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Echinoids from the Korytnica basin (Middle Miocene; Holy Cross Mountains, Poland)

ABSTRACT: The assemblage of echinoids from the Korytnica basin (Middle Miocene; Holy Cross Mountains, Central Poland) comprises mostly the representatives of the genus *Echinocyamus* van Phelsum in which four species are recognized (*E. pusillus, E. pseudopusillus, E. circularis, E. linearis*). Other taxa are represented i.a. by *Arbacina monilis, Parasalenia fontannesi, Schizaster ventiensis*, and many fragments of Aristotle's lantern, as well as plates, and spines of Cidaridae. Some remarks on the ecology of the investigated genera *Echinocyamus* and *Schizaster* are presented.

INTRODUCTION

The echinoids from the Miocene of Poland have not hitherto been investigated paleontologically, except of a few reports presented by Roemer (1870), Gołąb (1932), and Radwański (1973). From the Korytnica basin developed on the southern slopes of the Holy Cross Mountains, Central Poland (*cf.* Bałuk & Radwański 1977), only Kowalewski (1930) reported the occurrence of spines and isolated plates assigned to *Spatangus* sp., while Bałuk (1975) recorded the abundant *Echinocyamus* in the marly sands.

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MATERIAL

The collection of echinoids consists largely of specimens found in the marly sands overlying the Korytnica Clays (*cf.* Bałuk & Radwański 1977); the collection obtained from sifted samples of the Korytnica

Clays is much smaller. The specimens from the marly sands represent mostly the genus *Echinocyamus* van Phelsum, the tests of which are usually completely preserved although often deformed. The Korytnica Clays provided more diverse and relatively well preserved material, e.g. almost complete tests of *Parasalenia fontannesi* Cotteau, and *Arbacina monilis* Desmaret, or some fragments of the latter (*cf.* Pl. 3), as well as isolated plates, spines, and loose elements (*cf.* Sieverts--Doreck 1958, Philip 1969) of Aristotle's lanterns (*cf.* Pls 1—2). Larger specimens in the Korytnica Clays have completely been destroyed, either on the sea bottom, or during compaction, as shown by the presence of common fragments of the spatangoid tests, that should certainly be attributed to genus *Spatangus* Leske.

The collection is housed at the Museum of the Earth (Polish Academy of Sciences) in Warsaw, and kept under the Catalogue Numbers *MZ VIII Ee 883—955.*

SYSTEMATIC DESCRIPTION

Family **Cidaridae** Gray, 1825
Genus *CIDARIS* Leske, 1778
Cidaris cf. *desmoulinsi* Sismonda, 1842
(Pl. 1, Figs 7 and 13)

1915. Cidaris Desmoulinsi Sism.; M. E. Vadász, p. 104, Pl. 8 (2), Fig. 6.
Material: Two spine fragments (specimens *No. MZ VIII Ee 885*) from the Korytnica Clays.

Remarks. — The investigated spines are relatively massive and uniformly ornamented. Strongly developed thorny raws form regular and fairly tight files. Because of the lack of spine bases, the investigated specimens cannot be assigned specifically with certainty.

Occurrence. — Spines of *Cidaris desmoulinsi* Sismonda have hitherto been reported from the Miocene of Hungary (Vadász 1915).

Cidaris sp. div.
(Pl. 1, Figs 4—6, 9—12 and 14—16)

Material: Fifteen spine fragments and five interambulacral plates (*MZ VIII Ee 885—890*) from the Korytnica Clays.

Remarks. — The investigated spines and plates represent probably diverse species of the genus *Cidaris* Leske. Their precise recognition is impossible because of too small sample size and poor preservation state of the material.

Cidarid spines, isolated plates, or test fragments occur commonly in the Miocene deposits. Their occurrence in the Korytnica basin is remarkable since the Cidaridae have not insofar been recorded from the Miocene of Poland. The investigated spines and plates resemble in their ornamentation those described from the Miocene of the Rhone basin (Lambert 1910), Kenya (Stephenson 1968), Brazil (Brito & Ramires 1974), New Zealand (Fell 1954), and Australia (Philip 1963).

Family **Diadematidae** Gray, 1855
Genus *CENTROSTEPHANUS* Peters, 1855
Centrostephanus calarensis Cotteau, 1905
(Pl. 1, Fig. 8)

1907. *Centrostephanus calarensis* Cotteau; J. Lambert, p. 28, Pl. 1, Figs 19 and 20.
1915. *Centrostephanus calarensis* Cott. sp.; M. E. Vadász, p. 106, Pl. 2, Fig. 11.
Material: Two spine fragments, one of which preserved with its base (*MZ VIII Ee 883*) from the Korytnica Clays.

Remarks. — The investigated specimens are well preserved and consistent with those described by Lambert (1907) and Vadász (1915).

Occurrence. — Spines of *Centrostephanus calarensis* Cotteau were reported from the Miocene of Sardinia (Lambert 1907) and Rumania (Vadász (1915).

Family **Temnopleuridae** A. Agassiz, 1872
Genus *ARBACINA* Pomel, 1869
Arbacina monilis Desmaret
(Pl. 3, Figs 6—9)

1884. *Psammechinus monilis,* Desor.; M. Bazin, p. 34, Pl. 1, Figs 15—21.
1910. *Arbacina monilis* Desmaret; J. Lambert, Pl. 1, Figs 65 and 66.
1915. *Arbacina monilis* Desm. sp.; M. E. Vadász, p. 109.
1950. *Arbacina monilis* Des-manest; E. Szörényi, p. 140, Pl. 1, Fig. 1a-b.
Material: One slightly deformed test and several test fragments and isolated plates (*MZ VIII Ee 941—955*) from the Korytnica Clays.

Remarks. — The best preserved specimen is consistent with the descriptions and illustrations given by Bazin (1884) and Szörényi (1950), and the illustrations given by Lambert (1911). In the test size and shape it resembles the specimens from the Rhone basin (Lambert 1910) or Mecsek Mts (Szörényi 1950) rather than those from the Miocene of Brittany (Bazin 1884). Some of the test fragments may resemble the species *Arbacina catenata* Desor studied by Lambert (1910, p. 27, Pl. 1, Figs 52—58).

Occurrence. — Miocene of Brittany (Bazin 1884), of the Rhone basin (Lambert 1910) in France, and of the Mecsek Mts in Hungary (Szörényi 1950).

Arbacina sp.
(Pl. 1, Figs 1—3)

1915. *Arbacina* sp.; M. E. Vadász, p. 109, Pl. 2, Fig. 5.
Material: Eight whole spines and six fragments (*MZ VIII Ee 884*) from the Korytnica Clays.

Remarks. — The investigated specimens are consistent with the description and illustration given by Vadász (1915).

Occurrence. — Spines of *Arbacina* sp. were recorded in the Miocene of Rumania (Vadász 1915).

Family **Parasaleniidae** Mortensen, 1903
Genus *PARASALENIA* A. Agassiz, 1863
Parasalenia fontannesi Cotteau, 1888
(Pl. 3, Figs 1—5)

1910. *Parasalenia Fontanesi* Cotteau; J. Lambert, p. 21, Pl. 1, Figs 47—51.
1921. *P. Fontannesi* Cotteau; J. Lambert & P. Thiéry, p. 269.

Material: Fifteen specimens, mostly well preserved tests (*MZ VIII Ee 926—935*) from the Korytnica Clays.

Remarks. — The investigated specimens are consistent with the description given by Lambert (1910). The species is related to *Parasalenia marianae* Cook from the Miocene of Japan (*cf.* Nisiyama 1966; p. 262, Pl. 10, Figs 8—10).

Occurrence. — Miocene of the Rhone basin (Lambert 1910).

Family **Fibulariidae** Gray, 1855
Genus *ECHINOCYAMUS* van Phelsum, 1774

Several species of the genus *Echinocyamus* van Phelsum were also ascribed (*cf.* Lambert 1907; Lambert & Thiery 1921; Szörényi 1950, 1953) to the genus *Fibularia* Lamarck which differs from the former in the lack of internal septa. All the investigated species, coming both from the Korytnica Clays and the overlying marly sands, are assigned to the genus *Echinocyamus*, which is consistent with the opinions of the species authors, since there are weakly developed septa in the material studied (*cf.* Pl. 5, Fig. 5).

Echinocyamus pusillus (O. F. Müller, 1776)
(Pl. 5, Figs 1—4)

1948. *Echinocyamus pusillus* (O. Fr. Müller); T. Mortensen, p. 178, Text-fig. 96 [*synonymy given*].
1950. *Fibularia pusilla* Müller; E. Szörényi, p. 141, Pl. 1, Figs 2a and 3a.
1966. *Echinocyamus pusillus;* W. Durham, p. U455, Text-fig. 340/1—2.
Material: Eight fairly well preserved specimens (*MZ VIII Ee 921—925*).

Remarks. — The investigated specimens are consistent with the descriptions and illustrations given by Mortensen (1948), Szörényi (1950), and Durham (1966). Since Miocene time through Recent this has been one of the most common species of the genus *Echinocyamus;* however, in the Korytnica basin it occurs rather rarely. The juvenile specimens (Pl. 5, Figs 2*a-c*) resemble *Echinocyamus circularis* Capeder but they are more elongate along the symmetry axis, and almost ovate. The shape of the adults (Pl. 5, Figs *a-c*) is typical of the species; it is contracted anteriorly, widened posteriorily, and semi-ovate in the side view.

Occurrence. — This is widely distributed species ranging in Europe since the Miocene through Recent (Mortensen 1948). In the Miocene of Poland it was reported by Gołąb (1932, p. 31) from Niechobrz at the Carpathian margin.

Echinocyamus pseudopusillus Cotteau, 1895
(Pl. 6, Figs 1—3)

1906. *Echinocyamus pseudopusillus* Cotteau; G. Capeder, p. 522, Pl. 10, Figs 21a—b.
1907. *Fibularia pseudopusilla* Cotteau; J. Lambert, p. 39, Pl. 3, Figs 14—19.
1950. *Fibularia pseudopusilla* Cotteau; E. Szörényi, p. 142, Pl. 1, Figs 4 and 4a.
1953. *Fibularia pseudopusilla* (Cotteau); E. Szörényi, p. 60.
Material: Ten fairly well preserved specimens (*MZ VIII Ee 901*).

Remarks. — The investigated specimens are consistent with the descriptions given by Capeder (1906), Lambert (1907), and Szörényi (1950). The test is distinctly elongated along the symmetry axis, and contracted anteriorily, while its height is relatively small. A similar species is distinguished in the Eocene of the United States (*cf.* Kier 1968) as *Echinocyamus bisexus* Kier.

Occurrence. — Miocene of Sardinia (Capeder 1906; Lambert 1907), Hungary (Szörényi 1950), and Podolia in the Ukraine, Soviet Union (Szörényi 1953).

Echinocyamus circularis Capeder, 1906
(Pl. 6, Figs 4—5)

1906. *Echinocyamus circularis*, n. f.; G. Capeder, p. 519, Pl. 10, Figs 14a-d and 17a-c.
Material. Over half a hundred specimens (*MZ VIII 902—905*).

Remarks. — This species occurs commonly in the Korytnica basin. Among the investigated species of the genus *Echinocyamus* it appears as the highest one; it is slightly conical in shape (Pl. 6, Figs 4*c* and 5*c*). The specimens studied are consistent with the original characteristics given by Capeder (1906). In general, this species resembles *Echinocyamus marioi* Lovisato recorded in the Miocene of Sardinia (Capeder 1906) and Bulgaria (Kojumdgieva 1960).

Occurrence. — Miocene of Sardinia (Capeder 1906).

Echinocyamus linearis Capeder, 1906
(Pl. 7, Figs 1—6)

1906. *Echinocyamus linearis*, n. f.; G. Capeder, p. 517, Pl. 10, Fig. 12a-c.
Material: Over three hundreds fifty specimens, of differential sizes (*MZ VIII Ee 905—920*).

Remarks. — This is the most common echinoid species in the Korytnica basin. The shape and morphology of investigated tests are entirely consistent with the original description and illustrations given by the species author (Capeder 1906). The investigated material comprises both low, flattened (Pl. 7, Figs 2, 4 and 5), and high, slightly convex specimens (Pl. 7, Figs 1, 3 and 6); the pentagonal shape is most distinct in the adults (Pl. 7, Figs 5*a*, *b* and 6*a*, *b*). Periproct is suboval or oval, primarily marginal, with a distinct depression of the anal area.

Occurrence. — Miocene of Sardinia (Capeder 1906).

Family **Schizasteridae** Lambert, 1905
Genus *SCHIZASTER* L. Agassiz, 1836
Schizaster ventiensis Lambert, 1836
(Pl. 8, Fig. 1*a-g*)

1915. *Schizaster ventiensis* Lambert; M. E. Vadász, p. 222, Pl. 9 (3), Fig. 19.
Material. One specimen found in the uppermost part of the Korytnica Clays exposed at Karsy; the test is partly broken and its lower surface is absent (*MZ VIII Ee 900*). Another, damaged specimen comes from marly sands exposed at Chomentów (collection of Docent A. Radwański, University of Warsaw).

Remarks. — The shape and morphology of the investigated tests are consistent with the description and illustration given by Vadász (1915), although the specimens studied are somewhat larger. The investigated species is most closely related to *Schizaster karreri* Laube from the Miocene of the Vienna basin (*cf.* Laube 1871).

Occurrence. — Miocene of France and Rumania (Vadász 1915).

REMARKS ON ECOLOGY

The most common in the Korytnica basin are the echinoids of the genus *Echinocyamus*. The species *E. linearis* Capeder occurs almost in masses; *E. circularis* Capeder occurs fairly abundantly; while *E.*

pseudopusillus Cotteau and *E. pusillus* (O. F. Müller) are relatively uncommon. Many observations on life habits and ecology (Mortensen 1948; Nichols 1959) were made on the present-day individuals of *E. pusillus*. At present, this species lives usually at depths of 35—55 m (Nichols 1959). Owing to the adaptations of some test elements and accessory tube feet to ensure an adequate circulation of water, the individuals are able to burrow in bottom sediment (Nichols 1959; Durham 1966). The bathymetric range of the genus *Echinocyamus* is recorded as 20—1886 metres (Kier 1966).

The species of the genera *Cidaris, Arbacina, Centrostephanus,* and *Parasalenia,* recorded in the Korytnica basin represent vagile echinoids. In general, they are adapted to living on fairly firm or sandy substrates (Hyman 1955); however, in the Korytnica basin they lived on the clayey substrate.

The echinoid asemblage of the Korytnica basin consists of thermophilic forms, which is indicated *e.g.* (*cf.* Fell 1954) by the presence of the representatives of the genus *Schizaster*.

Most of the investigated species occur also in the Miocene of the Rhone basin (Lambert 1910, 1912, 1913), Sardinia (Capeder 1906; Lambert 1907), and Transylvania (Vadász 1915; Szörényi 1950); some species are common with the Miocene of Podolia in the Ukraine, Soviet Union (Szörényi 1953).

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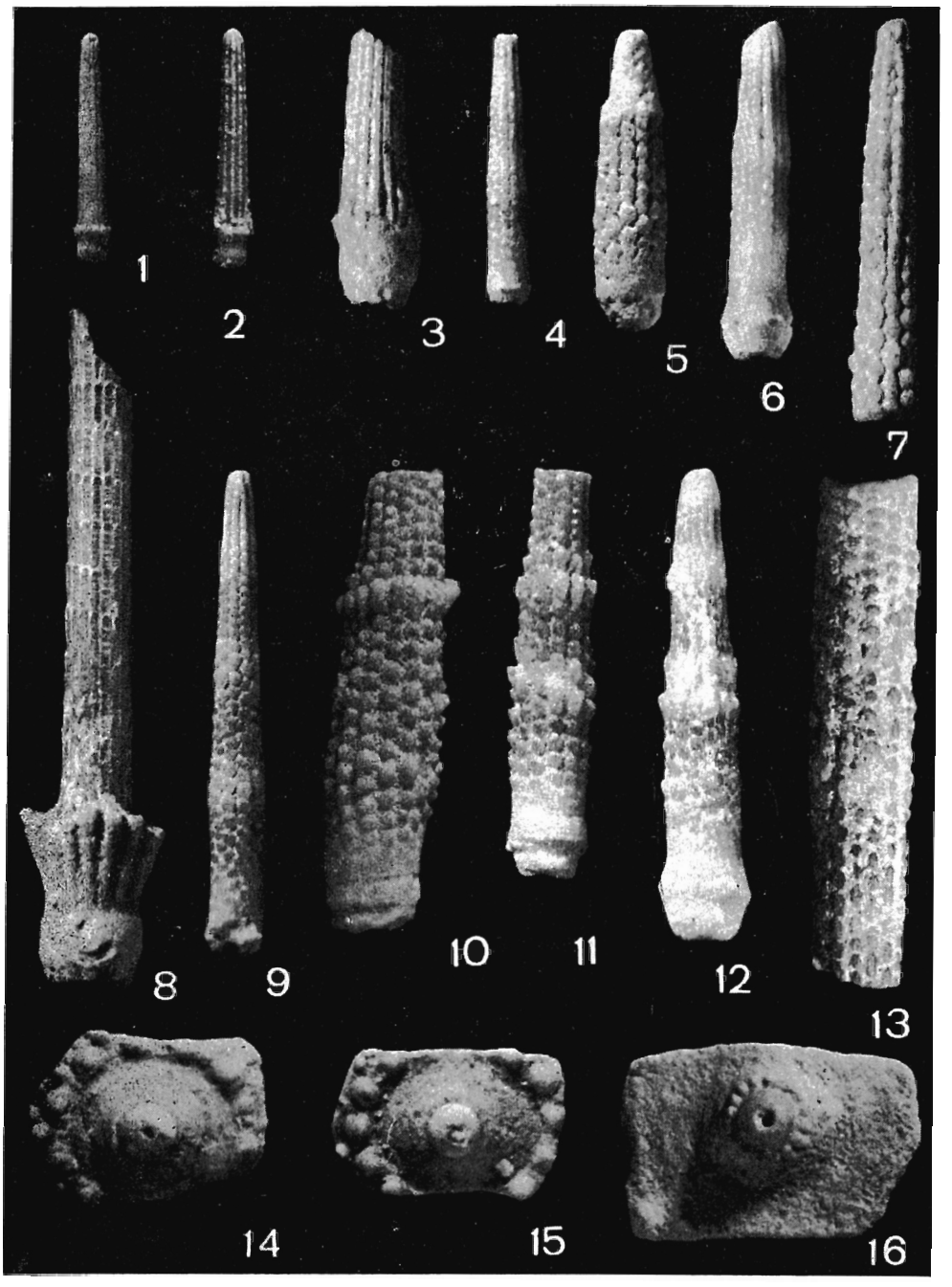
S. MĄCZYŃSKA

JEŻOWCE Z BASENU KORYTNICY

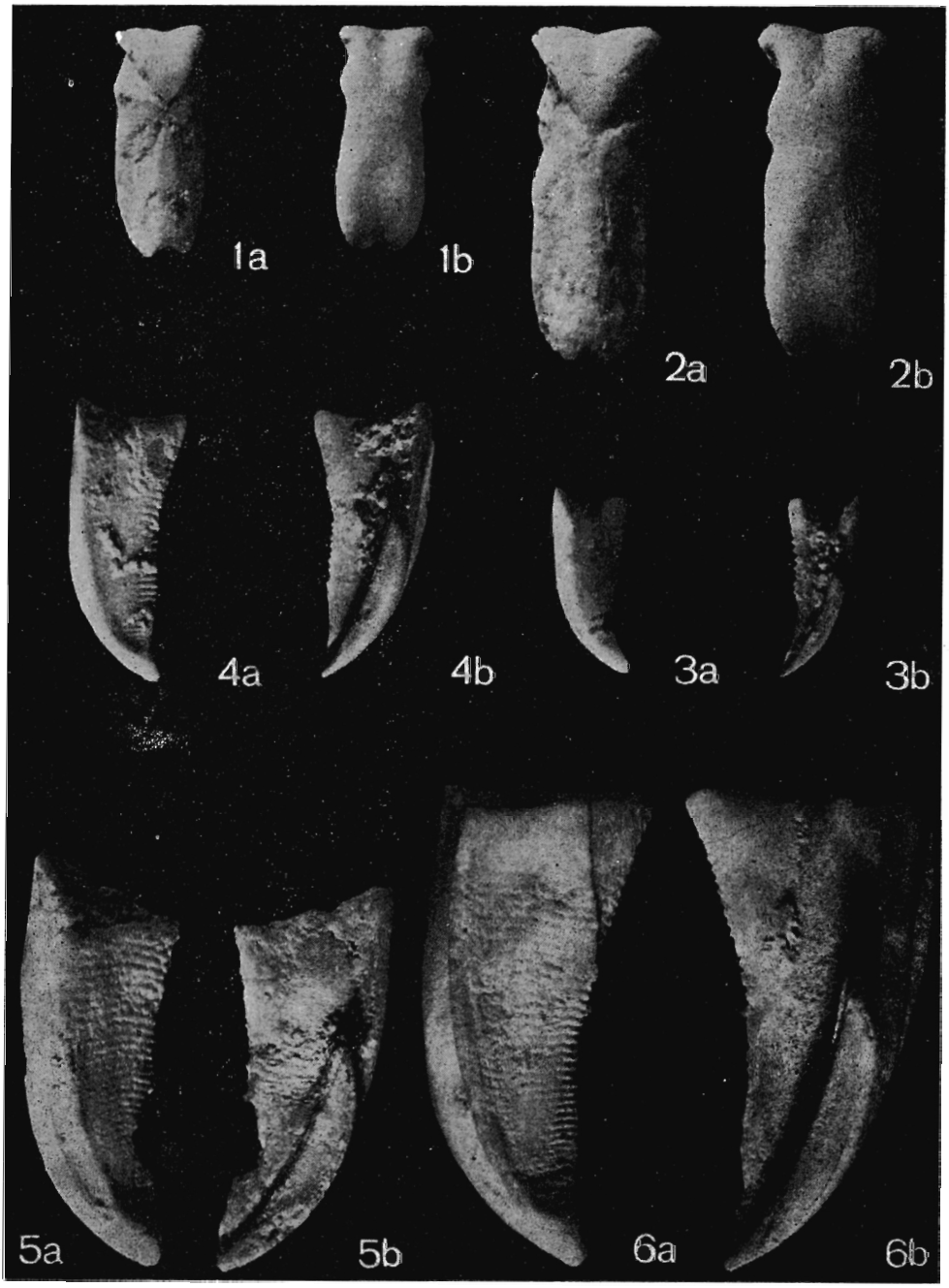
(Streszczenie)

Praca przedstawia charakterystykę zespołu jeżowców występujących w różnych osadach mioceńskiego basenu Korytnicy (*por.* Bałuk & Radwański 1977). W badanym zespole (patrz pl. 1—6) najbardziej liczną ilościowo i gatunkowo grupę stanowią przedstawiciele rodzaju *Echinocyamus* van Phelsum, wśród których oznaczono cztery gatunki: *E. pusillus* (O. F. Müller), *E. pseudopusillus* Cotteau, *E. circularis* Capeder oraz *E. linearis* Capeder. Rzadziej występują *Arbacina monilis* Desmaret, *Parasalenia fontannesi* Cotteau, oraz *Schizaster ventiensis* Lambert. Obok całych okazów znaleziono luźne elementy rozmaitych pancerzy, np. kolce i płytki osobników z rodzaju *Cidaris* Leske, oraz luźne fragmenty latarni Arystotelesa (piramidy i tarki; *por.* pl. 2).

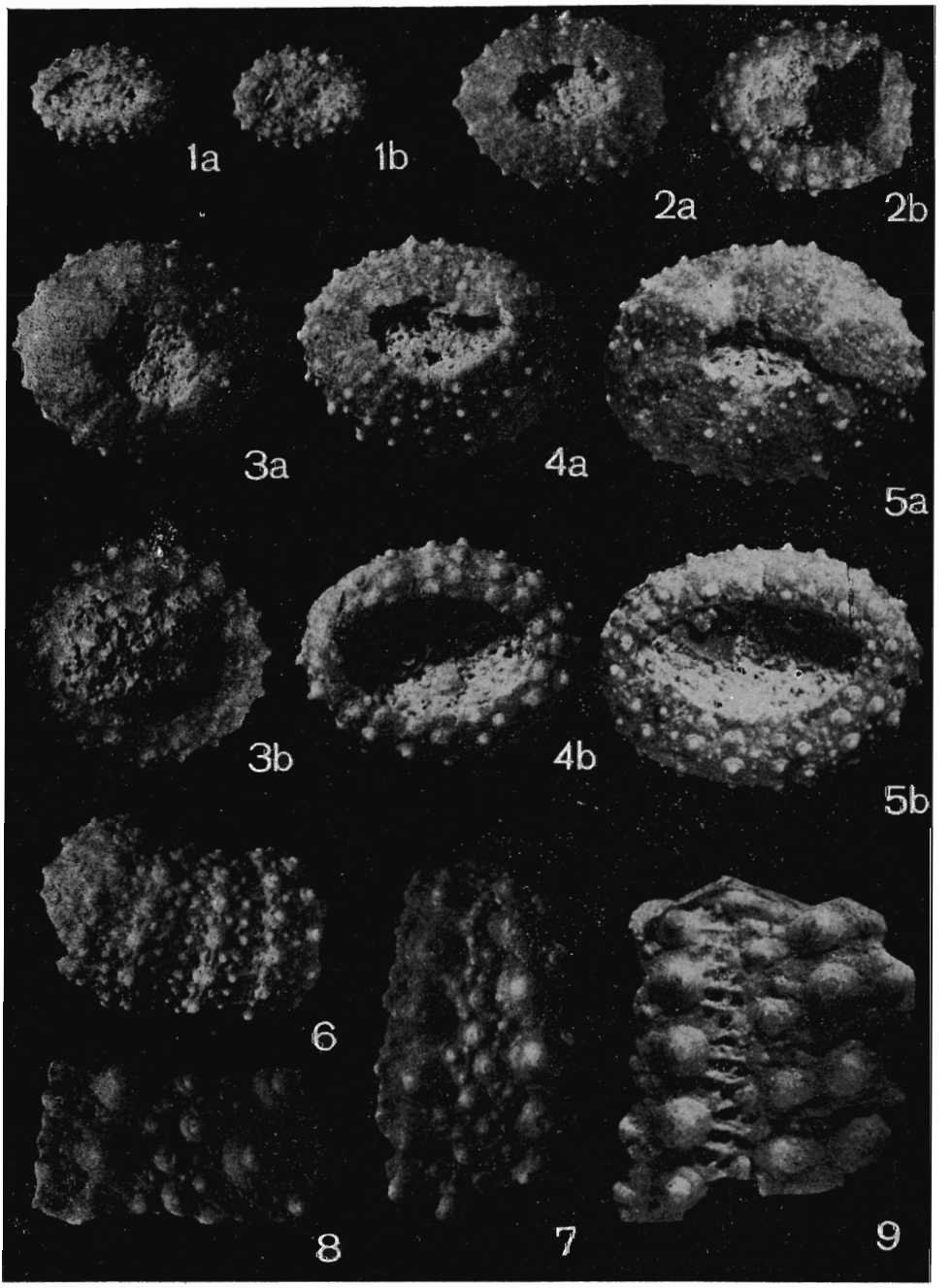
Stwierdzono, że wśród jeżowców z basenu Korytnicy przeważają formy wspólne z miocenem śródziemnomorskim (Sardynia, basen Rodanu).



1—3 *Arbacina* sp.; specimens No. *Ee 884.*
4—6 *Cidaris* sp. div.; specimens No. *Ee 885—886.*
8 *Centrostephanus calarensis* Cotteau; specimen No. *Ee 883.*
9—12 *Cidaris* sp. div.; specimens No. *Ee 886* and *891*
7, 13 *Cidaris* cf. *desmoulinsi* Sismonda; specimens No. *Ee 885.*
14—16 *Cidaris* sp.; specimens No. *888—890.*
All photos taken × 7.5

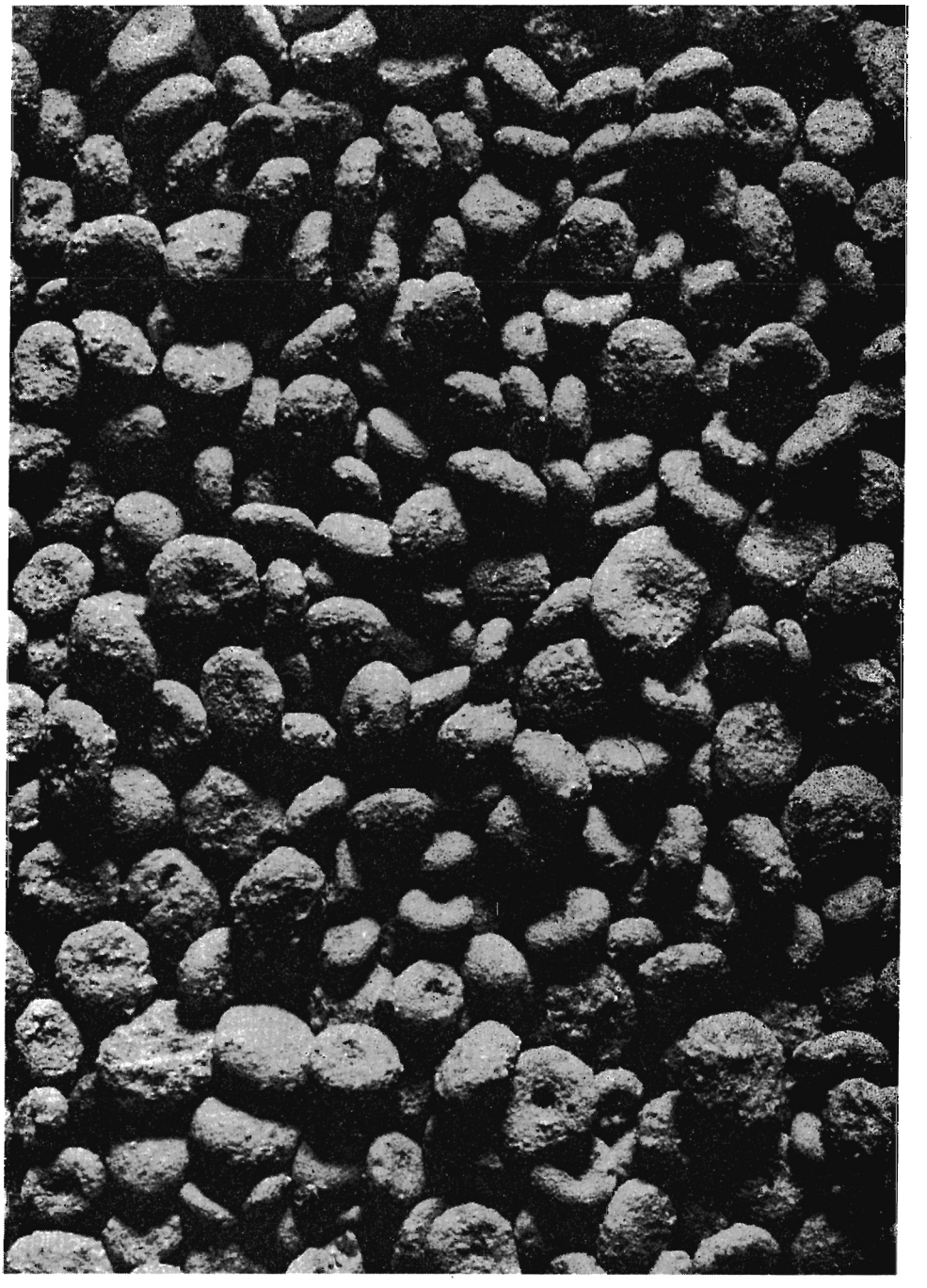


1—6 Elements of Aristotle's lanterns: *1—2* rotules (specimens No. *Ee 894—895*), *3—6* demipyramids (specimens No. *Ee 896—899*); all × 7.5
a—b views of the same specimen from both sides

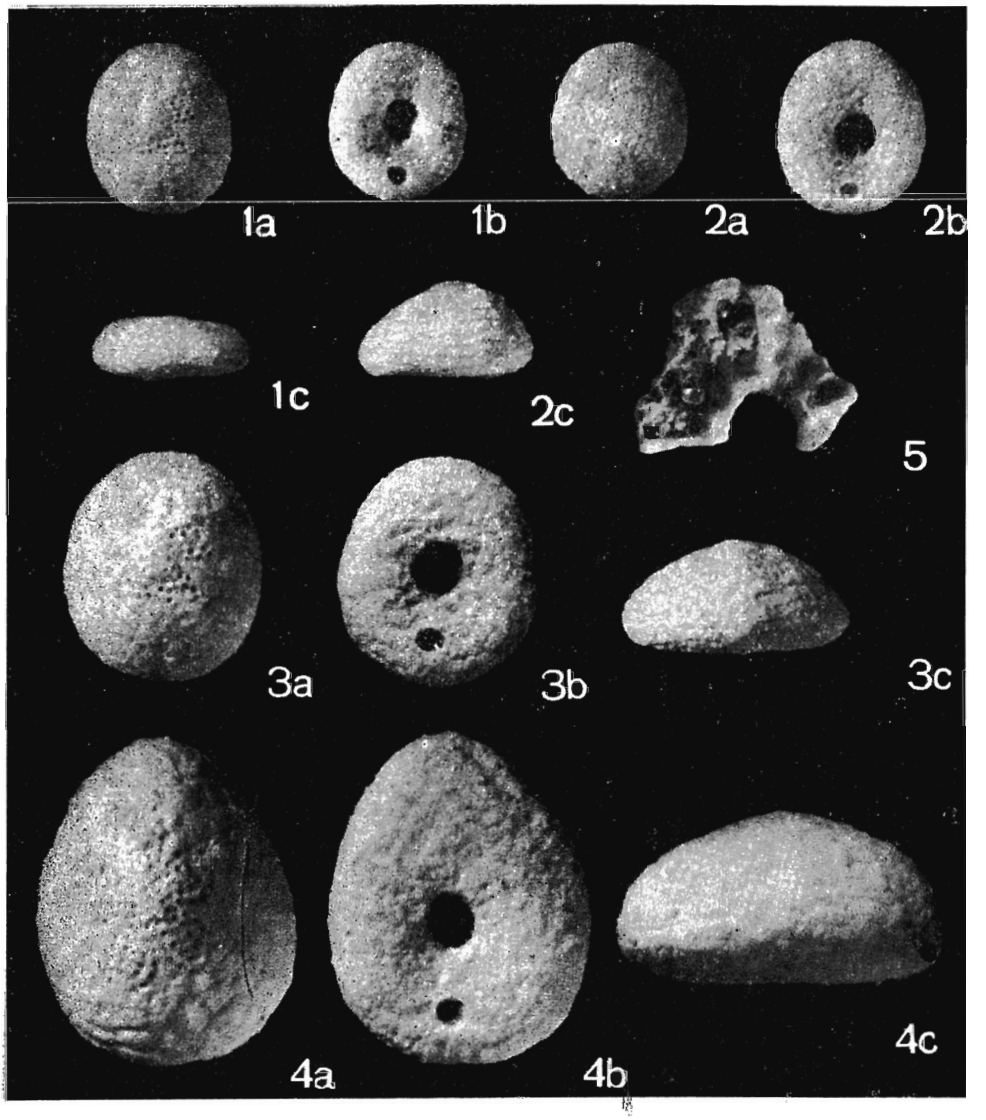


1—5 *Parasalenia fontannesi* Cotteau: *1* specimen No. *Ee 926; 2* No. *Ee 928; 3* No. *Ee 930; 4* No. *Ee 931; 5* No. *Ee 933*
a aboral view, *b* oral view; all × 7.5

6—9 *Arbacina monilis* Desmaret
6 fragment of the test (specimen No. *Ee 943*), *7* interambulacral plates (specimen No. *Ee 944*), *8, 9* ambulacral plates (specimens No. *Ee 946—947*): all × 7.5

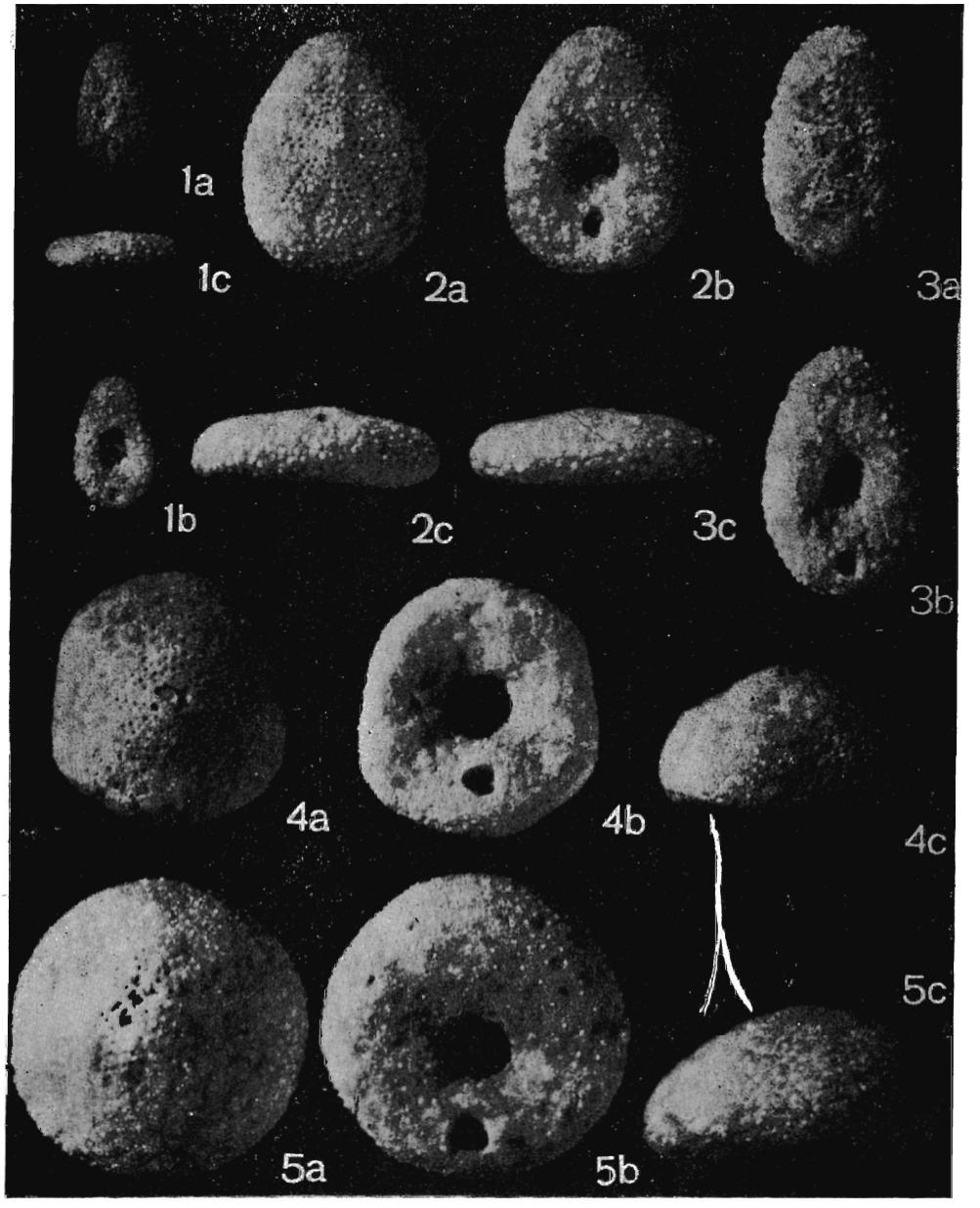


A sample of the sifted material with abundant, diverse species of *Echinocyamus* from the marly sands; × 5

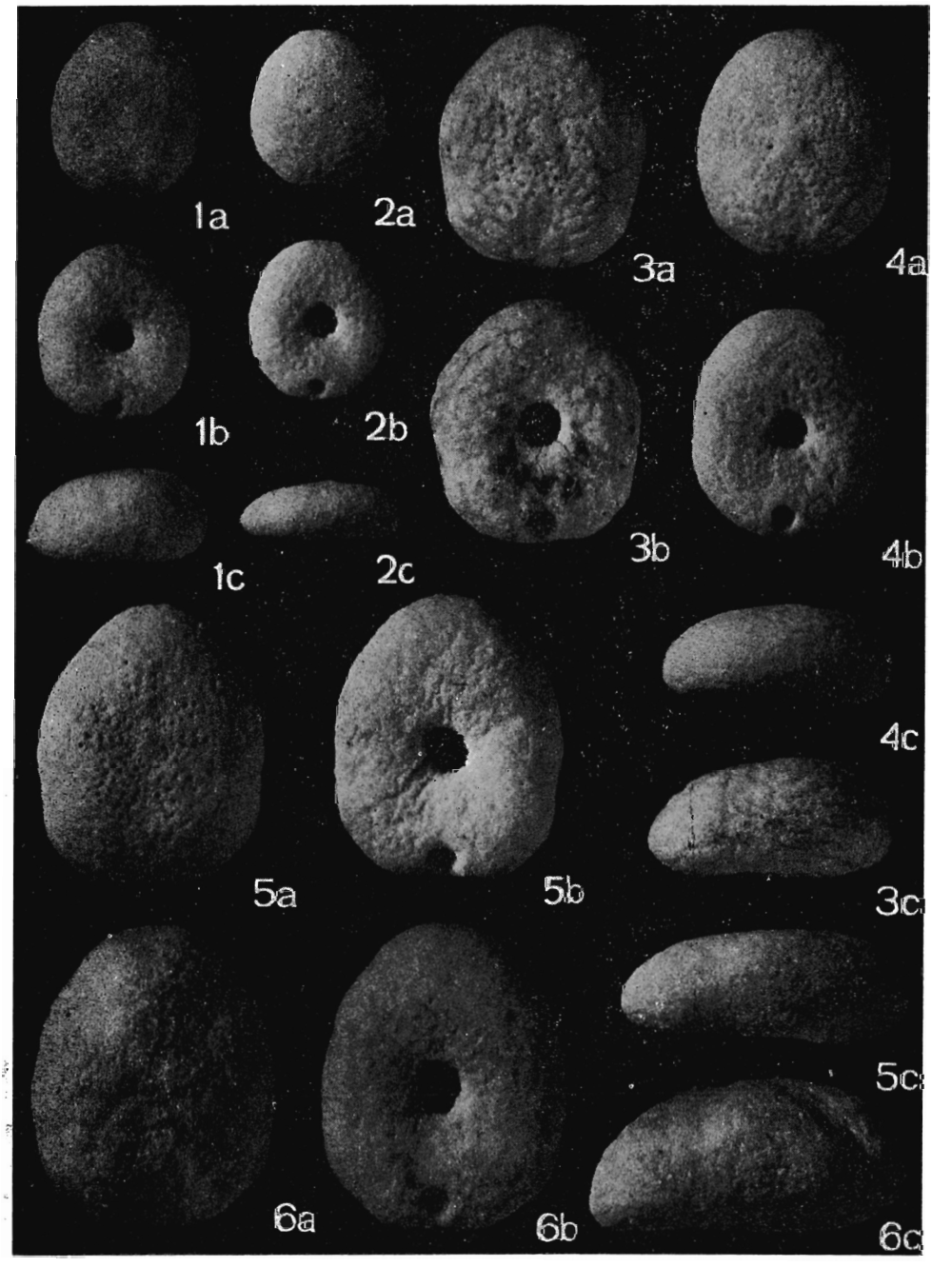


1—4 *Echinocyamus pusillus* (O. F. Müller); specimens No. *Ee 921—924*
a — aboral, *b* — oral, *c* — side view; all × 7.5

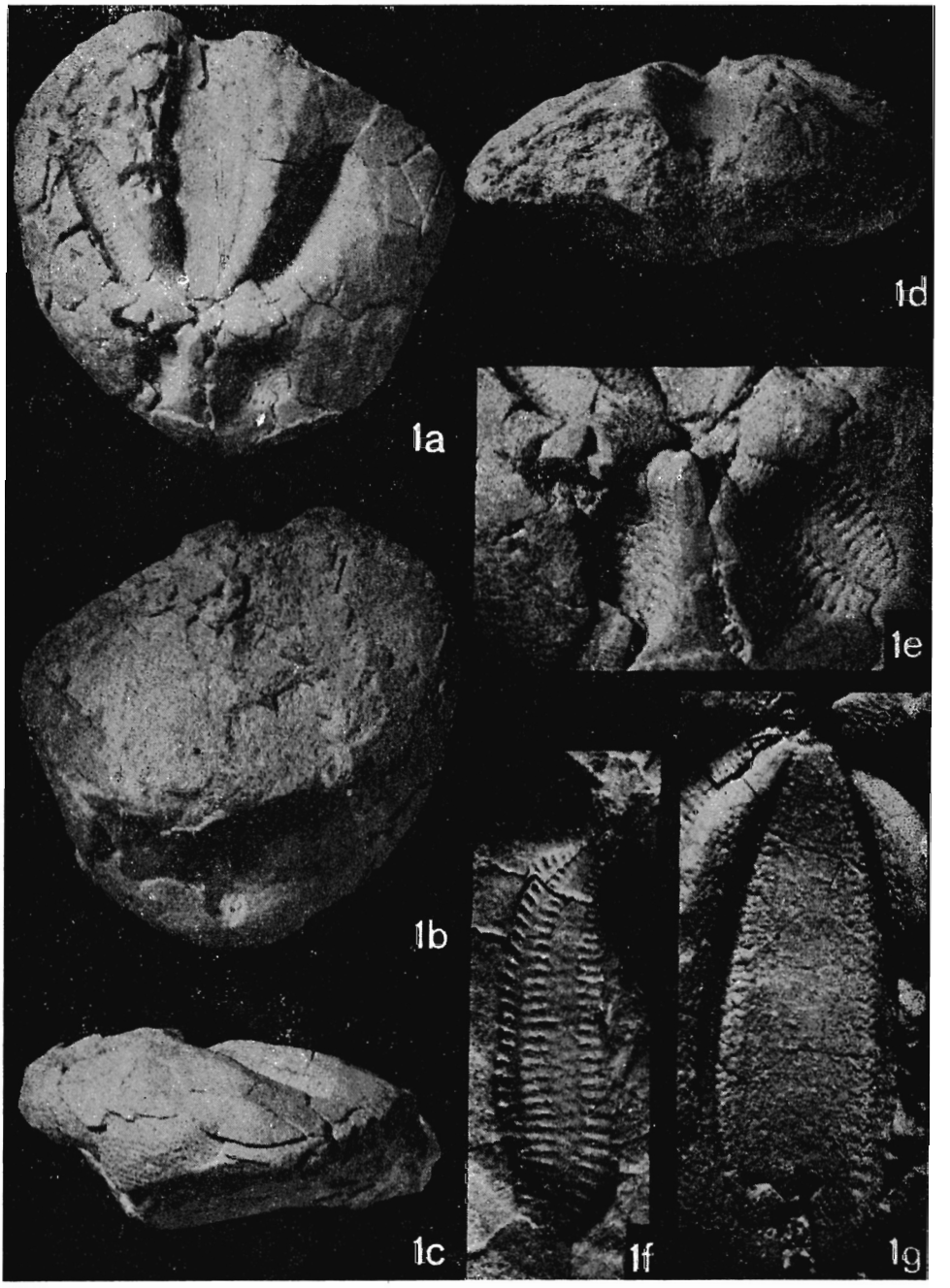
5 *Echinocyamus* sp.; specimen No. *Ee 920;* internal view to show the radial supports; × 7.5



1—3 *Echinocyamus pseudopusillus* Cotteau; specimens No. *Ee 901*
4—5 *Echinocyamus circularis* Capeder; specimens No. *Ec 902—903*
a aboral, *b* oral, *c* side view; all × *c* 7.5



1—6 *Echinocyamus linearis* Capeder; specimens No. *Ee 905—910*
a aboral, *b* oral, *c* side view; all × *c* 7.5



1 *Schizaster ventiensis* Lambert; specimen No. *Ee 900*
a aboral, *b* oral, *c* side, *d* posterior view; all × 1.5
e petal of ambulacrs *I* and *V*, *f* petal of ambulacrum *II*; *g* petal of ambulacrum *III*; all × 5