinoids restricted to the foreign Berriasian, only one species, *Toxaster laffitei* DEVRIÈS (1960, p. 21, pl. 5, figs. 10–19, pl. 35, figs. 15–16) representing the most primitive form of the genus, has been reported from Algeria. However, FISCHER (in MOORE, ed., 1966) maintained that it is not truly assigned to *Toxaster* and with this I agree. The above species, whether a *Toxaster* or not, is entirely different from the present new species.

Toxaster priscus sp. nov. distinctly differs from *T. africanus rochi* DEVRIÈS (1960, p. 16, pl. 1, figs. 13–14) from the Berriasian and the Lower Valanginian of northern Africa, in having a more elongate test, a distinct frontal sinus and anterior notch and sunken paired ambulacra. Moreover, there are distinct differences between them in the features of pore pairs in all the ambulacra.

This new species is also easily distinguishable from *Toxaster* species occurring in the Valanginian of western Europe and/or northern Africa, for example, *T. granosus* (D'ORBIGNY) (1853–60 (1853), p. 153, pl. 839, figs. 1–9), *T. granosus kilianii* LAMBERT (DEVRIÈS, 1960, p. 17, pl. 2, figs. 11–15), *T. subcavatus* (GAUTHIER) (COTTEAU *et al.*, 1873–91 (1875), p. 69, pl. 11, figs. 54–58) and *T. casterasi* REY (1972, p. 439, pl. 18, figs. 10–14, text-figs. 128–129). In the new species, especially the frontal ambulacrum is much broader than the paired ambulacra, which are composed of poriferous zones of very unequal width. More-

over, the features of the pore pairs in all the ambulacra of this species clearly differ from those of the above foreign species.

Occurrence:—Soma area, Fukushima Prefecture; Koyamada Formation, Soma Group, Berriasian; siltstone. Oshika area, Miyagi Prefecture; middle part of the Ayukawa Formation, Oshika Group, Berriasian; siltstone.

Toxaster sp. aff. *T. amplus* DESOR

Pl. II, Fig. 4

Compare:

1853. *Echinospatagus cordiformis*, D'ORBIGNY, *Paléont. franç., Terr. créét., Echin.*, ser. 1, vol. 6, p. 155, pl. 840, figs. 1-7.
1858. *Toxaster amplus*, DESOR, *Synopsis*, p. 353.
1903. *Toxaster amplus*, PELLAT, *Bull. Soc. Géol. France*, ser. 4, vol. 3, p. 127.
1904. *Toxaster amplus*, LAMBERT, *Bull. Soc. Géol. France*, ser. 4, vol. 4, p. 841.
1931. *Toxaster amplus*, LAMBERT, *Mém. Soc. Géol. France*, nouv. série, vol. 7, no. 16, p. 37, pl. 2, fig. 16.

Material:—GSJ F6011, incomplete external cast (test largely stripped off on the aboral surface), from loc. K-655 (=loc. 2 in TANAKA and OKUBO, 1954), Hotsuto, Yuasa-cho, Aridagun, Wakayama Prefecture, Middle Member of the Arida Formation (=Am of OBATA *et al.*, 1976), Lower Barremian (coll. K. TANAKA).

Description:—This specimen is incomplete and secondarily deformed.

The test is large and seems to have a cordate outline which is more or less angular and is widest somewhat in front of the midpoint. The frontal sinus is broad, more or less deep and gradually open towards the ambitus with increasing depth, forming a broad and deep notch in the anterior edge of the test and then extending to the peristome. The oral surface is fairly depressed around the peristome and more or less inflated in the plastral region. The apical system is probably somewhat behind the centre.

The frontal ambulacrum is wide, more or less deeply sunken throughout its length and subpetaloid. At the middle of the petaloid part

each poriferous zone is widest and somewhat narrower than the interporiferous zone which widens from the apical system to the ambitus. Each poriferous zone consists of straight inner pore row and gently curved outer row, thus becoming narrower towards the apical system and the ambitus. It comprises at least 50 pore pairs. In the middle portion of the petaloid part the pores are elongated in the inner row and longer and slit-shaped in the outer row; the pores of each pair are opposite and widely set. In the proximal and distal portions of the petaloid part the pores of each pair become smaller and closer together.

The paired ambulacra are wide, unequal in length, flexuous, slightly depressed and subpetaloid. The anterior paired ambulacra are nearly as long and wide as the frontal ambulacrum and are longer and wider than the posterior paired ambulacra, having petaloid parts which extend about four-fifths the way to the margin and are open distally. Their poriferous zones are widest near the middle, tapering towards the ambitus and the apical system. The anterior poriferous zones are narrower and less flexuous than the posterior zones which are narrower than the interporiferous zones at the middle. The interporiferous zones widen towards the ambitus. Each poriferous zone comprises about 53 pore pairs. The anterior poriferous zones consist of elongate pores and the posterior ones of longer, slit-shaped pores which are longer in the outer row than in the inner row; the pores of each pair are opposite and widely set. The posterior paired ambulacra are shortest and have petaloid parts extending about two-thirds the way to the ambitus. Their poriferous zones are nearly equal in width and narrower than the interporiferous zones. They consist of similar, elongate pores, the pores in each pair being opposite and widely set.

The peristome is very eccentric in front, deeply sunken and pentagonal. The plastron is protamphisternous. The tubercles are small, of various sizes, perforate, crenulate and scrobiculate. They are smaller and widely scattered in the anterior region of the aboral and oral surfaces and crowded on the plastron.

Comparison:—This species, though represented by a fragmentary test, closely resembles *Toxaster amplus* DESOR from the Hauterivian of western Europe and northern Africa, especially in the general outline of the test, the broad and deep frontal sinus and anterior notch and in the slightly sunken paired ambulacra. But it differs from that species in the more anteriorly placed peristome and closer tuberculation at least on the oral surface where the tubercles become smaller in the anterior region. As to *Toxaster amplus*, peculiar granulation and tuberculation on the ambulacral plates of the frontal ambulacrum were figured by D'ORBIGNY (1853) and PELLAT (1903). However, whether or not similar features are present in the specimen is not ascertained because of the poor preservation.

The present form is also similar to *Toxaster retusus* (LAMARCK) (LAMBERT, 1931–32, p. 36, pl. 2, figs. 11–12, 18; MORTENSEN, 1950, p. 341, text-fig. 227; DEVRIÈS, 1960, p. 19, pl. 4, figs. 3–9; REY, 1972, p. 448, pl. 19, figs. 3–4), from the Hauterivian and the Barremian of the circum-Mediterranean region. However, in the species described herein the test is broader and less constricted behind, the paired ambulacra are more flexuous and the pores of each pair in all the ambulacra are widely set.

The present species is easily distinguishable from the contemporary *Toxaster sanchuensis* TANAKA (1965, p. 131, pl. 15, figs. 5–6, pl. 16, figs. 1–2, text-fig. 3), from the Barremian portion of the Ishido Formation of the Sanchu Graben, Saitama–Gumma Prefecture. It has a wider and deeper frontal sinus and anterior notch and more flexuous paired ambulacra.

Occurrence:—Yuasa area, Wakayama Prefecture; Middle Member of the Arida Formation, siltstone, Lower Barremian.

Suborder Hemiasterina FISCHER, 1966

Family Hemiasteridae CLARK, 1917

Genus *Hemiaster* DESOR, 1847

Subgenus *Mecaster* POMEL, 1883

Hemiaster (Mecaster) mikasaensis sp. nov.

Pl. III, Figs. 1–3; Text-fig. 6

Material:—Holotype, NSM-PA5392, internal mould, from loc. Ik-1101 (in MATSUMOTO *et al.*, 1969), about 350 m northeast of a bridge called Ohashi, built over the River Ikushumbetsu, Mikasa City, central Hokkaido, lower part of Unit IIb of MATSUMOTO (1965), lower part of the Mikasa Formation, Middle Yezo Group, Lower Cenomanian (coll. T. MURAMOTO); paratypes, NSM-PA5393, internal mould, from the same locality and horizon (coll. T. MURAMOTO), and GSJ F6144A, B (A, internal mould; B, external mould of aboral surface), from the same stratigraphic unit about 100 m northeast of the above bridge (coll. K. TANAKA).

Diagnosis:—Test small, angular ovately-cordiform in outline, moderately emarginate in front, nearly as long as wide, widest somewhat in front of the midpoint, evenly rounded at the antero-lateral margins, contracted behind with a truncate posterior margin which is very shallowly emarginate, moderately high; frontal sinus wide, somewhat deep, open towards the ambitus with constant depth, forming a more or less deep notch in the anterior edge of the test, extending to the peristome as a somewhat shallow sinus. Aboral surface moderately inflated, highest somewhat behind the apical system, sloping anteriorly, abruptly truncated posteriorly with a slight obliquity, somewhat strongly inflated near the apical system in the antero-lateral and postero-lateral interambulacral areas; posterior truncated surface slightly concave; oral surface slightly convex on the whole, depressed around the peristome, a little more inflated in the plastral region; margin broadly rounded. Apical system subcentral or somewhat eccentric anteriorly, with four gonopores.

Frontal ambulacrum rather short and wide, open towards the ambitus, moderately sunken throughout its length, subpetaloid; poriferous zones having small oval pores within the fasciole; pores of each pair transverse in the outer row, oblique in the inner row, close together, separated by a granule.

Paired ambulacra broad, moderately sunken, petaloid. Anterior paired petals somewhat longer than, nearly as wide as and much more

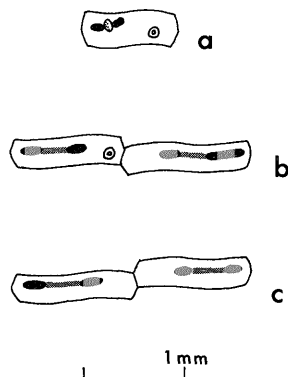


Fig. 6. *Hemiaster (Mecaster) mikasaensis* sp. nov., paratype, GSJ F6144. a, Frontal ambulacrum. b, Right anterior petal. c, Left posterior petal.

divergent than the posterior, moderately flexuous, rather open distally, extending about two-thirds the way to the margin; anterior poriferous zones narrower than the posterior zones, nearly equal to the interporiferous zones in width; pores in the anterior poriferous zones elongate oval; pores in the posterior zones elongate oval in the inner row, slit-shaped in the outer row. Posterior paired petals rather long, 0.70–0.75 as long as the anterior paired petals, diverging from each other at an angle about half as large as in the anterior, somewhat flexuous, more or less closed distally, extending about halfway to the margin; anterior poriferous zones narrower than the posterior zones, having oval pores; posterior zones consisting of elongate oval pores which are longer in the outer row than in the inner row. Pores of each pair in the paired petals opposite, widely set, conjugate.

Peristome eccentric in front (near the anterior fourth), transverse. Plastron mes-amphisternous. Periproct small, oval in outline, vertically elongate, pointed at both ends, high up on the posterior truncated surface, visible from above. Tubercles of various sizes, perforate, crenulate, scrobiculate; tubercles on the aboral surface somewhat larger near the ambitus in the anterior region, widely scattered; interporiferous zones of all the ambulacra dotted with smaller tubercles; numerous granules between tubercles. A peripetalous fasciole distinct, broad, slightly curved towards the

ambitus in the antero-lateral interambulacra, bending more or less deeply towards the apical system in the postero-lateral interambulacra; no other fascioles.

Measurements:—Both the holotype and the paratypes are secondarily deformed, and their original dimensions are hardly estimated with precision. The holotype in the least deformed state measures 23.0 mm long, 22.5 mm wide and 13.8 mm high. In one of the paratypes, GSJ F6144 probably attaining about 15 mm in length, the peripetalous fasciole is some 1 mm wide.

Remarks:—In the specimens available the structure of the apical system is not ascertained and tuberculation of the oral surface is not known, because of the poor preservation. The holotype has about 18, about 32 and about 23 pore pairs within the fasciole in each poriferous zone of the frontal ambulacrum, anterior petals and posterior petals, respectively.

Comparison:—This new species closely resembles *Hemiaster (Mecaster) chirakhanensis* CHPLONKER (1939, p. 240, pl. 25, fig. 4) from the Cenomanian (very probably Lower Cenomanian) of western India. But it differs from that species in that the test is smaller, less constricted behind with a broader posterior margin and less elevated posteriorly on its aboral surface and in that the peripetalous fasciole crosses the frontal ambulacrum more apically and is somewhat deeply embayed in the postero-lateral interambulacra.

The species described herein seemingly resembles *Hemiaster (Mecaster) vicinus* STOLICZKA (1873, p. 13 (83), pl. 2 (12), fig. 1) whose generic position is somewhat doubtful on account of the peripetalous fasciole being not distinctly traceable and also as suggested from its specific name, from the Uttatur Group (Upper Albian—Lower Turonian) of southern India. But it is distinguished from that species, whether a hemiasterid or not, by its distally less closed paired petals with elongate pores that are widely set in each pair and by its smaller tubercles at least on the aboral surface of the test.

The present species is also similar to *Hemiaster (Mecaster) scutigera* (FORBES) (LORIOU, 1887–88,

p. 98, pl. 18, figs. 4–12) from the Cenomanian of Portugal, in many respects. However, it possesses shorter posterior paired petals, a more anteriorly placed peristome and a peripetalous fasciole that is more deeply embayed between the anterior and posterior petals.

This species distinctly differs from *Hemiaster (Mecaster)* sp. aff. *H. (M.) indicus* STOLICZKA (TANAKA, 1984) from the Lower Santonian of the Onogawa area, eastern Kyushu. In the latter species the apical system is posterior, the frontal ambulacrum and paired petals are narrower, the posterior petals are longer and the peripetalous fasciole is embayed between the anterior and posterior petals.

Occurrence:—Ikushumbetsu area, Mikasa City, central Hokkaido; lower part of the Mikasa Formation, Middle Yezo Group, silty fine-grained sandstone, Lower Cenomanian.

Suborder Asterostomatina FISCHER, 1966

Family Asterostomatidae PICTET, 1857

Genus *Niponaster* LAMBERT, 1920

Niponaster hokkaidoensis LAMBERT

Pl. III, Figs. 4–5; Text-fig. 7

1894. *Ananchytinarium* sp. indet., JIMBO, p. 45 (191), pl. 9 (25), fig. 8.
 1924. *Niponaster hokkaidoensis* LAMBERT in LAMBERT and THIÉRY, p. 426.
 1950. *Niponaster hokkaidoensis*, MORTENSEN, p. 170, text-fig. 132.
 1955. *Niponaster hokkaidoensis*, MORISHITA, p. 99, pl. 15, figs. 1–3.
 1968. *Niponaster hokkaidoensis*, NISIIYAMA, p. 171, text-fig. 62 (37).

Material:—Four specimens are available: GSJ F6098, internal mould, from a station about 600 m southwest of Korikawa, Nandancho, Mihara-gun, Hyogo Prefecture, lower part of the Kitaama Formation (=Kitaama Sandstone and Shale redefined by TANAKA *et al.*, 1952), Izumi Group, Lower Maastrichtian (coll. MAEDA); GSJ F6190, internal mould, from the wave cut bench off the coast of Hiraiso, Nakaminato City, Ibaraki Prefecture, lower part of the Hiraiso Formation, Naka-

minato Group, Campanian (coll. T. TANAKA); NSM-PA12123, represented almost by an internal mould, from the Saru Valley, Hidakacho, Saru-gun, central Hokkaido, upper part of the Upper Yezo Group, Campanian (coll. T. MURAMOTO); MNH1107A, B, internal mould, from Daini-Kiyohama (Orannai), Wakkanai City, northern Hokkaido, Orannai Formation, Middle(?) Campanian (MATSU-MOTO and MIYAUCHI, 1984) (coll. MIYAUCHI).

Descriptive remarks:—The specimens available are in a greater or lesser degree secondarily deformed. They are characterized by the conical test with subcircular or rounded oval outline, the absence of a frontal sinus, the subcentral apical system, all the ambulacra being alike, straight, superficial, subpetaloid and gradually widened towards the ambitus, the inframarginal periproct and by the mesamphisternous plastron. Moreover, the perforiferous zones of the petals are nearly as wide as the interporiferous zones above the ambitus, having elongate or comma-shaped outer pores and rounded oval inner pores; the pores in each pair are widely spaced and opposite or slightly in circumflex. Scrobiculate tubercles are seen on the oral surface of NSM-PA12123.

The original dimensions of the specimens are hardly estimated with precision because of the secondary deformation. Nevertheless, the largest of the specimens, GSJ F6098, probably attains about 75 mm in longitudinal diameter. In the least deformed specimen, MNH1107, the test is about 0.7 as high as

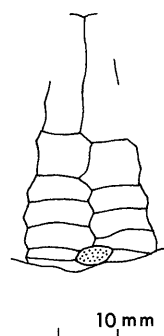


Fig. 7. Posterior interambulacrum on the oral surface of *Niponaster hokkaidoensis* LAMBERT, GSJ F6098.

across.

The detailed structure of the apical system is not known because of the poor preservation. The presence of a marginal fasciole was regarded as one of the characteristics of the genus *Niponaster* by LAMBERT and THIÉRY (1924) and MORTENSEN (1950), but was doubted by NISIYAMA (1968). As to the type species, *N. hokkaidoensis* LAMBERT, MORISHITA (1955) described its marginal fasciole to be indistinct. On the other hand, it is uncertain whether a marginal fasciole is present in the specimens available, because of the internal mould.

The genus *Niponaster* was allocated by NISIYAMA (1968) to the family Palaeopneustidae MORTENSEN (1950) which is now synonymous with the family Asterostomatidae PICTET according to FISCHER (in MOORE, ed., 1966). FISCHER (*loc. cit.*) maintained that the Asterostomatidae of Eocene to Recent age is characterized by having an ethmolytic apical system. On the other hand, NISIYAMA (1968) described *Niponaster* to possess an ethmophract apical system. Anyhow, in view of the general features of the test, the present genus is provisionally assigned to the Asterostomatidae. If so, *Niponaster* will represent the oldest and the most primitive genus in the family in that it is found in the Upper Cretaceous Campanian and has a less specialized apical system and a less specialized plastron.

Occurrence:—Campanian: Upper Yezo Group, calcareous concretion in fine sandy siltstone, Hidaka area, Hokkaido; Orannai Formation, equivalent of the Hakobuchi Group, calcareous concretion in fine sandy siltstone, Wakkanai area, Hokkaido; Hiraiso Formation, Nakaminato Group, fine-to medium-grained sandstone, Nakaminato area, Ibaraki Prefecture. Lower Maastrichtian: Kitaama Formation, Izumi Group, sandy mudstone, Awaji Island, Hyogo Prefecture. A fragmentary specimen, GSJ F6087, which is probably identical with this species was obtained from the Kada Formation (Campanian) of ISHIGAMI and YOSHIMATSU (1972) of the Izumi Group near Kada, Wakayama City. Moreover, this species is reported from the Minato Shale (Campanian)

of the Izumi Group (MORISHITA, 1955). The type locality of this species (JIMBO, 1894) is at Urokobets near Urakawa, southern Hokkaido, being contained in the Campanian part of the Upper Yezo Group.

Concluding Remarks

The Japanese Cretaceous echinoids identified include the following species, with indication of their geological age in parentheses:

Trochotiarra kiiensis sp. nov. (Coniacian?)

Pygurus (Pygurus) posteroexpansus sp. nov. (Barremian)

Pseudananchys (?) tumida sp. nov. (Campanian)

Toxaster priscus sp. nov. (Berriasian)

Toxaster sp. aff. *T. amplus* DESOR (Barremian)

Hemiaster (Mecaster) mikasaensis sp. nov. (Cenomanian)

Niponaster hokkaidoensis LAMBERT (Campanian—Maastrichtian)

Brief remarks are given on some of the species described herein in the lines to follow. *Toxaster priscus* sp. nov. is the second Berriasian species in the world, except for "*Toxaster*" *laffitei* DEVRIÈS which as noted above, should be excluded from the genus. This new species is found in two separated areas of Japan, though very rarely. Therefore, it will be noted that the present species is used as a characteristic fossil of the Japanese Berriasian, although its exact upper limit of stratigraphic occurrence has not been made clear.

As has been mentioned, in *Toxaster priscus* its ethmophract apical system shows a peculiar feature in that the left antero-lateral ocular plate is inserted between the left antero-lateral and postero-lateral genital plates. Such a feature has been noticed in the earlier (Berriasian—Hauterivian) species of *Toxaster* of foreign countries (DEVRIÈS, 1960). On the other hand, the new species displays specialized features in that the paired ambulacra distinctly differ from the frontal ambulacrum and in that the paired ambulacra, especially the anterior ones, consist of poriferous zones of very unequal width (the anterior zones being much narrower than the posterior, thus the pore pairs being much smaller or shorter in

the former than in the latter). In foreign countries, however, such specialized features of *Toxaster* appeared later than in Japan, that is, in the Hauterivian. On the other hand, the two Japanese Berremian species, *Toxaster* sp. aff. *T. amplus* described above and *T. sanchuensis* TANAKA, are referred to the typical *Toxaster* (from the Valanginian). The above specialized features of the ambulacra recall the genus *Heteraster* which appeared later, that is, in the Hauterivian. To sum up, in view of the evolutionary trend in *Toxaster* (DEVRIÈS, 1960; REY, 1972), it must be conceded that the Japanese Berriasian *Toxaster* species is a specialized form. In connexion with this, it should be noticed that a primitive representative of the family Toxasteridae, *Allotoxaster tosaensis* (LORIOU) (LORIOU, 1902, p. 36, pl. 3, fig. 7; LAMBERT and THIÉRY, 1924, p. 437; NISIYAMA, 1968, p. 182), was reported from the Torinosu Group, which has been correlated with the upper Middle to Upper Jurassic but according to AIDA and OKADA (1984), attains up to at least the lower Berriasian. It is a matter of course that *Toxaster priscus* is much specialized in the general features of the test in comparison with *A. tosaensis*. In this way I am inclined to consider *T. priscus* as being not allocated to a main stock of the family Toxasteridae but to an offshoot from which certain Japanese species of *Heteraster* may have been derived directly or indirectly.

Hemiaster (Mecaster) mikasaensis sp. nov. from the Lower Cenomanian is closely allied to a certain *Hemiaster (Mecaster)* species from the Cenomanian (probably Lower Cenomanian) of western India. This affords additional evidence for the hemiasterid faunal affinity between Japan and India that will be pointed out in another paper (TANAKA, 1984).

Niponaster hokkaidoensis occurs in the Campanian of various separated areas of Japan and is found also in the Lower Maastrichtian, though only at one locality. Moreover, its occurrence in the Middle Campanian of southern Saghalien which includes a Cretaceous domain extending from Hokkaido, is known from a specimen, IGPS coll. cat. no. 73929,

preserved in the Institute of Geology and Palaeontology, Tohoku University. Thus, this species may serve as a horizon marker as limited mainly to the Campanian.

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日本の白亜紀ウニ化石

田 中 啓 策

要 旨

本邦各地の白亜系から産したウニ化石について、下記の6属7種を識別した。その中の5種は新種である。

Trochotiara kiiensis sp. nov. (有田川, 松原層, コニアシアン?)

Pygurus (*Pygurus*) *posteroexpansus* sp. nov. (大分県, 佩楯山層群上部, パレミアン)

Pseudananchys (?) *tumida* sp. nov. (浦河, 上部蝦夷層群, カンパニアン)

Toxaster priscus sp. nov. (牡鹿半島, 鮎川層; 相馬, 小山田層; ベリアシアン)

Toxaster sp. aff. *T. amplus* DESOR (湯浅, 有田層, パレミアン)

Hemiaster (*Mecaster*) *mikasaensis* sp. nov. (幾春別, 三笠層, セノマニアン)

Niponaster hokkaidoensis LAMBERT (カンパニアン: 日高, 上部蝦夷層群; 稚内, 函渚層群相当層; 茨城県, 那珂湊層群; 和泉山脈-淡路島, 和泉層群. マストリヒチアン: 淡路島, 和泉層群)

Trochotiara 及び *Pseudananchys* は本邦から最初に報告される属である。*Toxaster priscus* はベリアシアンのものであるにもかかわらず、歩帯が特殊化した性質を示している点で注目される。

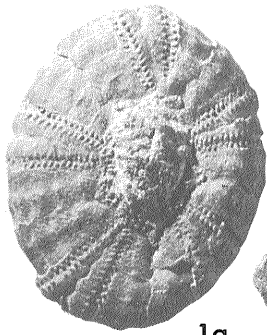
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PLATES
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EXPLANATIONS

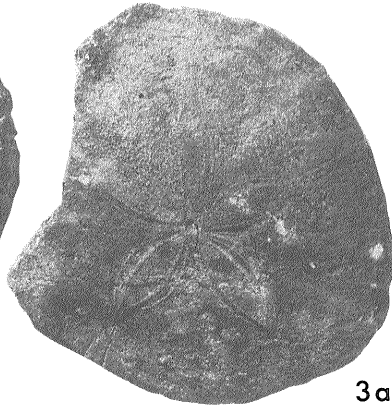
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Plate I

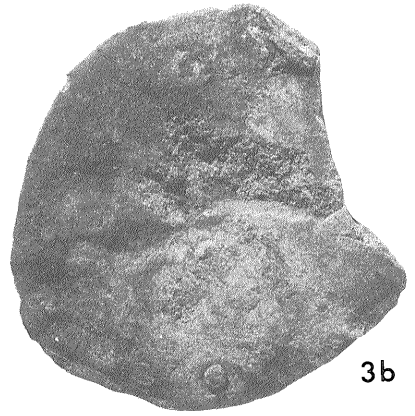
- Figs. 1-2. *Trochotiara kiiensis* sp. nov. Page 189
1. Holotype, GSJ F6073A, internal mould, aboral (a) and oral (b) views, $\times 2.5$.
2. Paratype, GSJ F6074, internal mould, aboral (a) and left lateral (b) views, $\times 2.5$.
- Fig. 3. *Pygurus (Pygurus) posteroexpansus* sp. nov. Page 190
Holotype, GSJ F6076, aboral (a) and oral (b) views of an internal mould (A), $\times 0.9$,
and aboral view of an external mould (B) (c), $\times 1$.
- Fig. 4. *Pseudananchys(?) tumida* sp. nov. Page 192
Holotype, YCM. U611-1, external cast, aboral (a), left lateral (b) and posterior (c)
views, $\times 0.8$.



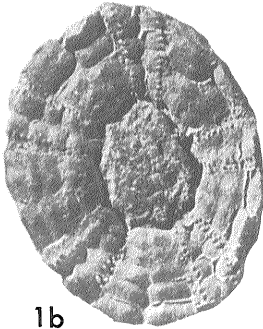
1a



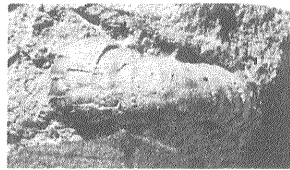
3a



3b



1b



2b



4b



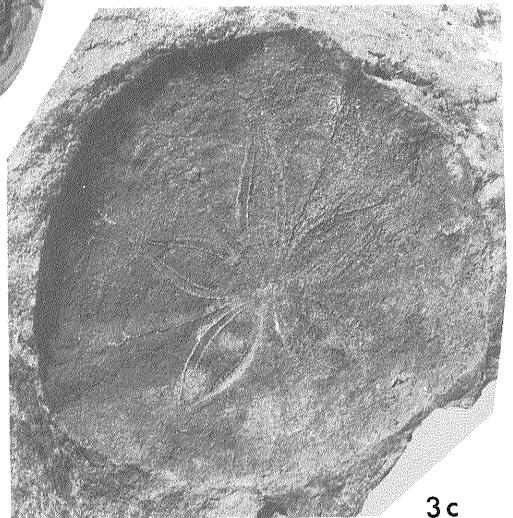
2a



4a



4c



3c

Plate II

- Fig. 1. *Pseudananchys(?) tumida* sp. nov. Page 192
Paratype, YCM. U611-2, fragmentary external cast, aboral (a), left lateral (b) and anterior (c) views, $\times 1$.
- Figs. 2-3. *Toxaster priscus* sp. nov. Page 193
2. Holotype, GSJ F6185, internal mould, aboral (a), oral (b), left lateral (c) and anterior (d) views, $\times 1.5$.
3. Paratype, GSJ F6134, aboral views of an external mould (a) and of a gum cast taken from the same external mould (b), $\times 2$.
- Fig. 4. *Toxaster* sp. aff. *T. amplus* DESOR Page 195
GSJ F6011, incomplete external cast, aboral (a) and oral (b) views, $\times 1$.
- Fig. 5. *Trochotiara kiiensis* sp. nov. Page 189
Holotype, GSJ F6073B, aboral view of an external mould, $\times 2.5$. Front to the lower.

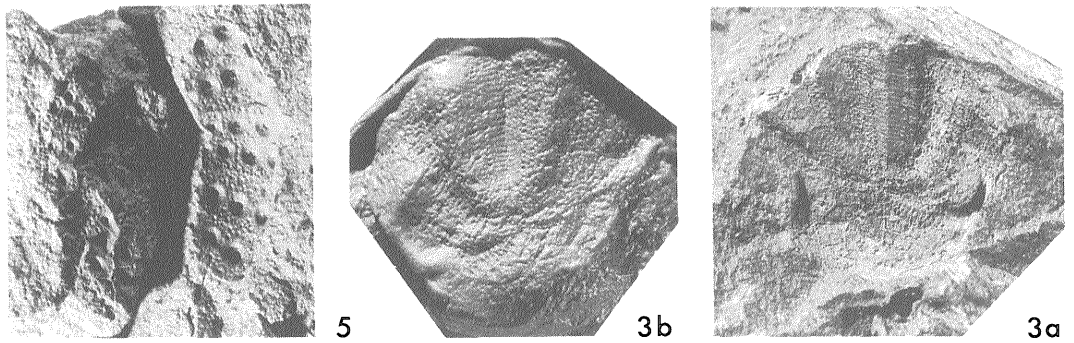
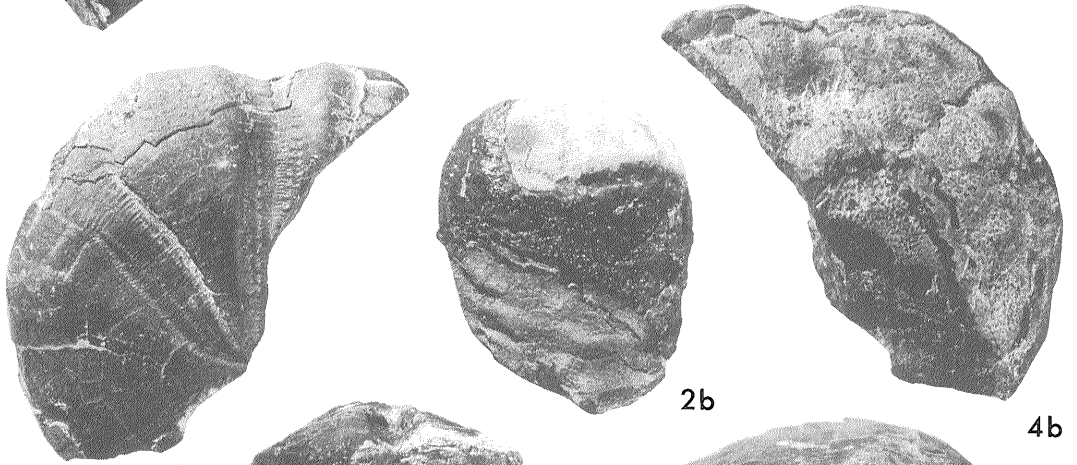
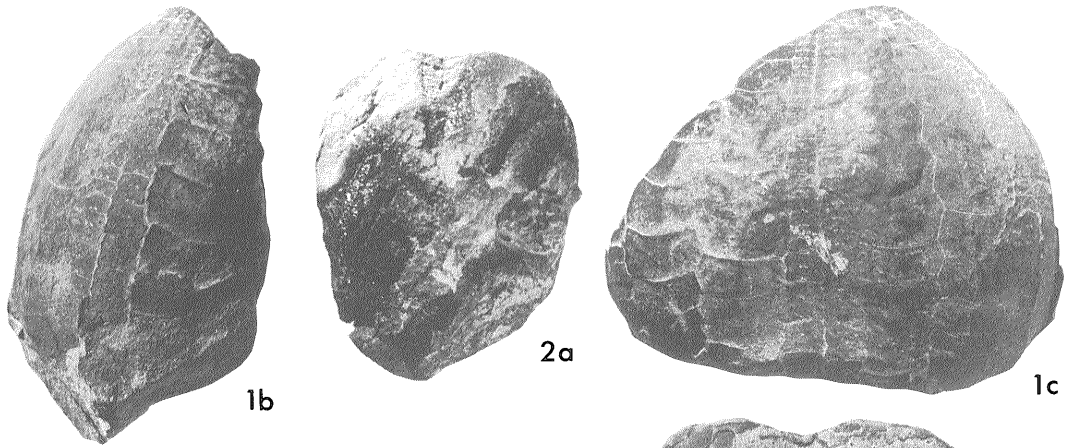


Plate III

- Figs. 1-3. *Hemiaster (Mecaster) mikasaensis* sp. nov. Page 196
1. Holotype, NSM-PA5392, internal mould, aboral (a), oral (b), right lateral (c), anterior (d) and posterior (e) views, $\times 1.8$.
 2. Paratype, NSM-PA5393, internal mould, aboral (a), oral (b) and left lateral (c) views, $\times 2$.
 3. Paratype, GSJ F6144, internal mould, aboral (a) and oral (b) views, $\times 2$.
- Figs. 4-5. *Niponaster hokkaidoensis* LAMBERT Page 198
4. MNH1107A, internal mould, aboral (a) and right lateral (b) views, $\times 1$.
 5. GSJ F6098, internal mould, aboral view, $\times 0.8$.

