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Late Quaternary Marine Diatom *Ethmodiscus rex* from the Northwestern Pacific Ocean

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Introduction

Remains of *Ethmodiscus rex* (RATTRAY) HENDEY, one of largest diatoms in marine plankton, have been reported from the deep-sea sediments in the various oceans (MANN, 1907; HANZAWA, 1935; KOLBE, 1954, 1955, 1957; WISEMAN & HENDEY, 1953; RIEDEL, 1954; GARDNER & BURCKLE, 1975). They often occur as monospecific diatomaceous deposits of a few centimeters to several meters in thickness, consisting mainly of broken frustules (GARDNER & BURCKLE, 1975).

In the piston cores collected by R. V. *Hakuho-maru* in 1980 (KH80–3) at her stations 5, 12, 18 and 22, several *E. rex* remain-rich layers were encountered. The present paper describes the occurrence of those layers and stratigraphic implications of this finding.

Preparation of Materials and Method of Study

Figure 1 and Table 1 show the core-sampling locations. The descriptions of sedimentary facies of the cores were given in KOBAYASHI (1981). Prior to the examination with an optical microscope, cleaning of raw materials and preparation of slides were done as follows: 1) Sediment samples, taken from the cores at about 5–20 cm intervals, were placed in 200 ml beakers with 20 ml of hydrogen peroxide (H_2O_2, 15%), and the contents were boiled for about 20 min. to decompose organic materials. 2) Each beaker was filled with water, and kept at room temperature for about 10 hrs. Then fine-grained materials in suspension were carefully removed by decantation. 3) The residue obtained by the above process was stirred while adding 100 ml of water, and then 0.5 ml of which was sucked into a syringe. 4) For preparation of slides, the material in the syringe was placed on an 18×18 mm cover glass. After drying, it was mounted on a slide with Pleurax. Because majority of *E. rex* remains in the present materials was almost always found as fragments, the identification rested upon fragments of the central portion of the valve, and the relative abundance of the species to other diatoms was estimated by means of the Visual Percentage Estimation Chart ("Colour Index", TANAKA & KATADA, 1969). The relative abundance of *E. rex* was defined as $\mathbf{A}=100\times\mathbf{S}/\mathbf{N}$, where **S** was visual percentage of the area occupied by the *E. rex* fragments in a field at 10×10 magnification (the average value of 50 field observations),

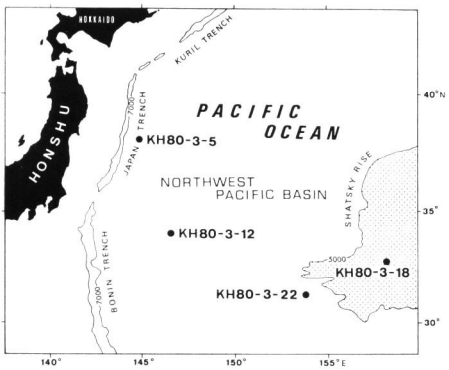

Table 1. Location of sediment cores studied

Core	Latitude	Longitude	Depth (m)
KH80–3– 5	38°08.7′N	144°45.0′E	5550
–12	34°08.4′N	146°34.2′E	5820
–18	32°44.9′N	158°17.6′E	2640
–22	31°16.2′N	153°42.9′E	5750

Fig. 1. Locality map of the sediment cores used in the present study.

and **N** was the number of other diatom valves along a line at 10×100 magnification (the average value of 20 line observations) with oil immersion objective lens of $100\times$. Thus, the application of this method requires the assumption that the range of dimensional variation of frustule is narrow. The argument of the present paper is, however, based on more or less the apparent presence of *E. rex* remains itself. Therefore, a significant error is not introduced by the size variation of frustule.

Occurrence of *Ethmodiscus rex* in the Cores

The fragments of *Ethmodiscus rex* remains are found abundantly at several stratigraphic positions of the four cores (Fig. 2). In the core KH80–3–5 which was taken near the Japan Trench, *E. rex* remains occur commonly in ten samples at and around the intervals from the bottom to 640 cm (D_1) and from 530 to 500 cm (D_2) measured from the top. The samples rich in *E. rex* remains are also found in the core KH80–3–12 which was taken from the location approximatery 4° farther south of the core KH80–3–5, within the Northwest Pacific Basin. They occur within the intervals from 840 to 730 cm (D_3), from 550 to 350 cm (D_4) and from 315 to 300 cm (D_5). Furthermore, the limited stratigraphic positions of *E. rex* bearing samples are recognized in the cores KH80–3–18, taken from the Shatsky Rise, at and around the intervals from 230 to 160 cm (D_6) and from 130 to 100 cm (D_7). A similar occurrence of the layers involving abundant *E. rex* remains are also observed in the core KH80–3–22, taken from the western periphery of Shatsky Rise.

The relationship between the length of the cores and geologic time is shown in Fig. 3. Four solid lines corresponding to the cores KH80–3–5, –12, –18 and –22 are drawn on the basis of the stratigraphic positions of the last occurrence of *Axoprunum angelinum* (CHAPBELL & CLARK) [=LAa] and *Rhizosolenia curvirostris* JOUSÉ [=LRc] in each core (SAKAI *et al.*, 1981), and their ages (LAa=ca. 0.41 Ma, HAYS & SHACKLETON, 1976; LRc=ca. 0.25 Ma, Fig. 17 in BERGGREN *et al.*, 1980). In the core KH80–3–5, two cleary-separated *E. rex* remain-rich layers (shaded zone in Fig. 2) are observed.

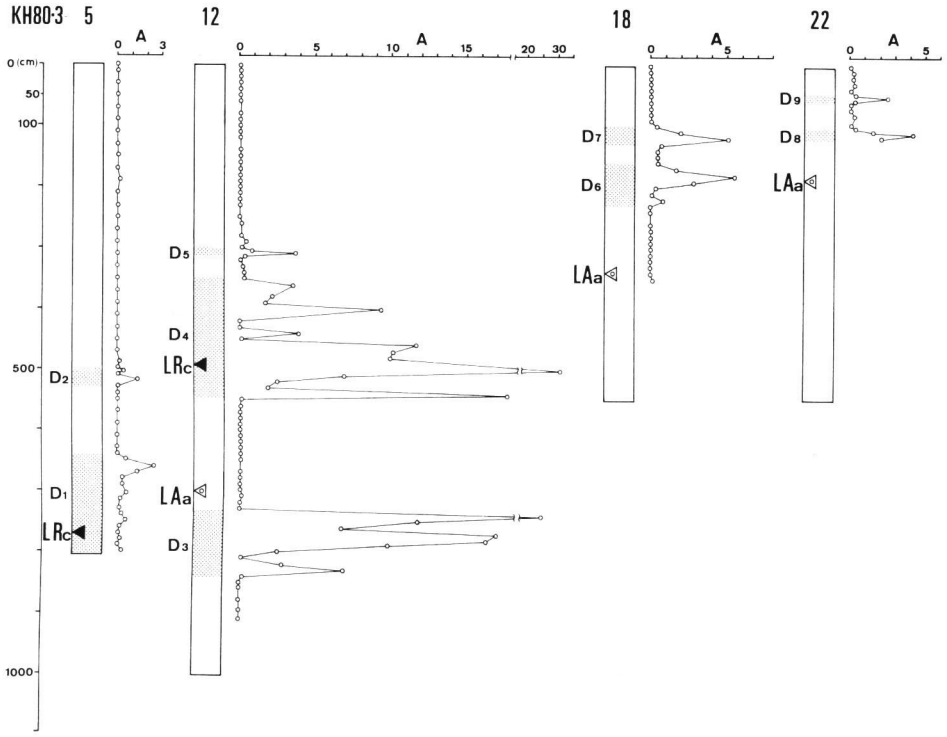

Fig. 2. Fructuation of the **A** value in the four sediment cores studied in the present paper. LAa (◀), last occurrence of the *Axoprunum angelinum* (Radiolaria); LRc (◀), last occurrence of *Rhizosolenia curvirostris* (Diatom). Shaded zones with letter symbol D_1–D_9 represent the *Ethmodiscus rex* remain-rich layers in the four cores.

The ages and time-intervals represented by the lower and upper layers are shown by the width of rectangles with letter symbol D_1 and D_2 respectively (Fig. 3). Two or three layers (from D_3 to D_9) with high **A** values are also recognized in the core KH80–3–12, –18 and –22, and the age assigment of these layers is performed in the same manner (Fig. 3). These data indicate that the lower *E. rex* remain-rich layers (D_1, D_6 and D_8) in the core KH80–3–5, –18 and –22 could be correlated with the rather thick layer (D_4) in the core KH80–3–12, which is an interval from 550 to 350 cm measured from the top. Further, the upper or uppermost *E. rex* remain-rich layers (D_2, D_5 and D_7) in the core KH80–3–5, –12 and –18 are correlated with each other. The upper layer (D_9) in the core KH80–3–22 is, however, rather isolated from others in age. This isolation may be introduced by the minor change of sedimentation rate during the period represented by the thickness of the upper half of the core.

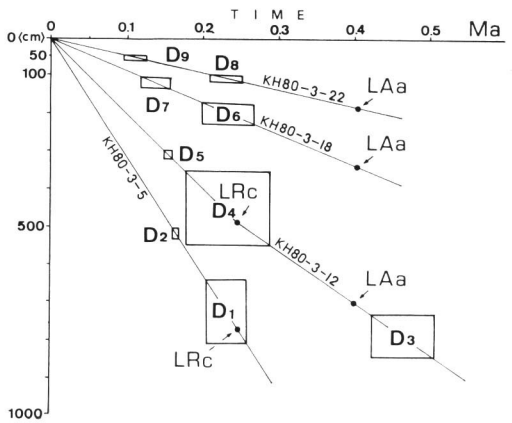

Fig. 3. Age assingment of the layers (D_1–D_9) characterized by enrichment of *Ethmodiscus rex* remains.

Concluding Remarks

1) During the last about 400,000 years, the congregated deposition of *Ethmodiscus rex* remains occurred twice with intervening layers void of this species in the northwestern Pacific Ocean. 2) The lower D_1, D_4, D_6 and D_8 layers characterized by enrichment of *E. rex* remains are safely correlated with each other. 3) The upper D_2, D_5 and D_7 layers are same correlative handling to which D_9 layer can be involved after the consideration of shortage of sedimentation rate. Such widespread and simultaneous distribution of *E. rex* remains suggests that ocean circulation-related conditions responsible for the formation of *E. rex* remainrich layers may have changed at least twice in the middle latitude of the northwestern Pacific Ocean.

Taxonomic Notes

Ethmodiscus rex (RATTRAY) HENDEY in WISEMAN & HENDEY, 1953, p. 51, pls. 1, 2.

Valves circular, somewhat convex, about 1000–1800 μm in diameter; precise range of diameter could not be defined because of the fragmental nature of frustules. Valve surface sparsely perforated, arrangement of the pores irregular in the inner portion and radial toward the valve margin (Plate 1, fig. 1). Pores 2–3 in 10 μm in the central part, and 3–5 in 10 μm in the marginal, each about 1–2 μm in diameter. In the central portion of the valves, sub-circular hyaline areas appear, about 10–20 μm in diameter, and they associated with curved process, 7–20 μm long (Plate 1, figs. 1, 3). Perforation of the mantle and girdle forms parallel rows, 3 in 10 μm (Plate 1, fig. 2).

Remarks: The specimens in the present materials show a fairly wide variation in length of central processes in comparison with the HENDEY's description of the species (WISEMAN & HENDEY, 1953). They can be, however, safely assigned to *Ethmodiscus*

rex by the characteristic central portion of the valves as described above.

Occurrence in the present materials: As shown in the previous section, *E. rex* was found at and around the following stratigraphic positions;

KH80–3– 5 .... Bottom–640 cm and 530–500 cm
–12 .... 840–730 cm, 550–350 cm and 315–300 cm
–18 .... 230–160 cm and 130–100 cm
–22 .... 120–100 cm and 55–45 cm

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Explanation of Plates

Plate 1

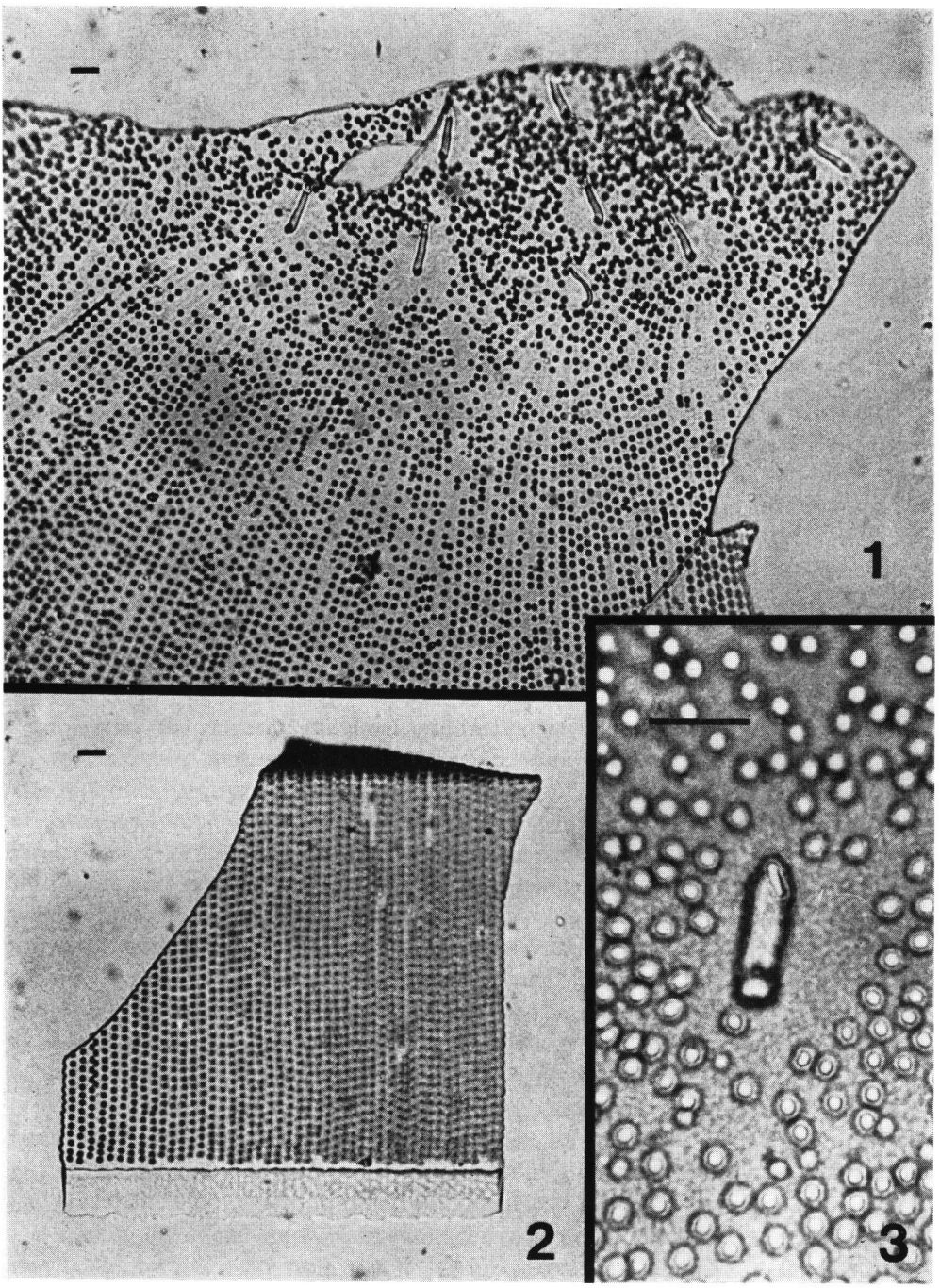
(Scale bar=10 μm)

Ethmodiscus rex (RATTRAY) HENDEY

Fig. 1. Fragment of valve showing central processes, sub-circular hyaline areas and the radial lines of pores. Sample KH80–3–12, 499–501 cm.

Fig. 2. Fragment of valve mantle showing the parallel rows of pores and hyaline margin. Sample KH80–3–12, 499–501 cm.

Fig. 3. Sub-circular hyaline area with central process. Sample KH80–3–12, 499–501 cm.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