

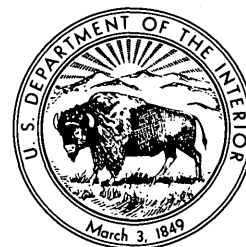
Fossil Echinoids from the Marshall Islands

By PORTER M. KIER

BIKINI AND NEARBY ATOLLS, MARSHALL ISLANDS

GEOLOGICAL SURVEY PROFESSIONAL PAPER 260-GG

*A report of three species of echinoids from drill
cuttings, with a description of an evolutionary
trend within one of them*



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FOSSIL ECHINOIDS FROM THE MARSHALL ISLANDS

By PORTER M. KIER¹

ABSTRACT

Two new species of *Echinocyamus* are described from cuttings in drill holes in Eniwetok Atoll. *E. petalus* Kier, n. sp. from the Upper Eocene shows an evolutionary trend toward elongation of the test and movement of the periproct nearer the peristome. *E. parviporus* Kier, n. sp. occurs in the Miocene. There are two specimens of *Fibularia ovulum* Lamarck from beds thought to be Pleistocene.

INTRODUCTION

Echinoids described in this paper were found in cuttings from three deep holes drilled on Eniwetok Atoll (Ladd and others, 1953) in 1951-52 (fig. 328) and two on Bikini Atoll in 1947. Because they came from cuttings, none of the large echinoids was intact. Although it is apparent from the fragments that both irregular and regular echinoids are represented, none of the large echinoids can be identified by this author. Numerous specimens of several species of small fibularids are preserved intact from drill hole E-1 on Eniwetok Atoll (fig. 329). The new species, *Echinocyamus petalus*, occurs in cuttings from depths of 2,780 to 2,930 feet (Upper Eocene (fig. 330)). This species is particularly interesting because of an evolutionary trend which occurs in it; specimens from the lower depths are much more rounded and their periprocts more distant from their peristomes than in those from higher depths. Another new species, *Echinocyamus parviporus*, was found from depths of 1,658 to 2,760 feet (Miocene). Depths of 1,080-2,687 feet were previously recognized by Cole (1957, p. 1) as Miocene (Tertiary *e*), but he had no diagnostic fossils from depths of 2,687 to 2,780 feet. The presence of *E. parviporus* at these depths suggests that this interval is also Miocene (*e*). This species is constant throughout its range and is easily distinguished from *E. petalus*. A specimen from depths of 1,227 feet 7 inches to 1,238 feet 1 inch on Eniwetok, and two fragments from depths 2,493 to 2,514 feet of drill hole 2B on Bikini may belong to *E. parviporus*.

¹ U.S. National Museum. This report is published by permission of the Secretary of the Smithsonian Institution.

Fibularia ovulum Lamarck, a species living in the present seas off Eniwetok, occurs in beds that are thought to be Pleistocene.

PALEOECOLOGY

Today, species of *Echinocyamus* and *Fibularia* occur at depths of 0-800 meters and live buried in calcareous mud or coarse sediments. These fossil species probably lived in a similar environment.

SYSTEMATIC DESCRIPTIONS

Genus ECHINOCYAMUS van Phelsum

Echinocyamus petalus Kier, n. sp.

Plate 302, figures 1-7; text figure 330

Diagnosis.—Species characterized by well-developed petals with broad interporiferous zones.

Material.—Ten specimens from four levels.

Measurements of the 10 specimens are as follows.

Depth (feet)	Length (mm)	Width (mm)	$\frac{W}{L} \times 100$ (percent)	Distance (D) periproct from peristome (mm)	$\frac{D}{L} \times 100$ (percent)
2,780-2,790	2.9	2.1	72	0.20	7
2,790-2,802	3.2	2.2	70		
	4.5	3.2	71	.26	6
	3.4	2.4	70		
	5.0	3.5	70	.31	6
2,910-2,920	5.3	4.2	79	.59	11
2,920-2,930	4.6	4.0	87		
	4.2	3.5	83	.59	14
	4.8	4.1	85	.57	12

Shape.—Elongate, width 70-87 percent of length, low, greatest width at midlength; flat adapical and adoral surfaces except where depressed around peristome.

Apical system.—Eccentric anteriorly with four genital pores arranged in trapezoid; anterior pair closer together than posterior pair; single hydropore.

Ambulacra.—Petals well developed, equal, flush with test, extending over two-thirds distance to margin; four pore pairs in petals II or IV, five in I or V of the smallest specimen, seven in II or IV, nine in I or V of largest

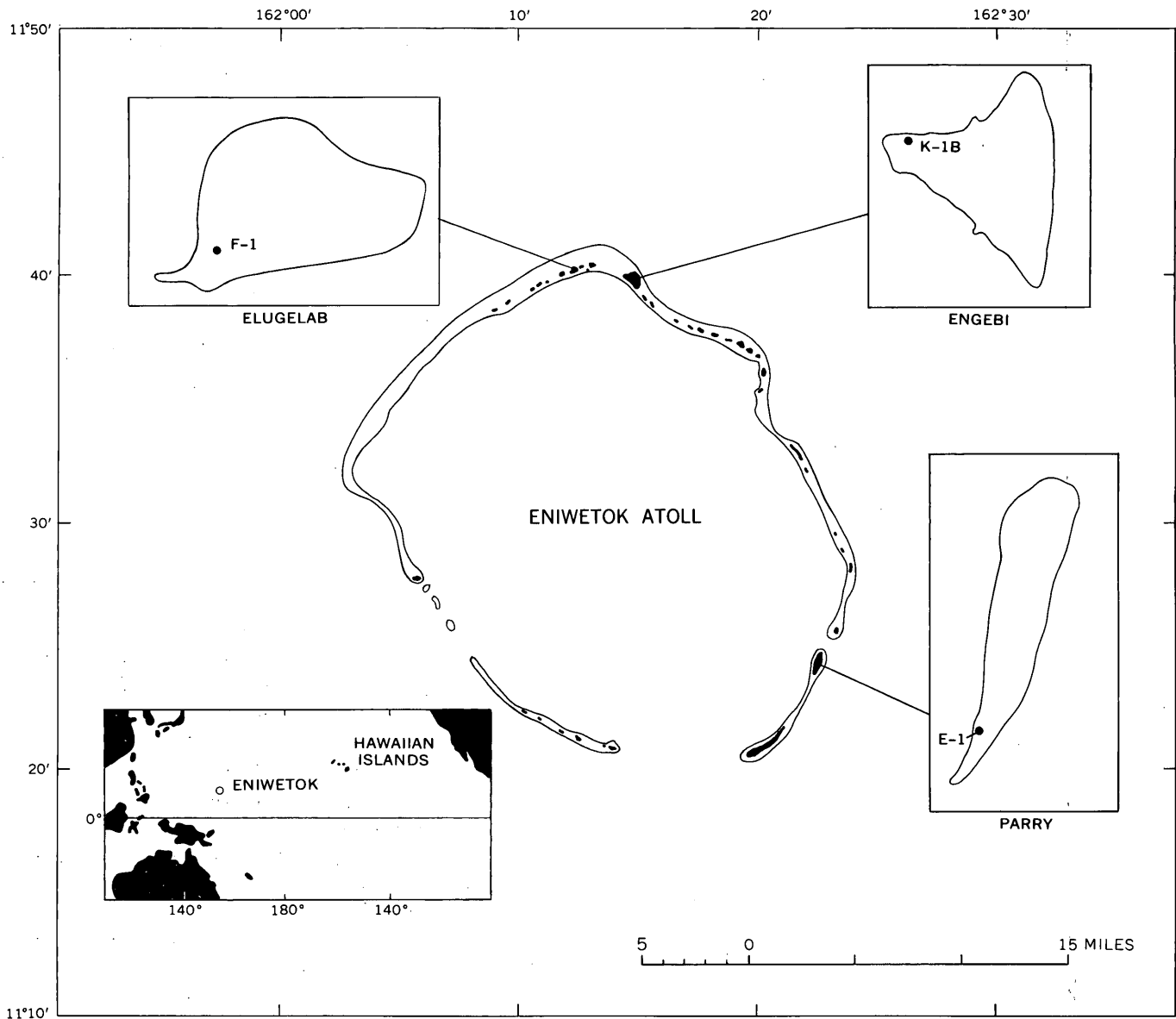


FIGURE 328.—Map showing location of drill holes on Eniwetok Atoll. Reprinted from Ladd and Schlanger (1960).

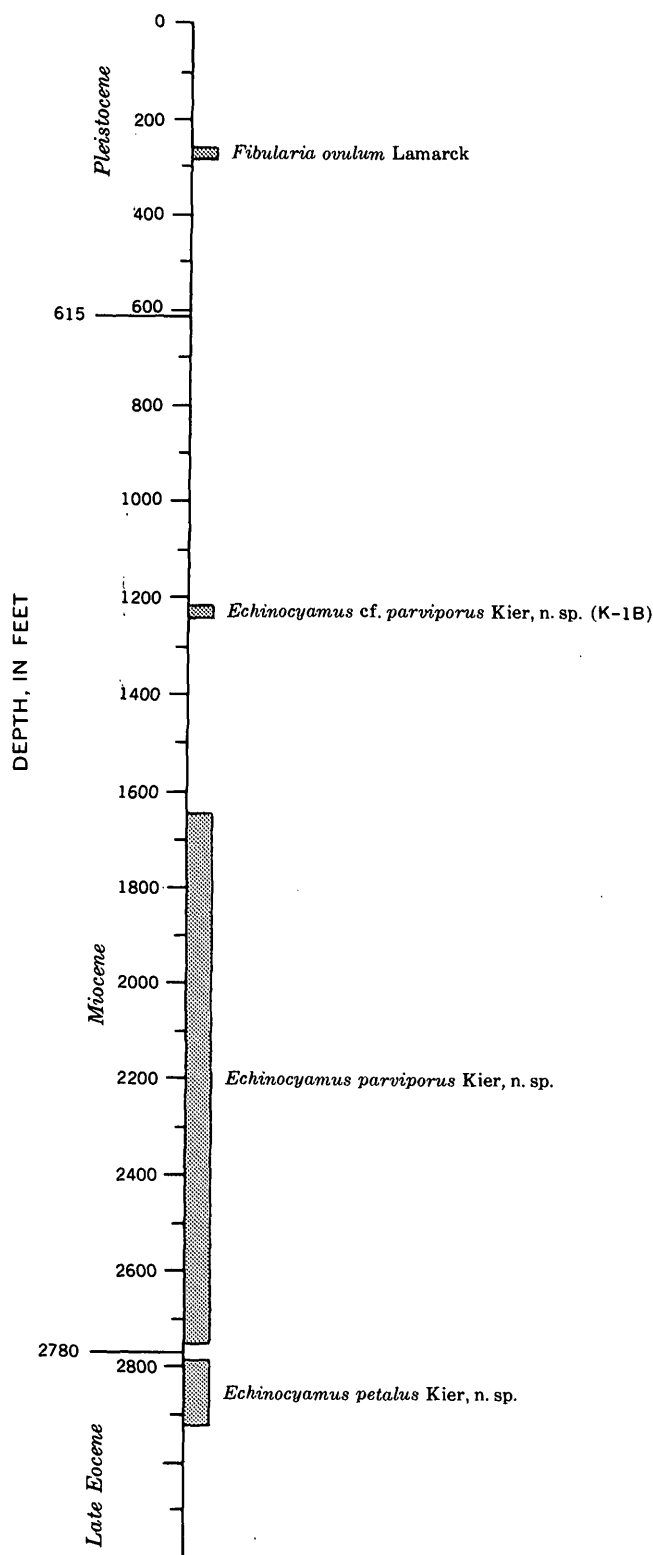


FIGURE 329.—Stratigraphic section showing distribution of echinoids in drill hole E-1 on Eniwetok Atoll.

specimen. Pores of pair oblique with inner pore nearest apical system. Interporiferous zones wide, in some specimens three times width of poriferous zones. Minute accessory pores near sutures of ambulacral plates beyond petals.

Periproct.—Round, smaller than peristome, situated between $\frac{1}{3}$ and $\frac{1}{2}$ distance from peristome to posterior margin.

Peristome.—Slightly pentagonal, depressed, in central position in less elongate specimens, posterior in more elongate specimens.

Internal structure.—Ten radiating partition walls (pl. 302, fig. 4) arranged in pairs corresponding in location to interambulacra, most developed near margin. Auricles fused, rising abruptly at slight angle outward, expanding at base, very thin at tip.

Intraspecific variation.—The specimens from the lowest level are wider with the width 83–87 percent of the length, whereas those from higher levels are much more elongate with the width only 70–72 percent of the length (fig. 330). The width of the single specimen from an intermediate level is intermediate, being 79 percent of the length. Furthermore, specimens from the lowest levels have the periprocts more distant from the peristomes with a periproct distance 12–14 percent of the length, whereas this distance in the specimen from the intermediate level is 12 percent and 6 percent in specimens from the highest levels. Although there are only a few specimens available, the lack of variability of these two characters within any of the populations supports the proposition that these specimens are typical of the populations. It is interesting to note that a trend in the elongation of the test and movement of the periproct nearer the peristome was described (Kier, 1957, p. 863) in a very similar species, *Echinocyamus polymorpha* (Duncan and Sladen) from the Middle Eocene of British Somaliland.

Comparison with other species.—This species is distinguished from most other species of *Echinocyamus* by wide well-developed petals. It resembles most *Echinocyamus polymorpha* (Duncan and Sladen) from the Middle Eocene Kirthar Series of India and Karkar Series of British Somaliland. In *E. petalus* the petals are more open at the extremities, with wider interporiferous zones, and the petals are flush with the test instead of slightly raised as in *E. polymorpha*. Furthermore, the Eniwetok species has a more elongate test with the periproct nearer the peristome. It is possible that the evolutionary trend described in *E. petalus* is a continuation of the trend described in *E. polymorpha*, with both species of the same stock.

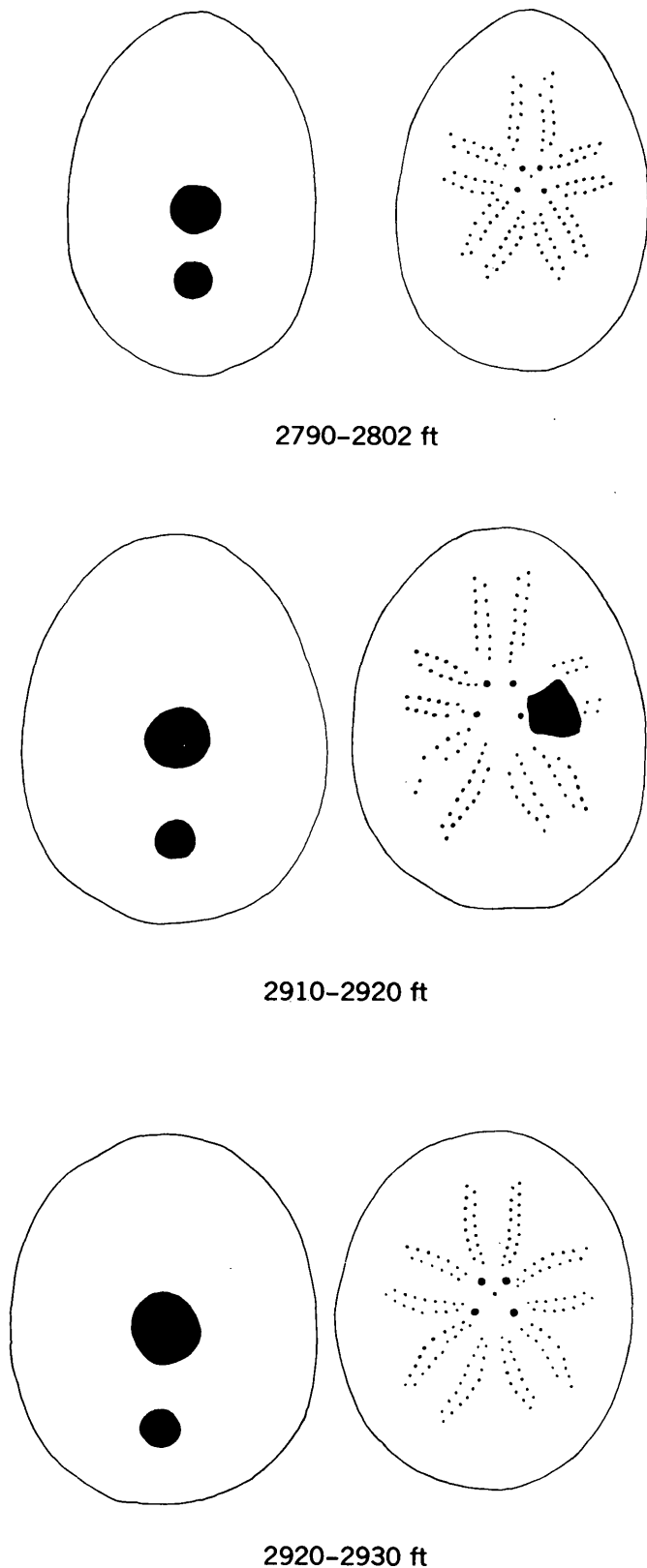


FIGURE 330.—Eocene *Echinocyamus petalus* Kler, n. sp. Stratigraphic sequence of forms, $\times 10$, illustrating the evolutionary trend toward elongation of the test and movement of the periproct nearer the peristome. Specimens from Eniwetok E-1, 2,790–2,802 feet, USNM 563445; 2,910–2,920 feet, holotype USNM 563446; 2,920–2,930 feet, USNM 563443.

Occurrences: Eniwetok E-1, 2,780–2,790 ft, 2 specimens; E-1, 2,790–2,802 ft, 4 specimens; E-1, 2,910–2,920 ft, 1 specimen; E-1, 2,920–2,930 ft, 3 specimens.

Geologic age: Late Eocene (Tertiary b).

Types: Holotype USNM 563446, paratypes USNM 563443–563445.

Echinocyamus parviporus Kler, n. sp.

Plate 302, figures 11–15; text figure 331 C–E

Diagnosis.—Species characterized by broad short petals with wide interporiferous zones and small pores.

Material.—Twelve specimens and fifteen fragments ranging in size from 2.9 to 7.3 mm in length. Dimensions of holotype: length 6.8 mm, width 5.6 mm, height 2.6 mm.

Shape.—Elongate with anterior margin slightly pointed, posterior margin slightly truncated, greatest width slightly anterior of center, width 83–98 percent of length. Adapical surface flat and adoral surface depressed around peristome.

Apical system.—Eccentric anteriorly with four genital pores arranged in trapezoid with anterior pair closer together than posterior pair, pores minute; single hydropore.

Ambulacra.—Petals broad, short, extending one half the distance from apical system to margin, three pore pairs (fig. 331 C) in poriferous zone of smallest specimen, 2.5 mm long; seven in largest, 7.3 mm long; pores small, difficult to discern, oblique with inner pore of pair nearest apical system. Interporiferous zones wide, three times width of poriferous zones. Minute accessory pores near sutures of ambulacral plates beyond petals.

Periproct.—Round, smaller than peristome, situated approximately midway between peristome and posterior margin, distance of periproct from peristome between 11 and 15 percent of length of specimen.

Peristome.—Pentagonal, depressed, in center of test.

Internal structure.—Ten radiating partition walls (pl. 302, figs. 11–12) arranged in pairs corresponding in location to interambulacra, most developed near margin. Auricles fused, rising abruptly at slight angle outward, expanding at base, thin at tip.

Comparison with other species.—This species is distinguished from *E. petalus* by shorter and generally wider petals and smaller pores. In *E. parviporus* the petals extend only half the distance from the apical system to the margin, whereas in *E. petalus* the petals extend over two-thirds that distance. *E. parviporus* resembles *Echinocyamus sadeki* Lambert from the Miocene (Helvetian) of North Africa, but it is less pointed anteriorly, with slightly shorter petals, wider interporiferous zones, and a much lower test than in *E. sadeki*.

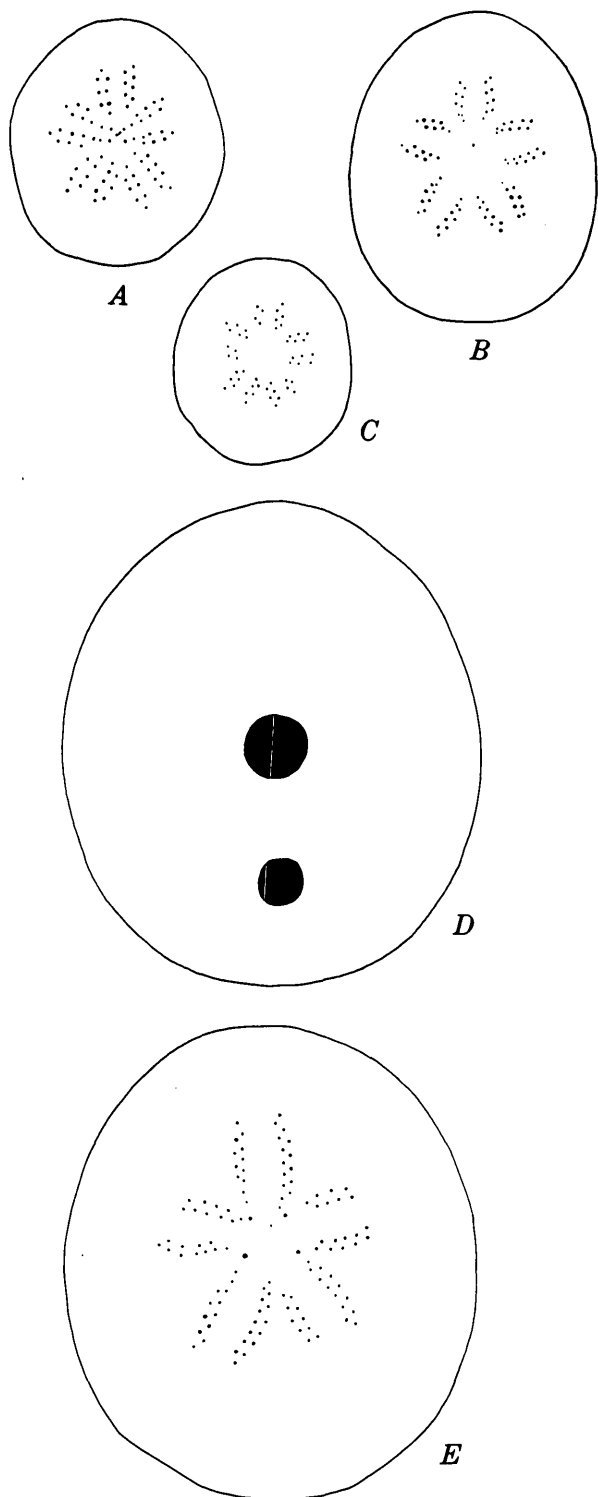


FIGURE 331.—Miocene and Pleistocene(?) echinoids. A, *Fibularia ovulum* Lamarck ($\times 10$) from Eniwetok E-1, depth 280-290 feet (Pleistocene?), USNM 563453. B, *Echinocyamus* cf. *parviporus* Kier, n. sp. ($\times 10$) from Eniwetok K-1B, depth 1,227 feet 7 inches-1,238 feet 1 inch (Miocene), USNM 563452. C-E, *Echinocyamus parviporus* Kier, n. sp. ($\times 10$). C, Immature specimen ($\times 10$) from Eniwetok E-1, depth 2,580-2,590 feet (Miocene), USNM 563448. D-E, Adoral and adapical view of specimen ($\times 10$) USNM 563451 from Eniwetok E-1, depth 2,500-2,510 feet (Miocene).

E. parviporus is easily distinguished from *Echinocyamus excavata* (H. L. Clark) from the Miocene of Fiji. *E. parviporus* has a lower wider and smaller test lacking the greatly depressed area around the peristome that characterizes the Fijian species. Clark (1945, p. 320) referred *E. excavata* to *Fibularia* on the mistaken assumption that it lacked internal partitions. However, I have cleaned a specimen of *E. excavata* and found well-developed partitions.

Occurrences: Eniwetok E-1, 1,658-1,688 ft, 2 specimens; 1,688-1,715 ft, 1 specimen; 2,500-2,510 ft, 5 specimens, 15 fragments; 2,580-2,590 ft, 1 specimen; 2,750-2,760 ft, 3 specimens. Two specimens perhaps belonging to this species from Bikini 2B (for location of hole see Emery and others, 1954, fig. 31) depths 2,493-2,514 ft.

Geologic age: Miocene (Tertiary e).

Types: Holotype USNM 563449; paratypes USNM 563447, 563448, 563450, 563451.

***Echinocyamus* cf. *parviporus* Kier**

Plate 302, figures 8-10; text figure 331B

Material.—One specimen 4.0 mm long, 3.3 mm wide, 2.7 mm high.

Remarks.—This immature specimen occurs much higher than the specimens of *E. parviporus* but may belong to this species. Its general shape, number of pore pairs, shape of petals, and position of periproct are the same as in *E. parviporus*. However, its pores are much larger. As this difference in pore size may be an individual variation, and as it is an immature specimen, it is not possible to know how important is this distinction.

Occurrence: Eniwetok K-1B, 1,227 ft, 7 in.-1,238 ft, 1 in.

Geologic age: Miocene (Tertiary e).

Figured specimen: USNM 563452.

Genus FIBULARIA Lamarck

***Fibularia ovulum* Lamarck**

Text figure 331 A

Fibularia ovulum Lamarck, 1816. Histoire Naturelle des Animaux sans Vertèbres, v. 3, p. 17.

Fibularia trigona Lamarck, 1816. Histoire Naturelle des Animaux sans Vertèbres, v. 3, p. 17.

Fibularia craniolaris Gray, 1872. Annals and Mag. Nat. History, ser. 4, v. 10, p. 123.

For complete synonymy see Mortensen, 1948, p. 208, 210.

Material.—Two specimens, one 3.4 mm long, 2.9 mm wide, 2.3 mm high.

Remarks.—This species is common in the tropical part of the Indo-Malayan seas from the Red Sea to the Philippines. Many Recent specimens were collected at Eniwetok in 1946. As a fossil it has been reported by Lambert (1932, p. 208) from the raised beaches of the

Red Sea, and by Brighton (1931, p. 326) from the Pleistocene or Pliocene (?) of the Farsan Islands.

Mortensen considered *Fibularia trigona* as a variety of *F. ovulum*. In his monograph, he included a picture of the type specimen of *F. trigona* (Mortensen, 1948, text fig. 117a) and a picture and drawing of a specimen he referred to *F. ovulum trigona* (Mortensen, 1948, pl. 46, figs. 8-9, 25, text fig. 119). He distinguished the variety *trigona* from *ovulum* by the petals and stated that the petals in *trigona* are less developed and the pores larger than in typical *ovulum*. As evidence he referred to his drawing of a specimen from the Korea Straits. In this specimen the petals are much less developed and the pores much larger, but such is not the case in the type specimen of *F. trigona* in which the petals and pores are indistinguishable from those of typical *F. ovulum*. It is my opinion that *F. trigona* is a synonym of *F. ovulum* and that Mortensen's specimens of *Fibularia* from the Korea Straits probably represents a new species. In the Fibularids, the shape and character of the petals is a diagnostic feature of a species and shows little variation within specimens of the same species.

Occurrence: Eniwetok E-1, 230-240 ft., 280-290 ft.

Geologic age: Probably Pleistocene.

Figured specimen: USNM 563453.

Echinoid fragments

There are many fragments of spines of regular echinoids, both cidarid and noncidarid, and plates of irregular echinoids in the collections. I am not able to identify these fragments.

Occurrences: Bikini 2A, depths 192-1,303 ft.; 2B, 1,650-2,503 ft.; Eniwetok E-1, depths 110-2,880 ft.; F-1, 55-1,050 ft.; K-1B, 957 ft. 3 in.-967 ft. 9 in.

Geologic age: Eocene to Pleistocene(?).

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PLATE 302

[All figures are 10 times natural size. Photographs by Jack Scott]

FIGURES 1-7. *Echinocyamus petalus* Kier, n. sp. (p. 1121).

1-3. Adapical, right side, adoral views of USNM 563443, from depths of 2,920 to 2,930 ft (Upper Eocene). Drawing of this specimen on text figure 330.

4. View showing internal partitions of USNM 563444, from depths of 2,790 to 2,802 ft (Upper Eocene).

5-7. Adapical, right side, adoral views of USNM 563445, from depths of 2,790 to 2,802 ft (Upper Eocene). Compare with figs. 1-3: note more elongate test and position of periproct nearer peristome as typical of specimen from higher horizon. Drawing on text figure 330.

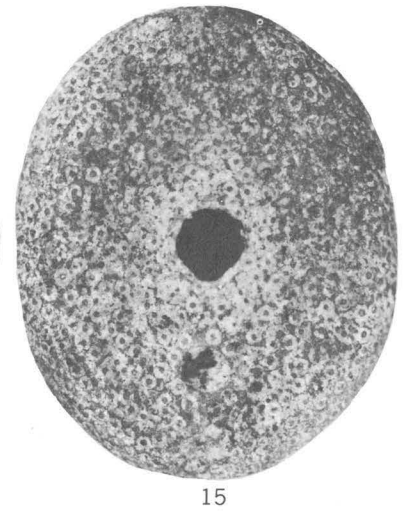
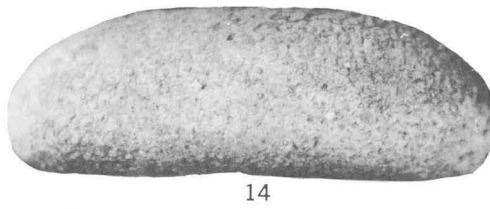
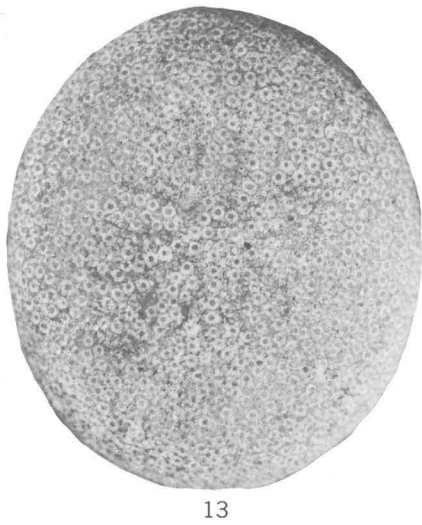
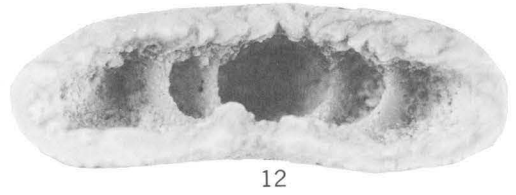
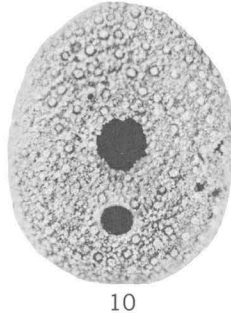
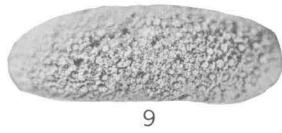
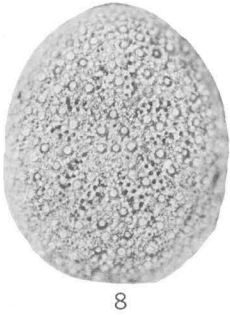
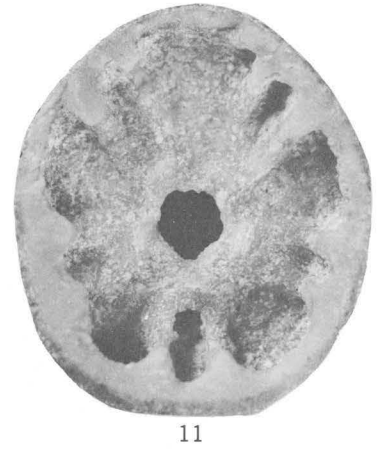
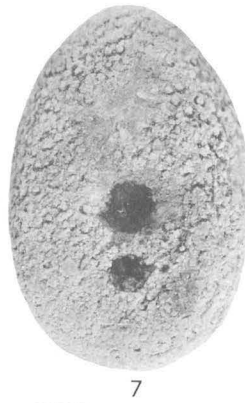
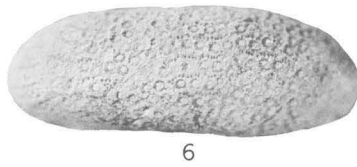
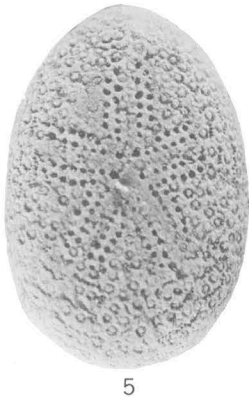
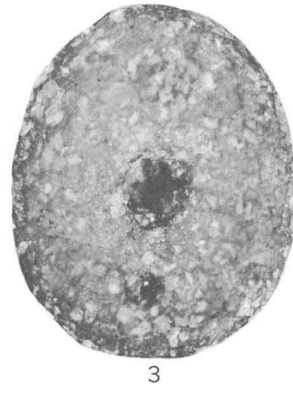
8-10. *Echinocyamus* cf. *parviporus* Kier, n. sp. (p. 1125).

Adapical, right side, adoral views of USNM 563452, from depths of 1,227 ft 7 in. to 1,238 ft 1 in. (Miocene). Drawing of figure 8 on text figure 331 B.

11-15. *Echinocyamus parviporus* Kier, n. sp. (p. 1124).

11, 12. Views showing internal partitions of USNM 563447 and 563450, from depths of 2,500 to 2,510 ft (Miocene).

13-15. Adapical, right side, adoral views of holotype USNM 563449, from depths of 2,500 to 2,510 ft (Miocene).



EOCENE AND MIOCENE *ECHINOCYAMUS*