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Fossil Astriclypeus from Japan.

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With 1 plate and 2 figures

Abstract

The fossil *Astriclypeus* of Japanese Miocene is discussed, and one new subspecies is described. The close relation with genus *Echinodiscus* and some associated problems are mentioned.

Introduction

A fossil echinoid genus *Astriclypeus*, that has been known by many palaeontologists and stratigraphers, especially Cenozoic students of Japan, seems to be found only in the Miocene strata (F_2 or F_3*). Their definite geological horizons, comparatively extensive distributions, and discovery of recent species in the Japanese waters give us several interesting palaeontological and stratigraphical problems. In this paper some problems are discussed mentioning the morphological differences of several specimens from various localities. I am especially indebted for many kind advices to Professor Jiro MAKIYAMA of our institute, and to Mr. Kazuo HUJITA of Osaka City University, Mr. Karyu TSUDA of Niigata University, Mr. Masazumi HUJITA of Osaka Gakugei University and Mr. Junji ITOIGAWA, a student of this institute for their kind offer of the specimens described in the present paper. I also wish to acknowledge my indebtedness to Professor Sotoji IMAMURA of Hiroshima University for his instruction by letter, and to Mr. Hujio KATO and Mr. Manzo CHIJI of this institute for lending their photographs.

Geographical and Stratigraphical Distribution

Species of *Astriclypeus* are discovered in rhe Miocene strata from Hokkaido of the north Japan to Hiroshima Prefecture of the south-west part of this country as well as the Miocene rocks of Taiwan. Because of missing the same stage in Kyusyu and Shikoku we have never heard of an occurence of this genus, nevertheless it may be discovered from these districts. Fossil *Astriclypeus* exists, as stated above, only in the Miocene strata of Japan: Yatsuo Subgroup[1] in

* IKEBE, N., Letter Nomination, 1948.

Toyama and Ishikawa Prefectures, Shukunohora Sandstone Member[2] in Gifu Prefecture, Shobara Formation[3] in Hiroshima Prefecture, Shiroyama Sandstone Member[4] in Shizuoka Prefecture, Kadonosawa Formation[5] in Iwate Prefecture, Moniwa Formation[6] in Miyagi Prefecture, and Oanzaigawa Formation[7] in Hokkaido etc..

It may be most interesting that it has not been discovered in the Pliocene and Pleistocene strata but it lives in the Japanese waters. The recent species[8] seems to be widely distributed in the seas from Kanto (E140°,N36°) to Ryukyu Islands (E127°, N26°).

The principal localities so far as known are as follows. (Fig. 1)

1) Tanosawa, Otose-mura, Nishi-Tsugaru-gun, Aomori Prefecture.
2) Hotatesawa, Iwasaki-mura, Nishi-Tsugaru-gun, Aomori Prefecture.
3) Kadonosawa, near Fukuoka-cho, Ninohe-gun, Iwate Prefecture.

Fig. 1. Distribution Map of Fossil *Astri lypeus* in Japan.

4) Kamakui, Tategoshi-mura, Iwafune-gun, Niigata Prefecture.
5) Tsuzara, Kurosedani-mura, Nei-gun, Toyama Prefecture.
6) Gomado, Yamakatsumi-mura, Nakashinkawa-gun, Toyama Prefecture.
7) Shimizu and Kamikurose, Unohana-mura, Nei-gun, Toyama Prefecture.
8) Nozoki, Saikawa-mura, Ishikawa Prefecture.
9) Higashi-Ichinose, Asakawa-mura, Kahoku-gun, Ishikawa Prefecture.
10) Mizuho-mura, Minami-Tsuru-gun, Yamanashi Prefecture.
11) Kanbara, Ihara-gun, Shizuoka Prefecture.
12) Shukunohora, Hiyoshi-mura, Toki-gun, Gifu Prefecture.
13) Yamauchi-Higashi-mura, Hiba-gun, Hiroshima Prefecture.
14) The Basin of the Natori River, Oide-mura, Natori-gun, Miyagi Prefecture.
15) The Basin of the Oanzaigawa River, Kaminokuni-mura, Hokkaido.

Astriclypeus and Echinodiscus

Astriclypeus, which belongs to Scutellidae, has a large lunule, on the extremity of each ambulacral petal, a larger test than in *Echinarachnius*, a periproct at the centre of the actinal 5 th interambulacrum. These are the different characters from the other genera of the same family.

Astriclypeus is much like *Echinodiscus* in various points, for example, in its shape and size of the test. Although, *Echinodiscus* has no lunule, there are two slits at the marginal extremities of the pair of posterior petals. Here, the geographical and stratigraphical distributions of both genera *Astriclypeus* and *Echinodiscus* must be compared. The recent species of *Echinodiscus*[9] live in the Indo-Pacific waters between Ryukyu Islands, the East Indies and Australia, and they have never been discovered in the Japanese waters. The fossils of *Echinodiscus* were found only in the Palaeogene strata of Kyusyu,[10] and they have not yet been discovered from the Japanese Neogene. In Taiwan the fossil forms of *Echinodiscus*[11] were found in the Miocene strata and a recent species[12] is known. While *Astriclypeus* are found in the Miocene and Pliocene strata[13] and no recent species is known. As has been stated above, both the genera are very much alike morphologically and have similar geographical and chronological distributions. I believe *Astriclypeus* branched off from *Echinodiscus* during the Miocene Epoch, had been distributed from northern Japan to Taiwan and now is limited to the Japanese waters. Meanwhile *Echinodiscus* gradually migrated to the warmer seas southwards to Kyusyu.

One specimen which proves the relationship of both genera was discovered from the Neogene strata of Taiwan.[14] This form *Astriclypeus?* is intermediate of the two genera in shape; the pair of posterior lunules are rather large and the other three lunules are very small.

Echinodiscus chikuzenensis NAGAO from Kyusyu suggest the close relation with *Astriclypeus* too, because the pair of posterior slits are nearly like the lunules.

In discussing the evolution of the genera of the Scutellidae S. NISHIYAMA[15] divides them into two groups: *Echinarachnius* series and *Scutella* series according to the various morphological features. He says that *Scutella* series including

Astriclypeus and *Echinodiscus* appeared in the Late-Tethys Sea and some of them (*Astriclypeus*, *Echinodiscus* etc.) migrated into the Pacific Ocean and the Indian Sea across the Red Sea while others (*Encope*, *Mellita* etc.) were confined to the Atlantic Ocean in the present time. *Astriclypeus* and *Echinodiscus* are believed to exist only in the Asian Sea Waters after Miocene Epoch judging from their geographical distribution.

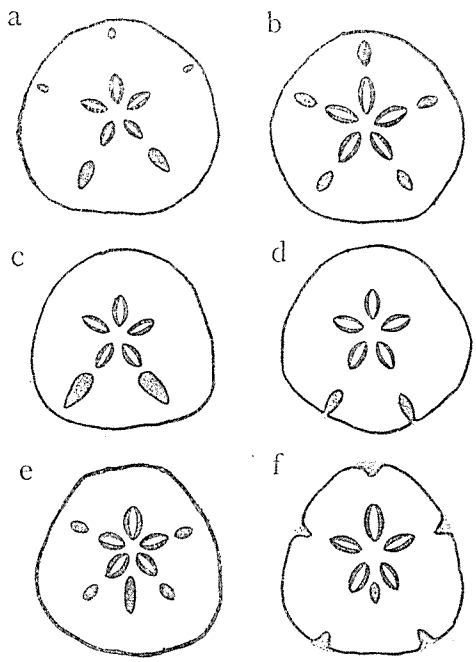

Fig. 2 a-f. Diagramatic figures of different lunules or slits in Scutellidae. (all are abactinal side)

a. A migrating form of *Astriclypeus* sp. from the Miocene strata of Taiwan.
b. An average form of *Astriclypeus manni* VERRILL.
c. *Echinodiscus chikuzenensis* NAGAO from Palaeogene strata of Kyûsyû.
d. A recent form of *Echinodiscus auritus* LESKE.
e. *Mellita longifissa* MICHELIN from the Pleistocene strata of North America.
f. *Encope tenuis* KEW from the Pliocene strata of North America.

The Comparison of Each Species

So far as known, there are two species and one subspecies in the genus *Astriclypeus*: *Astriclypeus manni* VERRILL, *Astriclypeus integer* YOSHIWARA and *Astriclypeus manni ambigenus* NISHIYAMA. *Astriclypeus manni* is characterized with its narrow lunules and the short distance from the lunule to the margin of the test, although the proportion of the width and length, and the width of the interporiferous zones of the ambulacral petals are variable; while *Astriclypeus integer* is characterized with its large width of the lunules and comparatively large distance from the lunules to the margin of the test, the more rounded

ambulacral petals and the broader interporiferous zones.

Astriclypeus manni ambigenus seems to have features of both; namely, the rounded lunules, larger intervals from the ambulacral petals to the lunules, and the large primordial ambulacral plate are characters identical to *Astriclypeus manni*. However, in its posterior marginal periproct, and scanty podial pores of the ambulacra it is similar to *Atsriclypeus integer*.

Table 1 is the comparative table of the measurements of the specimens from the different localities.

Table. 1

Nr.	Species	Locality	A	B	C	D	E	F
1	A. manni	Tateyama Bay, Chiba Pref.	0.47	0.40	0.24	0.055	0.066	
2	A. manni	Osaka Bay, Osaka Pref.	0.70	0.29	0.29	0.037	0.125	0.103
3	A. manni	Nozoki, Ishikawa Pref.	0.56	0.59	0.40	0.074	0.072	0.107
4	A. manni	Yamauchi, Hiroshima Pref.	0.53	0.32	0.45			0.091
5	A. manni	Byoritsu, Taiwan.	0.50	0.42	0.30	0.037	0.087	
6	A. manni	Shukunohora, Gifu Pref.	0.49	0.44	0.40	0.024	0.088	0.103
7	A. integer	Mizuho-mura, Yamanashi Pref.			0.67			
8	A. integer	Heirinkei, Taiwan.	0.54	0.65	0.50	0.051	0.102	
9	A. manni ambigenus	Iwasaki-mura, Aomori Pref.	0.56	0.41	0.58	0.079	0.053	0.105
10	A. manni n. subsp.	Shukunohora, Gifu Pref.	0.59	0.49	0.19	0.046	0.11	0.066

A: Ratio of Width and Length of Ambulacral Petal.
B: Ratio of Width of Interporiferous Zone and Ambulacral Petal.
C: Ratio of Width and Length of Lunule.
D: Ratio of Interval from Ambulacral Petal to Lunule and Diameter.
E: Ratio of Distance from Lunule to Margin of Test and Diameter.
F: Ratio of Thickness and Diameter of Test.

Their morphological features are synthesized in this table as follows: A) The ratio of width and length of the ambulacral petals is not constant and considerably variadle. B) The width of the interporiferous zones of ambulacral petals is also comparatively variable. A broad interporiferous zone means, in other words, a narrow poriferous zone of ambulacral petal. C) The shape of lunules is the most important mark on the classification of this genus. A specimen from Gifu (Number 10) is extremely narrow in comparison with the other specimens as shown in the table. The character of lunules must be discussed when we consider their phylogenetic relation with *Echinodiscus*. D) The interval

from the extremity of ambulacral petal to the lunule is unfixed. E) The distance from the extremity of the lunule to the margin of the test seems to be of no use for division of species. This point, however, cannot be overlooked on considernig the appearance, the migration, and the extinction of lunules. F) The thickness of the test is indefinite, but only the specimen from Gifu is remarkably thin.

In conclusion, *Astriclypeus manni* is still hardly distinguished from *Astriclypeus integer*. It is necessary to observe many more specimens, before we can reach a definite conclusion.

Anyhow, the shape of their lunules seems to be the most smportant feature for the classification of species. The lunules of *Astriclypeus manni* are narrower than those of *Astriclypeus integer*. It has been believed up to the present time, that the majority of the fossil species from the various localities belong to *Astriclypeus manni*, while a few to *Astriclypeus integer*, according to the shape of their lunules.

Only the specimen from Gifu is distinguishable in its remarkably narrower lunule and thinner test. I propose a new subspecies for this specimen as described later. However, all specimens from Gifu do not belong to the new subspecies (Number 6).

Some Associated Problems About Astriclypeus

It is very difficult to decipher palaeo-ecologic circumstances of these forms. But the fossil species of *Astriclypeus* have something to show their living conditions. The occurrences in conglomerates associated with *Operculina, Miogypsina, Clementia, Telescopium, Vicarya, Vicaryella* suggest an assumption. Problems of sedimentation should be considered. The conglomeratic sediments do not mean necessarily shallow seas. However, it may possibly be said that they lived in shallow seas judging from the recent species living in the shallow sea bottom of a few fathoms. Fossil *Astriclypeus* species seem to have been dwelling in a warm shallow sea water, in view of *Telescopium* on the tropical tidal planes, *Clementia* in shallow water and *Operculina* under a warm current.

Another problem is the fact that they are discovered only in the Miocene strata as stated above. It is certainly strange that they have not yet been found from the Pliocene or Pleistocene strata. In Taiwan, species of *Astriclypeus* are found in the Pliocene strata (Upper Byoritsu Formation) as well as in the Miocene. Future discovery of an *Astriclypeus* form in the Pliocene and the Pleistocene is by no means impossible. They have not been known, however, from such strata as yet, though every search was made for them. It is then seemingly possible to assume that the genus reached the acme of its phylogenetic development during the Miocene. The various conditions are demanded on their preservation. Many fossils had been removed from their original environments before fossilization, but some others may still show its palaeo-ecological condition, for it had been transported only a short distance. If we can observe their occurrence in each locality in detail, we are able to solve the problem. Dealing

with transported fossils, it is possibly assumed that the larger fossils are derived from a nearer habitat than the smaller ones. The flat *Astriclypeus* is considered to show shorter transportations than the round *Echinolampas*[16] which are found with *Astriclypeus* in Niigata, Toyama, Ishikawa and Aomori Prefectures.

Description of Astriclypeus From Gifu Prefecture

Astriclypeus manni minoensis subsp. nov.

Plate XI, Figure 1

Description.- The test is remarkably large, thin and flat, gradually elevated from the thin ambitus towards the centre. The outline is subpentagonal. The ambulacral area is very flat and considerably narrow in comparison with the all surface area. The ambulacral petals are broad, and the paired ones are perfectly closed distally. The poriferous zones are comparatively broad, and the pores of these are numerous, about 60. The apical system is nearly at the centre, other details are unknown.

Observation.- This subspecies looks very much like *Astriclypeus manni* VERRILL. They are alike in their subpentagonal thin tests, but the present subspecies in thinner in the thickness of the test; the distance from the ambitus of the lunule to the margin of the test is larger; the interval of the ambulacral petal and the lunule is narrower; and the shape of the lunules is much more slender than in *Astriclypeus manni* VERRILL.

Measurements.- Diameter, 137mm.; Thickness, 9mm.; Proportion of thickness to diameter, 0.066; Proportion of width to length of ambulacral petals, 0.54 to 0.63; Proportion of width of interporiferous zones to width of petals, 0.41 to 0.52; Proportion of width to length of the lunule (the most important feature), 0.16 to 0.13; Proportion of intervals of petals and lunules to diameter, 0.046; Proportion of distances from lunule to margin of the test and diameter, 0.10 to 0.11.

Locality.- Shukunohora, Hiyoshi-mura, Toki-gun, Gifu Prefecture.

Geological Horizon.- Shukunohora Sandstone, Miocene (F_2 or F_3).

Holotype.- No. JC 750001, deposited in Geol. Inst. Kyoto Univ.

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Explanation of Plate

Plate 1.

Fig. 1: Astriclypeus manni minoensis subsp. nov., Shukunohora, Hiyoshi-mura, Tokigun, Gifu Prefecture. Abactinal side. ×7/10

Fig. 2: A recent species of Astriclypeus manni VERRILL, Osaka Bay. Abactinal side. ×9/10