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Notes on *Echinarachnius* in Japan

By

Akira MORISHITA

Geological and Mineralogical Institute, University of Kyoto

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Abstract

Synoptical evolutional changes of an echinoids genus *Echinarachnius* during the Neogenic times in Japan are observed. The Miocene species differ from the other later species in their small tests, more oval forms, simple ambulacral furrows and their supramarginal periprocts. These facts are important for the biostratigraphy. The variable ambulacral petals exhibit no definite evolutionary tendency.

Introduction

Echinarachnius is one of the most popular genera among all echinoids living around Japanese Islands. It lives on the sandy shallow sea bottoms.

The fossils of this genus are discovered in the Tertiary strata of this country. The living species were studied by S. TOKUNAGA, S. NISIYAMA, H. IKEDA, K. ONODA and TH. MORTENSEN, and the fossil species by S. TOKUNAGA, T. NAGAO, S. NISIYAMA, W. HASHIMOTO, I. HAYASAKA, M. SHIBATA and the author.

The geological horizons of these fossil species of *Echinarachnius* were clarified later by efforts of many students. They occur in so various horizons from the Oligocene to the Recent as almost successively, offering valuable data in considering the development. The elaborate evolutional successions, such as the echinoids in the Chalk of England or in the Tertiary of North America, cannot be established in Japan for the preservation is by no means good. Nevertheless, *Echinarachnius* occurred in localities of various geological horizons of Japan would be very valuable with regard to its phylogenical development.

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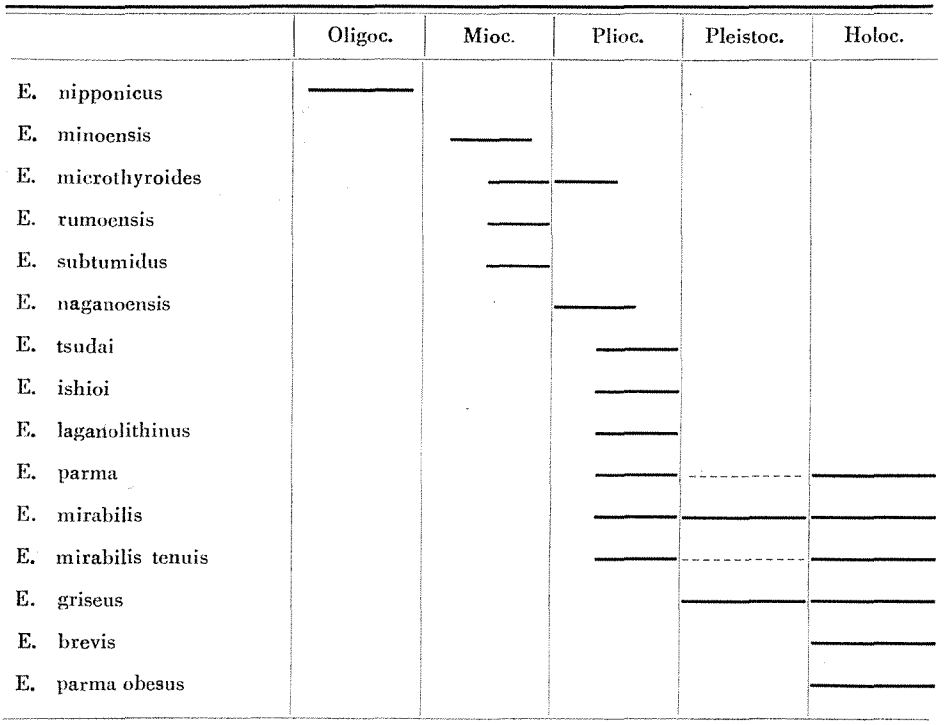
Recent and fossil species of *Echinarachnius* in Japan

The recent species of *Echinarachnius* live, not only in the Pacific Ocean, but also in the Atlantic Ocean, the Indian Ocean and the Red Sea. The Japanese

species are known widely distributed from Hokkaido in the north to Kyusyu in the south. The fossils occur in the various strata since the Oligocene.

These *Echinarachnius* are living without exception on the sandy bottom in the shallow sea shores. The fossil species are always discovered from the sandy or conglomeratic matrices, and this fact seems to show the circumstance of shore waters in the past. At present, the following thirteen species and two subspecies are recognized in Japan. (* fossil species)

Table 1 The geological range chart of *Echinarachnius*.



* *Echinarachnius nipponicus* (NAGAO)
* *Echinarachnius subtumidus* NISIYAMA & HASHIMOTO
* *Echinarachnius rumoensis* HAYASAKA & SHIBATA
* *Echinarachnius microthyroides* NISIYAMA
* *Echinarachnius minoensis n. n.*
* *Echinarachnius naganoensis* MORISHITA
* *Echinarachnius parma* (LAMARCK)
* *Echinarachnius laganolithinus* NISIYAMA
* *Echinarachnius mirabilis* (A. AGASSIZ)
* *Echinarachnius ishioi* MORISHITA

* *Echinarachnius tsudai* MORISHITA
* *Echinarachnius mirabilis tenuis* YOSHIWARA
* *Echinarachnius griseus* MORTENSEN
Echinarachnius brevis IKEDA
Echinarachnius parma obesus H. L. CLARK

Besides, *E. asiaticus* MICHELIN (Recent), *E. elongatus* NISIYAMA (Miocene), and *E. parvus* NISIYAMA (Oligocene) have been reported by S. NISIYAMA from Saghalien.

Morphologic feature of each epoch

Oligocene Only one species, *E. nipponicus* (NAGAO) from the Ashiya Group of Kyusyu is known. The systematic position of this species is not certain, but some morphologic features, such as its large longitudinal diameter, eccentric apical system, periproct be in supramarginal, undifferentiated ambulacral furrows seem to show the ancestral form. The figure given by Nagao illustrates the general feature of this species, very much allied to the Miocene species, *E. minoensis n. n.*, except it's moderate size of test.
E. parvus of Saghalien is very close to the Miocene species stated above.

Miocene The following four species are known.

Echinarachnius microthyroides NISIYAMA
Echinarachnius subtumidus NISIYAMA & HASHIMOTO
Echinarachnius rumoensis HAYASAKA & SHIBATA
Echinarachnius minoensis n. n.

Among these, *E. minoensis* occurs from the middle Miocene of Nagano, Gifu, Kyoto, Nara and Yamaguchi Prefectures, and the other three species probably from the upper Miocene of Iwate, Toyama Prefectures and Hokkaido.

The most remarkable feature of *E. minoensis* is its small size of test, measuring 8 mm. in diameter. Moreover its eccentric apical system and its supramarginal periproct are the other important features. The ambulacral furrows of this species are indistinct, but certainly it is undifferentiated as in *E. parvus*.

The test of *E. microthyroides* is moderate in size being about 55 mm. in diameter. However, the eccentric apical system, and the bifurcated ambulacral furrows near margin are the distinctive features of this species.

E. subtumidus and *E. rumoensis* are just alike in trifurcated ambulacral furrows at margin of test, supramarginal periproct and rather small test—the former about 33 mm., the latter about 41 mm. in longitudinal diameter.

E. elongatus from Saghalien has the similar characters besides: the smaller test (about 28 mm. in long. diameter), undifferentiated ambulacral furrows, more oval shape, and supramarginal periproct.

The general characteristic common to the Miocene *Echinarachnius*, is the smallness and oblong of the tests with undifferentiated or simple bifurcated

ambulacral furrows near margin, as well as the supramarginal periproct.

Pliocene The following six species and one subspecies are recognized in the Pliocene rocks.

Echinarachnius naganoensis MORISHITA
Echinarachnius parma (LAMARCK)
Echinarachnius mirabilis (A. AGASSIZ)
Echinarachnius mirabilis tenuis YOSHIWARA
Echinarachnius tsudai MORISHITA
Echinarachnius ishioi MORISHITA
Echinarachnius laganolithinus NISIYAMA

The Pliocene forms are variable, presumably indicating the most thrivingness of the genus. In general, these species have the wavy margin of test, ambulacral furrows bifurcated near the peristome or re-bifurcated between the margin and peristome. The tendency towards the wider transverse diameter, and the migration of periproct to the postero-margin, are conceivable.

Pleistocene The following two species are known.

Echinarachnius mirabilis (A. AGASSIZ)
Echinarachnius griseus MORTENSEN

The general features of the Pleistocene forms are not essentially different from those of the Pliocene. But the supramarginal periproct of *E. griseus* is interesting.

Holocene The following four species and two subspecies are known.

Echinarachnius brevis IKEDA
Echinarachnius parma obesus H. L. CLARK
Echinarachnius parma (LAMARCK)
Echinarachnius mirabilis (A. AGASSIZ)
Echinarachnius mirabilis tenuis YOSHIWARA
Echinarachnius griseus MORTENSEN

Besides, there is the Saghalien form, *E. asiaticus* MICHELIN.

E. mirabilis is reported from the alluvium of Namba, Osaka City also. The general features seem to have been not changed since the Pliocene Epoch.

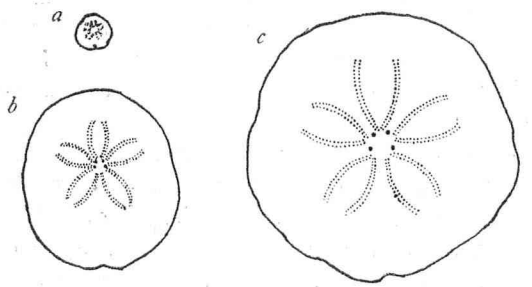
General change through the geological epochs

This modern genus of Irregular Echinoids, appeared in the Tertiary period. Their flat mode, specialization of digestive system (periproct and peristome) and the reproductive organ (genital pores), denote the adaptation to a new living method. The degeneration of Aristotle's lantern in this genus as in other irregular echinoids indicates a changes of diet. The backward location of periproct and the disappearance of genital pore upon the posterior interambulacrum are related to the flattened test. The depression leads to complication of all organs. The

oesophagus lies between peristome and periproct hardly remain a space to accept another organ. This is why the posterior genital pore is missed in this genus. In fact, all species of *Echinarachnius* have no genital pore in the posterior interambulacrum.

The morphological changes through the epochs between the Oligocene and the Recent, are as follows:

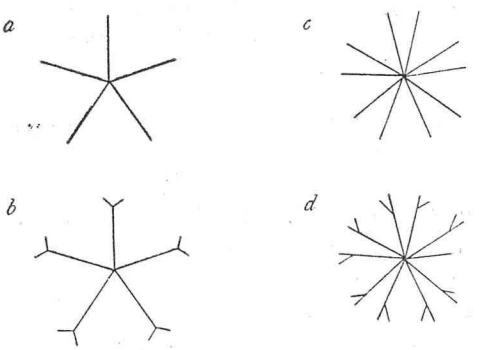
1) Size increased, old longitudinally oval test replaced by new transversely oval one. Height unchanging, always at abactinal. Slightly concave actinal surface flattened later.



Textfig. 1 The relative figure showing the differences between the Miocene and the later species. a. a small species of *Echinarachnius* from the Miocene. b. an oblong species of *Echinarachnius* from the Miocene. c. a wavy species of *Echinarachnius* since the Pliocene.

2) Number of genital pores is invariably four. This is related to the flat test and the situation of oesophagus.

3) Simple actinal ambulacral furrows of the early types changed to the later complex ones. The furrows are undifferentiated or bifurcated only near at the



Textfig. 2 The relative figure showing the changes of ambulacral furrows between the Miocene and the later species.
a,b. The simple ambulacral furrows of the Miocene species.
c,d. The complex ambulacral furrows of the Pliocene species.

margin in the Oligocene and the Miocene species, while the bifurcation take place near around the peristome and even rebifurcation is common in the later forms after the Pliocene.

4) Change in location of periproct from supramarginal to posteromarginal. The change happened during the later Miocene.

5) Petaloidal area indifferent, excepting the increasing number of pore-pairs of petals i. e. about 41 in *E. microthyroides* of Miocene, about 68 in *E. mirabilis* of Recent.

Among the changes stated above, the height, thickness of margin of test and the properties of petaloidal area do not show any definite tendency. These characters seem to be variable. The changes between the Miocene and Pliocene suggest a big alteration in circumstance. The apparent immutability after the beginning of the Pliocene may represent the relative shortness of time, some million years may not be enough.

Some poor specimens of *Echinarachnius* at hand furnish an examination of the young form. The general features of young form of *Echinarachnius mirabilis* were described by S. NISIYAMA. It is oblongly oval in outline, it has a supramarginal periproct, eccentric apical system and a small number of pore-pairs. These young characters of the Recent species are well corresponding with the adult characters of the pioneers of the Oligo-Miocene.

Notes on the species of *Echinarachnius*

Echinarachnius nipponicus (NAGAO)

(Pl. XI, figs. 3, 4)

1928 T. NAGAO, Sci. Rep. Tohoku Imp. Univ., 2nd ser. 12, 1, p. 16, pl. 1, figs. 5, 6
1940 S. NISIYAMA, Jub. Publ. Comm. Prof. YABE's 60th Birth., p. 821

Oligocene : Ashiya Group ; Takasu and Asakawa, Ashiya-cho, Onga-gun, Fukuoka Prefecture. (Long. E–130°40′, Lat. N–34°, near Wakamatsu City)

Echinarachnius microthyroides NISIYAMA

(Pl. IX, fig. 5)

1940 S. NISIYAMA, Jub. Publ. Comm. Prof. YABE's 60th Birth., p. 828, pl. 44, figs. 17-20
1949 A. MORISHITA, Jour. Geol. Soc. Japan, 55, p. 256
1953 A. MORISHITA, Mem. Coll. Sci., Univ. Kyoto, ser. B, 20, 4, p. 219, pl. 1, fig. 3

Miocene : Suenomatsuyama Formation ; Fukuoka-cho, Ninohe-gun, Iwate Prefecture. (Long. E–141°20′, Lat. N–40°15′)

Tsubono Siltstone ; Mukugahara, Sendanno-mura, Higashitonami-gun, Toyama Prefecture. (Long. E–137°, Lat. N–36° 40′, near Takaoka City)

? ; Kamitsugu-mura, Kitashidara-gun, Aichi Prefecture. (Long. E–137°40′, Lat. N–35°10′)

Pliocene ? : Shigarami Formation ; Kawashita, Togakushi-mura, Kamiminochi-gun, Nagano Prefecture. (Long. E–138°10′, Lat. N–36°40′, near Nagano City)

Echinarachnius subtumidus NISIYAMA & HASHIMOTO

1950 S. NISIYAMA & W. HASHIMOTO, Shortpapers IGPS, 2, p. 39, textfigs. 1-3

Miocene : Togeshita Formation ; Togeshita, Rumoe City, Hokkaido. (Long. E–142°40′, Lat. N–44°20′)

Echinarachnius rumoensis HAYASAKA & SHIBATA

1952 I. HAYASAKA & M. SHIBATA, Jour. Fac. Sci., Hokkaido Univ., ser. 4, 8, 2, p. 82, fig. 1

Miocene : Togeshita Formation ; Togeshita, Rumoe City, Hokkaido.

Echinarachnius minoensis (MORISHITA) *nom. nov.*

(Pl. XI, figs. 5~7)

1953 *Sismondia naganoensis*, A. MORISHITA, Mem. Coll. Sci., Univ. Kyoto, ser. B, 20, 4, pl. 218, fig. 2, pl. 1, figs. 1, 2

1954 *Echinarachnius brevis*, A. MORISHITA, Mem. Coll. Sci., Univ. Kyoto, ser. B, 21, 2, p. 225, fig. 2, pl. 7, figs. 1-3

1955 *Echinarachnius sp.*, K. MASUTOMI, Jour. Soc. Earthsci. Amat. Japan, 8, 1, p. 29

Description :— The outline of test is subpentagonal and pointed behind. The largest width is in the posterior paired interambulacra. The highest point is at a little anterior to the apical system, which is eccentric anteriorly, situated at 4.7 mm. from the anterior margin, and measures 10 mm. in longitudinal diameter. The genital pores are four.

The abactinal surface rises to apex gently. Its anterior part is more elevated than its posterior part.

Ambulacral petal III is more broadly open at it's extremity than the other four, but it is nearly equal to the paired petals in size–Length 3.1 mm., width 1.7 mm. . Poriferous area is narrower than interporiferous area–0.3 mm and 1.1 mm. in width. Number of the pore pairs are about 22·

The row of pore pairs diverge near the centre and converge towards the extremities. The actinal surface is slightly concave. The peristome is a little eccentric anteriorly, similar to the apical system. The periproct is round in outline and supramarginal being at about 0.5 mm. from the posterior periphery. The ambulacral furrows are indistinct.

Measurements :—

Loc.	Length	Width	Loc.	Length	Width
Inkyoyama	8.5 mm.	9.2	Nagashino	7.0 mm.	
〃	7.6	7.8	〃	13.5	
〃	6.0	6.3	〃	8.6	
〃	6.4	6.9	〃	8.5	
〃	4.1	4.2	〃	7.2	
〃	10.0	10.6	Fujiwara	15.8	16.4
〃	9.8	10.0	Aoki	6.0	6.3
〃	11.0		〃	4.5	4.6
Kamado	12.4	13.0	〃	4.0	4.5
Nagashino	6.0		Kyoto	6.4	6.8
〃	9.4		Yamaguchi	11.0	

Remarks :— A small fossil of sand-dollar from the Aoki Formation of Nagano Prefecture was named *Sismondia naganoensis*. (A. MORISHITA, 1953) But the material was internal mode, which is quité identical with the many small specimens obtained from the Miocene of Gifu and Aichi Prefectures, and determined as the young of *Echinarachnius brevis*. After then small fossils belong to the same category have been discovered at various localities ; Okuyamada of Kyoto, Susa of Yamaguchi and the same localities of Gifu Prefecture. Examined in detail, all these specimens are referred to the same species of *Echinarachnius*. They are not really young ; they are small but adult specimens of a distinct species of *Echinarachnius*. Therefore the author has to rectify the former nomenclature. However, as the name "*Echinarachnius naganoensis*" is preoccupied by a species of the Ogawa Formation in Nagano Prefecture, a new name *Echinarachnius minoensis* is introduced here.

This species is very much allied to *Echinarachnius parvus* NISIYAMA from the Oligocene of Saghalien, but distinguished from the latter by no shallow groove in the middle part of interambulacrum V ; the ambulacrum III undifferentiate from the others, its concave actinal side and its periproct being situated nearer to the posterior margin.

Geological Horizons and Localities :—

Middle Miocene : Aoki Formation ; Shimizusawa, Aida-mura, Higashichikuma-gun, Nagano Prefecture. (Long. E–138°, Lat. N–36°20′, near Matsumoto City)

Togari Tuffaceous Sandstone ; East of Haginoshima and Inkyo-yama, Kamado-mura, Toki-gun, Gifu Prefecture. (Long. E–137° 20′, Lat. N–35°25′, near Tajimi City)

Nagashino Formation ; Yoshimura, Nagashino-mura, Minami-shidara-gun, Aichi Prefecture. (Long. E–137°35′, Lat. N–34°50′, near Toyohashi City)

Tsuzuki Formation ; Okuyamada, Ujidawara-mura, Tsuzuki-gun, Kyoto Prefecture. (Long. E–135°50′, Lat. N–34°50′, near Uji City)

Susa Formation ; Koyama, Susa-chô, Abu-gun, Yamaguchi Prefecture. (Long. E–131°35′, Lat. N–34° 35′)

Fujiwara Formation ; Furuichi-cho, Nara City. (Long. E–135° 50′, Lat. N–34°40′)

Echinarachnius parma (LAMARCK)

(Pl. IX, fig. 6 : Pl. XI, fig. 1)

1900 S. YOSHIWARA, Zool. Mag., 12, p. 393, pl. 15, figs. 14, 15
1903 S. TOKUNAGA, Jour. Coll. Sci., Imp. Univ. Tokyo, 17, p. 12
1925 H. L. CLARK, Cat. Rec. Sea-Urchins Brit. Mus., p. 168
1933 S. NISIYAMA, Iwanami-koza, p. 47
1939 H. IKEDA, Jour. Dep. Agr. Kyusyu Imp, Univ., 6, 2, pl. 4, fig. 9, pl. 6, figs. 4, 5
1940 H. IKEDA, Annot. Zool. Japon., 19, p. 3, pl. 2, fig. 4
1942 C. W. COOKE, Jour. Palaeon., 16, p. 16
1948 TH. MORTENSEN, Monogr. IV_2. p. 367, pl, 71, figs. 16, 23-26
1949 A. MORISHITA, Jour. Geol. Soc. Japan, 55, p. 256

Pliocene : Omma Sandstone ; Maitani, Akamaru-mura, Nishitonami-gun, Toyama Prefecture. (Long. E–136°50′, Lat. N–36°40′, near Takaoka City)

Sawane Formation ; Sado Island, Niigata Prefecture. (Long. E–139°, Lat. N–38°)

Recent : unknown in Japan.

Echinarachnius mirabilis (A. AGASSIZ)

(Pl. VIII, figs. 3~6)

1885 L. DÖDERLEIN, Seeigel von Japan ū den Liukiu, p. 73
1900 S. YOSHIWARA, Zool. Mag., 12, p. 392, pl. 16, figs. 9, 10
1903 S. TOKUNAGA, Jour. Coll. Sci., Imp. Univ. Tokyo, 17, p. 11
1906 S. TOKUNAGA, Jour. Coll. Sci., Imp. Univ. Tokyo, 21, p. 71
1925 H. L. CLARK, Cat. Rec. Sea-Urchins Brit. Mus., p. 168
1929 TH. MORTENSEN, Sci. Rep. Tohoku Imp. Univ., 4th ser., 4, p. 477
1933 S. AOKI, Iwanami-koza, p. 47, fig. 60
1935 H. IKEDA, Bull. Fac. Sci., Kyusyu Imp. Univ., 6, p. 202, figs. 5-8

1935 H. IKEDA, Bot. Zool., 3, p. 1765, fig. 5, p. 1766, fig. 6
1937 S. NISIYAMA, Rec. Oceanogr. Works in Japan, 9
1939 H. IKEDA, Jour. Dep. Agr. Kyusyu Imp. Univ., 6, 2, pl. 2, figs. 1-2, pl. 4, fig. 7, pl. 8, fig. 4, pl. 12, fig. 10, pl. 13, figs. 1-3
1940 H. IKEDA, Annot. Zool. Japon, 19, p. 4
1940 S NISIYAMA, Jub. Publ. Comm. Prof. YABE's 60th Birth., p. 835, pl. 43, figs, 1-4, pl. 44, figs. 1-6
1941 D. MIYADI, Mem. Imp. Mar. Obs. Kobe, 7, p. 517, fig. 5
1947 I. HAYASAKA & A. MORISHITA, Acta Geol. Taiwan., 1, 2. p. 94, pl. 8, figs. 1-2
1948 TH. MORTEMSEN, Monogr. IV_2, p. 375, pl. 61, fig. 9, pl. 63, fig. 4, pl. 71, figs. 19-21
1949 A. MORISHITA, Jour. Geol. Soc. Japan, 55, p. 256
1954 H. UTINOMI, Publ. Seto Mar. Biol. Lab., 3, 3, p. 354

Pliocene : Omma Sandstone ; Takemata, Mitani-mura, Kahoku-gun, Ishikawa Prefecture. (Long. E-136°45′, Lat. N-36°35′, near Kanazawa City)
; Kuramadera, Akamaru-mura, Nishitonami-gun, Toyama Prefecture. (Long. E-137°, Lat. N-36° 45′, near Takaoka City)
; Hotta, Kamishiro-mura, Himi-gun, Toyama Prefecture. (Long. E-137°, Lat. N-36°50′, near Himi City)

Pleistocene : Narita Formation ; Chiba Prefecture (Narita etc., Long. E-140°20′, Lat. N-35°45′)
Miyata Formation ; Kanagawa Prefecture. (Hatsuse-mura etc., Long. E-139°40′, Lat. N-35°45′)
Shinagawa Formation ; Tokyo City. (Oji, Long. E-139°45′, Lat. N-35°35′)
Ibaragi Prefecture. (Kuga-mura, Long. E-140°5′, Lat. N-35°55′)

Holocene : Alluvium ; Namba, Osaka City. (Long. E-135°30′, Lat. N-34°40′)
Recent species is widely distributing from E-141° N-43° to E-130° N-33°. (Otaru, Hakodate Bay, Mutsu Bay, Coast of Sanriku, Sendai Bay, Tateyama Bay, Tokyo Bay, Yokohama, Misaki, Obama Bay, Inland Sea, Ise bay, Tanabe Bay, Hakata Bay, Omura Bay, Amakusa)

Echinarachnius laganolithinus NISIYAMA

(Pl. X, figs. 1, 2)

1940 S. NISIYAMA, Jub. Pub. Comm. Prof. YABE's 60th Birth., p. 830, textfig. 12, pl. 44, fig. 21, pl. 45, figs. 1-9

Pliocene : Shibikawa Sandstone ; Wakimoto-mura and Okura-mura, Minamiakita-gun, Akita Prefecture. (Long. E-139°55′, Lat. N-39°55′)

Echinarachnius tsudai MORISHITA

(Pl. X, fig. 5)

1949 A. MORISHITA, Jour. Geol. Soc. Japan, 55, p. 257, textfig. 1

75 mm in diameter, 5 mm in height. Test is very flat and round in outline. Apical system is central. Each interambulacral area is more or less depressed at margin of test. All amburacral petals are nearly equal in its length, reaching 3/4 of radius. (26 mm. in length) Poriferous zones are much narrower (1.5 mm.) than interporiferous zone (6 mm.). Number of pore-pairs are about 55. Actinal surface is slightly concave. Ambulacral furrows are bifurcated close to peristome that is central.

Straight ambulacral petals are remarkable feature of this species.

Pliocene: Omma Sandstone; Hutamata, Asakawa-mura, Kahoku-gun, Ishikawa Prefecture. (Long. E-136°50′, Lat. N-36°35′, near Kanazawa City)

Echinarachnius ishioi MORISHITA

(Pl. X, fig. 6)

1949 A. MORISHITA, Jour. Geol. Soc. Japan, 55, p. 257, textfig. 2

40.5 mm in longitudinal diameter, 42.2 mm in transverse diameter and 6 mm in height. Test is thin in margin, remarkably elevated to apex, and subpentagonal in outline. Apical system is more or less eccentric anteriorly, situated at 19.6 mm. from anterior margin of test. Number of genital pores are four.

Ambulacral petals are longer than half of radius of test, and widely open in their extremities. Anterior paired petals are slightly shorter than the other three. (II, IV : 12×6 mm. I, III, V : 13×6 mm.) Poriferous zones are broader than interporiferous. (por. 1 mm, intpor. 4 mm.) Number of pore-pairs are about 38. Ambulacral petals diverge at 2/3 of radius, then converge at their extremities.

Periproct is rather inframarginal. Actinal surface is somewhat concave. Peristome is slightly eccentric anteriorly. Ambulacral furrows are indistinct.

Elevated test, widely opened petals and inframarginal periproct are remarkable feature of this species.

Pliocene: Tagawa Formation; Tagawa, Konade-mura, Nishitonami-gun, Toyama Prefecture. (Long. E-136°50′, Lat. N-36°40′, near Takaoka City)

Echinarachnius naganoensis MORISHITA

(Pl. X, figs. 3, 4)

1953 A. MORISHITA, Mem. Coll. Sci., Univ. Kyoto, ser. B, 20, 4. pl. 1, fig. 3

Pliocene: Ogawa Formation; Naniai-mura, Sakae-mura, Minochi-mura, Kumeji-mura, Kamiminochi-gun and Miasa-mura, Kita-azumi-gun, Nagano Prefecture. (Long. E-138°10′, Lat. N-36°40′, near Nagano City)
Shiiya Formation; Mizuhara-mura, Nakakubiki-gun, Niigata Prefecture. (Long. E-138°5′, Lat. N-36°40′, near Takada City)

Echinarachnius mirabilis tenuis YOSHIWARA

(Pl. IX, figs. 3, 4)

1898 S. YOSHIWARA, Annot. Zool. Japon, 2, p. 61
1900 S. YOSHIWARA, Zool. Mag., 12, p. 392
1940 S. NISIYAMA, Jub. Publ. Comm. Prof. YABE's 60th Birth., p. 839
1948 TH. MORTENSEN, Monogr. IV_2, p. 378, pl. 61, figs. 3-5, pl. 62, fig 4
1949 A. MORISHITA, Jour. Geol. Soc. Japan, 55, p. 256
1954 H. UTINOMI, Publ. Seto Marine Biol. Lab., 3, 3, p. 354

Pliocene: Omma Sandstone; Hutamata, Asakawa-mura, Kahoku-gun, Ishikawa Prefecture. (Long. E-136°50′, Lat. N-36°35′, near Kanazawa City)
Recent: Kominato (Long. E-140°10′, Lat. N-35°10′) and Taitozaki (Long. E-140°25′, Lat. N-35°20′), Chiba Prefecture.
Katsuura (Long. E-136°, Lat. N-33°40′), Wakayama Prefecture.

Echinarachnius griseus MORTENSEN

(Pl. IX, figs. 1, 2)

1927 TH. MORTENSEN, Annot. Zool. Japon., 11, p. 195, pl. 1, figs. 1-4, textfigs 2a, 2f
1929 TH. MORTENSEN, Sci. Rep. Tohoku Imp. Univ., 4th ser., 4, p. 477
1933 S. AOKI, Iwanami-koza, p. 47
1935 H. IKEDA, Bull. Fac. Sci., Kyusyu Imp. Univ., 6, pl. 4, figs. 1-4
1939 H. IKEDA, Jour. Dep. Agr., Kyusyu Imp. Univ., 6, 2, pl. 2, figs. 3-5
1940 H. IKEDA, Annot. Zool. Japon., 19, p. 4
1940 S. NISIYAMA, Jub. Publ. Comm. Prof. YABE's 60th Birth., p. 841, textfig. 64, pl. 43, fig. 6
1948 TH. MORTENSEN, Monogr. IV_2, p. 379

Pleistocene: Kiyokawa Formation; Mandanoyama, Ichihara-gun, Chiba Prefecture. (Long. E-140°10′, Lat. N-35°30′)
Recent: Saghalien, Akkeshi (Hokkaido, Long. E-144°, Lat. N-43°10′), Coast of Yamagata Prefecture and Mutsu-Bay.

Echinarachnius brevis IKEDA

(Pl. VIII, figs. 1, 2)

1936 H. IKEDA, Bot. Zool., 4, 7, p. 73, figs. a-c

1939 H. IKEDA, Jour. Dep. Agr. Kyusyu Imp. Univ., 6, 2, pl. 3, figs. 1, 8
1940 H. IKEDA, Annot. Zool. Japon., 19, p. 5
1940 S. NISIYAMA, Jub. Publ. Comm. Prof. YABE's 60th Birth., p. 843, textfig. 65, pl. 43, figs. 7–9

Recent: Muroran (Hokkaido, Long. E–141°10′, Lat. N–43°), Onahama (Fukushima Prefecture), Kitasaki (Fukuoka Prefecture) and Shibushi (Kagoshima Prefecture, Long. E–131°, Lat. N–31°30′)

Echinarachnius parma obesus H. L. CLARK

(Pl. XI, fig. 2)

1935 H. IKEDA, Bull. Fac. Sci., Kyusyu Imp. Univ., 6, p. 205, pl. 4, fig. 9
1940 H. IKEDA, Annot, Zool. Japon., 19, p. 4
1940 S. NISIYAMA, Jub. Publ. Comm. Prof. YABE's 60th Birth., p. 827, textfig. 10, pl. 43, fig. 10
1948 TH. MORTENSEN, Monogr. IV_2, p. 372

Recent: Kamtchatka, Saghalien and Akkeshi (Hokkaido).

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Plate VIII

Explanation of Plate VIII

(All figures in natural size)

Echinarachnius brevis IKEDA

Fig. 1 Recent specimen from Onahama Bay. Abactinal side.

Fig. 2 ditto. Actinal side.

Echinarachnius mirabilis (A. AGASSIZ)

Fig. 3 Recent specimen from Suiken, Wakayama Prefecture. Abactinal side.

Fig. 4 ditto. Actinal side.

Fig. 5 Fossil specimen from Namba, Osaka City. Abactinal side.

Fig. 6 ditto. Actinal side.

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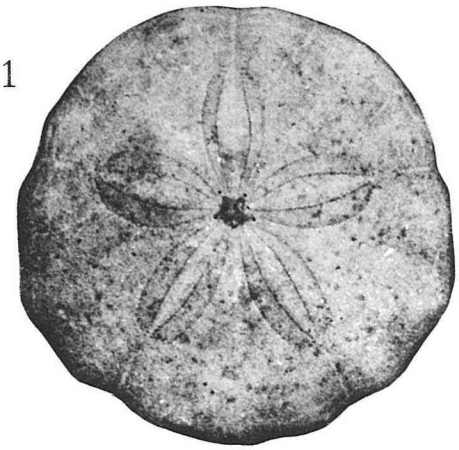

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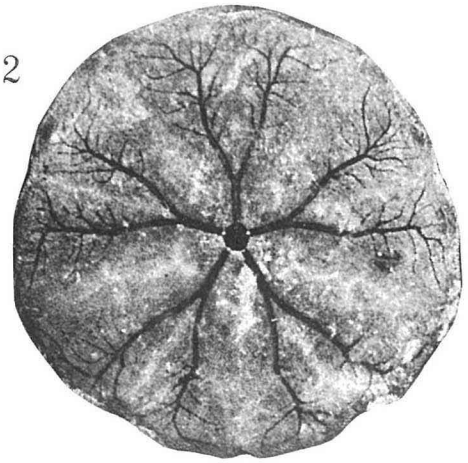

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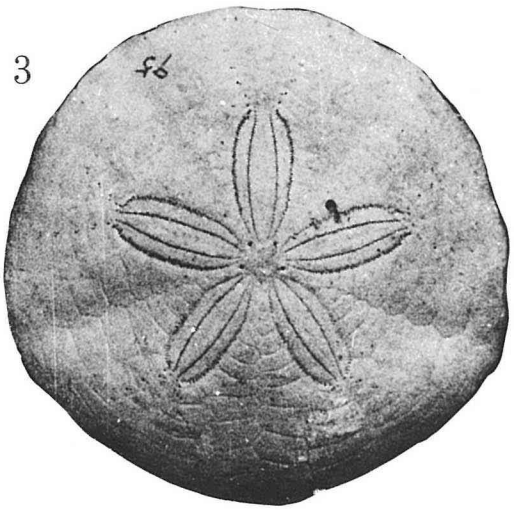

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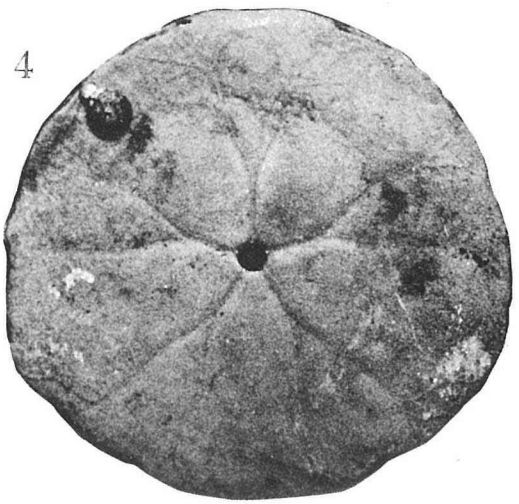

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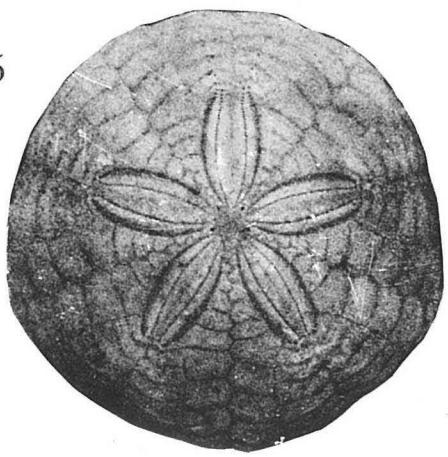

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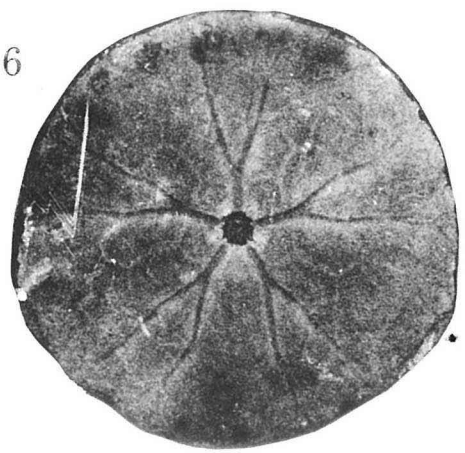

Plate IX

Explanation of Plate IX

(All figures in natural size)

Echinarachnius griseus MORTENSEN

Fig. 1 Recent specimen from Akkeshi Bay. Abactinal side.

Fig. 2 ditto. Actinal side.

Echinarachnius mirabilis tenuis YOSHIWARA

Fig. 3 Fossil specimen from the Omma Formation at Hutamata. Abactinal side.

Fig. 4 ditto. Actinal side.

Echinarachnius microthyroides NISIYAMA

Fig. 5 Fossil specimen from the Tsubono Siltstone at Mukugahara. Abactinal side.

Echinarachnius parma (LAMARCK)

Fig. 6 Fossil specimen from the Sawane Formation of Sado. Abactinal side.

1

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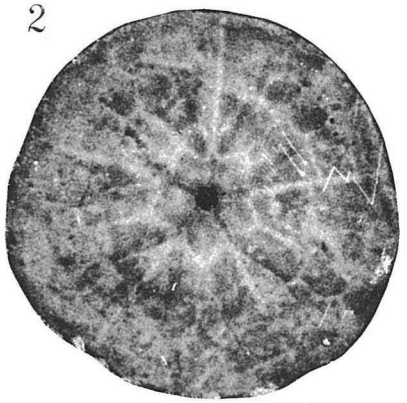

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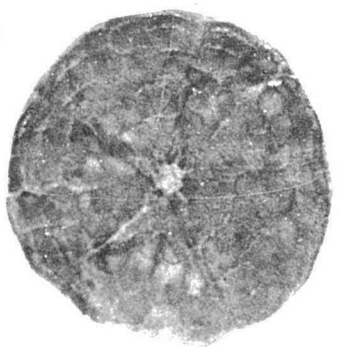

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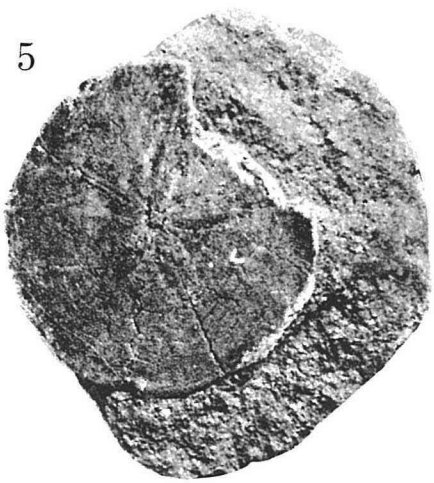

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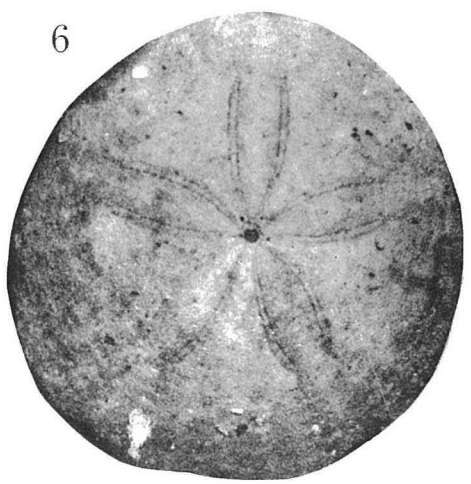


Plate X

Explanation of Plate X

(All figures in natural size)

Echinarachnius laganolithinus NISIYAMA

Fig. 1 Fossil specimen from the Omma Formation of Toyama. Abactinal side.

Fig. 2 Fossil specimen from the Shibikawa Formation of Akita. Abactinal side.

Echinarachnius naganoensis MORISHITA

Fig. 3 Fossil specimen from the Ogawa Formation of Miasa-mura. Abactinal side.

Fig. 4 ditto.

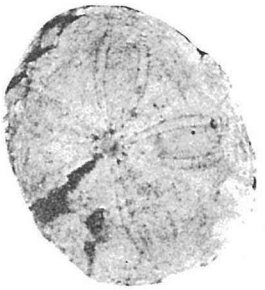
Echinarachnius tsudai MORISHITA

Fig. 5 Fossil specimen from the Omma Formation at Hutamata. Abactinal side.

Echinarachnius ishioi MORISHITA

Fig. 6 Fossil specimem from the Tagawa Formation at Tagawa. Abactinal side.


1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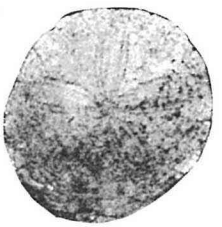
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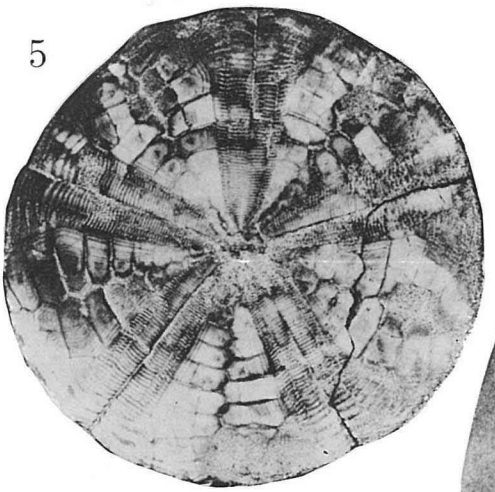
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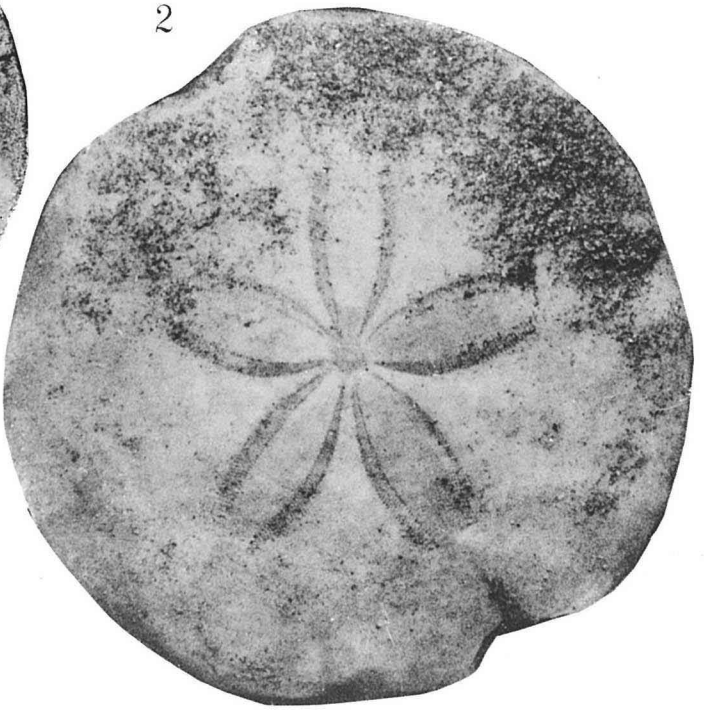
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Plate XI

Explanation of Plate XI

(All figures in natural size)

Echinarachnius parma (LAMARCK)

Fig. 1 Recent specimen from Akkeshi Bay. Abactinal side. (Ikeda's Fig.)

Echinarachnius parma obesus H. L. CLARK

Fig. 2 Recent specimen from Akkeshi Bay. Abactinal side. (Ikeda's Fig.)

Echinarachnius nipponicus (NAGAO)

Fig. 3 Fossil specimen from the Ashiya Group at Takasu. Abactinal side. (Nagao's Fig.)

Fig. 4 Fossil specimen from the Ashiya Group at Asakawa. Internal mould. (Nagao's Fig.)

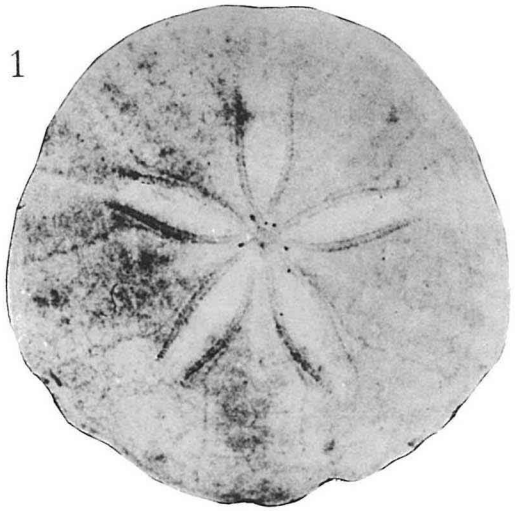
Echinarachnius minoensis n. n.

Fig. 5 Fossil specimens from the Togari Formation of Gifu. Abactinal side.

Fig. 6 Fossil specimen from the Nagashino Formation of Aichi. Internal mould.

Fig. 7 Fossil specimen from the Tsuzuki Group at Okuyamada. Internal mould.

1



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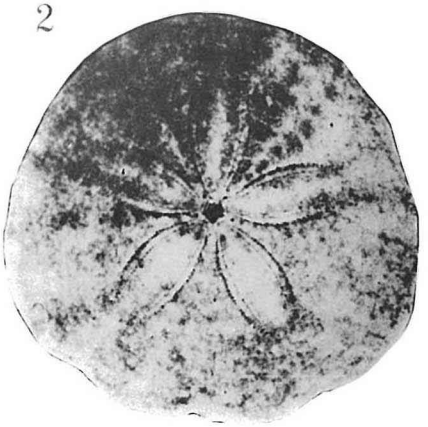

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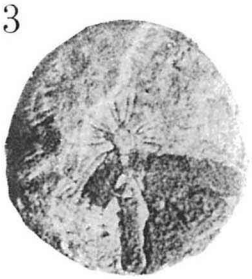

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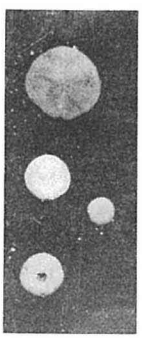

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