

PART T
ECHINODERMATA 2
CRINOIDEA

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VOLUME 2

SYSTEMATIC DESCRIPTIONS

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CRINOIDEA

Class CRINOIDEA Miller, 1821

[Crinoidea MILLER, 1821, p. 7 (family)] [=Stylasteritae MARTIN, 1809; Stylasteritae GOLDFUSS, 1826-33; Asterocrinitidae DE BLAINVILLE, 1834-37; Pinnigrada FORBES, 1841; Pinnastella AUSTIN & AUSTIN, 1842, p. 5; Brachiata BURMEISTER, 1856; Encrines PICTET, 1857, p. 278 (order); Actinoidea ROEMER, 1852-54, p. 224 (suborder); Eucrinoidea ZITTEL, 1879, p. 341] [Diagnosis by GEORGES UBAGHS]

Crinozoa provided with true arms; pentamerous symmetry well developed; theca di-

vided into aboral cup and adoral tegmen, comprising five radial plates from which invariably the aboral skeleton of the arms starts; radial growth pattern concentrated on arms, which are directed away from theca; column ordinarily well developed, lost in postlarval stage in some forms. *M. Cam.*; *L. Ord.-Holo.*

ECHMATOCRINEA

By JAMES SPRINKLE and RAYMOND C. MOORE

[University of Texas at Austin; University of Kansas]

Subclass ECHMATOCRINEA Sprinkle & Moore, new subclass

Primitive crinoids with an irregularly plated cup, plate circllets unrecognizable except for possible thin radials(?) directly below arms; no stem, cup attached to objects on substrate by long or short, irregularly plated holdfast; eight to 10 short, uniserial, atomous arms attached to rim of cup, 10 to 12 heavily plated brachials per arm bearing smaller soft appendages (?tube feet) attached alternately to each side of brachials; no tegmen structures known. *M. Cam.* (*Bathyriscus-Elrathina Zone*).

The subclass Echmatocrinea is based on

a single genus and species known from only five partially complete specimens and a single brachial plate from the Middle Cambrian Burgess Shale of western Canada. Unfortunately, none of these specimens is well enough preserved to show the original plating arrangement of the cup and holdfast. At least four specimens were found by C. D. WALCOTT between 1910 and 1917, but owing to their rarity, incompleteness, and relatively poor preservation, he did not describe or name them. The best preserved specimen was obtained by the Geological Survey of Canada in the summer of 1967 and has been chosen as holotype of *Echmatocrinus brachiatus* SPRINKLE (1973a).

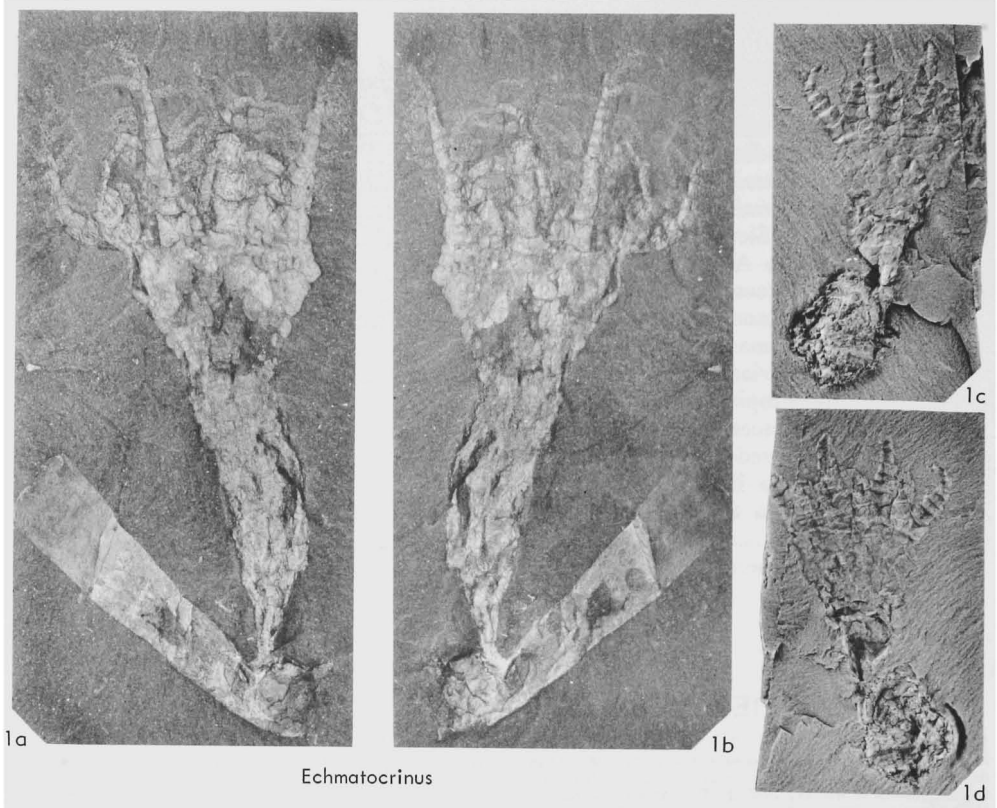


FIG. 219. *Echmatocrinidae* (p. T407) (Sprinkle, 1973a; from Special Publication of the Museum of Comparative Zoology, Harvard University (1973), courtesy of the Museum of Comparative Zoology).

Echmatocrinus is now the earliest crinoid (and crinozoan) known from the fossil record, predating the next oldest occurrence in the Early Ordovician (Tremadocian-Arenigian) of France and England by approximately 30 to 40 million years. It is also the most primitive known crinoid in terms of its cup, attachment appendage, and arm morphology. Except for its heavily plated atomous arms, which are definitely crinoid-like, *Echmatocrinus* resembles several Cambrian eocrinoids that also have irregular calyx plating and an attachment holdfast.

Echmatocrinus is probably most closely related to some early members of the crinoid subclass Inadunata, especially in its simple arms, but cannot be assigned to this subclass because of its irregular cup plating and presence of a holdfast. It differs considerably from members of the subclasses Camerata and Flexibilia, which have much more complex arms and specialized cup and

tegmen plating. Therefore, it is here assigned to the new subclass Echmatocrinea.

The largest and best preserved specimen of *Echmatocrinus* has numerous soft appendages attached to the arms (Fig. 219; 220). These secondary appendages are 4 to 6 mm. long; show no plate sutures, relief, or reticulate ornament like that on the arms; are severely folded over on themselves; in several places are apparently attached to opposite sides of the arm, one per brachial plate; and are visible only when this specimen is immersed in a liquid. These soft appendages most likely represent tube feet from the crinoid's water vascular system, although they might possibly be unplated pinnules instead. If this first interpretation is correct, then these soft appendages are the earliest preserved echinoderm tube feet known from the fossil record.

The two best preserved specimens show

a considerable difference in the size and length of their holdfasts (Fig. 219, *1a-d*). This might represent a growth difference, related to the size of the crinoid, or perhaps the holdfast plates were imbricately arranged, so that *Echmatocrinus* could vary the height of its cup above the sea floor by extending or telescoping these holdfast plates. Unfortunately, neither of these holdfasts is well enough preserved to determine whether the plating was actually adjacent or imbricate, although the former seems more likely because of similarities to the cup plating.

The presence of a holdfast in *Echmatocrinus* implies that crinoids underwent a holdfast-to-stem transition similar (but independent) to that shown by Middle Cambrian eocrinoids (SPRINKLE, 1973a). However, crinoids passed through a different intermediate stage characterized by multi-part columnals, such as those in the genus *Aethocrinus* described by UBAGHS (1969), and did not evolve a true stem with one-piece columnals until the Early Ordovician. The development of a columnal-bearing stem was probably one of the main features that led to the great diversity and success of Paleozoic crinoids. *Echmatocrinus* represents an earlier pre-stem stage of crinoid evolution characterized by apparent low diversity and primitive morphology.

Order ECHMATOCRINIDA Sprinkle & Moore, new order

Characters of subclass. *M.Cam.*(*Bathyriscus-Elrathina* Z.).

Family ECHMATOCRINIDAE Sprinkle, 1973

[Echmatocrinidae SPRINKLE, 1973a, p. 177]

Characters of subclass. *M.Cam.*(*Bathyriscus-Elrathina* Z.).

Echmatocrinus SPRINKLE, 1973, p. 177 [**E. brachiatus*; OD]. Cup moderately large, maximum cup diameter just below arms and greater than cup height, plated with numerous small to medium-sized adjacent plates not organized into obvious circlets, perhaps as many as 140 cup plates present, several arms mounted on thin, elongate plates, which may be radials(?); no stem present, but instead base of cup grades into tapering, cylindrical, irregularly-plated holdfast

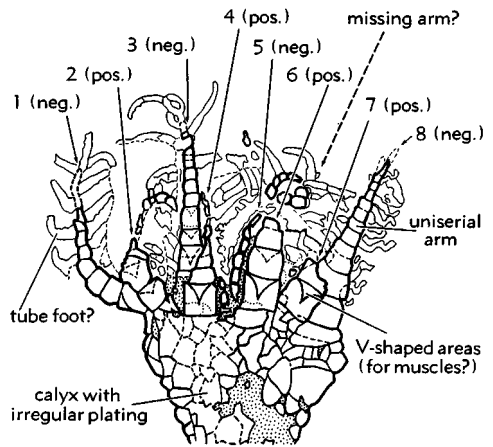


FIG. 220. *Echmatocrinus brachiatus* SPRINKLE, holotype, *M.Cam.*, Can.; drawing showing cup, arm, and ?tube foot morphology. Arms numbered and labeled with type of relief (positive or negative). Note irregular but imperfectly preserved cup plating, elongate cup plates (?radials) beneath several arms, V-shaped areas (?for muscles) on lower brachial plates, alternate branching of the ?tube feet (one per brachial plate) on arms 1 and 3, and alternating arm relief except between arms 6 and 7, where an additional arm (now missing) from the rear of the cup may have been located (after Sprinkle, 1973a; from Special Publication of the Museum of Comparative Zoology, Harvard University (1973), courtesy of the Museum of Comparative Zoology).

between 1 to 2 times height of cup, maximum holdfast diameter about one-fourth to one-half length; holdfast plates appear to be slightly larger but otherwise similar to those in cup, several holdfasts attached to objects (worm tubes, hyolithids) apparently lying on sea floor; 8 to 10 short, uniserial, atomous, heavily-plated arms present, 10 to 12 brachials per arm, smaller soft appendages (?tube feet) attached ?alternately to each brachial, dark V-shaped areas perhaps for muscle attachment on aboral side of proximal brachials; location of mouth, anal pyramid or tube, and other tegmen structures unknown. *M.Cam.*(*Bathyriscus-Elrathina* Z., *Burgess Shale*), Can.(B.C.). —FIG. 219, *1*; 220. **E. brachiatus*; 219, *1a,b*, counterparts of best specimen (immersed in water); note long holdfast attached to *Selkirkia* worm tube and ?tube feet attached to arms, $\times 1$; 219, *1c,d*, counterparts of smaller specimen (coated with ammonium chloride) showing positive and negative relief of arms and much shorter holdfast, $\times 0.9$; 220, drawing of cup and arms of best specimen showing plate sutures and ?tube feet (Sprinkle, 1973a).

CAMERATA

By GEORGES UBAGHS

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[With contributions by N. GARY LANE, R. C. MOORE, A. L. BOWSHER,
and H. L. STRIMPLE]

INTRODUCTION

The Camerata comprise one of the three main groups of Paleozoic crinoids. In the system that has been adopted in the *Treatise*, they are considered as a subclass, taxonomically equivalent to the subclasses Inadunata, Flexibilia, and Articulata. This subclass corresponds to the Cladocrinoidea of JAEKEL [originally (1894) introduced as an order, later (1918) raised to subclass rank] and to the orders Adunata, Monocyclica Camerata, and Dicyclica Camerata of BATHER's classification (1899b, 1900a).

Camerate crinoids form a unit fairly well defined on morphological grounds. They include 209 genera and two subgenera recognized herein, many of them comprising numerous species. Their known range extends from Early Ordovician to Late Permian time. They are represented by largest number of genera in Upper Silurian rocks and by largest number of species and individuals in Lower Mississippian deposits. Occurrence of relatively few representatives has been reported from the Late Mississippian, Pennsylvanian, and Permian, but seemingly none reached the Mesozoic Era.

The subclass Camerata contains both dicyclic and monocyclic genera, the latter being more than three times as numerous as the former. Throughout their history, these crinoids retained readily discernible characters. One of these is rigid union of the thecal plates, although early representatives and at least one specialized genus (*Scyphocrinites*) have somewhat loose connection between skeletal components of the test. The tegmen—one of their most salient features, from which the name Camerata is derived (Latin, *camera*, chamber)—forms a continuous generally (but not invariably) rigid vaulted ceiling above the sides and bottom of the theca. Except in a very few genera (e.g., *Cyttarocrinus*, *Lyonocrinus*), it covers the mouth and proximal parts of ambulacral tracts. The anus, com-

monly raised on a tube, is the only aperture found on the tegmen. The presence of an external hydropore or madreporite, as in some inadunates and articulates, has never been recorded.

Typically, a variable number of arm plates (and in some genera pinnulars) are incorporated in the calyx by means of interprimibrachial, intersecundibrachial, and (less commonly) intertertibrach and interpinnular plates. The number of fixed brachials may be as few as one or two to each ray or as many as 140 in a ray (e.g., *Himerocrinus*); in *Strotocrinus* up to 12 orders of brachials may enter composition of the calyx. The fixed brachials are uniserial, except in a few genera (e.g., *Spyridocrinus*, *Cyphocrinus*, *Abacocrinus*, *Tryblionocrinus*), in which they show a biserial arrangement distally. On the other hand, in several families (i.e., Nyctocrinidae, Hexacrinidae, Parahexacrinidae, Dichocrinidae, Acrocrinidae, Haplocrinidae, Platycrinidae, Paradoxocrinidae) the proximal brachials, though generally more or less suturally connected either with the first interprimibrach (if present) or with interambulacrals, offer virtually all characteristics of free arm plates, whereas generally no interbrachials take part in formation of the calyx. It is such crinoids, provided with a solid tegmen and a calyx typically reduced to the patina (radials, basals) and in some forms a single anal plate, that were included by BATHER (1899b, 1900a) in his order Adunata.

In many camerate genera, the posterior (*CD*) interray is very distinctive, the anal plates forming a median series that splits this interrachial area and consequently impresses a marked bilateral symmetry on the calyx; in many, however, they are reduced to a single plate or a few supplementary elements, or they may be lacking entirely. The anal plates of camerates are unlike those of the Inadunata and Flexibilia in that none of them can be considered as

equivalent to the radial of these crinoids. They have no particular relation to the C ray and show no tendency to migrate obliquely upward in a left posterior (D-ray) direction. The proximal anal plate (**primanal**) deserves special attention, for its position in or above the radial circlet is considered to be an extremely important taxonomic character.

The radials of camerates, invariably five in number, are never compound, i.e., divided into an inferradial and a superradial. At least ten free arms are present in all genera and there may be as many as 65 or 70 (e.g., *Strotocrinus*). Wherever only a single free arm seems to occur in each ray, it is because the two normal primary rami resulting from first division have either fused together longitudinally (as in *Melocrinites*) or have developed so unequally that one of them resembles a mere ramule (as in *Cytidocrinus*).

The free arms of camerates may be simple (atomous) or branching. Types of arm branching include 1) isotomy (division into equal rami), probably the primitive type of arm branching, 2) bilateral heterotomy (division into unequal rami with smaller ones disposed alternately on opposite sides), 3) exotomy (division into unequal rami with smaller ones all given off toward outer sides of the ray), and 4) endotomy (like exotomy but with smaller rami all directed toward the midline of the ray). Robust arm trunks carrying relatively slender ramuli characterize genera belonging to various families such as the Rhodocrinitidae (e.g., *Rhipidocrinus*), Lampterocrinidae (e.g., *Lampterocrinus*), Periechocrinidae (e.g., *Thamnocrinus*), Actinocrinitidae (e.g., *Cytidocrinus*, *Manillocrinus*, *Steganoocrinus*), Polypeltidae (e.g., *Trybliocrinus*), and Platycrinidae (e.g., *Eucladocrinus*). Marked reduction of arms and, still less, complete atrophy of arms, as in some inadunates, has never been recorded among camerate crinoids.

The arms are uniserial (condition judged to be primitive) or biserial, and almost invariably pinnulate. The brachials may be compound, and provided with two, three, or four (rarely more) pinnules. At points of bifurcation of uniserial arms are axillary brachials, which differ from those of other crinoids by the fact that in some species

they carry pinnules. In biserial arms axillaries generally are lacking, the division being effected by splitting of each of the two brachials just below the bifurcation.

The radials, brachials, and pinnulars (except distal pinnulars devoid of an ambulacral groove) are unperforated in nearly all camerate species. As a rule, the free brachials are united by immovable or very slightly movable articulations of zygostostial or symplectial type; however, even in such crinoids limited flexibility of the arms probably was achieved by the relatively large number of joints in a given length, for in biserial arms one commonly may count 20 to 25 transverse sutures in a span of 1 cm. on each side of the arm, the maximum recorded number being 60 in 1 cm. In some camerates with free arms directly supported by radials, the arm-bearing facets on the radials are more differentiated than others and the brachials are united by synostostial or pseudosynarthrial articulation, a condition allowing a greater capacity for movements of the arms.

Contrasting with the small amount of differentiation in articulations of brachials with contiguous neighbors, the pinnule-bearing facets on the arms of camerates are rather complicated. They certainly show that in most species the pinnules could move actively so as to spread out widely and fold up closely against the adoral side of the arm. In many species distal portions of the pinnules are composed of perforated pinnulars lacking an adoral groove. Such portions of the pinnules were able to flex inward to form a rooflike cover protecting soft parts of the arms and pinnules. This cover, in at least one genus (*Barrandeocrinus*), was permanent and solid, but generally it could open, as indicated by observing distal pinnulars in both extended and inwardly flexed positions.

All known camerates are stem-bearing, with possibly the single known exception of *Monstocrinus*, which W. E. SCHMIDT (1942) reported as showing no trace of a stem insertion on the base of its calyx. No camerate species has been recorded in which the column is divided into parts by longitudinal sutures, that is to say in which the columnals are composed of tetrameres or pentameres. In all other respects, by its structure, composition, presence or absence

of cirri, mode of growth, and nature of the holdfast, the stalk of camerates is similar to that of most Paleozoic crinoids. Although some camerates have very distinctive columns, most dissociated columnals and pluricolumnals cannot now be attributed certainly to any particular camerate genus.

Rarely stated is general agreement that main component parts and ossicles of the body of camerate crinoids are homologous to specified parts and ossicles of other crinoids. This has been denied by JAEKEL (1894, 1918), who considered the camerates to be utterly different in origin and morphogenesis from all other crinoids. For him, the most distinctive feature of camerate crinoids is branching of the ambulacra within the theca (hence the name Cladocrinoidea which he gave them) and their carrying of free articulated appendages outside the theca which he called *Finger* (German vernacular term), because with respect to each of the five rays they are given off like fingers of a hand. He termed *costals* (*costalia*), rather than radials and fixed brachials, the vertical series of calyx plates that support the fingers, which he judged to have been produced by a further evolution of the brachioles of eocrinoids through transformation of their covering ambulacral plates into pinnules. The arms of camerates, however, have precisely the same morphological relations with the theca as the arms of other crinoids. Seemingly, therefore, no valid reason exists for doubting the strictly homologous nature of these appendages and supporting calyx plates in all crinoids. This does not mean, of course, that any plate of a camerate is necessarily homologous with a corresponding plate in other crinoids. For instance, homologies of orals and anals of the camerates are quite uncertain, since these skeletal elements may be very similar in appearance to those of articulates and inadunates and yet be quite distinct in origin.

Subclass CAMERATA Wachsmuth & Springer, 1885

[*nom. transl.* MOORE & LAUDON, 1943a, p. 21 (*ex suborder* Camerata WACHSMUTH & SPRINGER, 1891, p. 345, *nom. correct. pro* Camerata WACHSMUTH & SPRINGER, 1885, p. 6 (228), *nom. imperfect.*)] [=Spheroidae WACHSMUTH, 1877, p. 186; family Sphaeroidocrinidae WACHSMUTH, 1880, p. 22; order Sphaeroidocrinacea NEUMAYR, 1889, p. 462; order Cladocrinoidea JAEKEL, 1894, p. 113; orders Monocyclica

Aduata + Monocyclica Camerata + Dicyclica Camerata BATHER, 1899b, p. 921-923; order Camerida DELAGE & HÉROUARD, 1904, p. 376] [Materials for this subclass prepared by GEORGES UBAGHS, with contributions by N. GARY LANE, R. C. MOORE, A. L. BOWSHER, and H. L. STRIMPLE]

Crinoidea characterized by monocyclic or dicyclic base; thecal plates typically united by rigid sutures; proximal brachials generally, though varyingly, incorporated in theca by union with aboral or adoral plates or both; interbrachials ordinarily present; ambulacrals corresponding to fixed brachials either incorporated in tegmental surface or pressed below it; mouth and proximal portion of food grooves (except very rarely) covered by tegmental pavement; anus opening directly through tegmen or at end of anal tube; posterior side of calyx typically differentiated by supplementary plates arranged according to crinoidal plane of symmetry (through midline of *A* radial and *CD* interray) and without any definite relation to the *C* ray; no compound radials, no radialial; rays dividing at least once; free arms uniserial or biserial; brachials monoor hyperpinnulate, imperforate. *L.Ord.-U. Perm.*

Order DIPLOBATHRIDA Moore & Laudon, 1943

[*nom. correct.* MOORE in MOORE, LALICKER & FISCHER, 1952, p. 614 (*pro* Diplobathra MOORE & LAUDON, 1943a, p. 79)] [=Dicyclica Camerata BATHER, 1899b, p. 923] [Materials for this order prepared by GEORGES UBAGHS]

Calyx dicyclic. *M.Ord.-U.Ord.*; *M.Sil.-L.Carb.*

Suborder ZYGODIPLOBATHRINA Ubahgs, 1953

[Zygodiplobathrina UBAGHS, 1953, p. 735]

Basals alternating with radials in a circllet of ten plates, all of them in contact with infrabasals. *M.Ord.,L.Dev.*

Family CLEIOCRINIDAE S. A. Miller, 1890

[Cleiocrinidae S. A. MILLER, 1890, p. 323]

Theca high conical or pyriform, test thin and probably pliant; infrabasals five, distinct, in deep concavity and overlapped by radial-basal circllet, which projects downward over stem; rays bifurcating several times in calyx, giving off fixed pinnules (or ramules); fixed brachials extremely

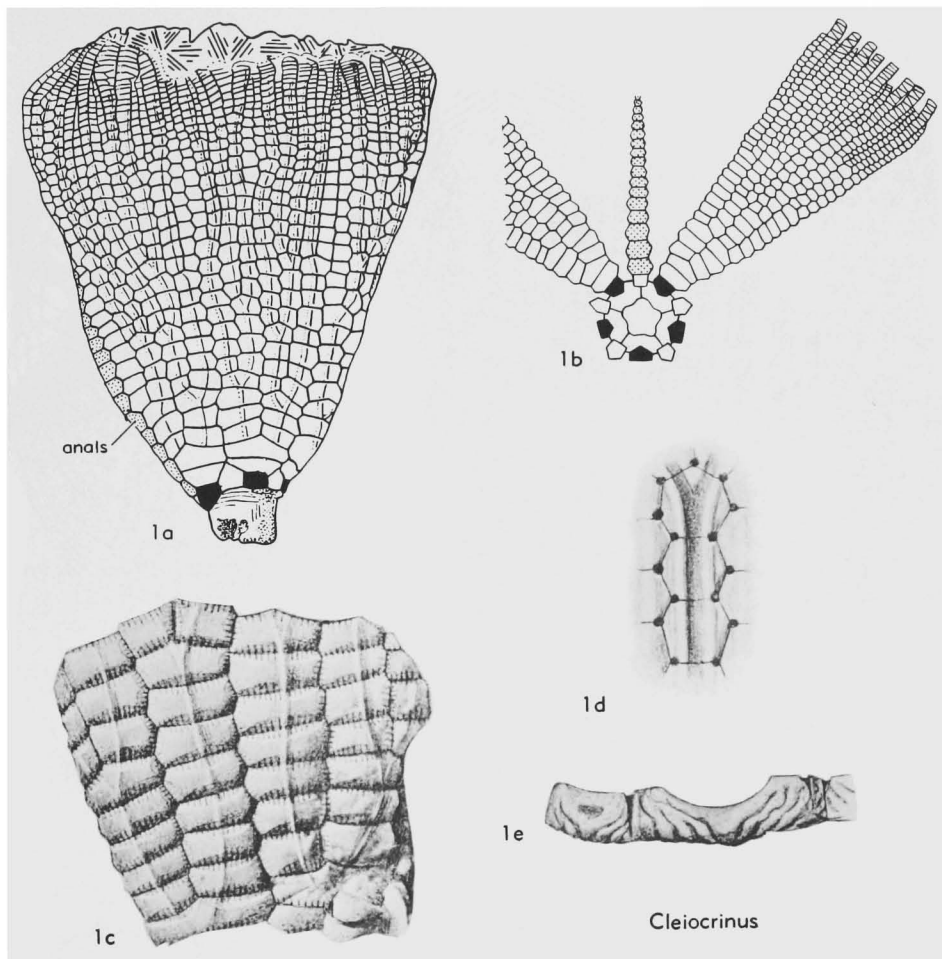


FIG. 221. Cleiocrinidae (p. T411).

numerous, contiguous, and interlocking; no interprimibrachs; anals in long uniserial vertical column resting on *CD* basal; numerous pores along suture lines comprising external apertures of sutural canals, which converge into large tunnel-like pores opening to interior of theca at plate corners. Tegmen many-plated, undifferentiated into ambulacral and interambulacral areas. Arms simple, uniserial. Column obtusely pentagonal or nearly round in cross section. *M. Ord.*

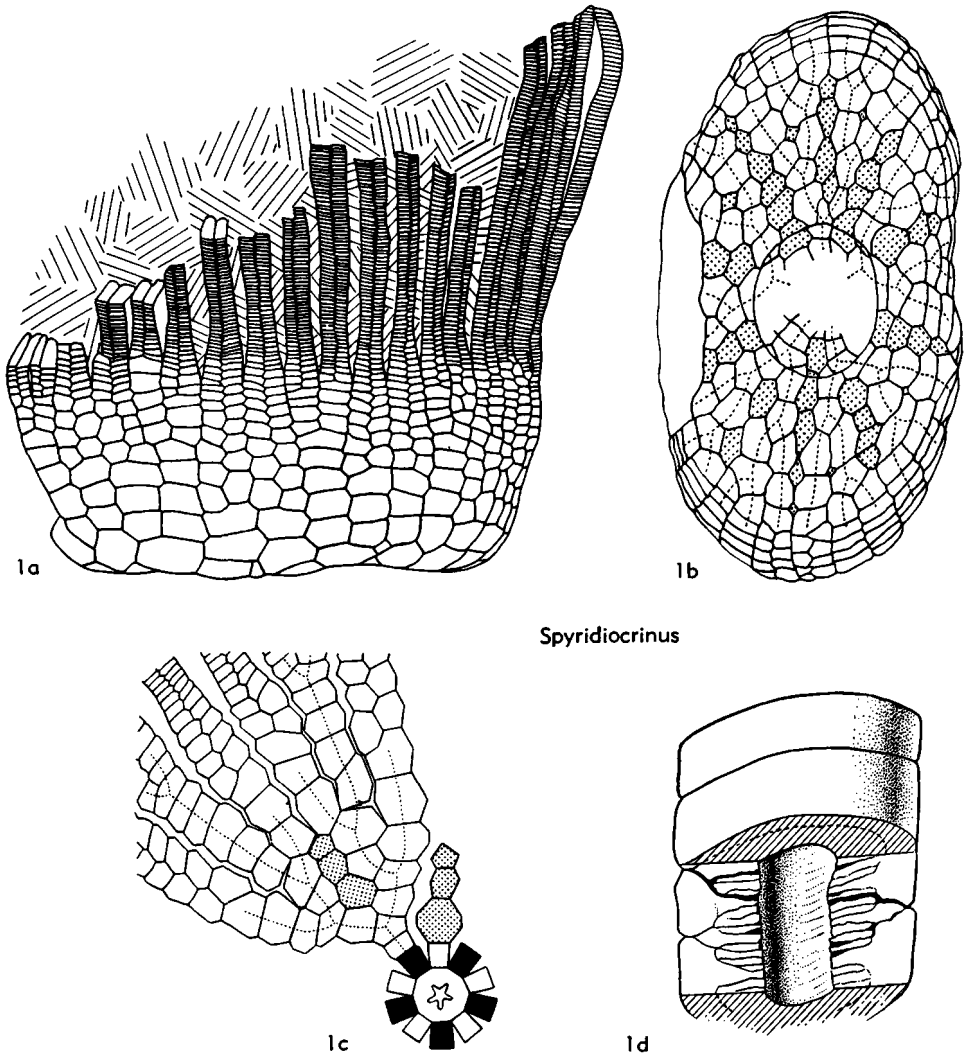
Cleiocrinus BILLINGS, 1857, p. 276 [**C. regius*; *M*] [= *Campanulites* TROOST, 1850b, p. 419 (*nom. nud.*) (type, *C. tessellatus*; *M*)]; *Cleistocrinus* LUDWIG, 1906, p. 8 (*nom. null.*); *Cliocrinus* HUDSON, 1911, p. 211 (*nom. van.*). Characters of family. *M. Ord.*, N.Am.(Can.-USA).—FIG.

221, 1a-d. **C. regius*, Trenton., Can.; 1a, lat. view of type specimen (radials black), $\times 1.3$ (Springer, 1905); 1b, diagram of base, *C* and *D* rays and *CD* interray (upward) (radials black, anals stippled) (Ubahgs, 1950); 1c, portion of arm, $\times 2.25$ (Springer, 1911b); 1d, inner side of fixed brachials, showing broad long. groove and pores at corners of plates, $\times 5$ (Springer, 1911b).—FIG. 221, 1e. *C. sculptus* SPRINGER, Trenton., Ky.; distal faces of thecal plates, showing sutural pore system, $\times 5$ (Springer, 1911b).

Family SPYRIDIOCRINIDAE Jaekel, 1918

[Spyridiocrinidae JAEKEL, 1918, p. 32]

Calyx broad, low, with a more or less deep basal concavity; infrabasals fused; rays bifurcating several times before becoming free; fixed ramules proximally uniserial, dis-



Spyridiocrinus

FIG. 222. Spyridiocrinidae (p. T412).

tally biserial; interprimibrachs in short uniserial series resting on basals; intersecundi-brachs few, intertertibrachs reduced or lacking; posterior side not differentiated in calyx. Arms simple, biserial. Stems round in cross section, with nudinodals concealing very short internodals, which do not reach periphery, at least in proximal region of stem; axial canal quinquelobate. *L.Dev.*

Spyridiocrinus OEHLERT, 1889, p. 786 [**S. cheuxi*; OD] [= *Lahuseniocrinus* CHERNYSHEV, 1893, p. 92 (type, *L. tirlensis*; OD)]. Characters of family. *L.Dev.*, Eu. (France-Boh.-USSR).—FIG. 222, 1.

**S. cheuxi*, France; 1a,b, lat. and dorsal views of calyx (interbrachials stippled), $\times 1$ (Ubaghs, 1950); 1c, plate diagram of base, D ray, and CD interray (radials black, anals and interbrachials stippled; CD interray directed upward) (Ubaghs, 1950); 1d, stem structure at 12 cm. below theca, $\times 3.3$ (Ubaghs, 1950).

Suborder EUDIPLOBATHRINA
Ubaghs, 1953

[Eudiplobathrina UBAGHS, 1953, p. 735]

Basals and radials alternating in two distinct circlets. *M.Ord.-U.Ord.*; *M.Sil.-L.Carb.*

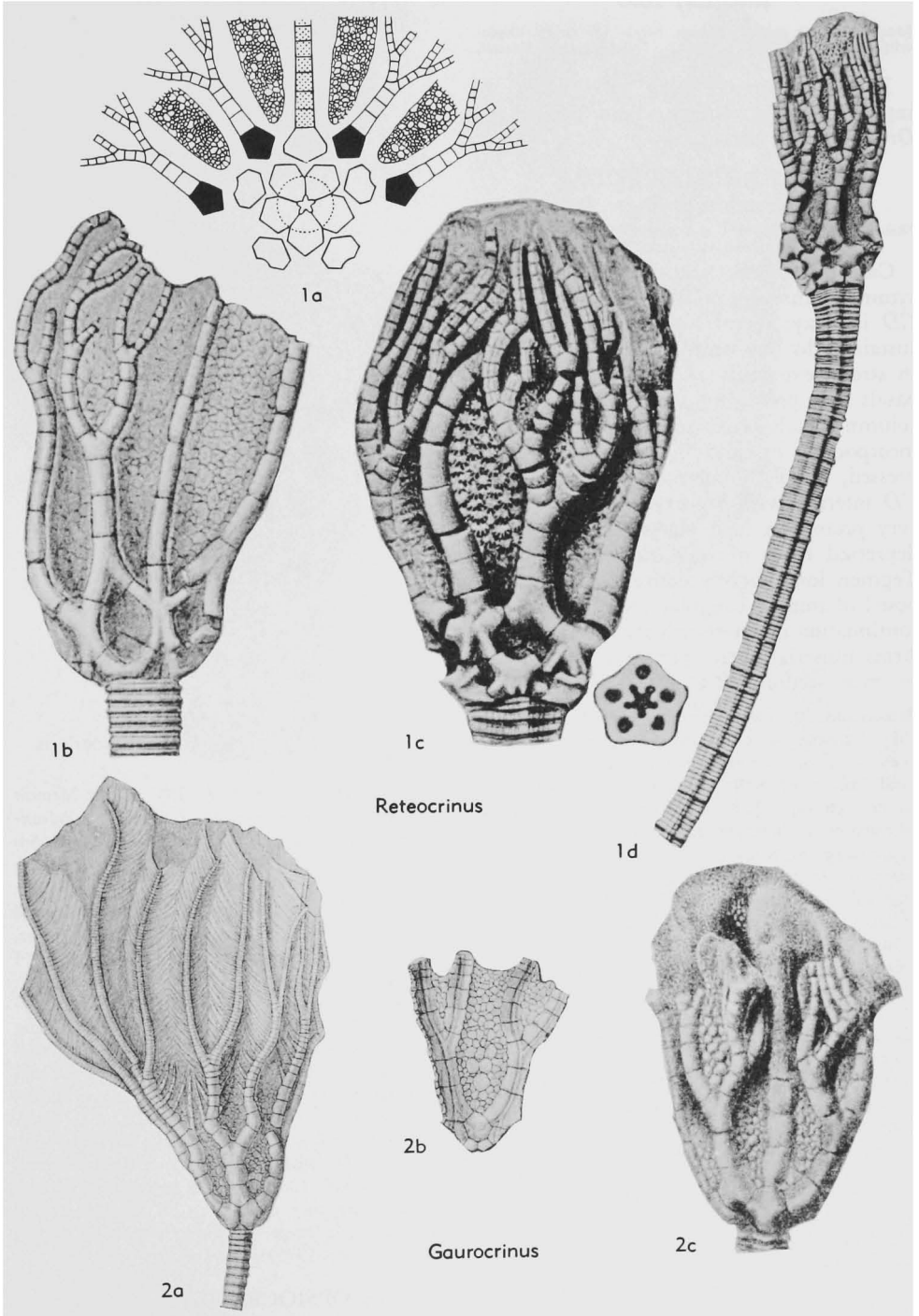


FIG. 223. Retiocrinidae (p. T414).

Superfamily RHODOCRINITACEA Roemer, 1855

[*nom. transl. et correct.* UBAGHS, herein (*ex* family Rhodocrinitidae ROEMER, 1855, p. 228)] [=Reteocrinidae UBAGHS, 1953, p. 735]

Radials separated from each other by interprimibrachs, which adjoin basals. *M. Ord.-U. Ord.*; *M. Sil.-L. Carb.*

Family RETEOCRINIDAE Wachsmuth & Springer, 1885

[Reteocrinidae WACHSMUTH & SPRINGER, 1885, p. 91 (313)]
[=Gaurocrinidae S. A. MILLER, 1890, p. 321]

Calyx obconical, with marked bilateral symmetry through midline of *A* radial and *CD* interray; thecal walls thin and weak, sustained by ray and anal plates plicated in strong externally rounded ridges; infra-basals five, projecting more or less beyond column; basals large; several secundibrachs incorporated in calyx; interprimibrachs depressed, small, numerous, and irregular; *CD* interray with sagittal uniserial row of very prominent anal plates separating two depressed fields of very diminutive plates. Tegmen low, slightly convex, pliant, composed of minute irregular pieces forming a continuation of interbranchials; no anal tube. Arms uniserial. Stem pentagonal or round in cross section. *M. Ord.-U. Ord.*

Reteocrinus BILLINGS, 1859, p. 63 [**R. stellaris*; M] [=Reteocrinus BIGSBY, 1868, p. 23 (*nom. van.*)]. Small spaces between infrabasals, basals, and radials generally present; primibrachs 2 to 6 in each ray. Arms many-branched, irregularly dichotomous; brachials rather long; no pinnules (according to KOLATA, 1975). Cross section of stem round or pentagonal or passing from pentagonal to round distally. *M. Ord.-U. Ord.*, N.Am. (Can.).—FIG. 223, *1a, b*, **R. stellaris*, Trenton., Can.; *1a*, plate diagram of part of calyx (radials black, anal series stippled, directed upward) (Ubaghs, n); *1b*, post. view, $\times 2$ (Wachsmuth & Springer, 1897).—FIG. 223, *1c, d*. *R. alveolatus* MILLER & GURLEY, Trenton., Can.; *1c*, *CD*-interray and *C*-ray views with cross section of stem, $\times 2$, enl. (Springer, 1911b); *1d*, *A*-ray view of calyx and stem, $\times 1$ (Springer, 1911b).

Gaurocrinus S. A. MILLER, 1883, p. 228 [**Glyptocrinus nealli* HALL, 1866, p. 2; OD]. Similar to *Reteocrinus*, but with interbranchials very irregular in form and size. Arms branching isotomously once or twice at rather long intervals; 2 to 3 fixed pinnules on each arm, 1st one considerably stouter than others; free brachials very short, wedge shaped, pinnulate. Stem pentagonal transversely. *U. Ord.*, N.Am.(USA).—FIG. 223, 2. **G. nealli* (HALL), Richmond., Ohio; *2a*, *A*-ray view of crown and part of attached stem, $\times 2$

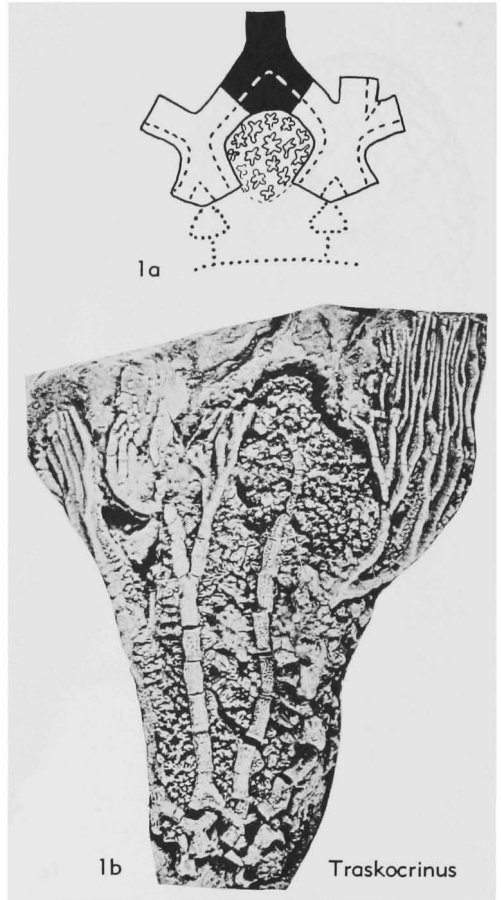


FIG. 224. Retiocrinidae (p. T 414). [From Memoir 7, Supplement to Vol. 49, no. 3, *Journal of Paleontology*, 1975; courtesy of the Paleontological Society and Dennis R. Kolata.]

(Wachsmuth & Springer, 1897); *2b*, portion of inner side of calyx $\times 2$ (Wachsmuth & Springer, 1897); *2c*, *CD*-interray view of crown, $\times 4$ (Springer, 1905).

Traskocrinus KOLATA, 1975, p. 46 [**T. mahlburgi*; OD]. Differs from *Reteocrinus* in having large spaces between deeply cleft sides of infrabasals, basals, and radials filled with numerous and irregular minute ossicles similar to interbranchials. *M. Ord.*, N.Am.(USA).—FIG. 224, *1*. **T. mahlburgi*, Platteville Gr., Blackriver., USA (Ill.); *1a*, holotype, *D* radial (in black), two basals and one infrabasal (dotted lines) surrounding spaces occupied by tiny ossicles, $\times 2.6$ (Kolata, 1975, mod.); *1b*, holotype, *CD* interray view of crown, $\times 0.8$ (Kolata, 1975).

Family OPSIOCRINIDAE Kier, 1952

[Opsiocrinidae KIER, 1952, p. 64]

Calyx relatively low, subconical; infra-

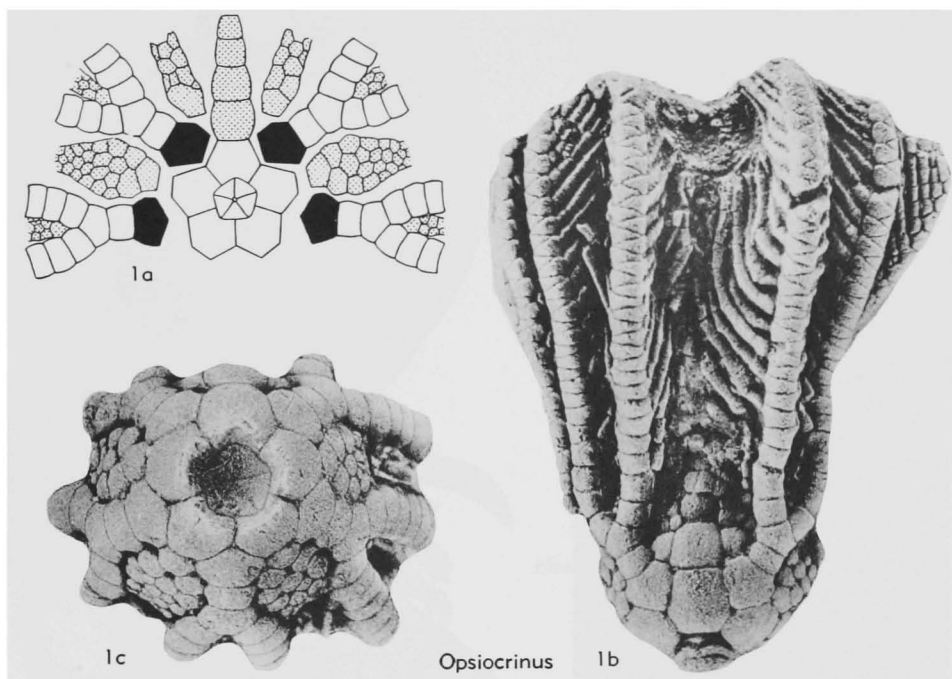


FIG. 225. Opsoicrinidae (p. T415).

basals forming a small pentagon entirely hidden by proximal columnal; interbrachials depressed, small, fairly regular, especially in proximal part of interrays; *CD* interray conspicuous, with median uniserial row of large, subquadrangular anal plates raised above field of tiny, rather irregular plates on each side. Arms ten, free at about level of second secundibrachs, biserial, unbranched distally. Stem star shaped in cross section, heteromorphic, comprising nodals and internodals; axial canal round. *M.Dev.*

Opsoicrinus KIER, 1952, p. 65 [**O. mariana*; OD] [= *Ameliacrinus* KESLING, 1968, p. 159 (type, *A. benderii*; OD)]. Characters of family. *M.Dev.*, USA (Mich.).—FIG. 225, 1. **O. mariana*, Silica F.; 1a, plate diagram of part of calyx, arms, and interradial areas (radials black, anals and interbrachials stippled, *CD* interray directed upward) (Kesling & Meyer, 1963); 1b, c, *CD*-interray views of immature holotype, and dorsal side of another specimen, $\times 7$ (Kesling & Meyer, 1963).

Family ARCHAEOCRINIDAE Moore & Laudon, 1943

[Archaeocrinidae MOORE & LAUDON, 1943a, p. 82]

Calyx more or less elongate; faint or well marked median ray ridges typically pres-

ent; interprimibrachs and intersecundibrachs regular, numerous, depressed, merging with tegmen; posterior side wider, generally with extra plates, but without distinct anal ridge. Arms uniserial to biserial. Column cylindrical. *M.Ord.-U.Ord.*

Archaeocrinus WACHSMUTH & SPRINGER, 1881, p. 189 (363) [**Glyptocrinus lacunosus* BILLINGS, 1857; OD]. Calyx high subconical; infrabasals very small concealed by stem or resting in concavity formed by lower part of rather large basals; median ray ridges faint proximally, but more conspicuous distally; each first interprimibrach followed by 2 plates, primanal by 3 plates. Free arms branching, biserial. [As restricted by the above diagnosis, *Archaeocrinus* comprises only a small compact group of species from the Trentonian of North America.] *M.Ord.*, N.Am. (Can.).—FIG. 226, 1a, b. **A. lacunosus* (BILLINGS), Trenton., Can.; 1a, *CD*-interray view of holotype, $\times 1.5$ (Ubaghs, n; Geol. Survey Canada, 1959); 1b, *C*-ray view of paratype, $\times 2$ (Ubaghs, n; Geol. Survey Canada).—FIG. 226, 1c, d. *A. microbasalis* (BILLINGS), Trenton., Can.; 1c, plate diagram of calyx, lower part of arms, and interradial areas (radials black, anals and interbrachials stippled, *CD* interray directed upward) (Ubaghs, n); 1d, *CD*-interray view of crown and stem, slightly reduced (Wachsmuth & Springer, 1897).

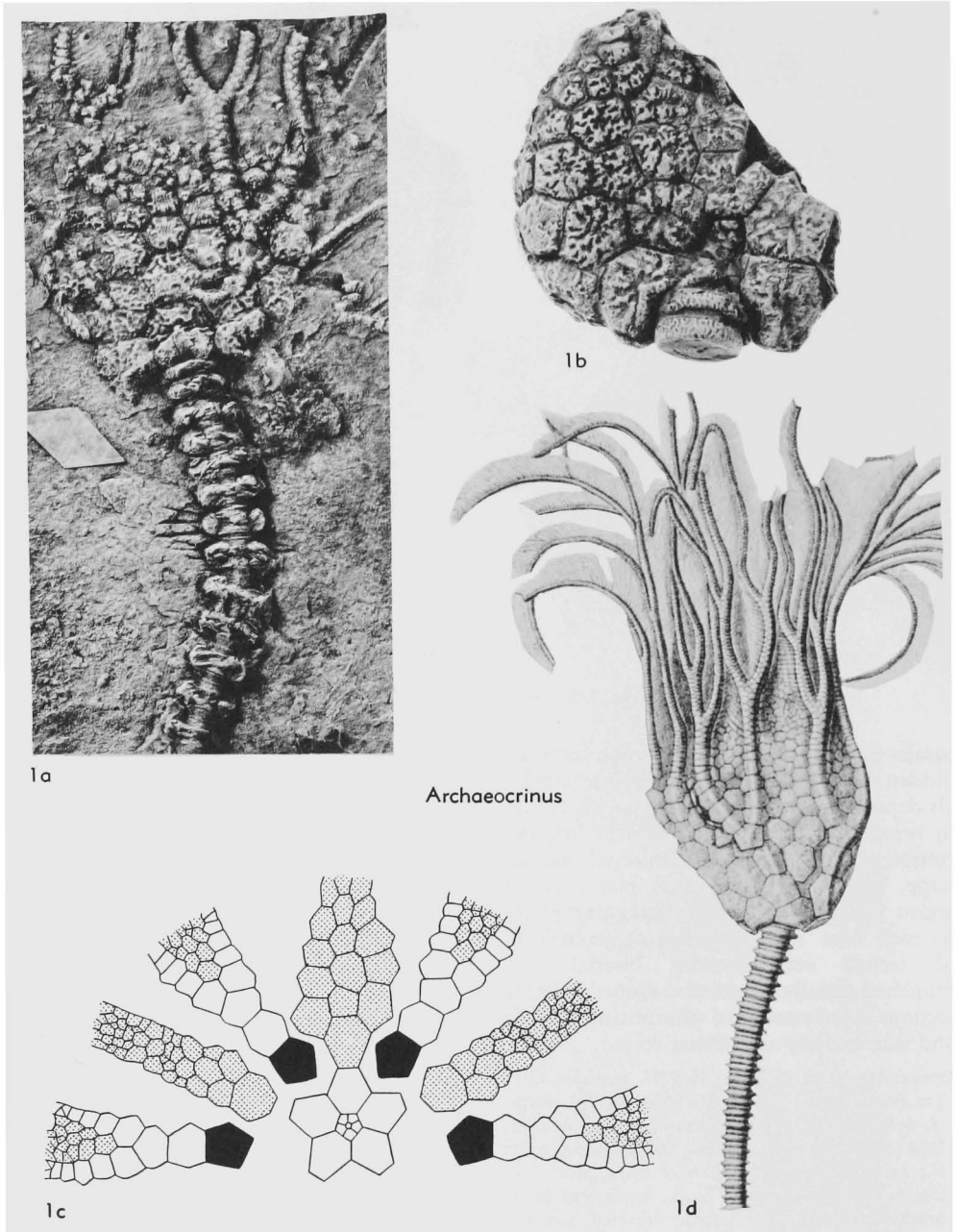


FIG. 226. Archaeocrinidae (p. T415).

Balacrinus RAMSBOTTOM, 1961, p. 24 [**Glyptocrinus basalis* M'COY, 1850, p. 289; OD] [= *Coelocrinus* SALTER, in RAMSAY, 1866, p. 283 (*non* MEEK & WORTHEN, 1865b)]. Calyx subglobular to conical; infrabasals visible in side view; median ray ridges narrow but distinct; all interradial areas with usually 3 plates in second row; CD interray

without extra plates. Arms uniserial; brachials short, cuneate. Stem formed of alternating nodals and internodals; lumen round and large. *M.Ord.* (*Caradoc.*), G.Brit.—FIG. 227,1. **B. basalis* (M'COY); CD-interray view of crown and part of stem, $\times 2$ (Ramsbottom, 1961). [= *Coenocrinus* DELAGE & HEROUARD, 1903 (*nom. null.*).]

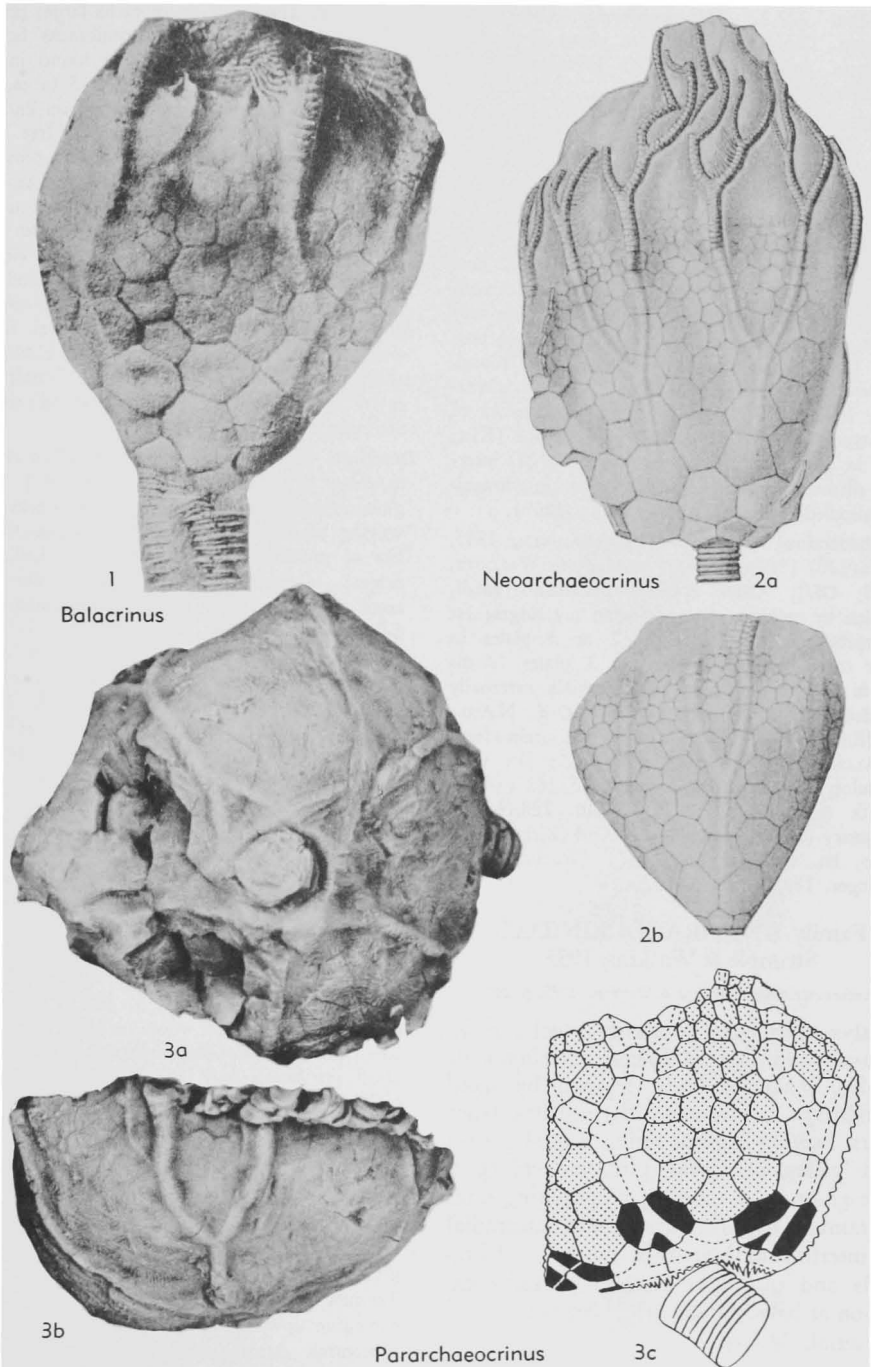


FIG. 227. Archaeocrinidae (p. T416-T418).

Neoarchaeocrinus STRIMPLE & WATKINS, 1955, p. 351 [**Thysanocrinus (Rhodocrinus) pyriformis* BILLINGS, 1857; OD]. Similar to *Archaeocrinus*

but calyx conical or pyriform and relatively large with upflaring infrabasals clearly visible in side view. *M.Ord.-U.Ord.*, N.Am.(Can.)-Eu.(Scot.).

—FIG. 227,2. **N. pyriformis* (BILLINGS), Trenton., Can.(Ont.); 2*a,b*, lat. views of crushed holotype and paratype, $\times 1$ (Wachsmuth & Springer, 1897).

Pararchaeocrinus STRIMPLE & WATKINS, 1955, p. 351 [**P. decoratus*; OD]. Calyx subglobular; basal concavity including infrabasals and proximal 3rd of basals, strong median ray ridges joined to other ridges which form pentagon about basal concavity; interradial areas except *CD* interray with 3 plates in second row; *CD* interray protruding, with 2 or 3 plates in direct contact with posterior basal. Arms uniserial; free brachials very short, cuneate. Stem obtusely pentagonal in outline (at least proximally); lumen large, round. *M.Ord.*, USA(Okla.).—FIG. 227,3. **P. decoratus*, Bromide F.; 3*a,b*, basal and lat. views of holotype (U.S. Natl. Museum S 4871), $\times 2$ (Kier, n); 3*c*, plate diagram of part of calyx, *ED* interray directed upward (radials black, interbrachials stippled) (Strimple & Watkins, 1955).

Rhaphanocrinus WACHSMUTH & SPRINGER, 1885, p. 98(320) [**Glyptocrinus? subnodosus* WALCOTT, 1883; OD]. Calyx conical; infrabasals small, hidden by column; strong median ray ridges; 1st interprimibrachs followed by 2 or 3 plates in next row; primanal supporting 3 plates. Arms 10 to 20, simple, uniserial; brachials externally quadrangular to cuneate. *M.Ord.-U.Ord.*, N.Am.-Eu.(Eng.-Est.).—FIG. 228,1*a*. **R. subnodosus* (WALCOTT), *M.Ord.*(Trenton.), N.Y.; lat. view of holotype crown with attached stem, $\times 1$ (Wachsmuth & Springer, 1897).—FIG. 228,1*b*. *R. sculptus* (S. A. MILLER), *U.Ord.*(Richmond.), Ohio; lat. view of crown, $\times 1$ (Wachsmuth & Springer, 1897).

Family ANTHRACOCRINIDAE Strimple & Watkins, 1955

[Anthracocrinidae STRIMPLE & WATKINS, 1955, p. 348]

Calyx with basal concavity involving infrabasals and part of basals; interbrachials regular, separated from tegmen by fixed pinnulars; *CD* interray differing little from others, lacking sagittal series of anal plates; fixed plates of lower pinnules enlarged, those of one ray meeting neighboring ones (or ramules in some rays) above interradial (or interbrachial) areas of theca; fixed brachials and pinnulars forming weblike extension at base of each arm. Arms uniserial to biserial. *M.Ord.*

Anthracocrinus STRIMPLE & WATKINS, 1955, p. 348 [**A. primitivus*; OD]. Calyx tall, with deep basal concavity involving elongate infrabasals and more than proximal half of basals; median ray ridges prominent; interbrachials few, mildly de-

pressed; proximal interprimibrachs large; primanal smaller than proximal interprimibrachs but succeeding plates larger than those found in other interrays. Arms uniserial, typically 3 to each ray, one half-ray in each ray bifurcating on 2nd fixed secundibrach (exceptionally on first); free brachials wedge shaped. Column cylindrical, proximally composed of expanded nudinodals and very thin narrow internodals; lumen large, quinquelobate in outline. *M.Ord.*, USA(Okla.).—FIG. 228,2. **A. primitivus*, Bromide F.; 2*a,b*, lat. views of holotype (U.S. Natl. Museum S4759) and paratype (USNM S4761), $\times 3$ (Kier, n); 2*c,d*, plate diagrams of *CD* interray and normal interray with parts of adjoining rays (radials black, anals and interbrachials stippled, shape of basal concavity indicated by dotted lines) (modified from Strimple & Watkins, 1955).

Deocrinus HUDSON, 1907, p. 121 [**Rhodocrinus asperatus* BILLINGS, 1859, p. 27; OD]. Calyx globose, with rather shallow basal concavity involving small infrabasals and about one third or less of proximal part of basals; no median ray ridges; interprimibrachs numerous, comprising large plate completely surrounded by small ones; *CD* interray with 2 large plates partially surrounded by small plates; 1 or 2 relatively large intersecundibrachs in each ray; fixed secundibrachs relatively numerous. Tegmen composed of many very small plates extending out over ambulacral grooves of lower pinnules and base of arms; anal tube nearly central. Arms 2 to each ray, brachials externally wedge shaped. Stem lumen round. *M.Ord.*, N.Am.(Can.).—FIG. 229,1. **D. asperatus* (BILLINGS), Chazyan, Can.; 1*a,b*, lat. and dorsal views of holotype crown, $\times 2$ (Ubahgs, n; Geol. Survey Canada, 1019a); 1*c*, plate diagram of part of theca (radials black, interbrachials stippled, *CD* interray directed upward) (Hudson, 1907).

Hercocrinus HUDSON, 1907, p. 125 [**H. elegans*; OD]. Calyx globose, more or less flattened at base with narrow basal concavity involving very small infrabasals and less than proximal half of each basal; interradial areas generally differing from each other in arrangement of plates and comprising relatively large plates partly or entirely surrounded by smaller ones; generally 2 interprimibrachs between radials; *CD* interray not wider than others and having about same plate arrangement; fixed secundibrachs 2 or more, each giving off a pinnule partly incorporated in calyx. Tegmen formed by very numerous small plates extending upward onto arm bases; short anal tube subcentral. Arms biserial. Stem circular in cross section, lumen moderately large, pentagonal, *M.Ord.*, USA(N.Y.).—FIG. 229,2. **H. elegans*, Chazyan; plate diagram of part of calyx and arms (radials black, interbrachials stippled) (Hudson, 1907).

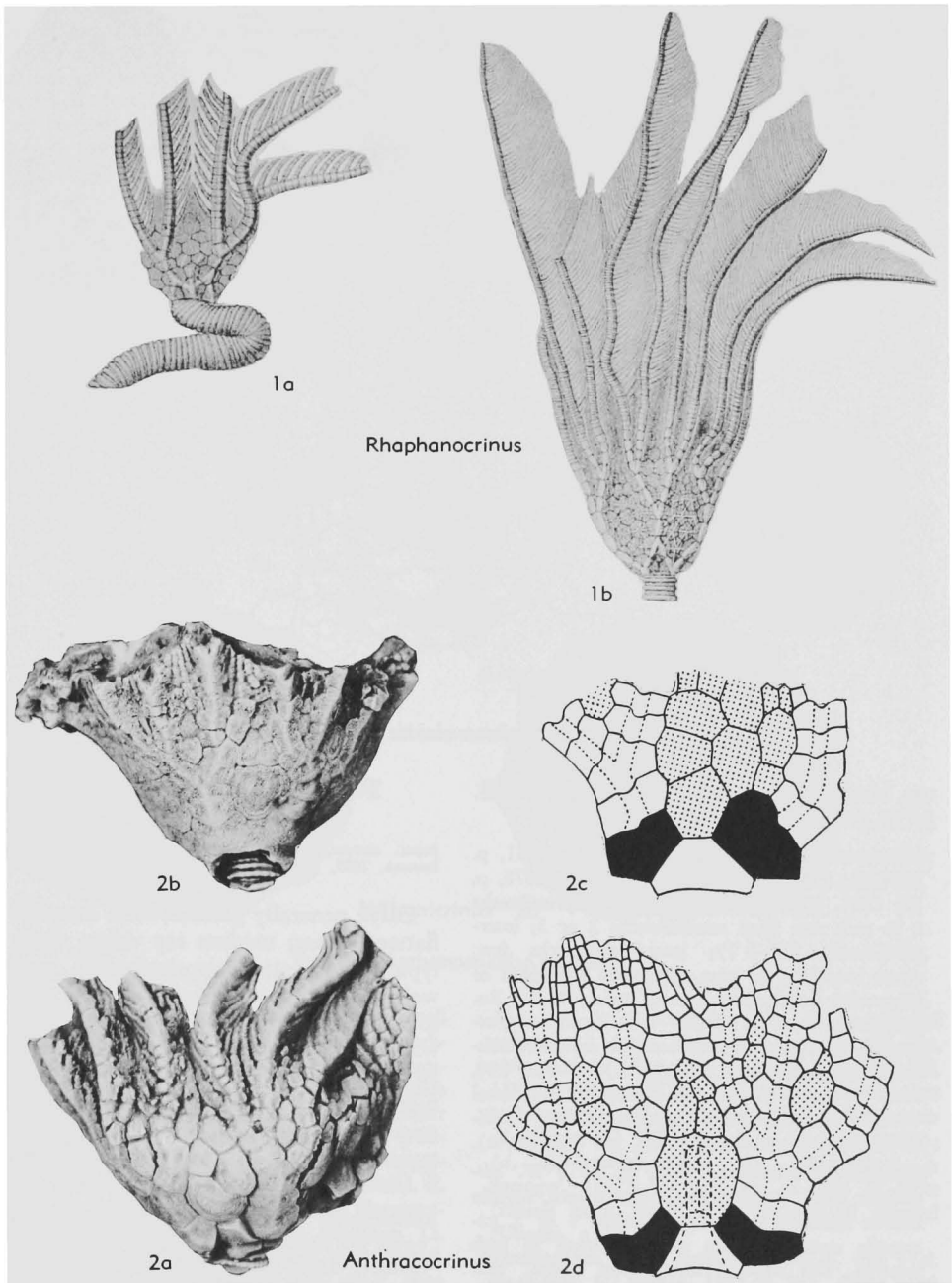


FIG. 228. Archaeocrinidae (1); Anthracocrinidae (2) (p. T418).

Family ANTHEMOCRINIDAE
Jaekel, 1918

[Anthemocrinidae JAEKEL, 1918, p. 40]

Calyx moderately to very low; infrabasals

four, unequal; interbranchials few, not connected with tegmen; CD interray indistinct or barely differentiated. Tegmen many-plated, with subcentral anal tube. Arms

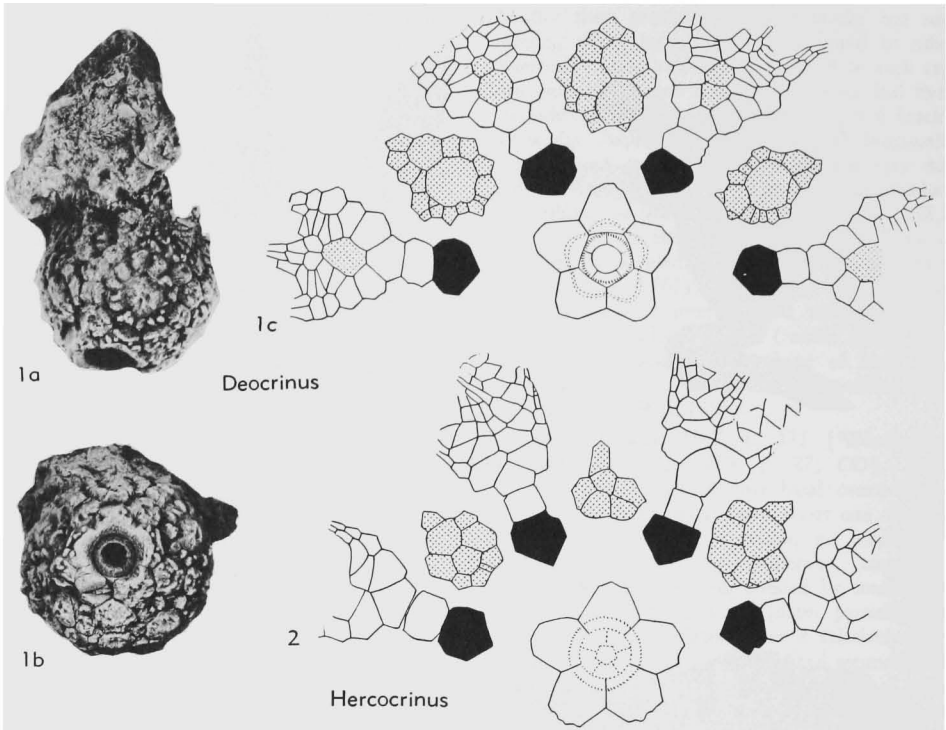


FIG. 229. Anthracocrinidae (p. T418).

ten, biserial. Axial canal of stem very small.
M.Sil.-U.Sil.

Anthemocrinus WACHSMUTH & SPRINGER, 1881, p. 208 (382) [**Eucrinus venustus* ANGELIN, 1878, p. 25; OD]. Calyx bowl shaped; fixed primibrachs 1 in each ray; fixed secundibrachs 2 or 3; interprimibrachs 2(1+1); intersecundibrachs few. Arms branching at least once, rami undivided or bifurcating isotomously once or twice. *U.Sil.*, Eu. (Sweden).—FIG. 230, 1a. **A. venustus* (ANGELIN), Gotl.; lat. view of lectotype crown (Stockholm Museum), $\times 2$ (Ubaghs, n).—FIG. 230, 1b,c. *A. minor* (ANGELIN), Gotl.; lat. and dorsal views of lectotype crown (Stockholm Mus.) (radials black, interbranchials stippled), $\times 3$ (Ubaghs, n).

Wilsonicrinus SPRINGER, 1926, p. 23 [**W. discoideus*; OD]. Calyx broad, wheel shaped, slightly convex aborally; fixed secundibrachs 4 or 5, externally cuneate; single interprimibrach in each interray, CD slightly wider than others; arm openings 10, widely separated; fixed pinnulars similar to interprimibrachs, leading to conspicuous interradial pinnule openings at margin between arm openings. *M.Sil.*, USA (Ind.).—FIG. 230, 2. **W. discoideus*, Niagaran (Laurel Ls.); 2a,b, dorsal and ventral views of holotype, $\times 2$ (Springer, 1926a).

Family RHODOCRINITIDAE Roemer, 1855

[*nom. correct.* BASSLER, 1938, p. 25 (*pro Rhodocrinitidae* ROEMER, 1855, p. 228)] [=Gilbertocrinitidae JAEKEL, 1918, p. 42]

Calyx generally globose, with excavate or flattened base; median ray ridges weak or typically absent; interprimibrachs regular, well defined, not depressed or only slightly so; posterior side usually widest with or without extra plates but generally lacking an anal ridge. Tegmen many-plated, anal tube ordinarily present. Arms free above secundibrachs, uniserial to biserial; stem typically round in cross section. *M.Ord.-U.Ord.*; *M.Sil.*; *L.Dev.-L.Carb.*

Rhodocrinites MILLER, 1821, p. 15, 106 [**R. verus*; SD ROEMER, 1855, p. 241] [= *Rhodocrinus* AGASSIZ, 1836, p. 196 (*nom. van.*)]. Calyx rounded, with sides nearly vertical or diverging upward, plates typically with stellate ornamentation; base flattened or concave; basals relatively small; fixed secundibrachs 1 or more in each ray; interradial areas large, many-plated, merging with tegmen; intersecundibrachs present; CD interray wider than others, with extra anal plates. Teg-

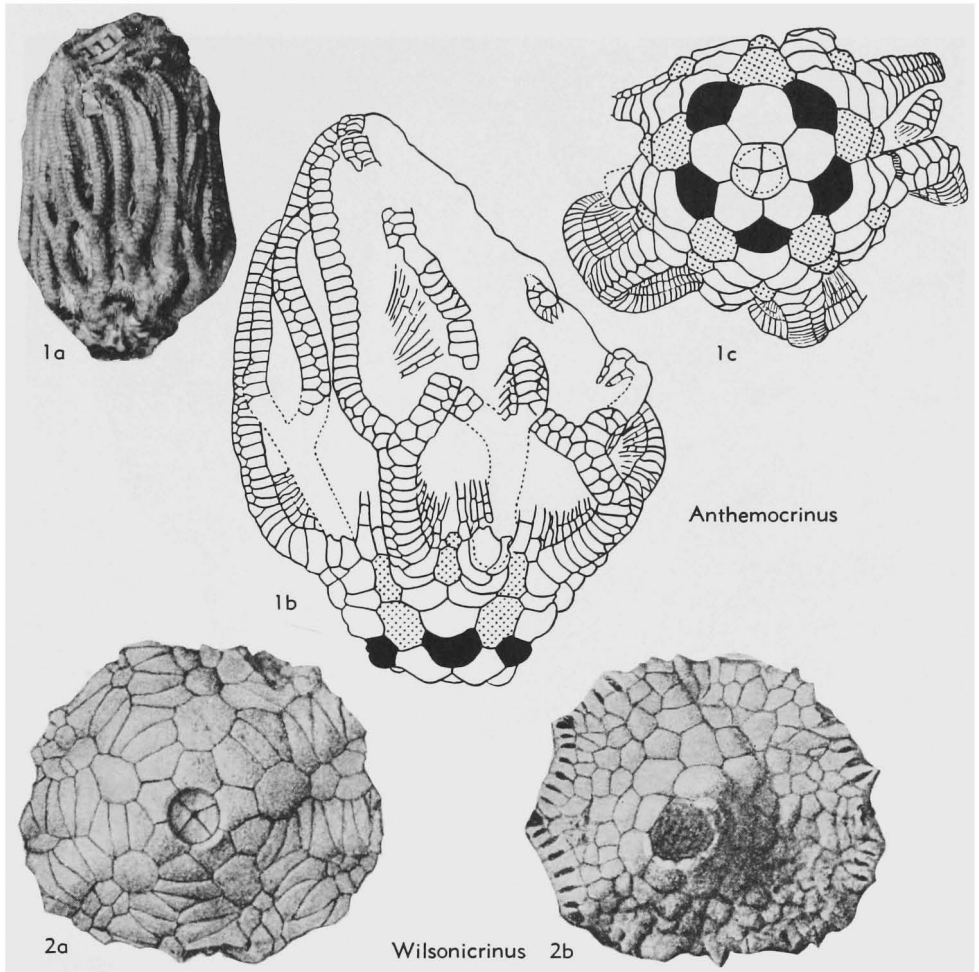


FIG. 230. Anthemocrinidae (p. T420).

men rather flat, composed of numerous small plates; anal tube short, excentric. Arms branching isotomously, uniserial to most distal bifurcations but compactly biserial above them. Stem cylindrical, composed of several orders of rather short columnals. *L. Carb.*, Eu.-N. Am.-Asia-?Australia. [In the original description of *Rhodocrinites*, MILLER confounded two species under *R. verus*, one from the Silurian of Dudley, Worcestershire, Eng., the other from the Mountain Ls. (L. Carb.) along the River Avon, near Bristol, England. The Silurian form has never been definitely selected as lectotype of *R. verus* by a subsequent author, but has been attributed to *Sagenocrinites expansus* (PHILLIPS) by WACHSMUTH & SPRINGER (1881, p. 201[375]). The Carboniferous form, with MILLER's specific name was designated as the type species of *Rhodocrinites* by ROEMER in 1855 (p. 241).]—FIG. 231,

1a, b. **R. verus*, Tournais., Eng.; *1a*, lat. view of crown, $\times 2$ (orig. figure by MILLER); *1b*, lat. view of theca of another specimen, $\times 1$ (Grenfell, 1876).—FIG. 231, *1c-e.* *R. kirbyi* (WACHSMUTH & SPRINGER), Miss., USA (Iowa); *1c*, A-ray view of crown, $\times 2$ (Wachsmuth & Springer, 1897); *1d*, CD-interray view, $\times 2$ (Wachsmuth & Springer, 1897); *1e*, diagram of part of calyx (radials black, anals and interbranchials stippled (Ubaghs, n)).

Acanthocrinus F. A. ROEMER, 1850, p. 679 [*A. longispina*; SD JAEKEL, 1895, p. 24]. Calyx bowl shaped, with slightly depressed base; faint median ray ridges and long spines on basals, radials, tegmen, and proximal interprimibrachs; slightly depressed interprimibrachs numerous, connecting with tegmen, which is low and composed of small irregular pieces; anus marginal on tegmen and without tube. Arms 10, branching, biserial.

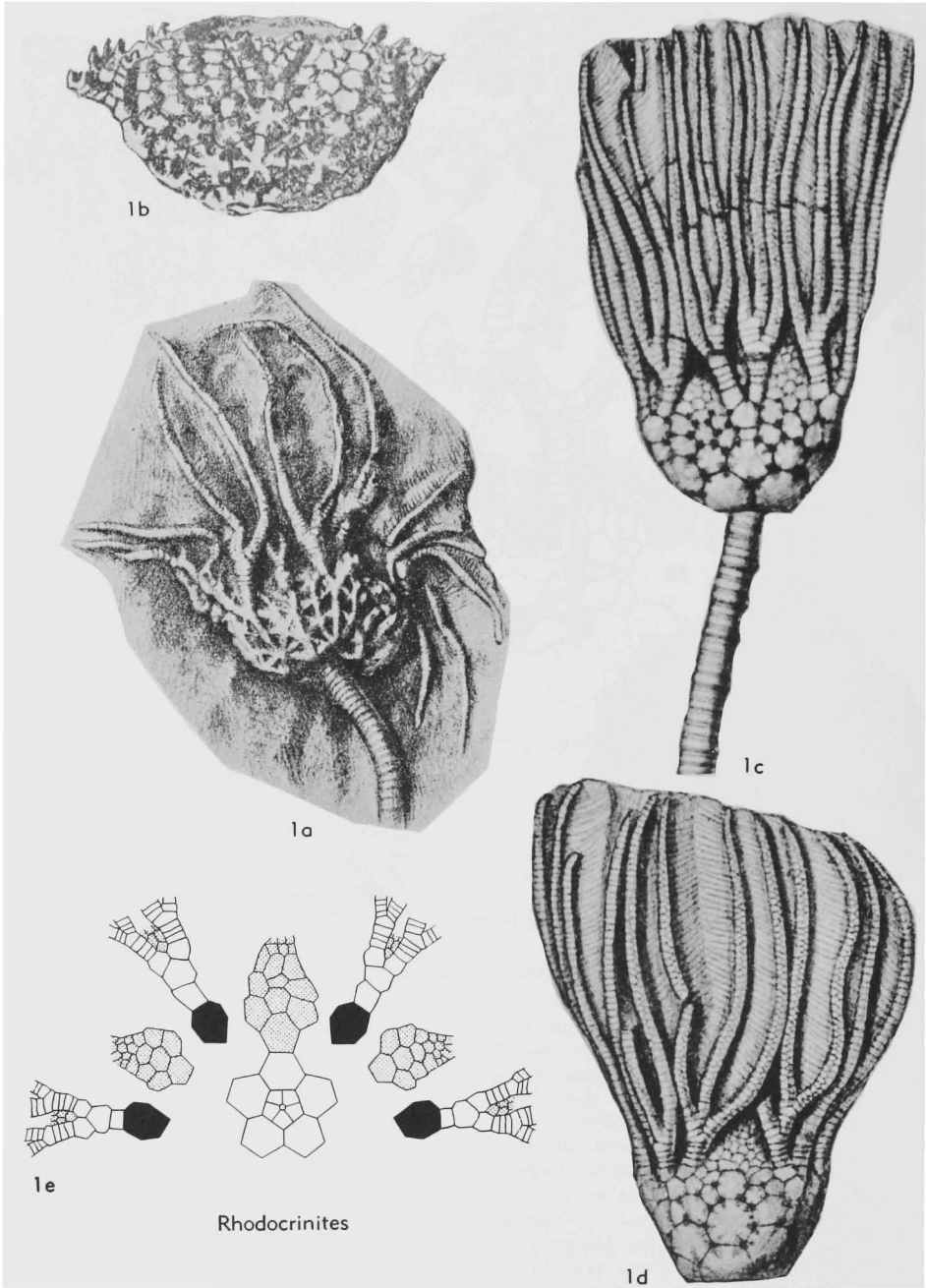
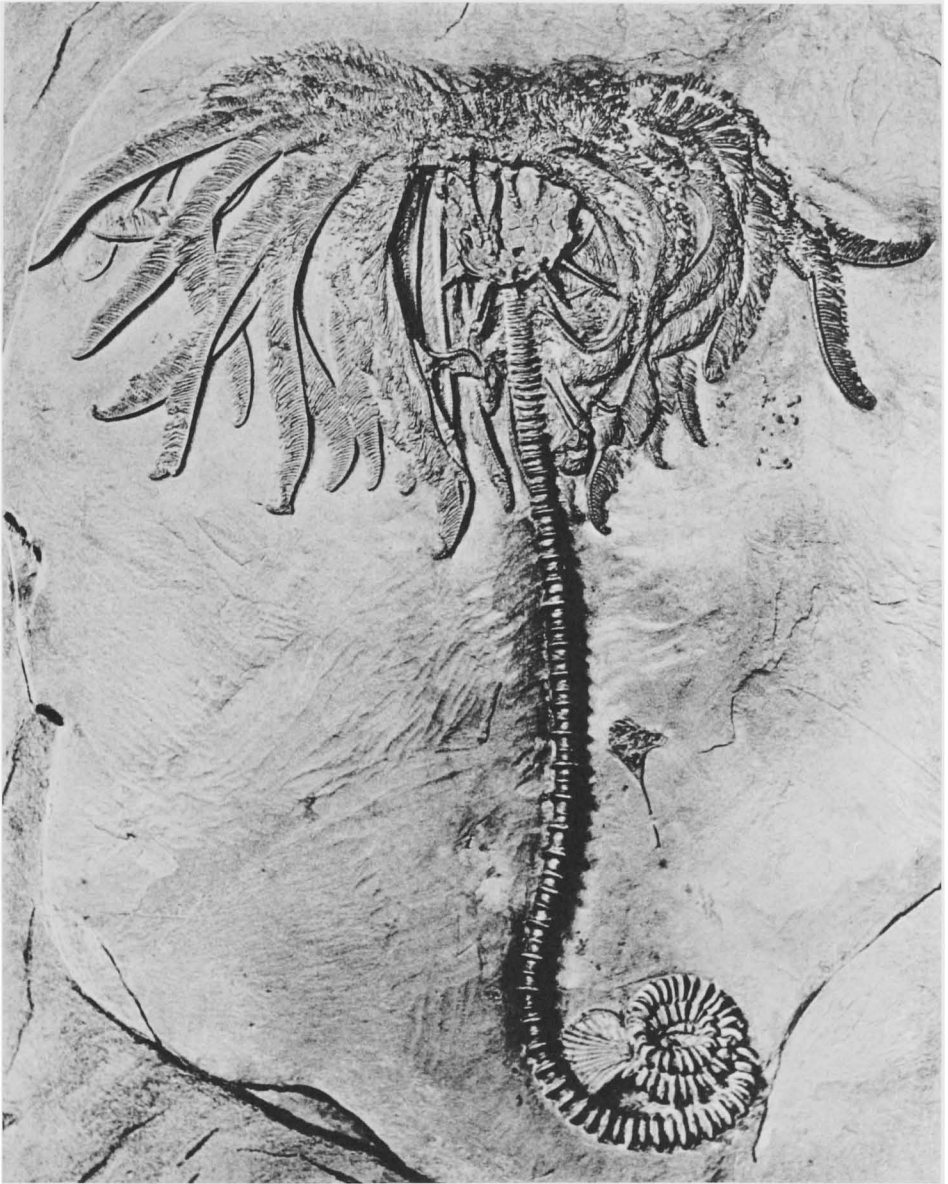


FIG. 231. Rhodocrinitidae (p. T420-T421).

Nudinodals generally prominent and internodals very short. *L.Dev.-M.Dev.*, Eu.-N.Am.-N.Afr.—
 FIG. 232, 1. *A. rex* JAEKEL, *L.Dev.* (Hunsrück-Schiefers), W.Ger.; complete specimen, $\times 0.5$

(Schmidt, 1934).
Atactocrinus WELLER, 1916, p. 239 [*A. wilming-
 tonensis*; OD]. Calyx bowl shaped; radials separated by 1st interradials in 2 adjoining interrays



1

Acanthocrinus

FIG. 232. Rhodocrinitidae (p. T421-T422).

and a 3rd opposite to them but meeting across the 2 remaining interrays; 1st interprimibrach followed by 2 plates; CD interray indistinct in cup. Tegmen, arms, and stem unknown. [As suggested by BATHER (1917), this may be an abnormal *Lyriocrinus*.] *U.Ord.*(*Richmond.*), USA (Ill.).

Cadiscocrinus KIRK, 1945, p. 346 [**C. southworthi*; OD]. Calyx subcylindrical, with flattened flaring invaginated base, containing small infra-basals and proximal part of very large basals; fixed secundibrachs 2; interprimibrachs 1 or 2 in each interray, that on posterior side largest and bearing median series of anal plates; arms

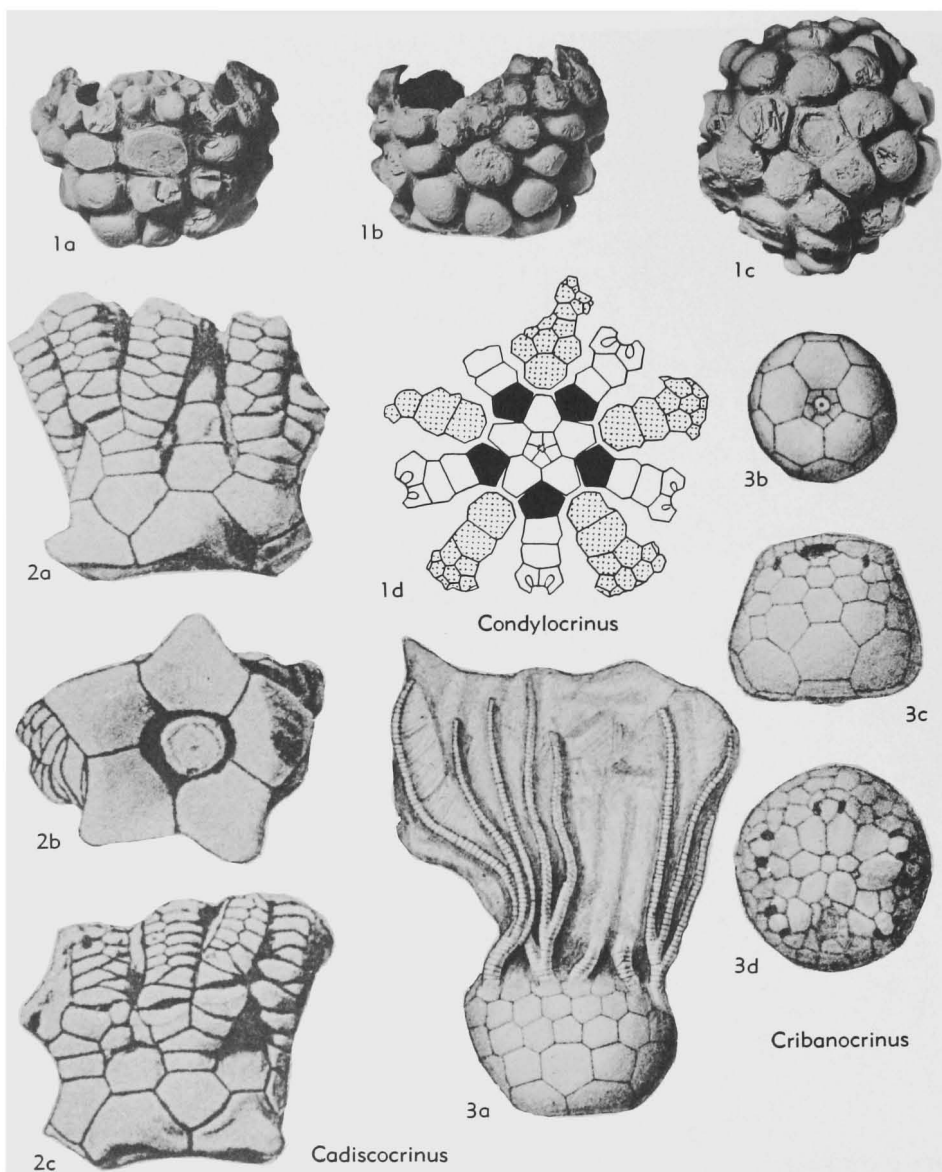


FIG. 233. Rhodocrinitidae (p. T423-T425).

10, biserial. Axial canal of stem round. *M.Dev.* N.Am.(Can.).—FIG. 233,2. **C. southworthi*, Arkona Sh.(Hamilton.), Can.(Ont.); 2a-c, holotype, CD-interray, dorsal, and A-ray views, $\times 2$ (Kirk, 1945a).

Condylocrinus EICHWALD, 1860, p. 612 [**C. verrucosus*; M]. Calyx subhemispherical; infrabasals small, flat, partly hidden by stem; basals large, widely in contact with 1st interprimibrachs; fixed secundibrachs 1 to each half-ray bearing brachial facet; interprimibrachs running 1, 1, 2, 3 or 4,

1st 2 larger than any other plates of calyx; no intersecundibrachs; posterior side with 3 anal plates in second row, at least 4 in 3rd row and numerous small elements in distal part. Tegmen, arms, and stem unknown; stem insertion round, with small, quinquelobate lumen. *L.Dev.*, USSR (Urals).—FIG. 233,1. **C. verrucosus*; 1a-c, AB-interray, CD-interray, and dorsal views of theca, $\times 1.5$ (Arendt, 1971c); 1d, plate diagram (radials black, anals and interbrachials stippled, CD-interray directed upward) (Arendt, 1971c, mod.).

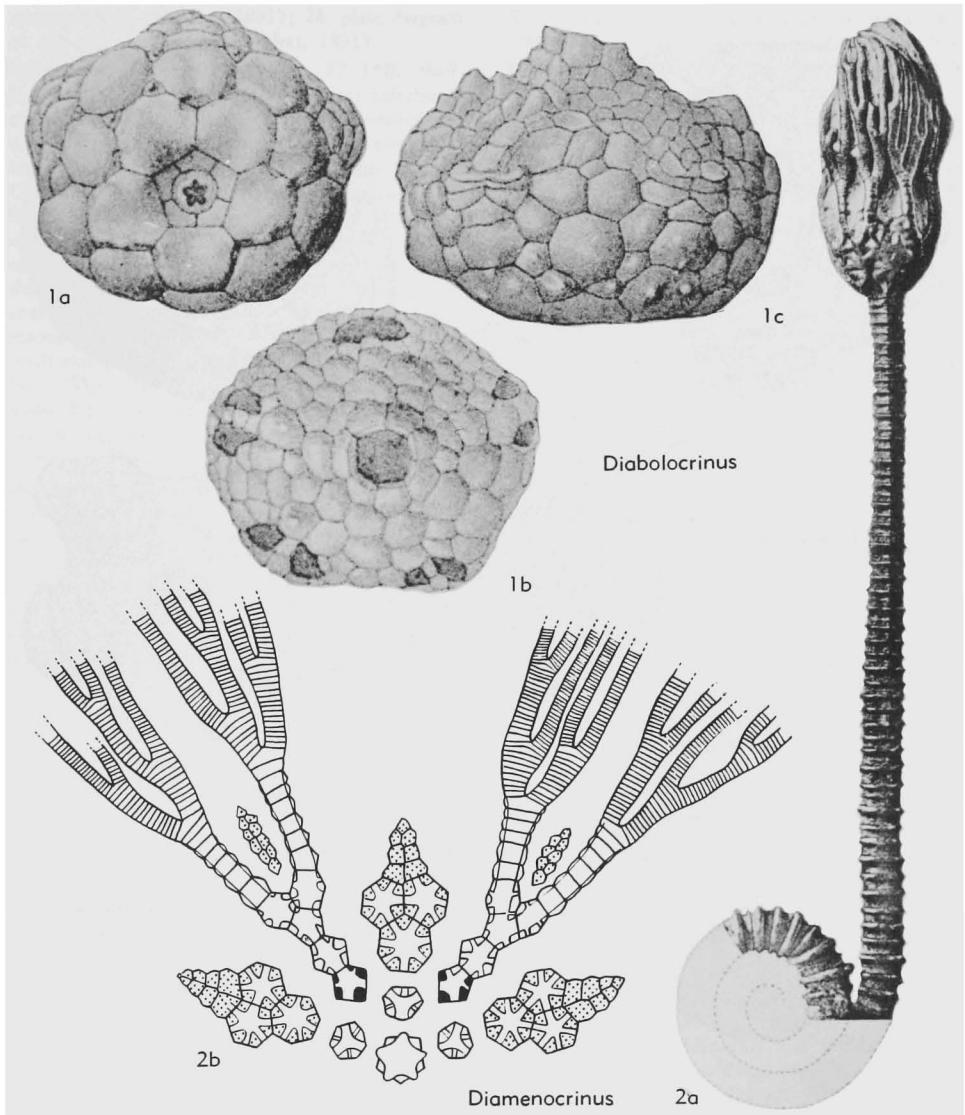


FIG. 234. Rhodocrinitidae (p. T425-T427).

Cribanocrinus KIRK, 1944, p. 13 [**Rhodocrinus wortheni* HALL, 1858b, p. 556; OD]. Similar to *Rhodocrinites* but having subglobose to ovate calyx constricted at arm level; ornamentation lacking or slight; basals and radials large in comparison to primibrachs; fixed secundibrachs 1 or 2 in each half-ray; interradial areas narrow, constricted at arm level; no intertertibachs; *CD* interray wider than others, rarely with poorly defined median row of plates. Tegmen very small, convex, made up of small plates; small anal protuberance, marginal or excentric. *L.Miss.*, USA (Iowa-N.

Mexico); *L.Carb.*, Eu.-E.Australia.—FIG. 233, 3a,b. **C. wortheni* (HALL), *L.Miss.* (Burlington Ls.), Iowa; 3a, lat. view of crown, $\times 1.5$ (Wachsmuth & Springer, 1897); 3b, dorsal view of calyx, $\times 1.5$ (Wachsmuth & Springer, 1897).—FIG. 233,3c,d. *C. urceolatus* (WACHSMUTH & SPRINGER), *L.Miss.* (Lake Valley Ls.), N.Mexico; *CD* interray and ventral views of theca, $\times 2$ (Wachsmuth & Springer, 1897).

Diabolocrinus WACHSMUTH & SPRINGER, 1897, p. 249 [**D. perplexus*; OD]. Calyx globose, deep, wide basal concavity, involving infrabasals and

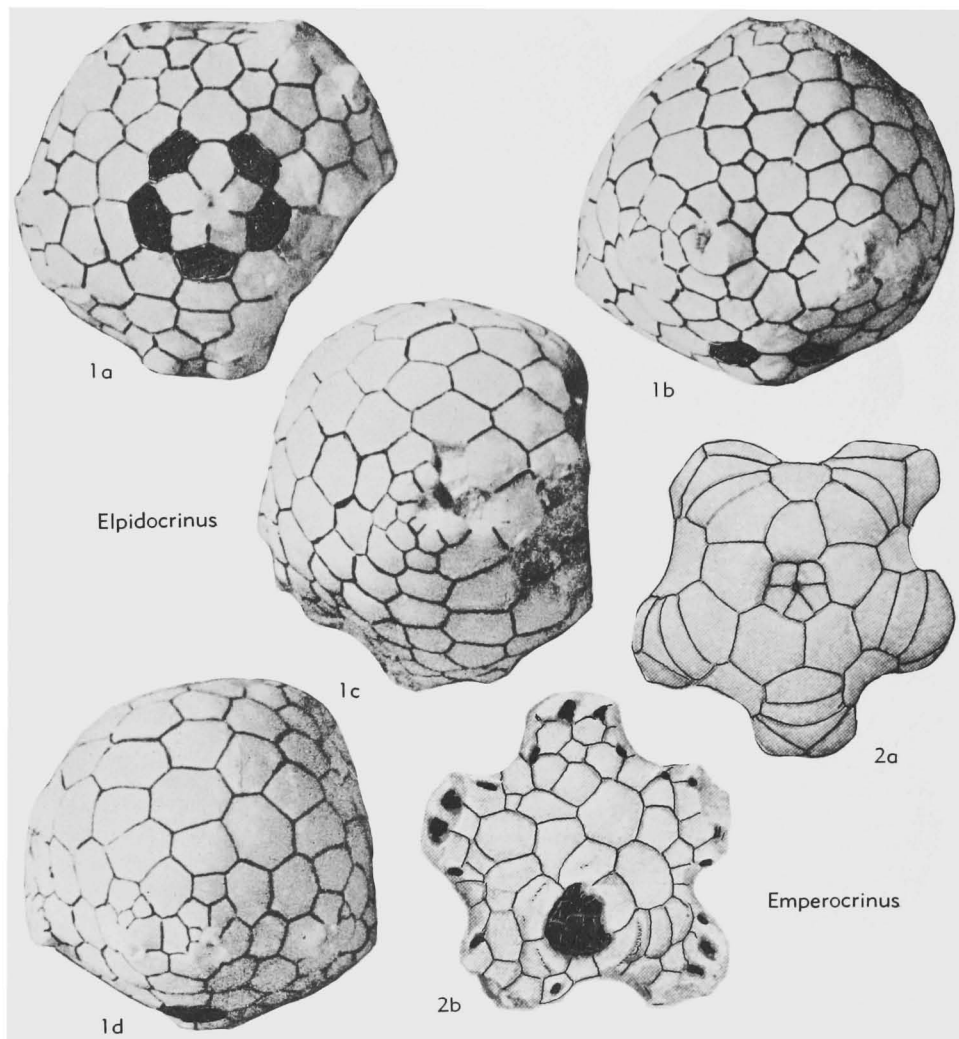


FIG. 235. Rhodocrinitidae (p. T427).

large portions of basals; fixed secundibrachs 1 or 2 in each half-ray; interradial areas wide, connected with tegmen, composed of large plates (1 + 2 + 3) usually surrounded by supplementary plates, which wholly or partly isolate proximal interradials from basals, radials, and primibrachs; *CD* interray wider than others, with 3 plates in 2nd row and 4 or more in 3rd row. Tegmen low, composed of moderate-sized plates with almost central anal tube. Arm openings very large, directed obliquely upward and arranged in groups. Column round or subpentagonal, with large quinquelobate canal. *M.Ord.*, N.Am.-Eu.(Scot.).—FIG. 234,1a,b. **D. perplexus*, Chazyan, Tenn.; dorsal and ventral views

of theca, $\times 2$ (Wachsmuth & Springer, 1897). —FIG. 234,1c. *D. vesperalis* (WHITE), Chazyan, Tenn.; lat. view, $\times 2$ (Wachsmuth and Springer, 1897).

Diamenocrinus OEHLERT, 1891, p. 836 [*D. jouani*; M]. Calyx subglobose or subcylindrical; plates thick, tumid, generally with stellate ornamentation; some species with each proximal plate bearing fixed spine or node; median ray ridges more or less conspicuous; each half-ray containing 5 to 8 fixed secundibrachs. Tegmen flat, many-plated. Arms biserial, repeatedly branching; brachials very short, cuneate, exteriorly in zigzag. Stem pentagonal, axial canal quinquelobate. *L. Dev.*, Eu.-?N.Afr.-?Sib.—FIG. 234,2. **D.*

jouani, Manche, France; *2a*, almost complete specimen, $\times 1$ (Oehlert, 1891); *2b*, plate diagram of cup and post. arms (Oehlert, 1891).

Elpidocrinus STRIMPLE, 1963, p. 77 [**E. tholiformis*; OD]. Calyx shallow, conical; infrabasals small, not visible in side view and probably entirely covered by proximal columnals; interprimibrachs running 1, 2, 3, connected with tegmen; *CD* interray with 3 anal plates in second row; fixed secundibrachs 2 in each half-ray; arm openings directed outward, paired but with proximal extremity of one intersecundibrach separating them. Tegmen high, made of rather large plates; anal opening almost central but somewhat displaced rearward. Stem insertion round, lumen small and quinquelobate. *M.Sil.*, USA (Okla.).—FIG. 235, 1. **E. tholiformis*; Niagaran (Henryhouse F.); *1a-d*, dorsal (radials black), *CD*-inter-ray, *E*-ray, and ventral views of holotype, $\times 2$ (Strimple, 1963a).

Emperocrinus MILLER & GURLEY, 1895, p. 42 [**E. indianensis*; OD]. Calyx low, pentagonal in outline in dorsal and ventral views; infrabasals ?3-5; interradial areas large, depressed, connecting with tegmen, each one occupied by single large plate; *CD* interray wider, with 3 anal plates in second row; arm openings 10; fixed pinnule openings few, apparently one to each arm on outer side, close to arm-base. Tegmen composed of relatively large plates; posterior anal tube. Lumen of stem insertion small, quinquelobate. *M.Sil.*, USA (Ind.).—FIG. 235, 2. **E. indianensis*, Niagaran (Laurel Ls.); *2a, b*, dorsal and ventral views, $\times 2$ (Springer, 1926a).

Gilbertocrinus PHILLIPS, 1836, p. 207 [**G. calcaratus*; SD BASSLER, 1938, p. 102] [= *Ollacrinus* CUMBERLAND, 1826 (*nom. nud.*); *Ollacrinites* DE BLAINVILLE, 1834, p. 659 (*nom. van.*); *Gilbertocrinites* BRONN, 1848, p. 530 (*nom. van.*); *Goniasteroidocrinus* LYON & CASSEDAY, 1859, p. 233 (type, *G. tuberosus*; M); *Trematocrinus* HALL, 1860c, p. 70 (type, *T. typus*; OD); *Goniasteroidocrinus* MARSCHALL, 1873, p. 400 (*nom. null.*)]. Calyx usually short, subcylindrical, basally excavate; interradial areas large, many-plated; *CD* interradial (primanal) usually not distinct in cup. Tegmen flat or low hemispherical, composed of numerous plates, with 5 interradial depressions in some species, and extended into 10 hollow tubular appendages, which taper gradually to a point; these appendages may remain distinct for their whole length, but generally those of same interray coalesce for some distance and then separate, in some late species branching once or twice; anus subcentral, directly through tegmen. Arms slender, pendent or folding over tegmen, branching, typically biserial. Nodals prominent. *M.Dev.-L.Carb.*, W.Eu.-N.Am.—FIG. 236, 1a-c. **G. calcaratus*, L.Carb. (Tournais.), Eng.; *1a-c*, dorsal, *C*-ray, and ventral views of calyx, $\times 1.5$ (Wright, 1955-60).—FIG. 236, 1d-f. *G. tubero-*

sus (LYON & CASSEDAY), *L.Miss.*, USA (Ind.-Iowa-Ky.); *1d, e*, lat., and ventral views of theca, $\times 1$ (Wachsmuth & Springer, 1897); *1f*, articular face of ossicles belonging to a tubular appendage, $\times 5$ (Van Sant & Lane, 1964).

[The tubular appendages of *Gilbertocrinus* are a feature that stands alone among crinoids. Each one is composed of a single series of cylindrical ossicles (primitive condition) or of one row of plates aborally and two rows of plates adorally; these interlock like covering plates (Fig. 236, 1d, e). Where the tubes are joined, the number of elements appears to be doubled. No ventral groove is observed. Each tube is perforated longitudinally by a central canal; when the appendages meet near the tegmen, their individual central canals remain separate. In some species, according to WACHSMUTH & SPRINGER (1897), each central canal connects with the subterminal ambulacral groove of the adjacent ray within the theca. The correctness of this observation has been questioned by VAN SANT (VAN SANT & LANE, 1964), but confirmed by LANE (personal communication, 1969). This tends to demonstrate that these appendages, while interradial in position, are radial in origin and morphological relation. The tubular extensions of *Gilbertocrinus* have been erroneously taken for the arms by early workers (HALL, PHILLIPS, LYON, CASSEDAY, ROEF), until the true arms were discovered by MEEK & WORTHEN (1866a, p. 217). Although apparently they do not open to the exterior, they have been generally regarded as analogous to the thecal pores of *Batocrinus* and other genera, even if they did not perform the same function. SPRINGER (1917) thought that they resulted from hypertrophy of proximal pinnules, which approached the cirri in structure and possibly in function. On the other hand, their position and construction have suggested to VAN SANT (VAN SANT & LANE, 1964) that they were modified terminal extensions, provided with limited mobility and serving directly or indirectly to 1) help support or anchor the theca, 2) protect the delicate arms, and 3) contribute to producing circulation of water around the theca.]

Lyriocrinus HALL, 1852, p. 197 [**Marsupiocrinites?* *dactylus* HALL, 1843, p. 114; M]. Calyx depressed globose; infrabasals very small, in deep pit; interprimibrachs arranged 1, 2, 1, ordinarily connected with tegmen, but not invariably touching basals; intersecundibrachs none or only 1 in a ray; *CD* interray indistinct or with single anal plate; fixed secundibrachs 2 in each half-ray. Tegmen flat, somewhat depressed in interrays, composed of many small plates, among which some larger ones (orals?) may be differentiated; probably small subcentral anal tube. Arms 10, simple, stout, biserial, rising in straight line with sides of calyx. Stem cylindrical, formed of regularly alternating nudinodals and internodals. *M.Sil.*, N.Am.(USA)-Eu.(Eng.).—FIG. 237, 1. **L. dactylus* (HALL), Niagaran, USA (N.Y.)-Can. (Ont.); *1a*, oblique view of holotype crown, $\times 1$ (Wachsmuth & Springer, 1897); *1b*, side view of crown showing pinnules, $\times 1$ (Wachsmuth & Springer, 1897).

Maquoketocrinus SLOCUM, in SLOCUM & FOERSTE, 1924, p. 330 [**M. ornatus*; M]. Calyx bowl shaped; infrabasals forming flat pentagonal disc extending beyond column; no fixed secundibrachs; interprimibrachs arranged 1, 2, 3, connecting with tegmen; *CD* interray indistinct. Stem insertion circular in outline, with pentagonal lumen. [RAMSBOTTOM (1961), has suggested that this genus probably represents an unusual *Lyriocrinus*.] *U.Ord.*, USA (Iowa).—FIG. 237, 2. **M. ornatus*, Maquoketa Sh. (Richmond.), Iowa; *2a, b*, lat. and

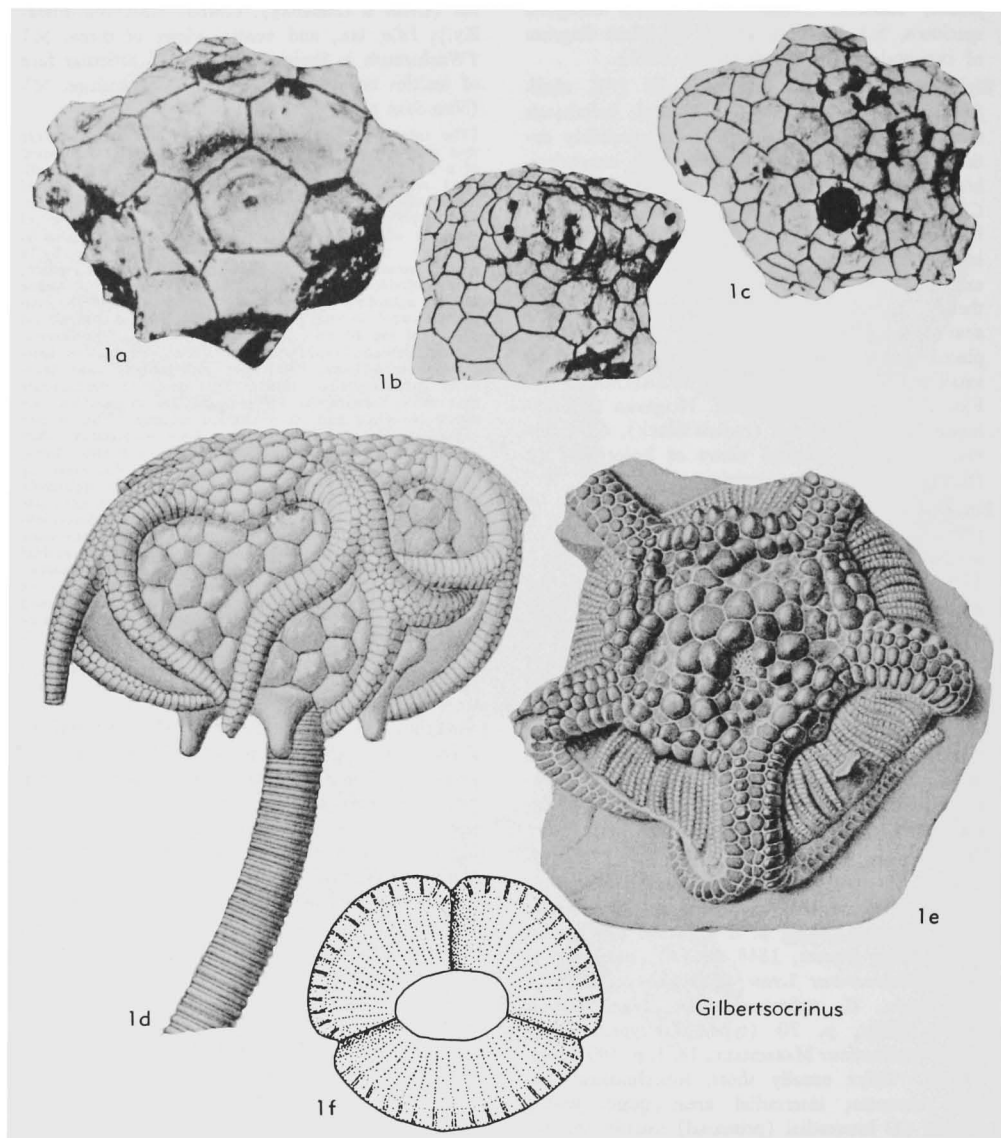


FIG. 236. Rhodocrinitidae (p. T427).

dorsal views of calyx (Field Museum Chicago; Ubaghs, n), $\times 5$; 2c, plate diagram of calyx (radials black, interbrachials stippled) (Slocum & Foerste, 1924).

Monstocrinus W. E. SCHMIDT, 1942, p. 213 [**M. securifer*; OD]. Similar to *Acanthocrinus* but bearing gigantic fixed spines on basals, radials, and interprimibrachs of 1st and 2nd orders. No stem(?). *L.Dev.-M.Dev.*, Eu.(Ger.).—FIG. 237, 3. **M. securifer*, M.Dev.; 3a,b, part of calyx and isolated spine, $\times 1$ (Schmidt, 1942).

Ophiocrinus SALTER, 1856, p. 223 (*non* CHARLES-

WORTH, 1865; *non* SEMPER, 1868; *non* ANGELIN, 1878) [**O. stangeri*; M]. Calyx moderately bowl shaped, slightly depressed below; infrabasals flat, small, entirely concealed by stem; basals prominent, overhanging stem; radials penetrating deeply between basals; fixed ray plates prominent, not ridged, including 2 primibrachs per ray, 2 to 3 secundibrachs per half-ray, and 1 to 2 tertibrachs to each arm; interbrachial areas well developed, slightly depressed, in contact with tegmen, composed of small, numerous plates; intersecundibrachs and intertribrachs present; extra plates in

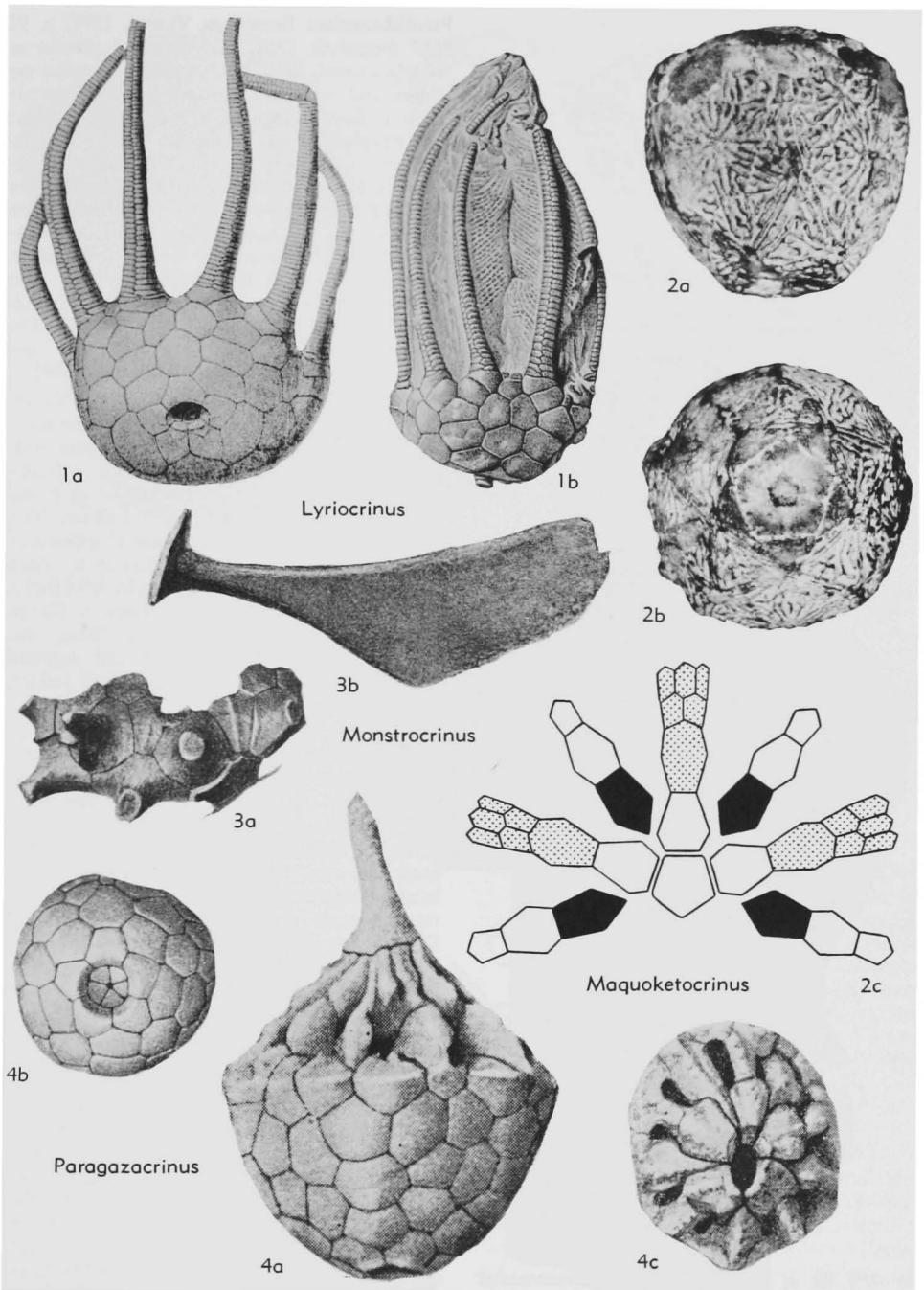


FIG. 237. Rhodocrinitidae (p. T427-T428, T430).

CD interray. Tegmen unknown. Free arms 4 to each ray, stout, simple, uniserial; brachials wedge shaped. Column circular in cross section,

heteromorphic. *L.Dev.*, S.Afr.—FIG. 238,2. **O. stangeri*, Bokkeveld Series, Cape Prov.; holotype, Sedgwick Museum Cambridge no. A 3441, latex

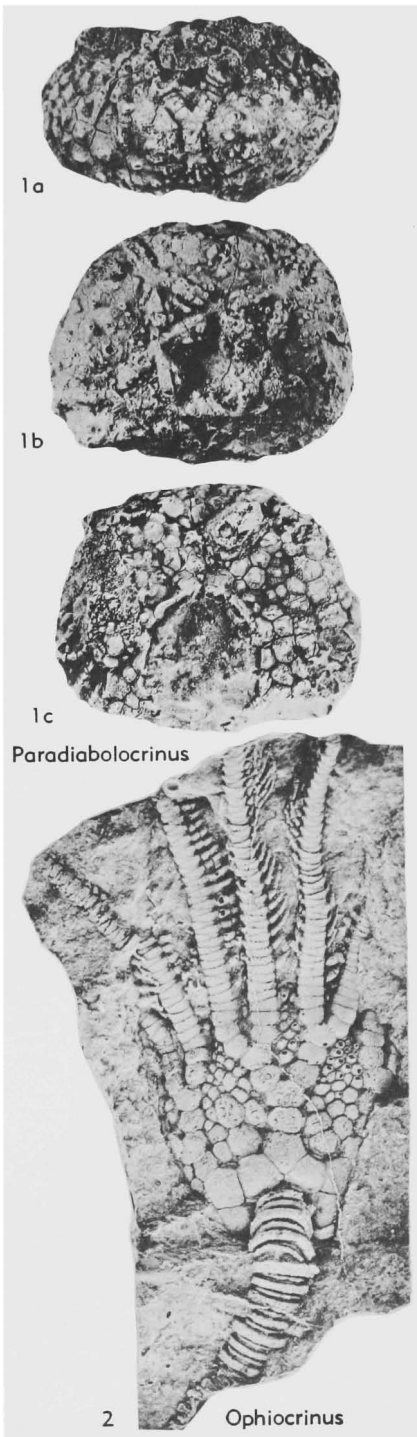


FIG. 238. Rhodocrinitidae (p. T428-T430).

cast of *C*-ray view, $\times 1.5$ (Ubaghs, n).

Paradiabolocrinus BROWER & VEINUS, 1974, p. 92 [**P. irregularis*; OD]. Cup depressed globular or widely conical, with basal concavity; median-ray ridges and stellate ridges on basals commonly present; fixed secundibrachs 3 to 5 per half-ray; interprimibrachs very numerous (17 to 36) irregularly shaped and placed, connecting with tegmen; intersecundibrachs several; *CD* interray wider and containing greater number of plates than other interrays. Tegmen many-plated, smoothly convex or with ambulacral areas faintly lobate. Two free arms per ray, originating from short lobate protruding arm bases. Free arms and column unknown. *M.Ord.*, USA (Tenn.).—FIG. 238, 1. **P. irregularis*; 1a-c, *D*-ray, basal, and tegminal views, $\times 1$ (Brower & Veinus, 1974).

Paragazacrinus SPRINGER, 1926, p. 22 [**P. rotundus*; OD]. Calyx medium bowl shaped; infra-basals small, in vertical-sided pit; interradial areas in contact with tegmen, composed of 4 or 5 relatively large plates; *CD* interray with 1 or 2 anal plates; fixed secundibrach 1 in each half-ray. Tegmen forming pyramid divided into 10 grooves by ridges and surmounted by tall erect spine. Arms 10, resting in tegminal grooves. *M.Sil.*, USA (Ind.).—FIG. 237, 4. **P. rotundus*, Niagaran (Laurel Ls.); 4a, lat. view of complete theca, $\times 3$ (Springer, 1926a); 4b,c, dorsal and tegminal views of theca, central spine on tegmen lacking, $\times 3$ (Springer, 1926a).

Rhipidocrinus BEYRICH in ZITTEL, 1879, p. 376 [**Rhodocrinites crenatus* GOLDFUSS, 1831, p. 212; M] [= *Rhipidocrinus* WACHSMUTH & SPRINGER, 1881, p. 205 (379) (*nom. van.*)]. Calyx low, flat-bottomed, globose; basals in lateral contact all around or with variable number of them separated from each other by radials in contact with infra-basals; interprimibrachs 5 to 9 in different interrays separated from tegmen by fixed ramules; *CD* interray indistinct; intersecundibrachs 1 to 5, not connected with tegmen; fixed secundibrachs usually 2 in half-ray, last one axillary and bearing ramule on its outer shoulder and main arm trunk on its inner shoulder, proximal part of both ramule and arm trunk being incorporated in calyx. Tegmen low, composed of numerous small plates which decrease in size toward periphery; anus excentric. Each ray produced into 2 long, heavy, uniserial trunks, carrying biserial, pinnuliferous ramules alternating on opposite sides. Stem cylindrical, comprising thin nudinodals with broadened peripheral rims and thin internodals concealed by nodals; axial canal pentalobate. *M.Dev.*, Eu. (Ger.-Eng.). [This genus stands apart from other *Rhodocrinitidae*, in organization of the calyx base and peculiar arm structure. It is retained in this family until its real affinities are known.]—FIG. 239, 1. **R. crenatus* (GOLDFUSS), Givet., Ger., 1a, lat. view of crown, $\times 1$ (Schultze, 1867); 1b,c, dorsal and ventral

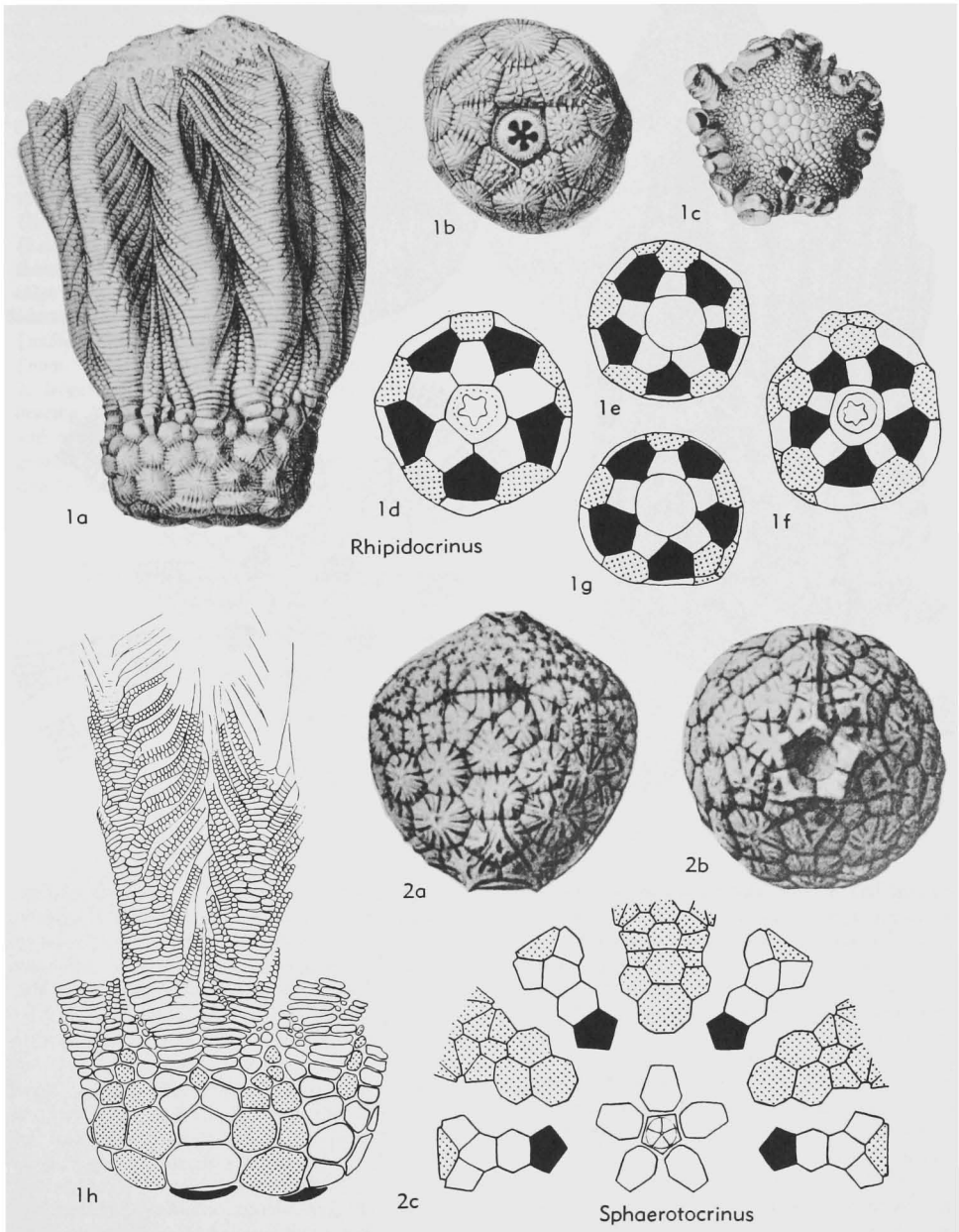


FIG. 239. Rhodocrinitidae (p. T430-T432).

views of theca, $\times 1$ (Schultze, 1867); 1d-g, diagrams of various arrangements of plates in base of calyx (radials black, interbrachials stippled) (Breimer, 1960).—FIG. 239, 1h. *R.* sp. cf. *R. perloricatus* W. E. SCHMIDT, Givet., Ger.; E-ray view of incompl. crown (radials black, interbrachials stippled), $\times 1$ (Breimer, 1960).

Sphaerotocrinus GOLDRING, 1923, p. 99 [**S. ornatus*; OD]. Calyx subglobose, with shallow basal depression; infrabasals very small, concealed by stem impression; single fixed secundibrach in each half-ray; 1st interprimibrach large, followed in 2nd row by 2 plates and in 3rd row by 3 plates which meet tegmen; CD interray with

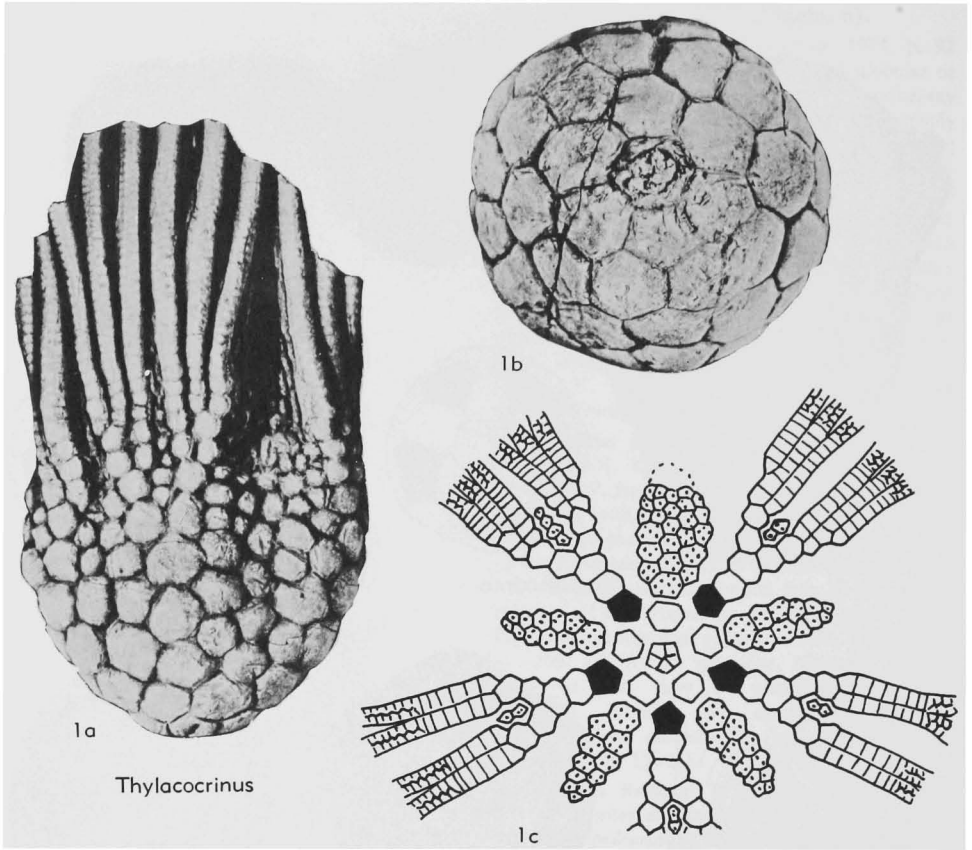


FIG. 240. Rhodocrinitidae (p. T432).

median line of anal plates bordered on each side by single row of rather irregular, small plates; triangular intersecundibrachs 1 in each ray; arm openings 10, very small. Tegmen strongly arched, composed of numerous small plates, with central anal tube. Arms unknown, but probably slender and abruptly separated from calyx. Stem insertion circular; axial canal small, round. *L.Dev.*, USA (Pa.).—FIG. 239, 2. **S. ornatus*, Helderberg; 2*a, b*, *A*-ray and dorsal views of theca, $\times 4$ (Goldring, 1923); 2*c*, plate diagram of part of calyx (radials black, and interbranchials stippled) (Goldring, 1923).

Thylacocrinus OEHLERT, 1878, p. 6 [*T. vannioti*; M]. Calyx large, medium to high conical or bowl shaped; infrabasals 5, small; fixed secundibrachs 2; fixed tertibrachs 6 to 9; interprimibrachs merging with tegmen, numerous; *CD* interray wider and with a sagittal series of supplementary plates; intersecundibrachs few. Tegmen low convex, composed of a large number of small pieces. Free arms 20 to 24, generally 4 per ray, occasionally 5 or 6 in *C* and *D* rays, biserial, simple. Stem heteromorphic, round or pentagonal in cross section. *L.Dev.*-*M.Dev.*, Eu.-N.Afr.-N.Am.-?E.Aus-

tralia.—FIG. 240, 1. **T. vannioti*, L.Dev., France; 1*a*, *D*-ray view of crown, $\times 1$ (Le Menn, 1974); 1*b*, basal view of lectotype, $\times 1$ (Le Menn, 1974); 1*c*, plate diagram of part of theca and arms (radials black, interbranchials and anals stippled) (Le Menn, 1974, mod.).

Trichinocrinus MOORE & LAUDON, 1943, p. 265 [*T. terranovicus*; OD]. Calyx bowl shaped; low median ray ridges present; infrabasals in basal pit; large interprimibrachs at least 1 in each interray. Rami 10, simple, uniserial; brachial externally cuneate; pinnules bearing appendages or pinnulets which may represent unusually long, weakly calcified tentacles. Stem transversely round, with thick projecting nodals and thin internodals. *M.Ord.*, Can.(Newf.).—FIG. 241, 1. **T. terranovicus*; side view of crown, ca. $\times 5$ (Moore & Laudon, 1943b).

Family UNCERTAIN

Paulocrinus SPRINGER, 1926, p. 22 [*P. biturbidatus*; OD]. Calyx truncate conical, spreading to horizontally directed arm bases which form projecting rim with fixed pinnulars; infrabasals visi-

ble in side view, unequal, 2 of them truncated by radials; radials unequal; primibrachs usually 2, exceptionally only 1 in ray; fixed secundibrachs 2 to 4 in each half-ray; fixed tertibrachs present; arm openings 4 to ray; interbrachials few, separated from tegmen by fixed pinnulars; *CD* inter-ray barely differentiated. Tegmen conical, many-plated, culminating in large excentric anal tube. [This genus, based on a single possibly abnormal specimen, is of uncertain affinity.] *M.Sil.*, USA (Ind.).—FIG. 242, *l*. **P. biturbinatus*, Niagaran (Laurel Ls.); *1a, b*, *CD* interray and basal views of theca, $\times 2$ (Springer, 1926a); *1c*, plate diagram of calyx base (radials black) (Springer, 1926a).

Siderocrinus Wood, 1909, p. 104 [**S. ornatus*; M] [= *Siderocrinites* TROOST in WOOD, 1909, p. 104 (*nom. nud.*)]. Deep basal excavation; infrabasals 5, large; basals thick; radials quadrangular, each bearing long spine. Other parts of theca, arms, and stem unknown. *M.Sil.*, USA (Tenn.). [This genus, founded on a single specimen, is insufficiently known for trustworthy recognition.]

Superfamily DIMEROCRINITACEA Zittel, 1879

[*nom. correct.* BROWER, 1973, p. 445 (*pro* Dimerocrinitaceae UBAGHS, 1953, p. 737, *nom. transl. ex* family Dimerocrinitidae ZITTEL, 1879, p. 344)]

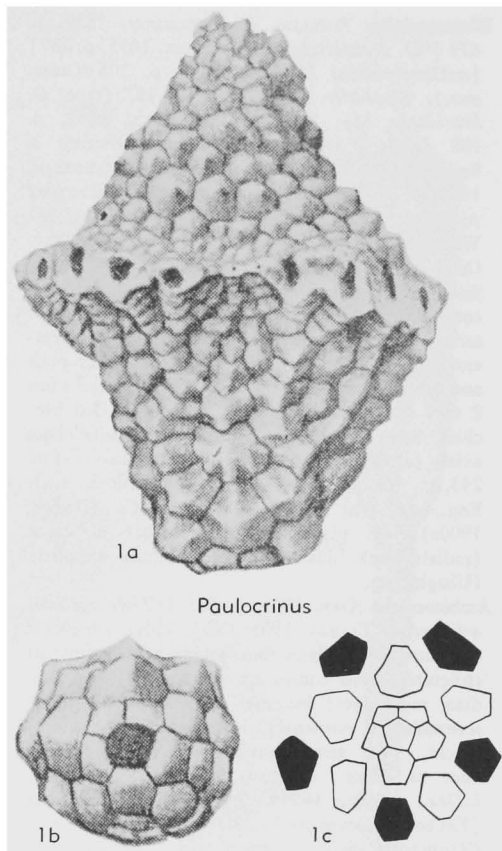


FIG. 242. Family Uncertain (p. T432-T433).

Radials adjoining each other except for separation by primanal on posterior side of calyx, primanal resting on posterior basal. *U.Ord.*; *M.Sil.-U.Dev.*

Family DIMEROCRINITIDAE Zittel, 1879

[*nom. correct.* BASSLER, 1938, p. 25 (*pro* Dimerocrinitidae ZITTEL, 1879, p. 344, 367)] [= *Eucrinidae* ANGELIN, 1878, p. 24; *Glyptasteridae* WACHSMUTH & SPRINGER, 1885, p. 89 (314); *Thysanocrinitidae* WACHSMUTH & SPRINGER, 1897, p. 188; *Ptychocrinitidae* JAEKEL, 1918, p. 41]

Median ray ridges present in primitive members; interprimibrachials well developed, regular, depressed or not, connecting with tegmen, first one typically followed by two plates; primanal supporting three plates in next higher row; generally with sagittal series of ridged or unridged extra plates, leading to anus in *CD* interray. Arms simple or branching, uniserial, biserial, or with compound brachials. Stem transversely round to substellate. *U.Ord.*; *M.Sil.-U.Dev.*

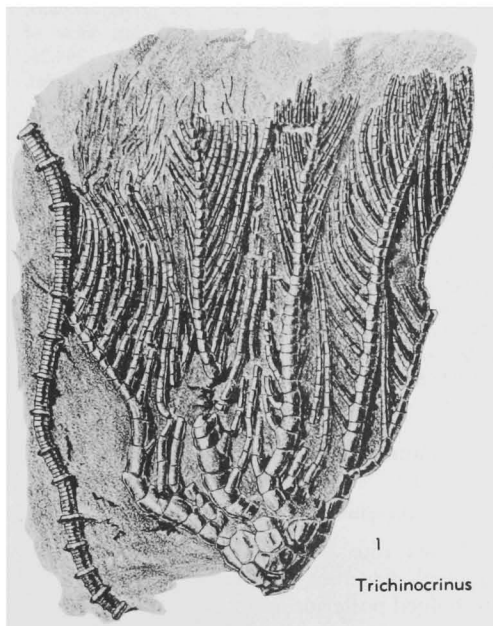


FIG. 241. Rhodocrinitidae (p. T432).

- Dimerocrinites** PHILLIPS in MURCHISON, 1839, p. 674 [**D. decadactylus*; SD ROEMER, 1855, p. 237] [= *Dimerocrinites* MÜLLER, 1843, p. 208 (nom. van.); *Glyptaster* HALL, 1852, p. 187 (type, *G. brachiatus*; M); *Thysanocrinites* HALL, 1852, p. 188 (type, *T. liliiformis*; SD WACHSMUTH & SPRINGER, 1897, p. 191); *Harmocrinites* ANGELIN, 1878, p. 22 (type, *H. longimanus*; M); *Eucrinus* ANGELIN, 1878, p. 24 (type, *E. laevis*; SD WACHSMUTH & SPRINGER, 1881, p. 197 (371)]. Calyx low to medium conical; plates moderately thick to heavy; median ray ridges more or less conspicuous and interray areas depressed; sagittal series of flush or keeled anal plates generally present joining tegmen, which contains distinct orals and ambulacra but lacks anal tube. Biserial rami 2 to 4 in each ray, generally free above 3rd brachial. Stem circular in section with quinquelobate axial canal. *M.Sil.-M.Dev.*, Eu.-N.Am.—FIG. 243,1. **D. decadactylus*, *M.Sil.*(Wenlock Ls.), Eng.; *1a*, post. view of crown, $\times 2$ (Bather, 1900a); *1b*, plate diagram of part of calyx (radials black, anals and interbranchials stippled) (Ubahgs, n).
- Ambicocrinites** KIRK, 1945, p. 353 [**Thysanocrinites arborescens* TALBOT, 1905; OD]. Calyx somewhat elongate; thecal plates thin, giving an incompetent structure; basals comparatively large, without median ray ridges; interrays not depressed; intersecundibrachs numerous; 3 or more fixed secundibrachs. Free arms compactly biserial, dividing once or twice. Column substellate in section. *L.Dev.*, N.Am.—FIG. 243,2. **A. arborescens* (TALBOT), Coeymans Ls., USA(N.Y.); *D*-ray and *CD*-interray view of crown with attached stem, $\times 1.5$ (Goldring, 1923).
- Cyphocrinites** S. A. MILLER, 1892, p. 50 [**C. gorbyi*; M] [= *Hyptiocrinites* WACHSMUTH & SPRINGER, 1892, p. 138 (type, *H. typus*; OD)]. Calyx low, wide, and recurving from narrow obconical base to spreading inverted bowl; fixed pinnule openings 4 to 6 in each interray. Tegmen with central and spiniferous radial dome plates. Arms 10, biserial, apparently stout and pendent (unknown beyond small remnants). *M.Sil.*, USA (Ind.)—FIG. 243,3. **C. gorbyi*, Niagaran (Laurel Ls.); *3a*, dorsal view of holotype theca, $\times 1.5$ (Wachsmuth & Springer, 1897); *3b,c*, lat. and ventral views of theca, $\times 1.5$ (Springer, 1926a).
- Eudimerocrinites** SPRINGER, 1926, p. 14 [**E. multibrachiatus*; OD]. Like *Dimerocrinites* but with free arms branching several times and column subpentagonal in cross section. *M.Sil.*, USA (Tenn.)—FIG. 243,4. **E. multibrachiatus*, Niagaran; *A*-ray view, $\times 1.5$ (Springer, 1926a).
- Griphocrinites** KIRK, 1945, p. 350 [**Rhodocrinites (Acanthocrinites) nodulosus* HALL, 1862, p. 126; OD]. Calyx subturbinate to bowl shaped, composed of thick, commonly nodose, plates; median ray ridges more or less distinct; infrabasals 5 (4 in *G. ovetensis*), small, but visible in side view; basals and radials large; in some specimens, all radials in lateral contact, in others all or variable number of radials separated by 1st interprimibrachs in contact with basals; interrays relatively narrow, with 2 plates in 2nd row and 2 or 3 in 3rd row; *CD* interray wide, with sagittal series of anal plates; intersecundibrachs present; fixed secundibrachs 1, 2 or more. Tegmen low, many-plated, with excentric anal opening; anal tube present in at least one species. Arms biserial, branching dichotomously twice or more. Column large, circular in section, with large quinquelobate lumen. *Dev.*, N.Am.-Eu.-N.Afr.—FIG. 243,5. **G. nodulosus* (HALL), M.Dev.(Moscow F.), USA (N.Y.); lat. view of holotype crown, $\times 1$ (Goldring, 1923).
- Macarocrinites** JAEKEL, 1895, p. 36 [**M. springeri*; M]. Calyx cupuliform or widely conical; no median ray ridges; interprimibrachs not depressed. Tegmen seemingly pliant, composed of coarse platelets, irregular in size and arrangement, with possibly oral and radial dome plates in at least some species. Arms uniserial, dichotomously branching 1 to 3 times. Column circular in cross section. *Dev.*, Eu.—FIG. 244,1. **M. springeri*, L.Dev.(HunsrückSchiefer), Ger.; *1a*, dorsal view of holotype crown, $\times 1$ (Jaekel, 1895); *1b*, plate diagram of calyx and lower part of arms (radials black, interbranchials stippled), $\times 2.5$ (Schmidt, 1934).
- Pterinocrinites** GOLDRING, 1923, p. 86 [**P. quinquenodus*; OD]. Similar to *Dimerocrinites* but having compound bipinnulated brachials. *Dev.*, N.Am.-Eu.—FIG. 244,2a. **P. quinquenodus*, U.Dev.(L.Chemung.), USA(N.Y.); lat. view of crown, $\times 2$ (Goldring, 1923).—FIG. 244,2b. **P. decembrachiatus* BREIMER, L.Dev., Spain; lat. view of crown, $\times 1.5$ (Breimer, 1962).
- Ptychocrinites** WACHSMUTH & SPRINGER, 1885, p. 99 (321) [**Gaurocrinites splendens* S. A. MILLER, 1883b, p. 230; SD WACHSMUTH & SPRINGER, 1897, p. 197]. Calyx obconical, thinly plated, with well-developed median ray ridges; interprimibrachs depressed; distinct anal ridge. Tegmen incompetent, composed of numerous small plates. Arms slender, uniserial, simple or branching. Column round in section. *U.Ord.*, N.Am.(USA)—FIG. 244,3. **P. splendens* (S. A. MILLER), Girardeau Ls., USA(Mo.-Ill.); lat. view of crown and attached stem, $\times 3$ (Wachsmuth & Springer, 1897).

Family LAMPTEROCRINIDAE Bather, 1899

[Lampterochinidae BATHER, 1899b, p. 923]

Calyx like that of *Dimerocrinitidae* in general structure but asymmetrical owing to bulged posterior interray. *M.Sil.*

Lampterochinus ROEMER, 1860, p. 37 [**L. ten-*

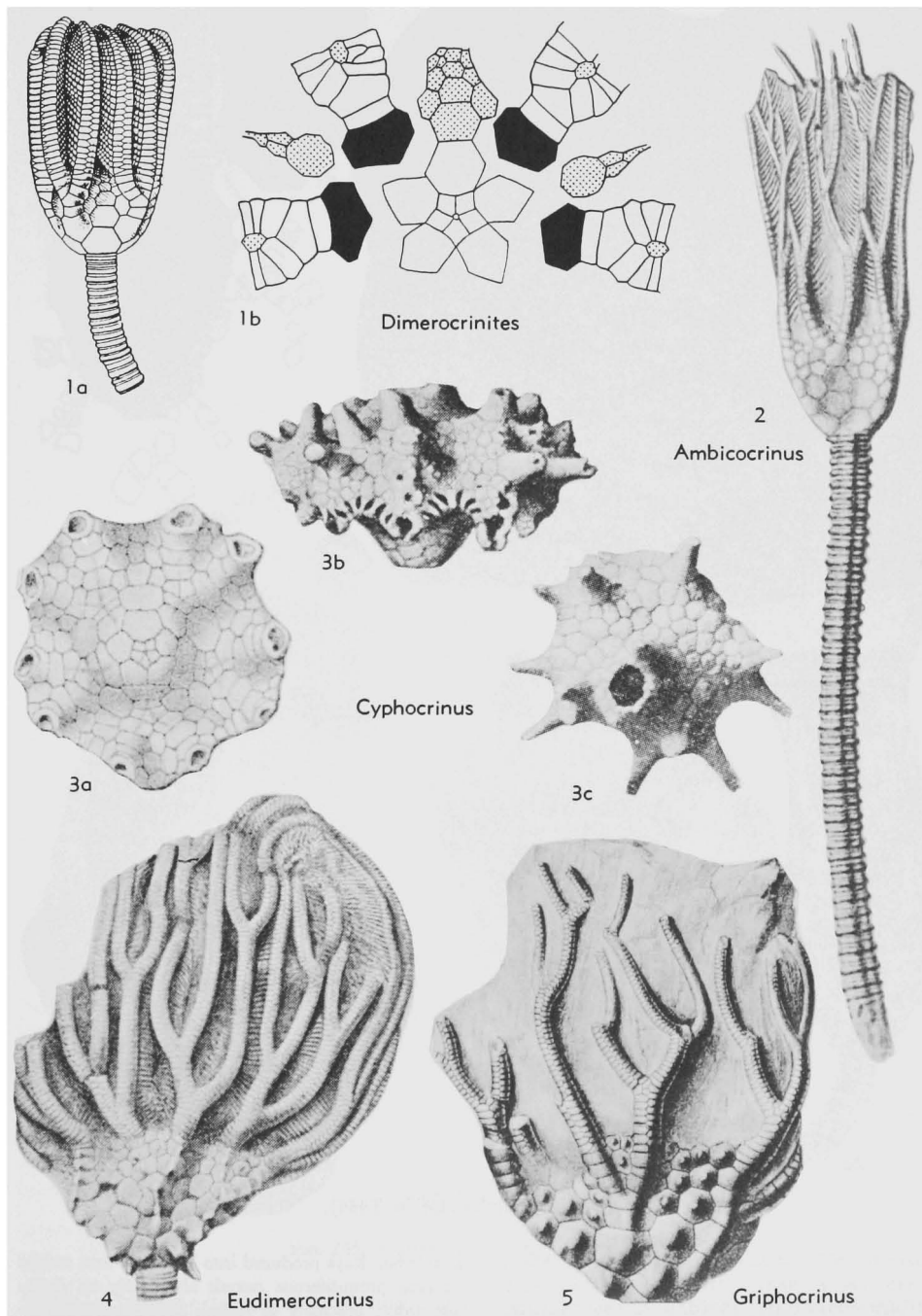


FIG. 243. Dimerocritidae (p. T434).

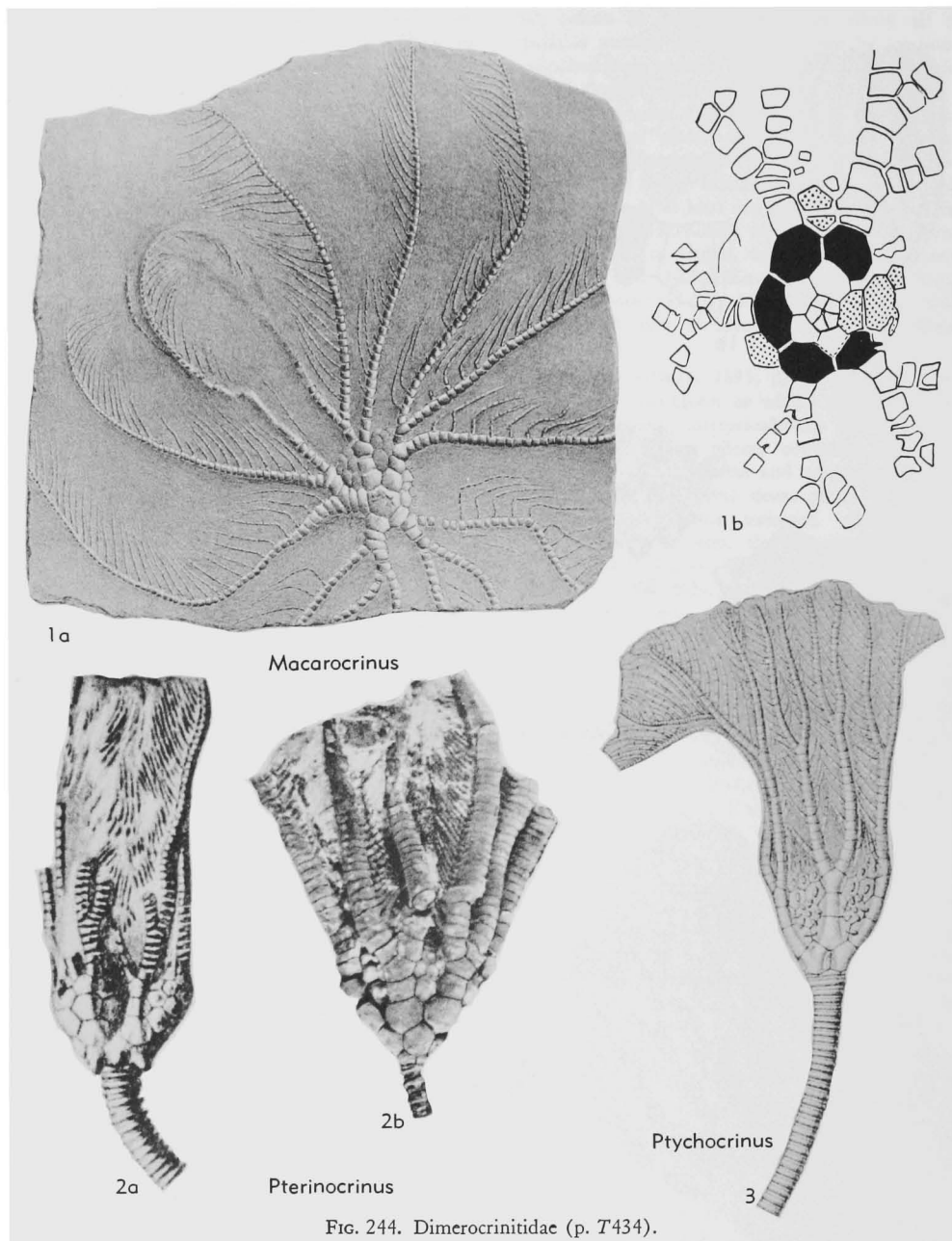


FIG. 244. Dimerocrinitidae (p. T434).

nesseensis; M] [= *Balanocrinites* TROOST, 1850b, p. 419 (*nom. nud.*) (type, *B. sculptus*; M)] [= *Balanocrinus* HALL, 1861d, p. 22 (*non* AGASSIZ, 1845) (*nom. van.*)]. Calyx high bowl shaped; infrabasals and basals rather high spreading; interprimibrachials few. Tegmen composed of numerous convex plates passing into strong subcentral

anal tube. Rays produced into 5 tubular arm trunks bearing pinnuliferous ramuli alternately on opposite sides; brachials of ramuli compound and bipinnulate. Column sharply pentagonal in cross section. *M.Sil.*, USA (Tenn.).—FIG. 245, 1. **L. tennesseensis*, Niagaran (Beech River F.); 1a, b, CD- and DE-interray views of theca, $\times 1$

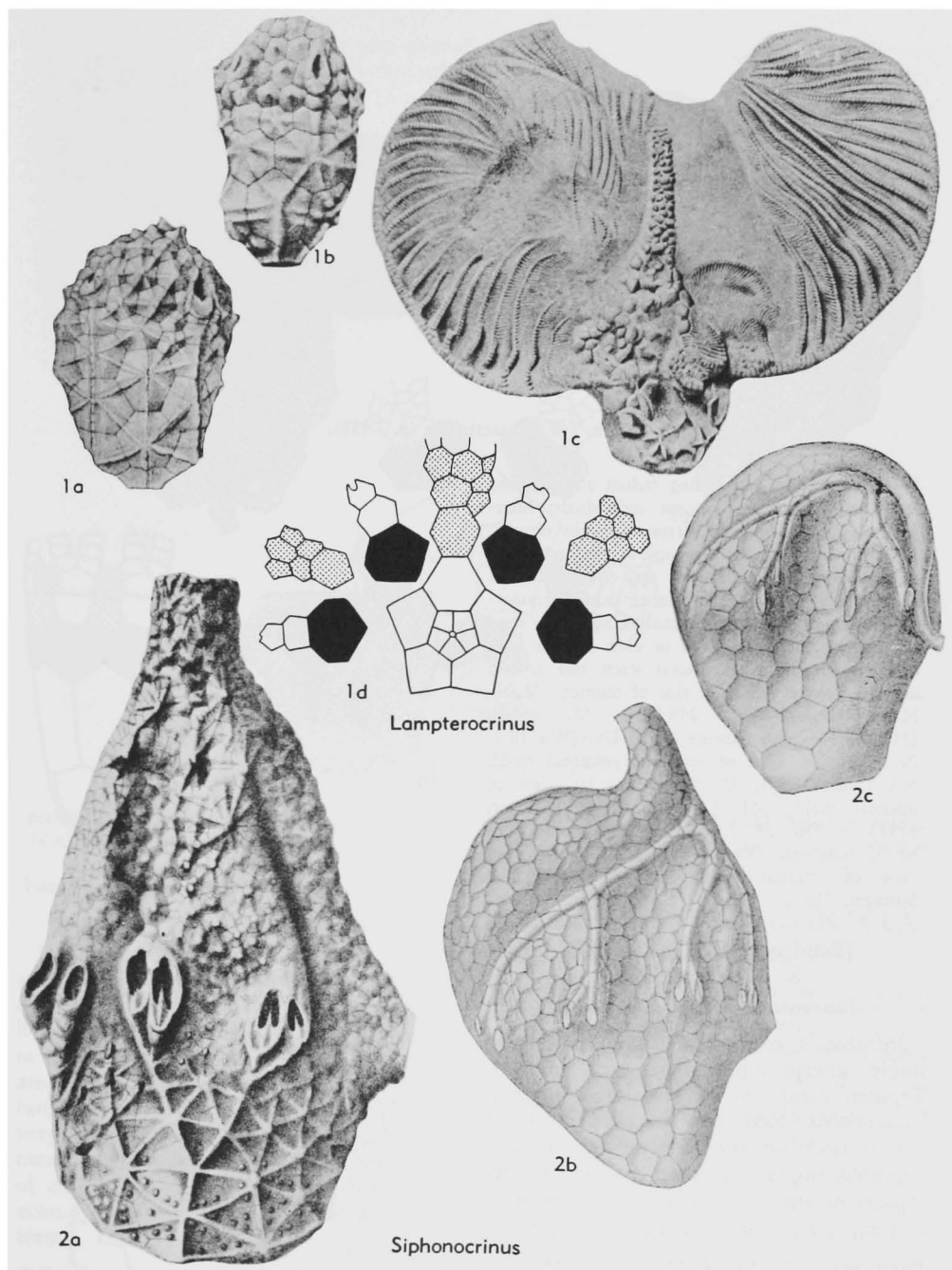


FIG. 245. Lampterocrinidae (p. T434-T438).

(Springer, 1926a); *1c*, lat. view of crown, $\times 1$ (Springer, 1926a); *1d*, plate diagram of part of theca (radials black; anals and interbranchials stippled) (Ubaghs, n).

Siphonocrinus S. A. MILLER, 1888, p. 263 [**Glyp-*

toerinus nobilis HALL, 1861d, p. 21; OD] [= *Ochlerocrinus* STRIMPLE, 1963a, p. 87 (type, *Eucalyptocrinus armosus* MCCHESENEY, 1861, p. 95; OD)]. Calyx very asymmetrical, somewhat depressed interradially and lobed at arm level; basals

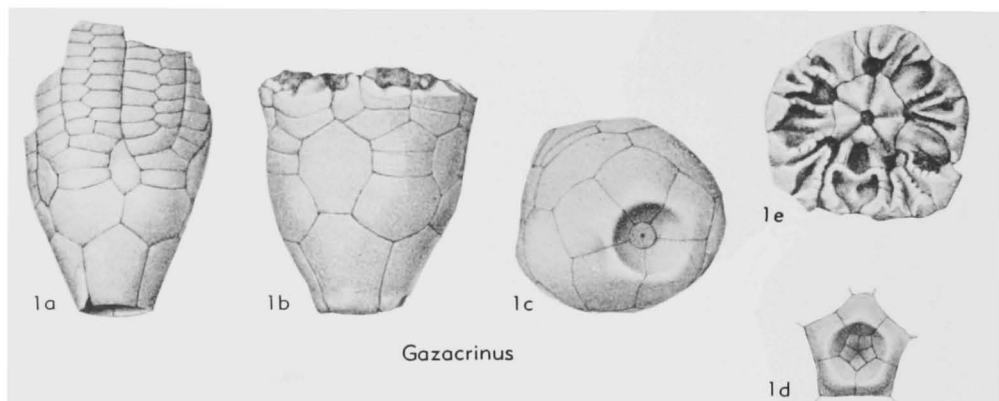


FIG. 246. Gazacrinidae (p. T438).

high, more or less separating radials and meeting 1st interprimibrachs in some individuals; interprimibrachs numerous; intersecundibrachs present. Tegmen very high, with conspicuous protuberance occupying whole *CD* interrayer and encroaching on *D* ray, distal part of protuberance either terminating in central anal tube or continuing across apex to anterior anal aperture at or even beneath arm bases; subtegminal ambulacral tracts and rectum in open grooves on inner side of tegmen. *M.Sil.*, N.Am.(USA).—FIG. 245,2a,b. **S. nobilis* (HALL), Niagaran (Racine Dol.), USA (Wis.-Ill.); 2a, *E*-ray lat. view of cast from external mold, $\times 1$ (Hall, 1865); 2b, *BC*-interrayer lat. view of internal mold, $\times 1$ (Wachsmuth & Springer, 1897).—FIG. 245,2c. **S. armosus* (McCHESNEY), Niagaran (Racine Dol.); *BC*-interrayer lat. view of internal mold, $\times 1$ (Wachsmuth & Springer, 1897).

Family GAZACRINIDAE

S. A. Miller, 1892

[Gazacrinidae S. A. MILLER, 1892a, p. 49]

Infrabasals confined to basal concavity; single interprimibrach in each interrayer. Tegmen composed of few large interambulacral crowns with central pyramid of five distinct or ankylosed plates; vertical tegminal ridges may form grooves for reception of arms. Arms ten simple, biserial. Column round in cross section. *M.Sil.*

Gazacrinus S. A. MILLER, 1892, p. 49 [**G. inornatus*; M] [= *Idiocrinus* WACHSMUTH & SPRINGER, 1892 (obj.)]. Characters of family. *M.Sil.*, N.Am. (USA).—FIG. 246,1. **G. inornatus*, Niagaran (Laurel Ls.), USA (Ind.); 1a, *A*-ray view of calyx and lower part of arms, $\times 2$ (Springer, 1926a); 1b, *CD*-interrayer view of theca, $\times 2.5$ (Springer, 1926a); 1c, dorsal view of theca (infrabasals con-

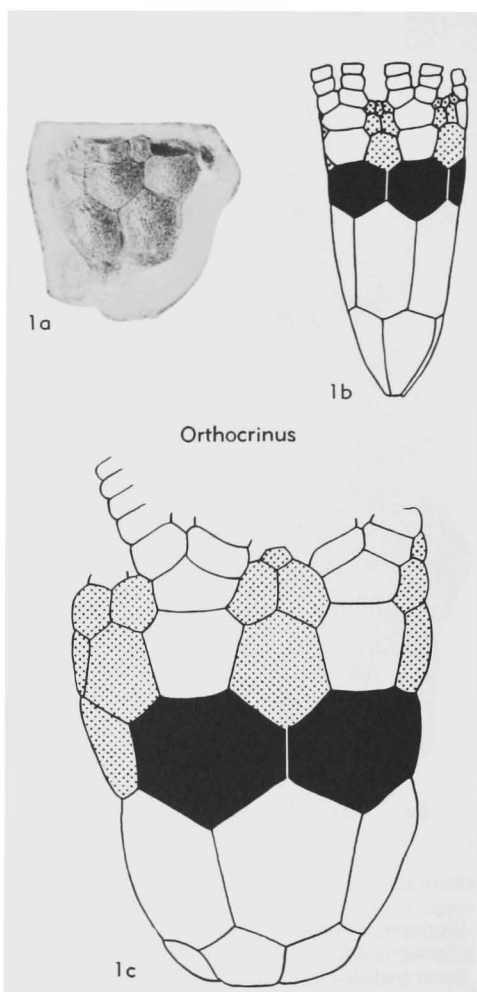


FIG. 247. Orthocrinidae (p. T439).

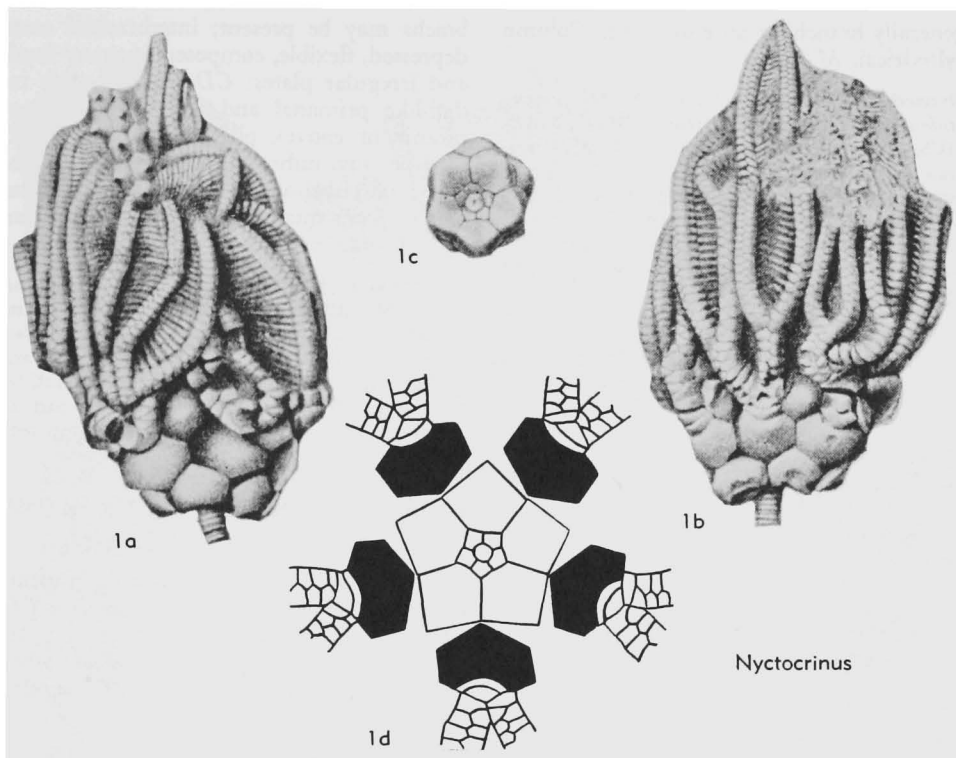


FIG. 248. Nyctocrinidae (p. T440).

sealed by columnal), $\times 2$ (Springer, 1926a); 1d,e, base and tegmen, $\times 2$ (Springer, 1926a).

Family ORTHOCRINIDAE Jaekel, 1918

[Orthocrinidae] JAEKEL, 1918, p. 42]

Calyx more or less elongate; infrabasal and basal circlets very high, occupying about one third to two thirds of calyx height; radials and fixed primibrachs (two in each ray) relatively small; interradian areas reduced, with two plates in second range and three in *CD* interray. Tegmen very low, composed of many minute elements. Arms ten, stout, simple, composed of compound, bipinnulated brachials. Column cylindrical, very delicate, with circular lumen. *L.Dev.-M.Dev.*

Orthocrinus JAEKEL, 1895, p. 29 [**O. simplex*; M]. Characters of family. *L.Dev.-M.Dev.*, W.Eu. —FIG. 247,1a. **O. simplex*, M.Dev., Ger.; lectotype, fragment of calyx, $\times 1$ (Schmidt, 1942). —FIG. 247,1b. *O. elongatus* BREIMER, L.Dev. (U.Ems.), Spain; lat. view of holotype (radials black, interbrachials stippled), $\times 1$ (Breimer, 1962). —FIG. 247,1c. *O. robustus* BREIMER,

M.Dev., Spain; lat. view of holotype (radials black, interbrachials stippled), $\times 1$ (Breimer, 1962).

Superfamily NYCTOCRINACEA Moore & Laudon, 1943

[*nom. correct.* UBAGHS, herein (*pro* Nyctocrinaceae UBAGHS, 1953, p. 737, *nom. transl.* ex family Nyctocrinidae MOORE & LAUDON, 1943a, p. 84)]

Radials adjoining each other all around, forming uninterrupted circlets. *M.Sil.*

Family NYCTOCRINIDAE Moore & Laudon, 1943

[Nyctocrinidae MOORE & LAUDON, 1943a, p. 84]

Calyx low conical, with truncated base; basals large, curving into concavity in which are located five small infrabasals; radials large, with narrow radial facets; primibrachs two in each ray, very short; interprimibrachs and first anal plate above radial circlet and largely confined to tegmen; primumal plate slightly larger than first interprimibrachs; long anal tube. Arms biserial, two in each ray, simple or more

generally branching once or twice. Column cylindrical. *M.Sil.*

Nyctocrinus SPRINGER, 1926, p. 54 [**N. magnitubus*; OD]. Characters of family. *M.Sil.*, N.Am. (USA).—FIG. 248, *1*. **N. magnitubus*, Niagara (Beech River F.), USA (Tenn.); *1a, b*, opposite views of somewhat crushed specimen, $\times 1.5$ (Springer, 1926a); *1c*, dorsal view of calyx base, $\times 1.5$ (Springer, 1926a); *1d*, plate diagram of calyx and lower part of arms (radials black) (Ubahgs, n).

Order MONOBATHRIDA Moore & Laudon, 1943

[*nom. correct.* MOORE, 1952a, p. 614 (*pro* Monobathra MOORE & LAUDON, 1943a, p. 86)] [Materials for this order prepared by GEORGES UBAGHS, with contributions by N. GARY LANE, R. C. MOORE, A. L. BOWSER, and H. L. STRIMPLE, as indicated in the text]

Calyx monocyclic. ?*L.Ord.*, *M.Ord.*-*U. Perm.*

Suborder COMPSOCRININA Ubahgs, new suborder

[=*Tanaocrinina* MOORE, 1952a, p. 614]

Basal circlet hexagonal; radials adjoining each other except for separation by primal on posterior side. ?*L.Ord.*, *U.Ord.*-*U. Perm.*

Superfamily XENOCRINACEA S. A. Miller, 1890

[*nom. correct.* BROWER, 1973, p. 443 (*pro* Xenocrinaceae UBAGHS, 1953, p. 738, *nom. transl. ex* Xenocrinidae S. A. MILLER, 1890, p. 318)]

Calyx elongate; fixed brachials numerous; basals four; interbrachials numerous, connecting with interambulacra; *CD* interray divided by median series of anal plates. Tegmen many-plated, without anal tube. Free arms few per ray. ?*L.Ord.*; *U.Ord.*; *U.Sil.*

Family XENOCRINIDAE S. A. Miller, 1890

[Xenocrinidae S. A. MILLER, 1890, p. 318]

Median ray and anal ridges conspicuous; radials usually adjoining each other in all interrays except posterior; sutures between some adjacent radials covered by small supplementary plates; fixed secundibrachs two, if there is further division, otherwise three to four to each half ray; few fixed ter-

trachs may be present; interbrachial areas depressed, flexible, composed of many small and irregular plates; *CD* interray with radial-like primal and median anitaxis of prominent convex plates. Free arms 2, 3 or 4 per ray, unbranched, uniserial or composed of cuneiform and interlocking brachials. Stem quadrangular in cross section, with pentagonal axial canal. *U.Ord.*

Xenocrinus S. A. MILLER, 1881, p. 71 [**X. penicillus*; M]. Characters of family. *U.Ord.*, N.Am. (USA)-Eu.(Scot.).—FIG. 249, *1*. **X. penicillus*, Richmond., USA (Ohio); *1a, b*, *CD* interray and *D*-ray views of crowns, $\times 2$ (Wachsmuth & Springer, 1897); *1c*, plate diagram of part of calyx and arms (radials black, anal plates stippled) (Ubahgs, n).

Family TANAOCRINIDAE Bather, 1899

[Tanaocrinidae BATHER, 1899b, p. 921]

Median ray and anal ridges present; radials in full lateral contact except in *CD* interray; interbrachial areas moderately depressed, probably solid, composed of rather numerous and moderately large and regular plates. ?*L.Ord.*, *U.Ord.*

Canistrocrinus WACHSMUTH & SPRINGER, 1885, p. 94(316) [**Glyptocrinus richardsoni* WETHERBY, 1880; OD] [= *Tanaocrinus* WACHSMUTH & SPRINGER, 1897, p. 185 (type, *T. typus*); *Canistrocrinus* JAMES, 1897, p. 104 (*nom. null.*)]. Basals visible in side view; fixed secundibrachs 5 or 6 in each half-ray; fixed tertibrachs passing to free brachials. Free arms uniserial, 4 to each ray, forking isotomously once or twice at long intervals, with short, cuneate brachials; proximal pinnales partly incorporated in calyx, fixed pinnules prominent. Column cylindrical. [As first recognized by ULRICH (in MS), the types of *Tanaocrinus* have 4 basals (not 5 as erroneously stated by WACHSMUTH & SPRINGER, 1897, p. 173) and a whole set of features undistinguishable from those of *Canistrocrinus*; consequently *Tanaocrinus* is here treated as a subjective junior synonym of the latter.] *U.Ord.*, N.Am.(USA).—FIG. 250, *1a*. **C. richardsoni* (WETHERBY), Waynesville F., USA (Ohio); lat. view of crown, $\times 3$ (Ubahgs, n).—FIG. 250, *1b*. *C. sp.*, Girardeau, USA (Mo.); *BC* interray view (U.S. Natl. Museum 92768), $\times 3$ (Ubahgs, n).—FIG. 250, *1c*. *C. typus* (WACHSMUTH & SPRINGER), paratype of *Tanaocrinus typus*, Richmond., USA (Ohio); *BC* interray view (U.S. Natl. Museum S. 716), $\times 3$ (Ubahgs, n).

Compsocrinus S. A. MILLER, 1883, p. 219, 223 [**Glyptocrinus harrisi* S. A. MILLER, 1881a, p. 74; OD] [*non Compsocrinus* PERNER in ZELIZKO,

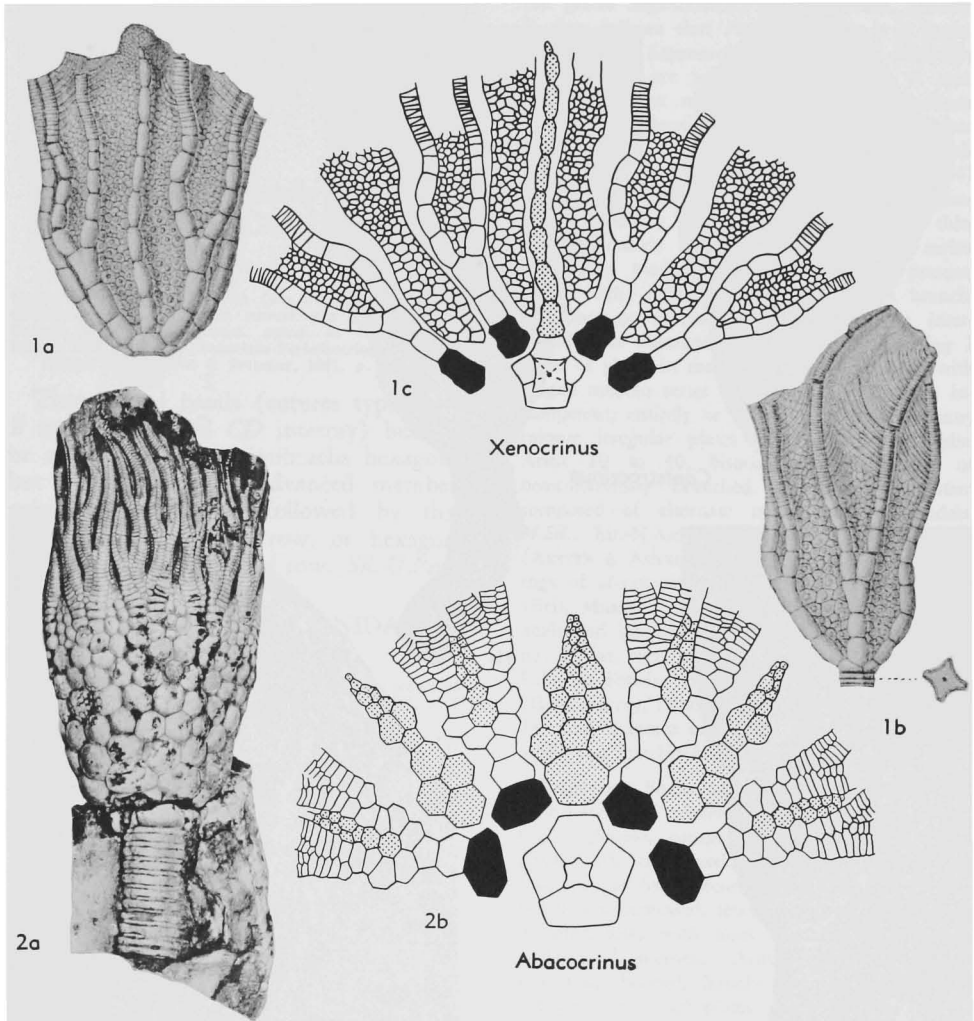


FIG. 249. Xenocrinidae (1); Abacocrinidae (2) (p. T440, T442-T443).

1911, p. 6 (*nom. nud.*) (= *Akadocrinus* PROKOP, 1962, Eocrinoida)]. Basals visible from side; fixed secundibrachs 2 if any further brachitaxis; fixed tertibrachs, if any, 4 or 5 in each ramus, passing to free brachials; all or only proximal interprimibrachs large and regular, according to species. Free arms unbranched, 2, 3, or 4 per ray, uniserial. Column quadrangular or round in cross section. *U.Ord.*, N.Am.(USA).—FIG. 250, 2. **C. harrisi* (S. A. MILLER), Richmond, USA (Ohio); *CD* interray view, $\times 2$ (Wachsmuth & Springer, 1897).

?*Proxenoocrinus* STRIMPLE & MCGINNIS, 1972, p. 72 [**P. inyoensis*; M]. Calyx bowl shaped; basals confined to basal concavity; interbrachials moderately large, mildly depressed, first one in notch

at summit of two radials; *CD* interray with median series of plates accompanied by single series of small plates on each side. Free arms 2 per ray, uniserial; first pinnule stout; free brachials slightly wedge shaped. [This genus was placed among the Xenocrinidae by STRIMPLE & MCGINNIS (1972, p. 72); however, uncertainty concerning the structure of the proximal part of its theca up to the radial cirlet and ignorance of the number of basal plates render its systematic position doubtful. Because of the relatively large size and regular arrangement of its interbrachials, it is here classified with doubt in the Tanaocrinidae.] *L.Ord.*, USA(Calif.).—FIG. 250,3. **P. inyoensis*, Al Rose F.; holotype, *C*-ray view, $\times 4$ (Strimble & McGinnis, 1972).

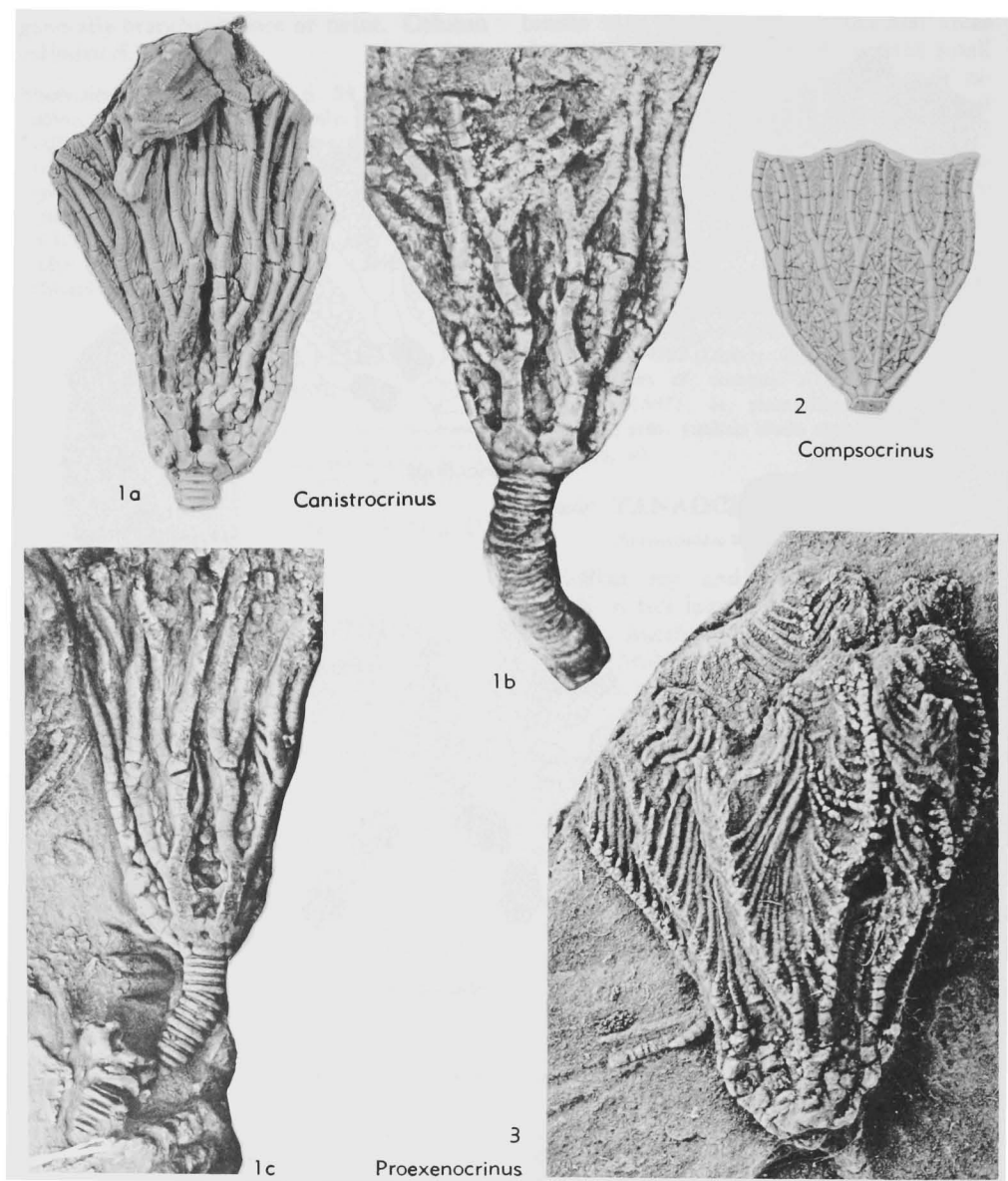


FIG. 250. Tanaocrinidae (p. T440-T441).

Family ABACOCRINIDAE Jaekel, 1918

[Abaccocrinidae JAEKEL, 1918, p. 31]

Calyx heavily plated, without distinct ray and anal ridges; fixed secundibrachs numerous, proximally uniserial, distally biserial; interbrachials not depressed, large, stout, and regular; CD interray with extra plates. Tegmen solid, with anal pyramid. Each half ray generally dividing on becoming

free; free arms 4 per ray, forking isotomously two or three times at wide intervals; proximal pinnules partly incorporated in calyx. Column round in cross section; heteromorphic. *U.Sil.*

Abacocrinus ANGELIN, 1878, p. 19 [**Actinocrinites tesseracontadactylus* GOLDFUSS, 1831, p. 194; SD WACHSMUTH & SPRINGER, 1881, p. 135(309)]. Characters of family. *U.Sil.*, Sweden(Gotl.).—

FIG. 249,2. **A. tessacontadactylus* (GOLDFUSS); 2a, lat. view of crown with attached part of stem (Nat. Riksmus. Stockholm, Ec 10867), $\times 1$ (Ubaghs, n); 2b, plate diagram of part of theca and arms (radials black, anals and interbranchials stippled) (Ubaghs, n).

Superfamily PERIECHOCRINACEA Bronn, 1849

[*nom. correct.* UBAGHS, herein (*pro* Periechocrinaceae RAMSBOTTOM, 1954, p. 687, *nom. correct. pro* Periechocriniteae UBAGHS, 1953, p. 738, *nom. transl. ex* Periechocrinidae BRONN, 1849, p. 179)] [=sections Periechocrinites + Actinocrinites WACHSMUTH & SPRINGER, 1881, p. 93, 267]

Three equal basals (sutures typically in *B* and *E* rays and *CD* interray) but may be ankylosed; first primibrachs hexagonal, but quadrangular in advanced members; primanal heptagonal, followed by three plates in next higher row, or hexagonal with two plates in second row. *Sil.-U.Perm.*

Family PERIECHOCRINIDAE Bronn, 1849

[Periechocrinidae BRONN, 1849, p. 179] [=Periechocrinidae BASSLER, 1938, p. 28; Saccocrininae JAEKEL, 1918, p. 34]

First primibrachs typically hexagonal; two to five fixed secundibrachs in each ray and two to seven tertibrachs may be incorporated in calyx; interprimibrachs not depressed or only slightly so, numerous and merging with tegmen; *CD* interray wide, primanal heptagonal, followed by three plates in second row. Tegmen many-plated, with ambulacrals and orals rarely distinct. Arms 10 to 40, biserial or uniserial, simple or branching. Column cylindrical. *Sil.-Miss.*

Periechocrinus MORRIS, 1843, p. 56 [**Periechocrinites costatus* AUSTIN & AUSTIN, 1843 (= *Actinocrinites moniliformis* PHILLIPS in MURCHISON, 1839, p. 673, *non* MILLER, 1821); SD RAMSBOTTOM, 1954, p. 687] [= *Crumenaecrinites* TROOST, 1850a, p. 420 (*nom. nud.*) (type, *C. ovalis*; M); *Geocrinus* D'ORBIGNY, 1850, p. 46 (obj.); *Saccocrinus* HALL, 1852, p. 205 (type, *S. speciosus*; M); *Crumenaecrinus* BATHER in LANKESTER, 1900a, p. 202 (*nom. van.*); *Periechocrinites* BASSLER, 1938, p. 149 (*non* AUSTIN & AUSTIN, 1843) (obj.); *Periechocrinites* AUSTIN & AUSTIN, 1842, p. 110 (*nom. nud.*)]. [In 1843, AUSTIN & AUSTIN erected a genus *Periechocrinites* and designated *P. articulatus* as its type species, but the type specimen of this species belongs to *Actinocrinites? expansus* PHILLIPS, type species of

the genus *Sagenocrinites* (RAMSBOTTOM, 1951b). It thus follows that *Periechocrinites* is a junior synonym of *Sagenocrinites* since their respective type species are subjective synonyms. A new name was then required for the genus hitherto called *Periechocrinites*, and as *Periechocrinus* MORRIS, 1843, was the earliest of several available names, it has been chosen by RAMSBOTTOM (1954) to replace *Periechocrinites*.] Calyx typically elongate, expanding to arm bases; calyx plates thin, and particularly in radial and primibrach series, very long; median ray ridges generally present; basals high; primaxils seven-sided; rays branching once or several times within calyx; interprimibrachs numerous, not depressed, forming 2 series of plates in each interray; *CD* interray with ridged median series of anal plates. Tegmen incompetent, entirely or mostly composed of many minute irregular plates and bearing anal tube. Arms 10 to 40, biserial, slender, simple or heterotomously branched. Heteromorphic stem composed of alternate nodals and internodals. *M.Sil.*, Eu.-N.Am.—FIG. 251,1. **P. costatus* (AUSTIN & AUSTIN), Wenlock, Eng.; 1a,b, drawings of *A*-ray and *CD* interray views of crown (Brit. Museum Nat. Hist. 57249) (radials black, anals and interbranchials stippled), $\times 0.5$ (Ubaghs, n); 1c, lat. view of complete crown, $\times 0.75$ (Brit. Palaeoz. Fossils, 1964); 1d, drawing of tegmen (Geol. Survey, London, 89.929), $\times 1$ (Ubaghs, n); 1e, plate diagram of part of calyx (radials black, anals and interbranchials stippled) (Ubaghs, n).

Aryballocrinus BREIMER, 1962, p. 72 [**Actinocrinus* (*Megistocrinus*) *whitei* HALL, 1861a, p. 271; OD]. Calyx globose, composed of thin plates; radial circlelet high; faint median ray ridges present in a few species; fixed secundibrachs few; interprimibrachs not depressed, few; *CD* interray very wide. Tegmen low, with anus excentric, little above surface of tegmen. Arms 10, dichotomously branching, biserial, densely pinnulate. Stem stout, composed of equal plates. *L.Carb.*, Eu.; *L.Miss.*, N.Am.—FIG. 252,1. **A. whitei* (HALL), Osag. (Burlington Ls.), USA (Iowa); 1a,b, *A*-ray view of crown with attached stem and side view of calyx, $\times 1$ (Wachsmuth & Springer, 1897).

Athabascocrinus LAUDON, PARKS, & SPRENG, 1952, p. 566 [**A. colemanensis*; OD]. Calyx low bowl shaped, with gradually sloping walls; basals and radials laterally directed; fixed secundibrachs 1 or 2 in each half-ray; interprimibrachs not depressed, rather numerous and large; *CD* interray broad, with primanal larger than radials. Tegmen low, conical, with markedly depressed interambulacral areas, and with single central plate surrounded by 6 slightly smaller ?orals and 4 still smaller plates on posterior side; plates covering ambulacral areas relatively large. Arm bases markedly projecting, facets directed laterally, 2 to 4 according to ray; arms unknown. *L.Miss.*, N.Am.(Can.).—FIG.

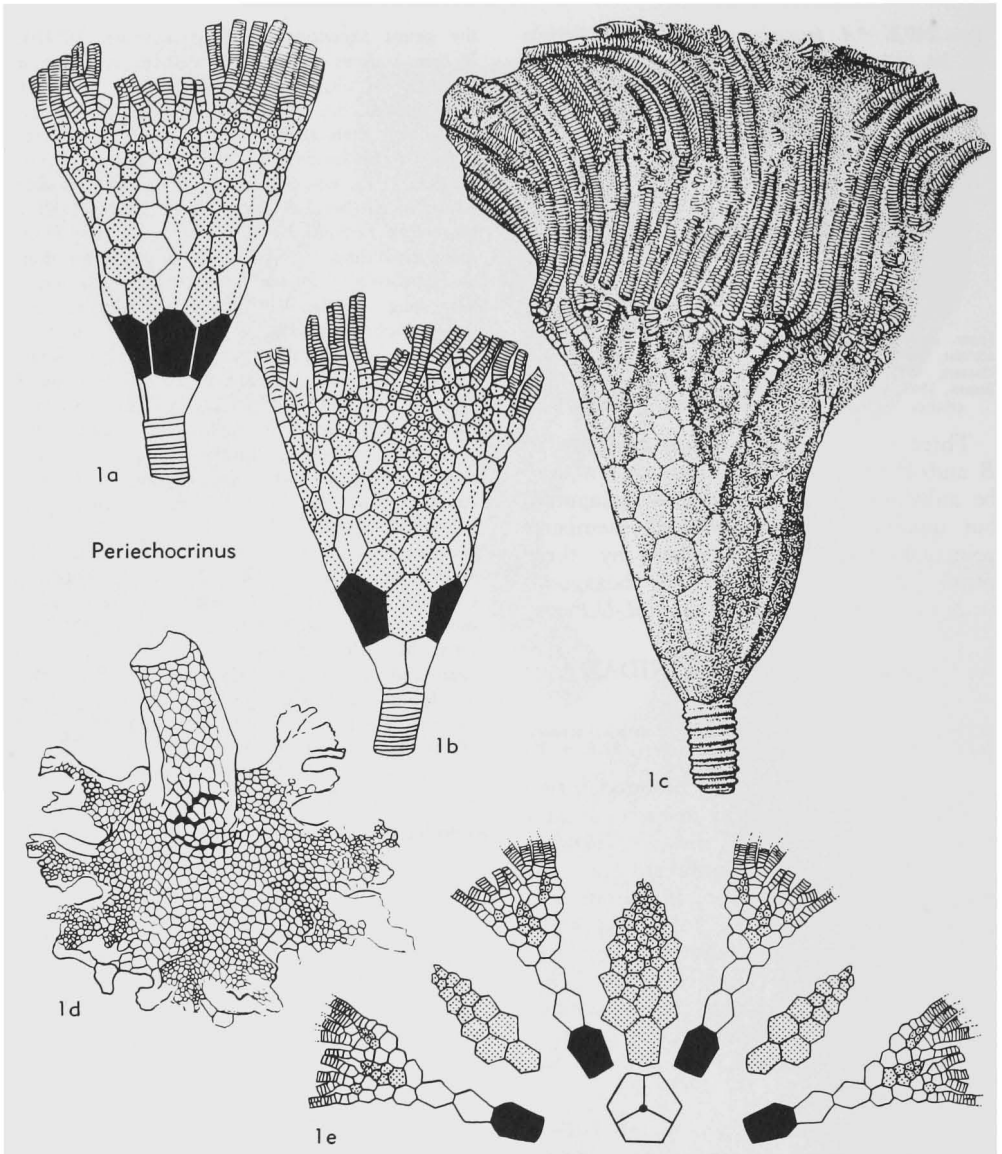


FIG. 251. Periechocrinidae (p. T443).

252,2. **A. colemanensis*, Banff F., Can.; 2a-c, dorsal, ventral, and A-ray view of holotype, $\times 2$ (Laudon, Parks & Spreng, 1952).

Beyrichocrinus WAAGEN & JAHN, 1899, p. 12 [**B. humilis*; M]. Calyx bowl shaped, with plates heavy and tumid; base slightly depressed; radials unequal, separated partially or entirely by interprimibrachs; primibrachs larger than radials; fixed secundibrachs 2 in each half-ray; fixed tertibrachs 6 or 7, becoming biserial distally; interprimibrachs numerous, not depressed; intersecundibrachs and intertertibrachs present; CD interray slightly wider than others, contracting distally; primanal meeting

posterior basal narrowly. Tegmen low, composed of small plates isolating larger ones; anus slightly excentric. Arm openings 20. *L.Dev.*, Eu. (Czech.). —FIG. 252,3. **B. humilis*, Koneprusy Ls.; 3a,b, dorsal and ventral views of theca, $\times 0.5$ (Natl. Museum, Prague; Ubaghs, n).

Corocrinus GOLDRING, 1923, p. 202 [**C. ornatus*; OD]. Calyx turbinate or bowl shaped with stellate or nodose plates; median ray ridges present; primaxils 7-sided; fixed secundibrachs few; interradial areas narrow, distally depressed; CD interray widely expanded, with ridged median series of anal plates. Tegmen many-plated, with anus

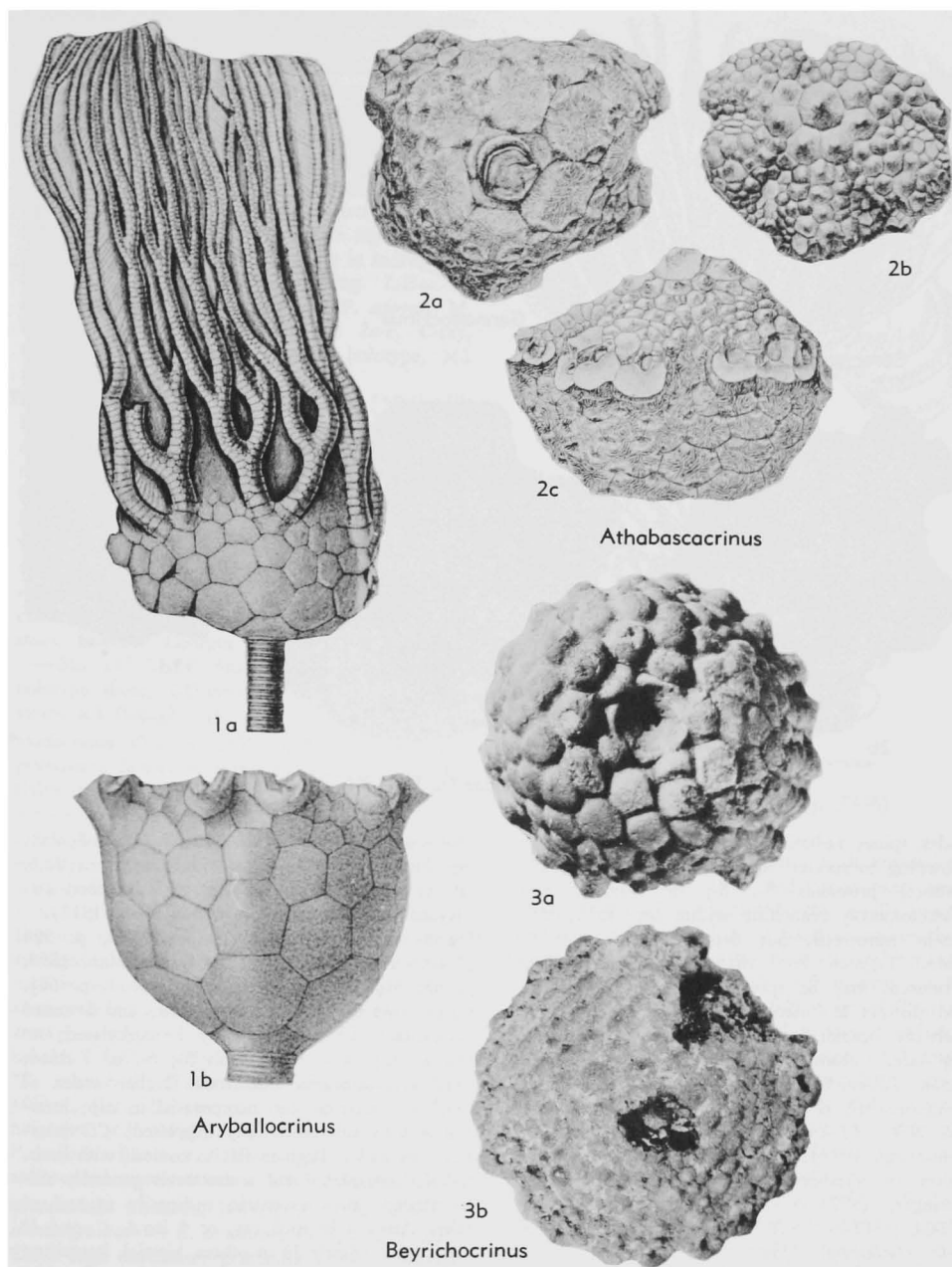


FIG. 252. Periechocrinidae (p. T443-T444).

at top of protuberance or anal tube. Arms 2 in each ray, bifurcating only once, biserial or uniserial according to species. *L.Dev.-M.Dev.*, N. Am.-Eu.—FIG. 253, 1. **C. ornatus*, M.Dev., USA(N.Y.); CD-interray view of theca with attached part of stem, $\times 1$ (Goldring, 1923).

Gennaeocrinus WACHSMUTH & SPRINGER, 1881, p. 160(334) [**Actinocrinus kentuckyensis* SHUMARD, 1868, p. 345; OD]. Calyx low to high, conical to globose, generally flattened at base, lobed at arm bases; plates thin and nearly smooth, ornamented in low relief, or coarsely ornamented with

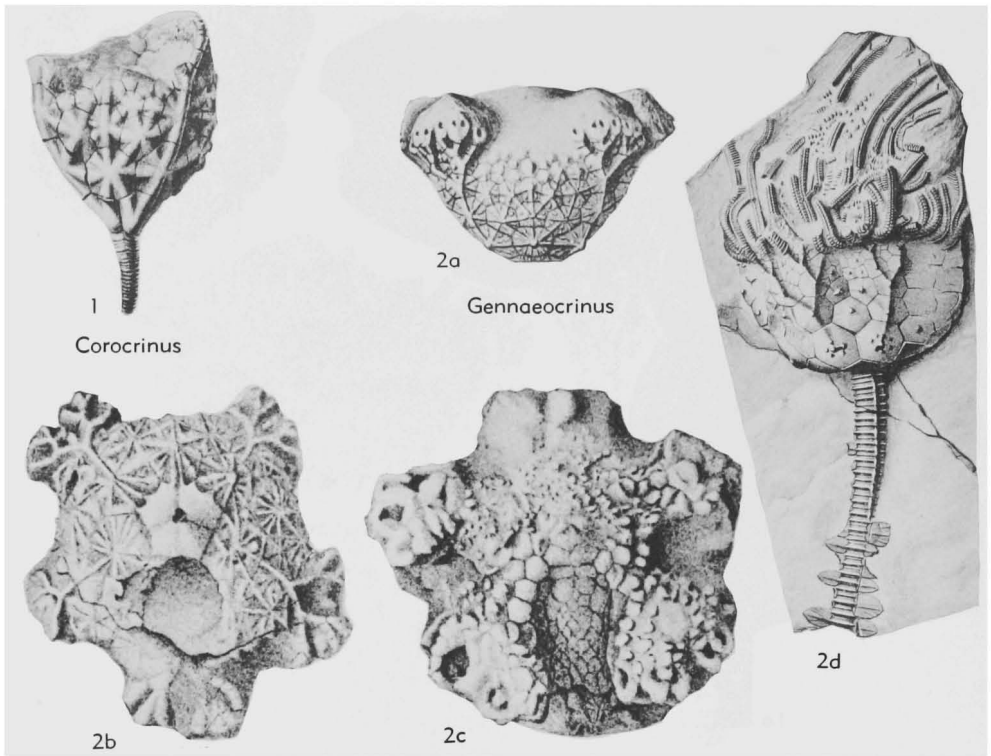


FIG. 253. Periechocrinidae (p. T444-T446).

nodes, spines, radiating ridges, and parallel carinae according to species; median ray ridges generally distinct; primaxils 5-, 6-, or 7-sided; rays heterotomously branching within cup; interprimibrachs numerous, not depressed; *CD* interray wide. Tegmen low, many-plated, interradially depressed, may be spiniferous, with small orals and distinct ambulacrals. Free arms 6 to 8 in each ray, biserial, long, slender, simple or branching once. Column with large quinquelobate axial canal. *L.Dev.-M.Dev.*, N.Am.(USA)-Eu.—FIG. 253,2a-c. **G. kentuckiensis* (SHUMARD), *M.Dev.*; 2a, N.Y., *CD*-interray view of holotype, $\times 1$ (Goldring, 1923); 2b,c, Ky., dorsal and ventral views of another theca, $\times 1$ (Wachsmuth & Springer, 1897).—FIG. 253,2d. *G. eucharis* (HALL), *M.Dev.*, N.Y.; crown and part of stem, $\times 0.5$ (Goldring, 1923).

Lenneocrinus JAEKEL, 1918, p. 35 [**L. cirratus*; OD]. Calyx conical; plates thin, with prominent radial ornamentation; median ray ridges present; primaxils 7-sided; fixed secundibrachs 2 in each half-ray; interprimibrachs few, depressed distally. Free arms 2 in ray, biserial, branching irregularly dichotomously; pinnules long and slender. Column composed of nodals of 2 orders separated by numerous internodals; long cirri on both

orders of nodals. *M.Dev.-U.Dev.*, Eu.(Ger.-Spain). —FIG. 254,1. **L. cirratus*, Givet., Ger.; 1a,b, lat. view of holotype crown with attached cirriferous stem, dorsal view, $\times 3$ (Jaekel, 1918).

Megistocrinus OWEN & SHUMARD, 1852, p. 594 [**Actinocrinus evansii* OWEN & SHUMARD, 1850, p. 68; M] [= *Tylocrinus* WOOD, 1904, p. 66]. Calyx bowl shaped with thick plates and flattened or excavate base; basals may be ankylosed; no median ray ridges; primaxils 5-, 6-, or 7-sided; fixed secundibrachs numerous; higher order of brachials more or less incorporated in cup; interprimibrachs numerous, not depressed; *CD* interray very wide. Tegmen flat to conical, with orals, radial dome-plates and ambulacrals generally differentiated; anus excentric, ordinarily at end of tube. Arms 4 in each ray, or 4 in *A*, *C*, and *D* rays and 2 (rarely 3) in others, biserial, branching dichotomously. Column stout; axial canal wide, quinquelobate. *L.Dev.-L.Miss.*, N.Am.(mainly) W.Eu.-New Zealand.—FIG. 255,1a,b. **M. evansii* (OWEN & SHUMARD), *L.Miss.* (Burlington Ls.), USA (Iowa-N.Mexico); lat. and ventral views, $\times 0.7$ (Wachsmuth & Springer, 1897).—FIG. 255,1c. *M. nobilis* WACHSMUTH & SPRINGER, *L. Miss.* (Hampton F.), USA (Iowa); *CD*-interray view, $\times 0.7$ (Wachsmuth & Springer, 1897).

Pithocrinus KIRK, 1945, p. 341 [**P. cooperi*; OD].

Calyx wide globose, with rather thick plates, convex to tumid or spiny, with gonioporoids; base commonly produced into rim; primaxils usually 5-sided; fixed portions of rays commonly curved; interrays relatively small, with interprimibrachs in 2 series; *CD* interray larger than others; interbrachials few. Tegmen convex to highly elevated, composed of many relatively small plates, some of which bear subspinous processes; stout subcentral anal tube. Free arms, 2 to 6 in each ray according to species and even according to ray in individuals, densely biserial, irregularly branching. *L.Dev.-M.Dev.*, Eu.-N.Am.—FIG. 255,2. **P. cooperi*, M.Dev. (Traverse Gr.), USA (Mich.); *2a-c*, C-ray, *CD*-interray, and dorsal views of holotype, $\times 1$ (Kirk, 1945a).

Pradocrinus DE VERNEUIL, 1850, p. 184 [**P. baylii*;

M]. Calyx very high, urn shaped; plates thin, slightly convex, with radial ornamentation; median ray ridges present; primaxils 7-sided; 2 secundibrachs in each half-ray incorporated in calyx; interprimibrachs not depressed, 9 to 10, merging with tegmen; *CD* interray with sagittal ridged series of anal plates. Tegmen low, composed of rather large plates, with central nodose plate; anus excentric, directly through tegmen. Free arms 10, stout, biserial. Column unknown. *L.Dev.*, Eu.—FIG. 255,3. **P. baylii*, L.Ems., Spain; *3a-c*, holotype theca, *CD*-interray, dorsal and ventral views, $\times 1$ (Ubaghs, n).

Pyxidocrinus MÜLLER, 1855, p. 82 [**Actinocrinus*

prumiensis ZEILER & WIRTGEN, 1855, p. 81; M]. Calyx conical; thin plated, with gonioporoids; no median ray ridges; primaxils 5-sided; 2 secundibrachs and 2 tertibrachs of each ray incorporated in calyx; interradian areas relatively small, with interprimibrachs in 2 series; interbrachials up to 3 in ray; *CD* interray without median ridge. Tegmen relatively low, composed of irregularly arranged plates and central nodose plate, which may be surrounded by 4 interradian spiny plates; anus excentric, directly through tegmen. Free arms 4 to ray, not certainly known. Column unknown. *L.Dev.-M.Dev.*, Eu.—FIG. 256,1a,b. **P. prumiensis* (ZEILER & WIRTGEN), probably M.Dev., Ger.; *CD*-interray and ventral views of holotype, $\times 3$ (Müller, 1855).—FIG. 256,1c,d. *P. collensis* BREIMER, L.Ems., Spain; *CD*-interray and ventral views of theca, $\times 1.5$ (Ubaghs, n).

Stammocrinus BREIMER, 1962, p. 59 [**Saccocrinus?*

intrastigmatus W. E. SCHMIDT, 1932, p. 21; OD]. Calyx high turbinate; primaxils 7-sided; interradian areas composed of many plates in 3 series; intersecundibrach areas large. Tegmen with anal tube and spines in ambulacral parts. Free arms and stem unknown. *L.Dev.-M.Dev.*, Eu.-N.Am.—FIG. 256,2. **S. intrastigmatus* (W. E. SCHMIDT), L.Ems., Spain; *2a-c*, B-ray, dorsal, and ventral views of theca, $\times 1$ (Breimer, 1962).

Stiptocrinus KIRK, 1946, p. 33 [**S. spinosus*; OD].

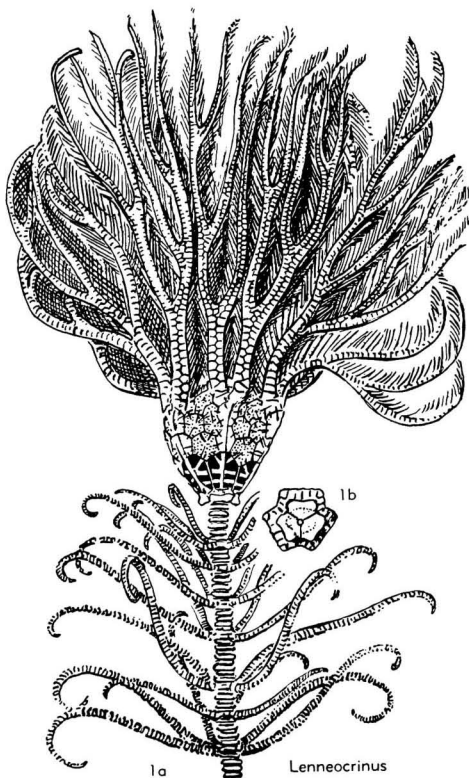


FIG. 254. Periechocrinidae (p. T446).

Cup subtrubinate to subglobose, with somewhat depressed interradian areas and pronounced tendency toward lobation; primibrachs usually much smaller than radials; 2 or 3 fixed secundibrachs, other brachs free; intersecundibrachs lacking, or single and enclosed by brachs; *CD* interray much larger than others, with median series of 2 to 3 or more plates; primanal equal in size to radials. Tegmen low, competent, many-plated; anal tube excentric. Free arms 2 per ray, united and uniserial proximally, beyond unknown. Column unknown. *Sil.*, USA.—FIG. 257,1a. *S. benedicti* (MILLER), Laurel Ls., Ind.; *CD*-interray view (radials black, anal plates and interbrachials stippled), $\times 2$ (Springer, 1926a).—FIG. 257,1b. **S. spinosus*, Laurel Ls., Ind.; *AE*-interray view (radials black, interbrachials stippled), $\times 2$ (Springer, 1926a).—FIG. 257,1c. *S. nodosus* (SPRINGER), Decatur Ls., Tenn.; tegmen, $\times 1.5$ (Springer, 1926a).

Thamnocrinus GOLDRING, 1923, p. 239 [**T. springeri*; OD]. Calyx subtrubinate with prominent median ray ridges; primaxils 7-sided; ray plates incorporated in to level of secundaxils or 1 or 2 plates beyond; interradian areas flattened, many-plated, uniting main rami up to last bifurcation;

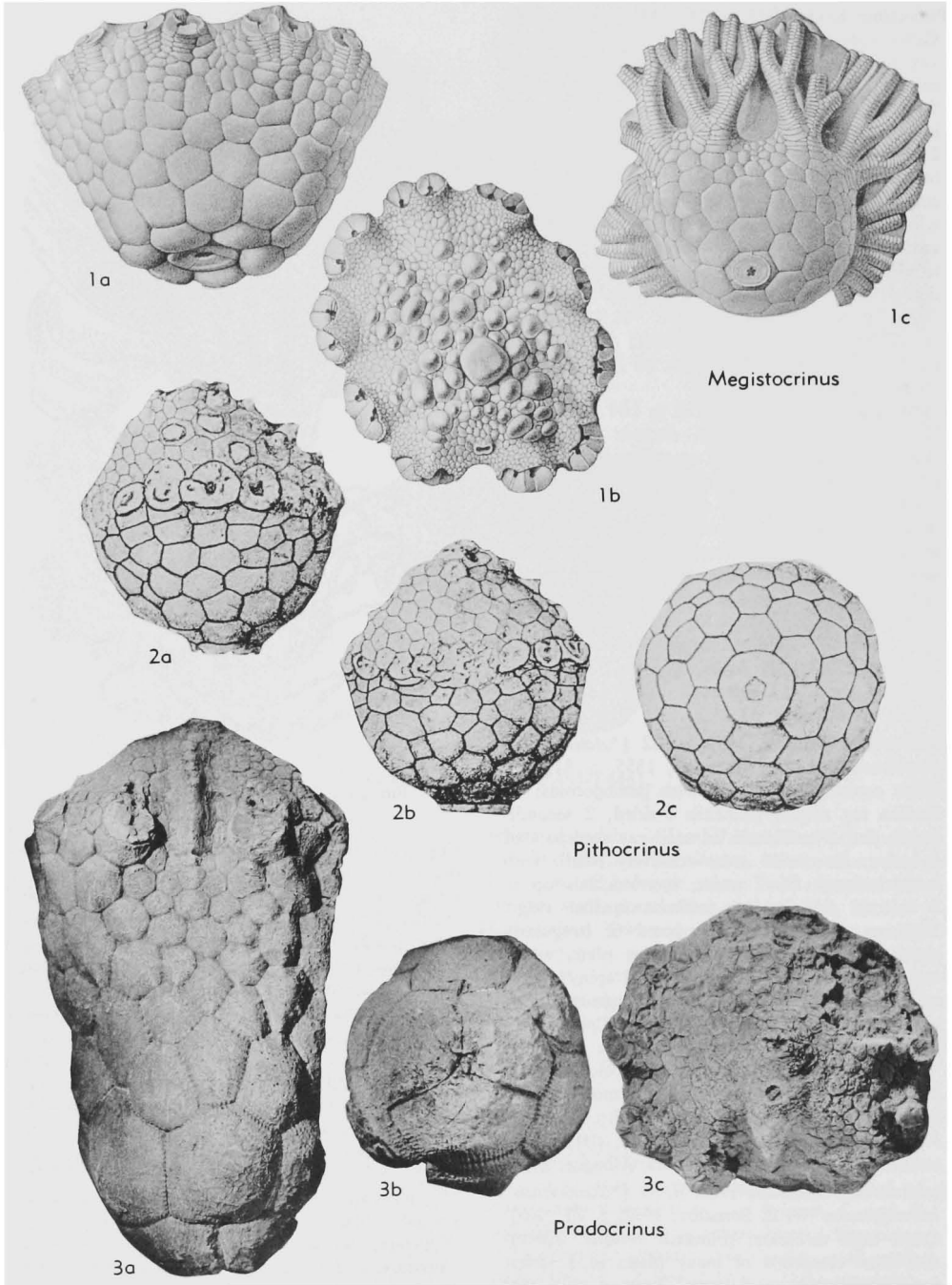


FIG. 255. Periechocrinidae (p. T446-T447).

median series of anal plates well marked. Tegmen lobed, interradially depressed sharply, spiniferous. Free arms 2 in each ray, short, uniserial, endotomous, bearing undivided biserial long and

pinnulate ramuli. Column with large circular axial canal. *M.Dev.*, N.Am.—FIG. 256,3. **T. springeri*, Moscow F., USA(N.Y.); *3a,b*, E-ray and dorsal views of crowns, $\times 1$ (Goldring, 1923).

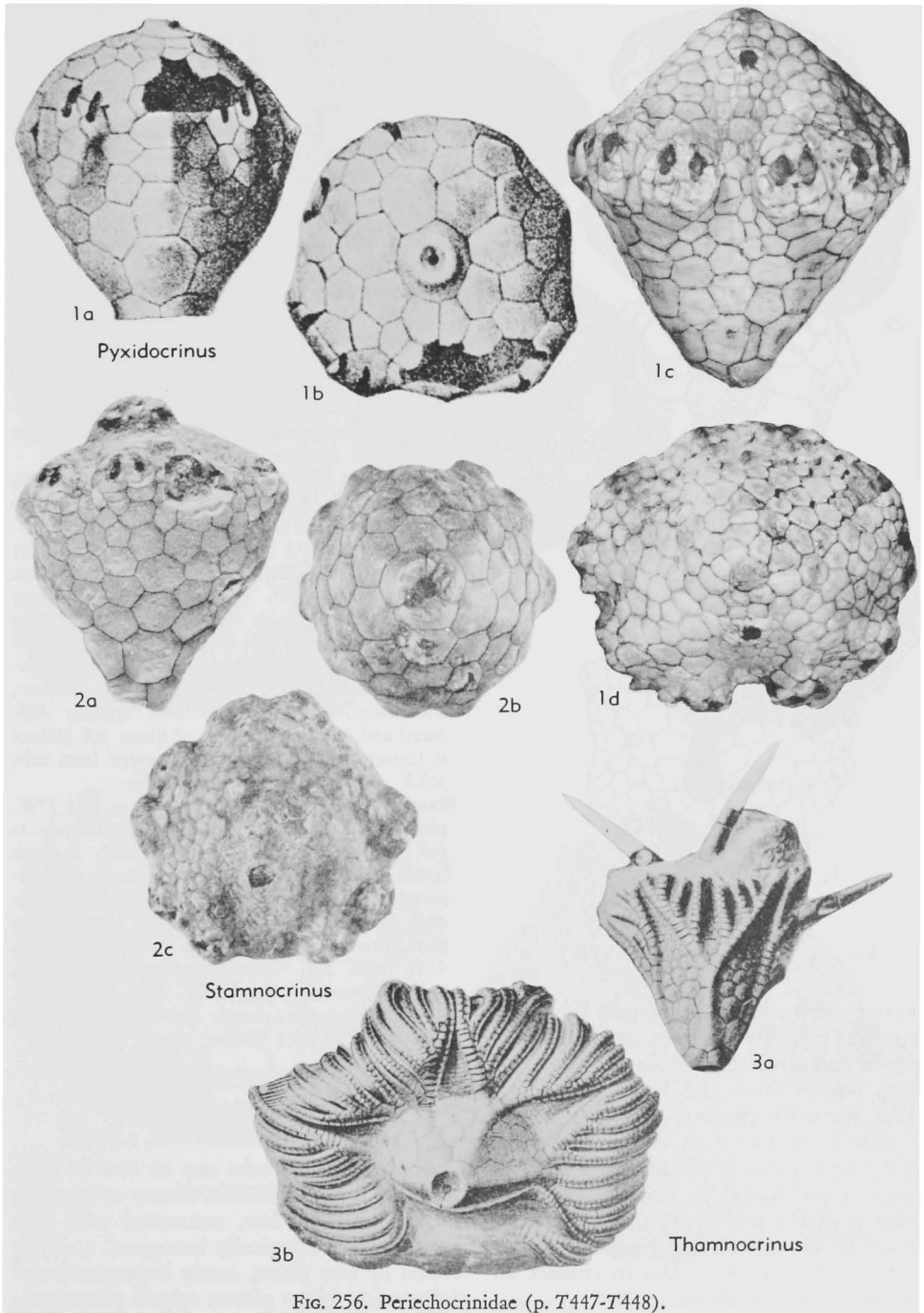
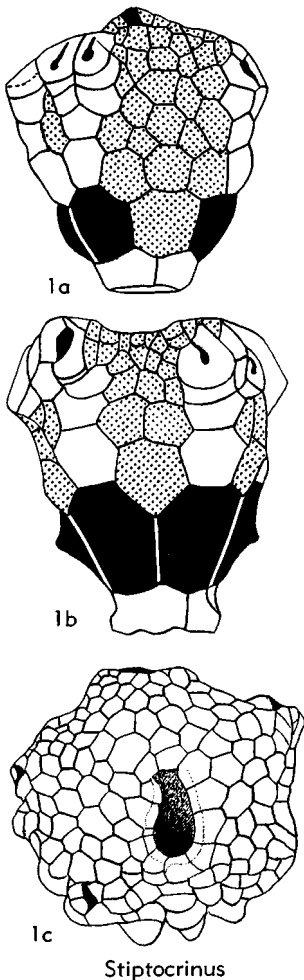


FIG. 256. Periechocrinidae (p. T447-T448).

Family PARAGARICOCRINIDAE
Moore & Laudon, 1942

[Paragaricocrinidae MOORE & LAUDON, 1942, p. 68]

Calyx low rounded, basally depressed; basals concealed by column; radials laterally directed, commonly forming part of basal



Stiptocrinus

FIG. 257. Periechocrinidae (p. T447).

concavity; first primibrach of each ray quadrangular; typically having single axillary secundibrach in each half-ray; fixed tertibrachs one to three and few fixed quartibrachs may be present; interprimibrachs few, not in contact with tegmen, first one large; *CD* interray wider than others, with two or three anals in second row, connected with tegmen in primitive members, but not in advanced ones. Free arms proximally biserial, more or less in contact all around. *U.Carb.*, *U.Perm.*

Paragaricocrinus YAKOVLEV, 1934, p. 271 [**P. mediterraneus*; OD]. Rays incorporated in calyx up to proximal tertibrachs; generally single interprimibrach in interrays; *CD* interray slightly wider

than others, not connecting with tegmen, 2 plates in 2nd row. Tegmen moderately elevated. Free arm bases in lateral contact all around, 8 in each ray. *U.Perm.*, Eu.(Sicily).—FIG. 258,1. **P. mediterraneus*; 1a,b, lat. and dorsal views of theca, $\times 1$ (Yakovlev, 1934).

Iberocrinus SIEVERTS-DORECK, 1951, p. 105 [**I. multibrachiatus*; OD]. Rays incorporated in calyx up to tertibrachs and in some rays to proximal quartibrachs; interprimibrachs few, 2 in 2nd row; *CD* interray wide, depressed, largely merging with tegmen, 3 plates in 2nd row. Tegmen conical, with subcentral spine; anal opening excentric. Free arm bases 4 to 5 in each ray, but 6 in *C* and *D* rays. *U.Carb.*, Eu.; *L.Penn.*, ?N.Am. [*Megaliocrinus exotericus* STRIMPLE (1951a), from L.Penn. of Oklahoma, seems nearer to *Iberocrinus* than to *Megaliocrinus*.]—FIG. 258,2. **I. multibrachiatus*, Westphalian D, Spain; 2a-d, lat., *CD*-interray, dorsal and ventral views of holotype theca, $\times 2$ (Sieverts-Doreck, 1951a).

Megaliocrinus MOORE & LAUDON, 1942, p. 68 [**M. aplatus*; OD]. Rays incorporated in calyx up to tertibrachs and in some rays to quartibrachs; interprimibrachs few, 1 or 2 in 2nd row; *CD* interray not depressed, narrowly connected with tegmen, 3 plates in 2nd row. Tegmen high conical, many plated, terminating in a large, blunt point; anus near summit. Free arm bases 5 in each ray, but 6 in *C* and *D* rays, in lateral contact all around except at posterior side. Column unknown. *L.Penn.*, USA (Okla.).—FIG. 258,3. **M. aplatus*; 3a,b, dorsal and *CD*-interray views of theca, $\times 2$ (Moore & Laudon, 1942); 3c, hypotype, calyx from side, $\times 2.7$ (Moore & Strimple, 1973a).

Wannerocrinus MAREZ OYENS, 1940, p. 294 [**W. glans*; OD]. Rays incorporated in calyx up to 3rd tertibrachs; single interprimibrach in each interray; *CD* interray wider than others, not connecting with tegmen, 2 plates in 2nd row. Tegmen dome shaped, with subcentral spine-bearing plate. Free arm bases in lateral contact all around, 4 in each ray. Column unknown. *U.Perm.*, Indon.(Timor).—FIG. 259,1. **W. glans*; 1a-d, *E*-ray, *CD*-interray, dorsal, and ventral views of holotype theca, $\times 1$ (Marez Oyens, 1940b).

Family AMPHORACRINIDAE Bather, 1899

[Amphoracrinidae BATHER, 1899b, p. 922]

Fixed secundibrachs one or two in each half-ray; fixed tertibrachs absent or present; interprimibrachs few, connected with tegmen; primanal typically hexagonal and followed by two plates, rarely heptagonal and followed by three plates; calycal plates generally with granulo-vermicular ornament. Tegmen usually high in relation to calyx; anal tube moderately developed. Proximal region of arms horizontal or projecting

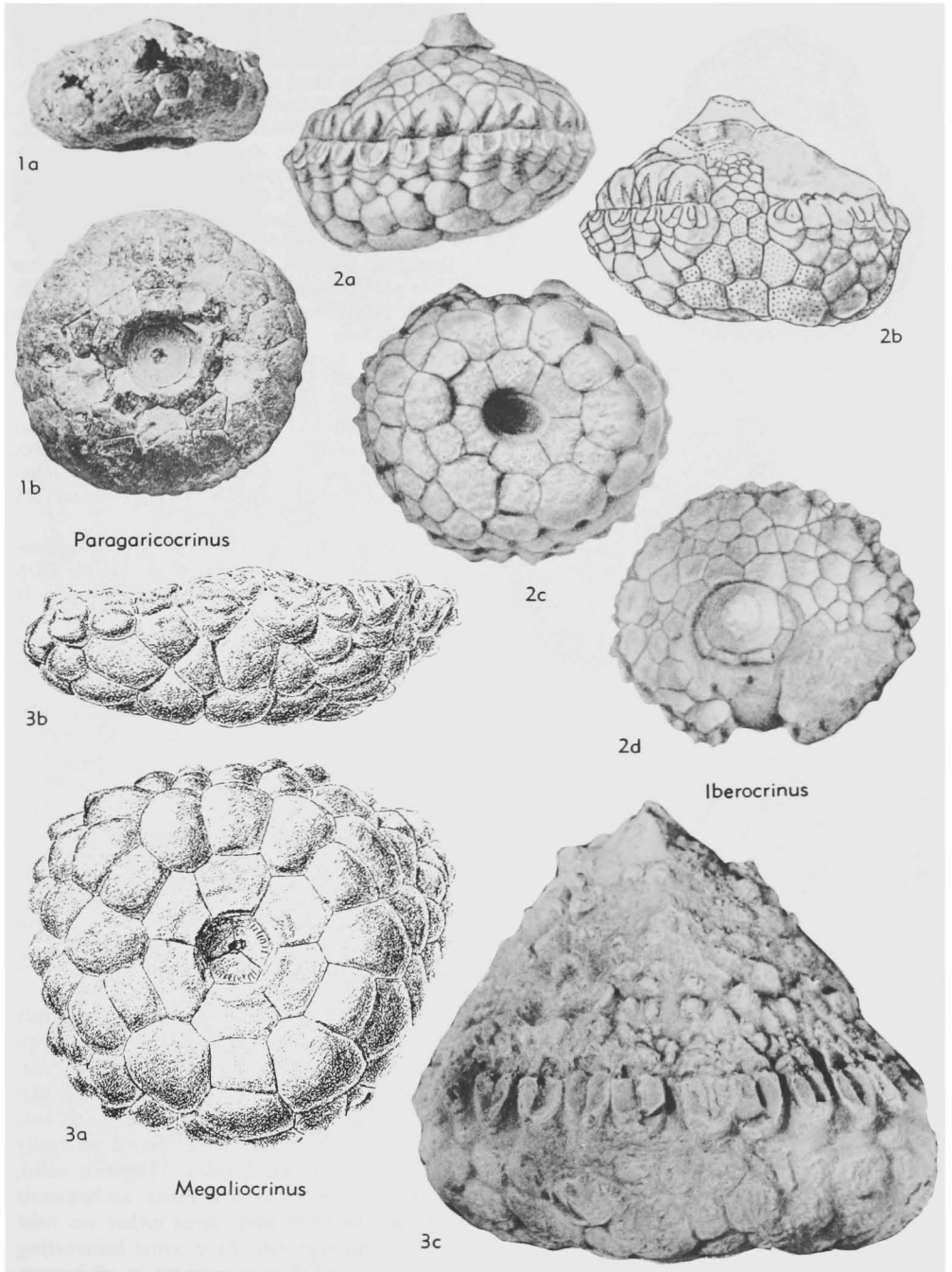


FIG. 258. Paragaricocrinidae (p. T450).

downward. *L. Carb. (Tournais.)-U. Carb. (Namur.)*.

Amphoracrinus AUSTIN, 1848, p. 292 [*Actinocri-*

nus gilbertsoni MILLER in PHILLIPS, 1836, p. 206; SD ROEMER, 1855, p. 250]. Calyx high or low, rounded or conical; fixed secundibrachs 2 in each

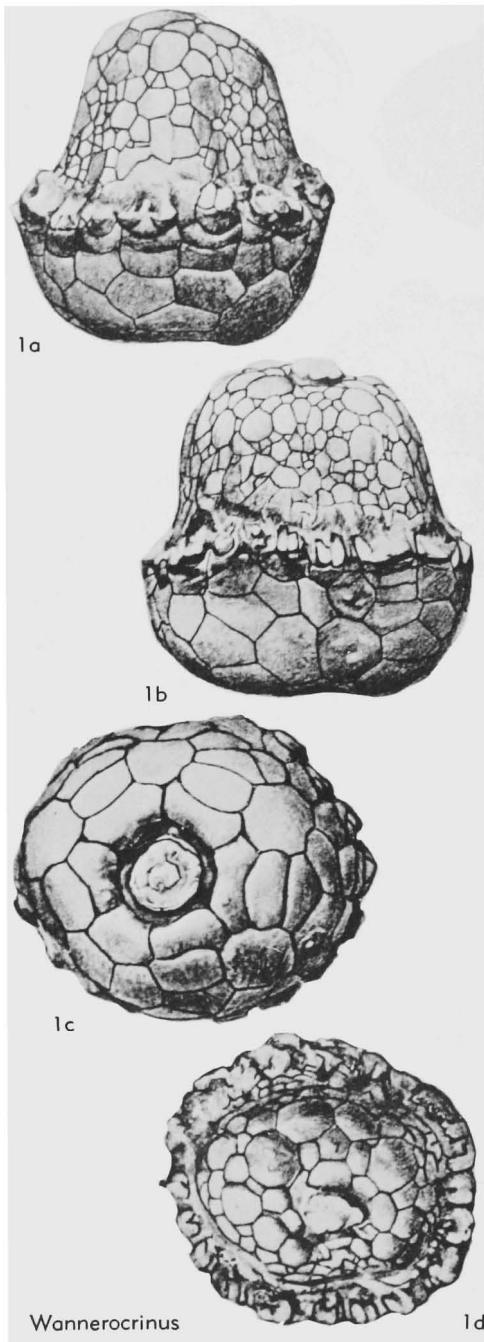


FIG. 259. Paragarcocrinidae (p. T450).

half-ray; primanal typically followed by 2 or rarely 3 plates. Tegmen usually more than calyx in height, but may be equal to or less than this,

tapering upward and prominently lobed, generally flat summit occupied by 5 orals, 4 of which form semicircle enclosing larger posterior one; anal tube excentric on distal side of posterior oral. *L. Carb.* Eu.; ?Japan; *U. Carb.* (*low. Namur.*), N. Afr.; *Miss.* N. Am.—FIG. 260, 1. **A. gilbertsoni* (MILLER); *L. Carb.*, Eng.; 1a-c, A-ray, CD-interray, and ventral views of neotype theca (anal tube lacking), $\times 1$ (Wright, 1955-60); 1d, BC-interray view of another specimen, with anal tube partly preserved, $\times 1$ (Wright, 1955-60).

Ectocrinus WRIGHT, 1955, p. 204 [**Actinocrinus* (*Amphoracrinus*?) *olla* McCoy, 1849, p. 248; OD]. Calyx rounded; 2 fixed secundibrachs in each half-ray. Tegmen constricted, with steeply sloping or concave sides and flat or slightly concave summit, composed of 5 large oral plates with posterior one largest; anal tube directed sideward immediately under or at short distance below posterior oral. *L. Carb.* (*Visean*), Eng.—FIG. 260, 2. **E. olla* (McCoy); 2a-c, A-ray, CD-interray, and ventral views of lectotype theca, $\times 1$ (Wright, 1955-60).

Pimlicocrinus WRIGHT, 1943, p. 89 [**Amphoracrinus* *clitheroensis* WRIGHT, 1942, p. 272; OD]. Calyx low to very shallow; low basals may be covered by column; single fixed secundibrach in each half-ray, axillary; 1 or 2 fixed tertibrachs usually present in half-rays. Tegmen moderately to very high in relation to calyx, without conspicuous orals and with subcentral anal tube. *L. Carb.*, Eu. (Eng.).—FIG. 260, 3. **P. clitheroensis* (WRIGHT), Tournais; 3a-d, A-ray, CD-interray, dorsal, and ventral views of holotype theca, $\times 1$ (Wright, 1955-60).

Family ACTINOCRINITIDAE Austin & Austin, 1842

[*nom. correct.* BASSLER, 1938, p. 27 (*pro* family Actinocrinoidea AUSTIN & AUSTIN, 1842, p. 109, based on *Actinocrinites* MILLER, 1821, p. 15)] [=Actinocrinitidae AUSTIN & AUSTIN, 1843, p. 199; tribu Actinocriniens PICTET, 1857, p. 321 (*vernacular*)] [Materials for this family prepared by A. L. BOWSHER, revised by GEORGES UBAGHS]

Calyx generally conical, less commonly bowl shaped; lower brachials usually forming rather important part of calyx; interprimibrachs numerous, connected with tegmen or not; primanal hexagonal with two plates next above it; calycal plates generally ornamented by axial folds. Tegmen solid, orals not prominent or distinct, ambulacrals may be differentiated; anus either on tube or piercing tegmen. Free arms bifurcating according to different patterns, in all known species (except in *Dialutocrinus*) becoming biserial just above calyx or forming uniserial trunks with biserial armllets. *L. Carb.* (*L. Miss.*)—*U. Carb.*, ?*Perm.*

Actinocrinitidae comprise a highly diversified

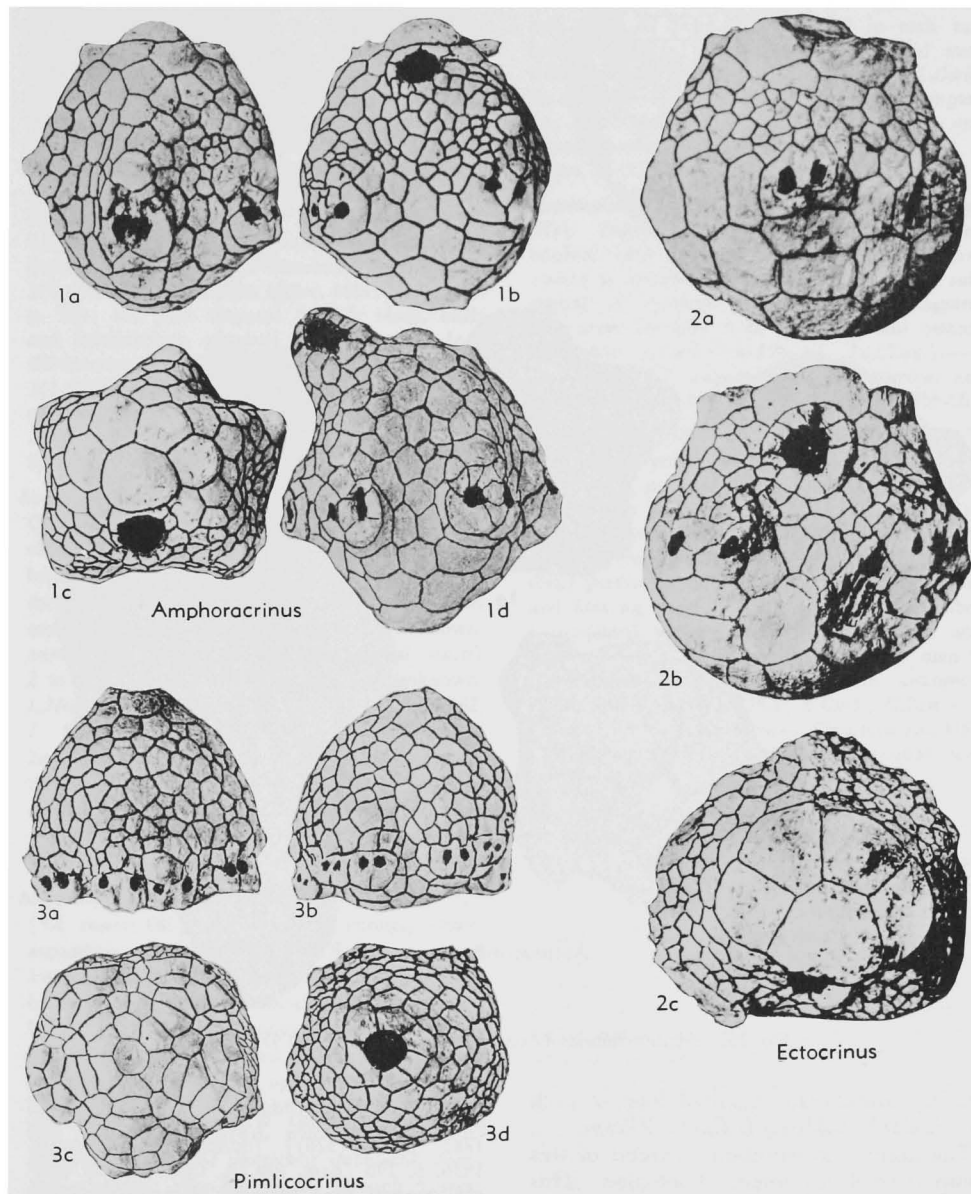


FIG. 260. Amphoracrinidae (p. T451-T452).

group, mostly of Mississippian age. In a recent review, BROWER (1967) has recognized four sections of subfamily rank based on common morphology and evolutionary trends; however, he did not give them formal names. The same classification is adopted herein, but each section is given a subfamily status and name.

Subfamily ACTINOCRINITINAE
Austin & Austin, 1842

[*nom. transl.* UBAGHS, herein (*ex* Actinocrinitidae BASSLER, 1938, p. 27, *pro* Actinocrinoidea AUSTIN & AUSTIN, 1842, p. 109)] [=Aacocrinid section BROWER, 1967, p. 676 (vernacular)] [=Actinocrinitinae JAEKEL, 1918, p. 36]

Fixed portion of arms strongly grouped,

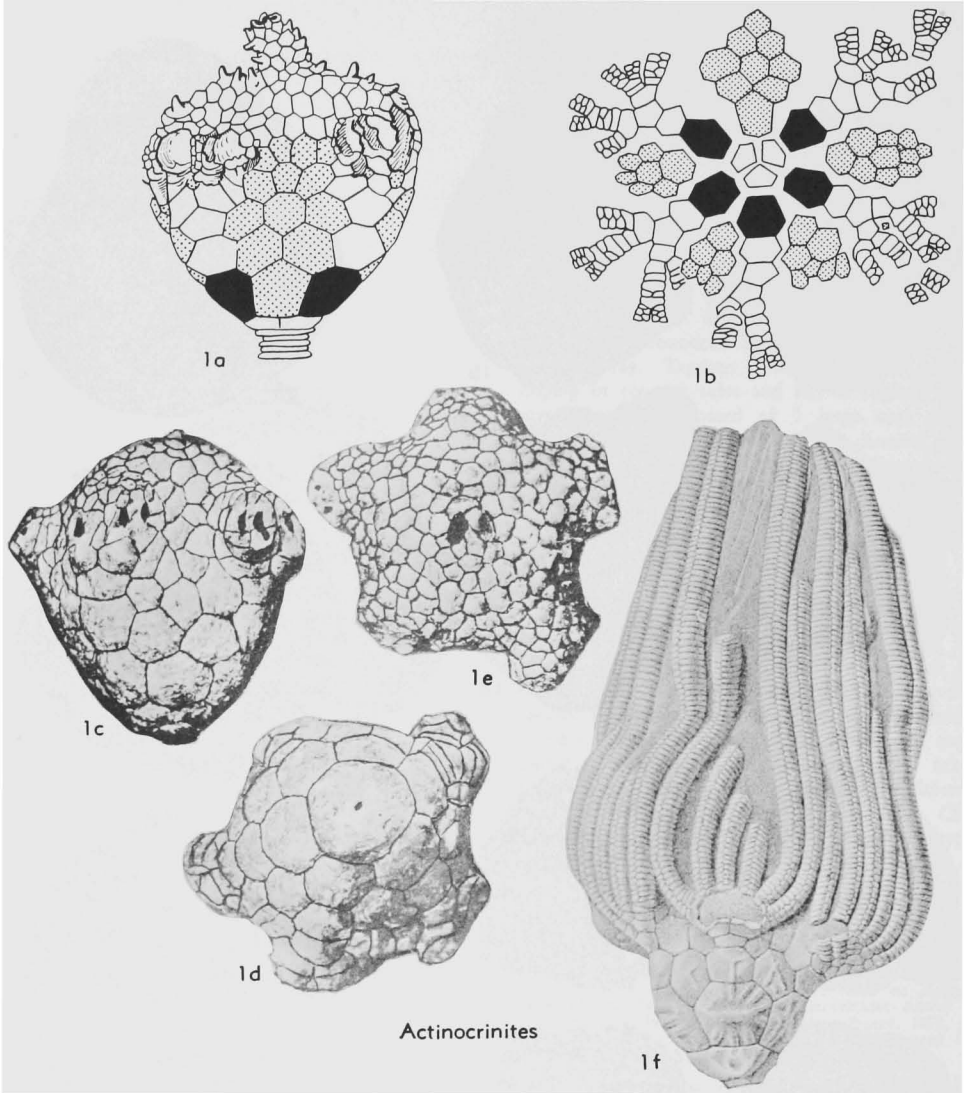


FIG. 261. Actinocrinitidae (Actinocrinitinae) (p. T454-T455).

forming protuberant brachial lobe in each ray. *L. Carb. (L. Miss.) - U. Carb.; ? Perm.*

The dominant evolutionary trend of this group is in development of lobation. This is accomplished by producing outwardly flared fixed brachials and ramifying arms of the rays in various ways. Other evolutionary trends shown by all or part of the group are 1) development of a large-plated tegmen with anal tube, 2) development of externally rectangular first primibrachs, 3) changes in thecal shape, and 4) addition of arms (BROWER, 1967-69).

Actinocrinites MILLER, 1821, p. 15, 94 [**A. triacontadactylus*; SD WACHSMUTH & SPRINGER, 1881, p. 146(320)] [= *Actinocrinus* AGASSIZ, 1836, p. 196 (*nom. van.*)]. Calyx usually elongate conical; fixed brachials relatively small, up to 3rd or 4th tertibrachs outwardly flared and braced by complex arrangement of covering plates and tegminals; brachial lobes widely separated by interprimibrachs. Tegmen somewhat variable in height, many-plated; orals and ambulacrals generally undifferentiated; central or subcentral anal tube prominent. Free arms biserial, 30 or perhaps more (number indeterminate in type and other British species), usually (but not invariably)

unbranched and grouped in clusters. *L.Miss.-Penn.*, ?*Perm.*, N.Am.; *L.Carb.-U.Carb.*, ?*Perm.*, Eu.-N.Afr.-E.Australia-?Indon.(Timor). [Species of Permian age assigned to *Actinocrinites* by WANNER (1916, 1924) are highly divergent. Many of them have very massive and protuberant brachial lobes. Their first primibrachs are rectangular and primaxils commonly are pentagonal. In some the primanals are followed by 3 plates. They probably represent a late and specialized development from some unknown actinocrinitid stock.]—FIG. 261, *1a-e*. **A. triacontadactylus*, *L.Carb.*, Eng.; *1a*, CD-interray view of theca (radials black, anals and interbrachials stippled), $\times 1$ (Ubaghs, n, based on Miller, 1821, pl. II, opp. p. 98); *1b*, plate diagram (radials black, anals and interbrachials stippled) (Bowsler, n); *1c-e*, CD-interray, dorsal, and tegminal views of theca, $\times 1$ (Wright, 1955-60).—FIG. 261, *1f*. *A. multi-radiatus* (SHUMARD), *L.Miss.*(Osag.), USA(Iowa); A-ray view of crown, $\times 1$ (Wachsmuth & Springer, 1897).

Aacocrinus BOWSHER, 1955, p. 3 [**A. nodorsatus*; OD]. Calyx conical, wide to elongate, composed of large, more or less tumid plates; distal fixed brachials large, directed semihorizontally. Tegmen low arched, commonly with nodose orals and ambulacrals. Free arms practically unknown, numbering (as judged from ambulacral tracts) 2 to 4 (exceptionally 3) in ray. Stem unknown. *L.Miss.*(*Kinderhook.*), N.Am.(USA).—FIG. 262, *1*. **A. nodorsatus*, Chouteau Ls., USA(Mo.); *1a-c*, CD-interray, E-ray, and ventral views of theca, $\times 2$ (Bowsler, 1955b); *1d-f*, plate diagrams of CD-interray, E-ray and ventral sides of calyx (radials black, anals and interbrachials stippled), $\times 1.3$ (Bowsler, 1955b).

Abactinocrinus LAUDON & SEVERSON, 1953, p. 528 [**A. rossei*; OD]. Calyx conical, strongly lobate, expanding rapidly upward, and flaring at top of 1st primibrachs into tubelike projections; fixed brachials comprising primibrachs and 1st secundibrachs only; interrays constricted at arm level, giving markedly pentagonal outline in dorsal and ventral views; ambulacral openings 2 in each ray, directed laterally and slightly upward. Tegmen low conical, many-plated, with depressed interambulacral areas and prominent ambulacral tracts; anus excentric, opening directly through tegmen. Free arms and stem unknown. *L.Miss.*(*Kinderhook.*), N.Am.(USA).—FIG. 262, *2*. **A. rossei*, Lodgepole F., USA(Mont.); *2a-c*, post., B-ray, and ventral views of holotype theca, $\times 2$ (Laudon and Severson, 1953).

Blaicrocinus S. A. MILLER, 1891, p. 69 [**B. trijugis*; M]. Calyx low, bowl shaped; basals forming flattened disc; cup plates tumid, generally marked by heavy stellate ridges. Tegmen convex,

composed of large plates, all or part of them spinose or nodose, orals and ambulacrals differentiated by size and spinosity; anal tube subcentral, stout at base; arm facets 4 in each ray, facing obliquely upward. Free arms and stem unknown. *L.Miss.*(*Kinderhook.*), N.Am.; *L.Carb.*, Eu.(Belg.).—FIG. 263, *1*. **B. trijugis*, Compton Ls., USA(Mo.); *1a-c*, CD-interray, dorsal, and tegminal views of holotype theca, $\times 2$ (Peck & Keyte, 1938).

Diatorocrinus WRIGHT, 1955, p. 235 [**D. angustus*; OD]. Calyx similar to that of *Actinocrinites*; brachial lobes strongly developed. Tegmen low convex to medium conical, many-plated; anus subcentral or excentric, directly through tegmen. Free arms (at least 4 in each ray) and column unknown. *L.Carb.*(*low.Visean*), Eu.(Eng.).—FIG. 263, *2*. **D. angustus*; *2a,b*, DE-interray and tegminal views of theca, $\times 1$ (Wright, 1955-60).

Sampsonocrinus MILLER & GURLEY, 1895, p. 51 [**S. hemisphericus*; OD] [= *Amphora* CUMBERLAND, 1826, p. 36 (type, *A.* 1st species, unnamed, = *Encrinites loricatus* VON SCHLOTHEIM, 1820)]. Like *Actinocrinites* but with more bowl-shaped and less elongate calyx, relatively larger radials, distal portion of 2nd primibrachs flaring outward and forming part of underside of brachial lobes. Large-plated tegmen with poorly developed anal tube and fewer arm openings (4 in ray) than in *Actinocrinites*. Free arms and stem unknown. *L.Miss.*(*Kinderhook.*), USA; *L.Carb.*, G.Brit.—FIG. 263, *3*. **S. hemisphericus*, Chouteau Ls., USA(Mo.); *3a-c*, BC-interray, dorsal, and ventral views of holotype, $\times 1.5$ (Peck & Keyte, 1938).

Steganocrinus MEEK & WORTHEN, 1866, p. 195 [**Actinocrinus pentagonus* HALL, 1858b, p. 577; OD] [= *Shumardocrinus* MILLER & GURLEY, 1895, p. 40 (type, *Actinocrinus concinnus* SHUMARD, 1855; OD)]. Calyx conical, bowl shaped, to highly elongate, strongly lobate; distal portion of 1st primibrachs and primaxils directed almost horizontally, forming base of ray trunk; calycal plates typically stellate, rarely almost smooth or highly tumid; interradiar areas wide, connecting with tegmen, which is low arched and generally made up of few fairly large and heavy plates, rarely composed of many small plates; subcentral or excentric anal tube usually present. Free arms (known only in *S. pentagonus*) consisting of 2 strong, long, tubular, uniserial, and nonpinnulate trunks, composed of high brachials, each of which bears relatively short, stout, biserial and pinnulate ramule on alternate sides of ray trunk. Column unknown. *L.Miss.*(*Osag.*), N.Am.(USA).—FIG. 263, *4*. **S. pentagonus* (HALL), Burlington Ls., USA(Iowa-Mo.-N.Mexico); *4a,b*, CD-interray and tegminal views of theca, $\times 1$ (Wachsmuth & Springer, 1897); *4c*, dorsal view of incomplete crown with arms preserved, $\times 1$ (Wachsmuth & Springer, 1897).

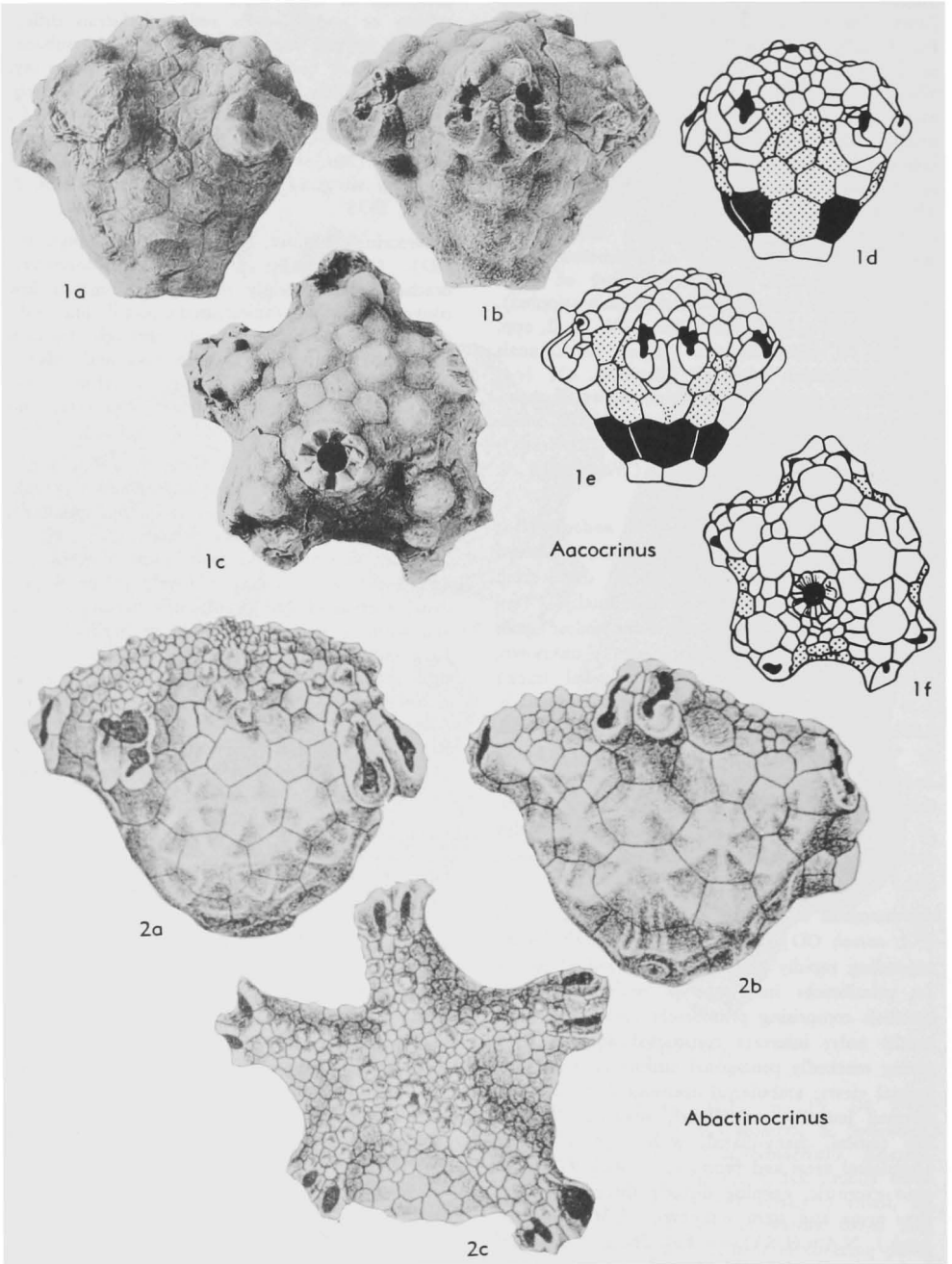


FIG. 262. Actinocrinitidae (Actinocrinitinae) (p. T455).

Subfamily EUMORPHOCRININAE
Ubaghs, new subfamily

[=eumorphocrinid section BROWER, 1967, p. 675
 (vernacular)]

Fixed portions of arms strongly grouped, but never forming protuberant brachial lobes; fixed brachials relatively numerous; tegmen many-plated. *L. Carb.*

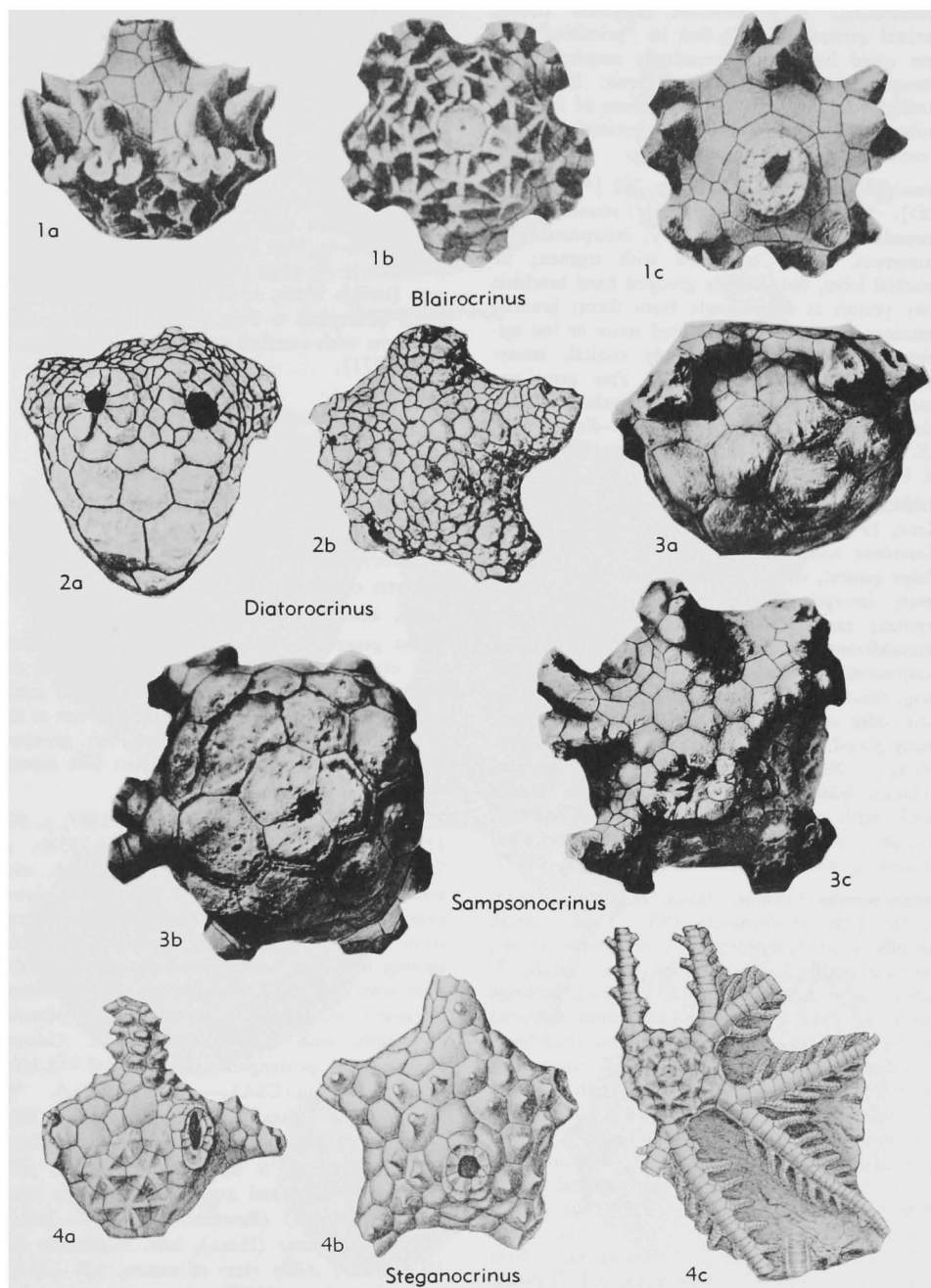


FIG. 263. Actinocrinitidae (Actinocrinitinae) (p. T455).

In the nature of their calyx, the crinoids included in this subfamily closely resemble the Periechocrinitidae, from which they differ mainly in having two plates in the second range of the

CD interray. Most of them (particularly *Malignocrinus*, Kinderhookian) may indeed be direct descendants of some periechocrinid stock; however, *Eumorphocrinus*, the type of the subfamily, being

early Viséan in age, appears as a relatively late actinocrinitid. It is therefore suggested (LANE, personal communication) that its "primitive" features could have been secondarily acquired from a more advanced, but older, ancestor. If so, the Eumorphocrininae would unite genera of basically similar calyx structure but not necessarily related to each other phylogenetically.

Eumorphocrinus WRIGHT, 1955, p. 232 [**E. erectus*; OD]. Calyx conical or slightly rounded; 2nd secundibrachs fixed and axillary; interprimibrachs numerous, openly connected with tegmen; no brachial lobes, but strongly grouped fixed brachials may project at slight angle from theca; brachial openings 4 in each ray, directed more or less upward. Tegmen low to steeply conical, many-plated, with central anal tube. Free arms unknown above 2nd or 3rd tertibrachs. *L.Carb.* (low.Viséan), Eu.(Eng.-N.Eire).—FIG. 264,1. **E. erectus*; 1a,b, AE-interray and tegmental views of holotype theca, $\times 1$ (Wright, 1955-60).

Cydidocrinus KIRK, 1944, p. 85 [*pro Cyrtocrinus* KIRK, 1943a, p. 263 (*non* JAEKEL, 1891)] [**Actinocrinus sculptus* HALL, 1858b, p. 582; OD]. Calyx conical, with practically no lobation at arm level; interprimibrachs widely connected with tegmen; each ray divided into small, biserial, pinnuliferous ramus and strong, rigid, uniserial, nonpinnuliferous, tubular arm-trunk which carries long, stout, biserial, pinnuliferous ramuli on alternate sides on each 2nd brachial. Tegmen high, many-plated, with central anal tube. *L.Miss.* (Osag.), N.Am.—FIG. 264,2. **C. sculptus* (HALL), USA(Iowa); 2a, plate diagram (radials black, anals and interbrachials stippled) (Bowsher, n); 2b,c, lat. view of theca and CD-interray view of crown, $\times 0.7$ (Wachsmuth & Springer, 1897).

Malignocrinus LAUDON, PARKS, & SPRENG, 1952, p. 564 [**M. medicinensis*; OD]. Calyx conical, broadly expanded; plate ornamentation stellate; 1st primibrachs hexagonal, primaxils typically 7-sided; single fixed secundibrach in each half-ray, axillary; 1 fixed tertibrach in each ramus, followed by free arm; brachial openings 4 in ray; interprimibrachs relatively large in 1st 3 ranges and small at arm level; CD interrayer wider than others. Tegmen consisting of many small plates, with interambulacral areas slightly depressed. Free arms and column unknown. *L.Miss.* (*Kinderhook.*), N. Am.(Can.). [This genus originally placed among Periechocrinidae has been assigned to the Actinocrinitidae by BROWER (1967).]—FIG. 264,3. **M. medicinensis*, Banff F., Alberta; 3a,b, A-ray and dorsal views of holotype theca, $\times 1$ (Laudon, Parks & Spreng, 1952); 3c, CD-interrayer view of paratype, $\times 1$ (Laudon, Parks, & Spreng, 1952).

Manillocrinus CAMPBELL & BEIN, 1971, p. 427 [**Cactocrinus? brownei* DUN & BENSON, 1920, p. 342; OD]. Calyx steep conical; plate ornamentation stellate; 1st primibrachs hexagonal, primaxils

octagonal; 2nd secundibrachs axillary; interprimibrachs well developed, widely connecting with tegmen; intersecundibrachs present; each ray divided into 4 rami, consisting of 2 small biserial pinnuliferous unbranched arms on outer sides and 2 main uniserial nonpinnuliferous exotomous trunks on inner sides; main arm trunks parallel, bearing biserial undivided pinnuliferous armlets on opposite sides at more or less regular intervals. Stem round, columnals alternating proximally, equidimensional and cirriferous distally. *L.Carb.*, E.Australia.—FIG. 265,1. **M. brownei* (DUN & BENSON); 1a, plate diagram of calyx and D-ray arm (radials black, anals and interbrachials stippled) (Campbell & Bein, 1971); 1b, D-ray view of crown with attached stem, $\times 1.5$ (Campbell & Bein, 1971).

Subfamily CACTOCRININAE Ubahgs, new subfamily

[=cactocrinid section BROWER, 1967, p. 676]

Fixed portions of arms weakly grouped or ungrouped (except in some species of *Dialutocrinus*); rays never protuberant. Tegmen composed of large undifferentiated plates, anal tube present. *L.Carb.*

Most genera of this subfamily show two dominant evolutionary trends. As additional arms are incorporated into the calyx, distal ranges of interbrachials tend to be resorbed or displaced out of the calyx, whereas the arms, less and less grouped, tend to be arranged in a continuous belt around the calyx.

Cactocrinus WACHSMUTH & SPRINGER, 1897, p. 600 [**Actinocrinus proboscidiialis* HALL, 1858b, p. 584; OD]. Calyx conical, wider than high, with arm bases laterally in contact all around; interprimibrachs numerous, not connecting with tegmen. Tegmen high, steeply conical, large-plated, passing into prominent, almost central, anal tube. Free arms biserial, 4 to 8 in each ray, equidistant or nearly so, forming continuous ring; pinnules commonly with sharp-pointed hooks. Column large, with pentangular axial canal. *L.Miss.* (Osag.), N.Am.(USA).—FIG. 266,1a,b. **C. proboscidiialis* (HALL), low. Burlington Ls., USA (Iowa-Mo.-N.Mexico); 1a, A-ray view of theca, $\times 1$ (Wachsmuth & Springer, 1897); 1b, plate diagram of calyx and arms (radials black; interbrachials stippled) (Bowsher, n).—FIG. 266,1c. *C. multibrachiatus* (HALL), low. Burlington Ls., USA(Iowa); A-ray view of crown, $\times 1$ (Wachsmuth & Springer, 1897).

Cusacrinus BOWSHER, 1955, p. 7 [**Actinocrinus nodobrachiatus* WACHSMUTH & SPRINGER in S. A. MILLER, 1889, p. 219; OD]. Calyx steeply conical; interprimibrachs numerous, 1 or 2 at arm level, connecting with tegmen. Tegmen low arched to

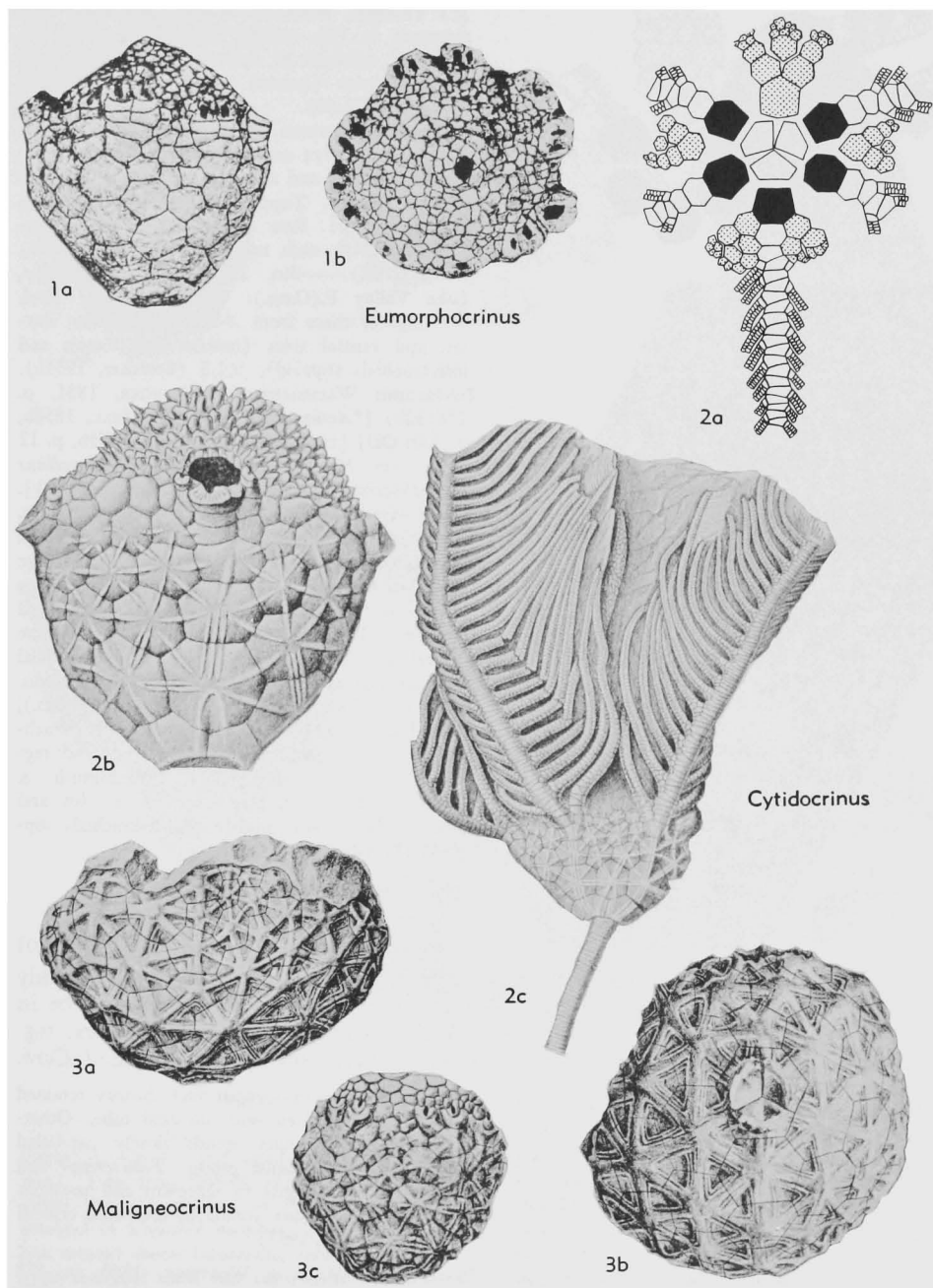


FIG. 264. Actinocrinitidae (Eumorphocrininae) (p. T458).

conical, large-plated, bearing prominent central anal tube. Arms biserial, weakly grouped, 6 or 8 (only 5 in some species) in each ray, unbranched. Column relatively large, composed of nudinodals and internodals. *L.Miss.*(*Kinderhook-*

Osag.), N.Am.(USA).—FIG. 266,2. **C. nodo-brachiatus* (WACHSMUTH & SPRINGER), Kinderhook, USA(Iowa); 2a, crown showing incurling arms, $\times 1$ (Bowsler, 1955b); 2b-d, drawings of A-ray, CD-interray and dorsal sides of theca

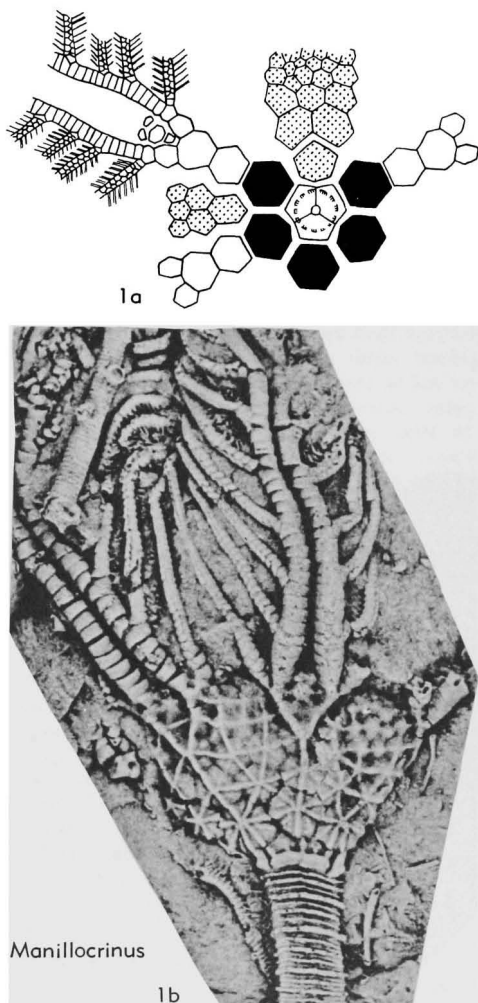


FIG. 265. Actinocrinitidae (Eumorphocrininae) (p. T458).

(radials black, anals and interbrachials stippled), $\times 1.3$ (Bowsheer, 1955b).

Dialutocrinus WRIGHT, 1955, p. 241 [**D. milleri*; OD]. Calyx conical or rounded; fixed brachials weakly or strongly grouped according to species; interprimibrachs numerous, one, two, or more at arm level; tegmen rounded, rising to anal tube which is long and composed of small or large polygonal plates. Free brachials remaining uniserial for some distance above calyx and not becoming biserial until above last branching; each ray dividing into 6 to 10 or even more free branches, which are long, and in some species characterized by thornlike processes on aboral surface; division of ray as shown by Fig. 267,1b-d. Column composed of alternating nudinodals. *L. Carb. (Tournais.)*, Eu. (Eire-Eng.-Belg.).—FIG.

267,1a. *D. laevisissimus* (AUSTIN & AUSTIN), Eire; $\times 1$ (Wright, 1955-60).—FIG. 267,1b-d. Ray structure in **D. milleri*, Eng., Eire (1b), *D. aculeatus* (AUSTIN & AUSTIN), Eire (1c), and *D. laevisissimus* (AUSTIN & AUSTIN), Eire (1d) (Wright, 1955-60).

Nunnacrinus BOWSHER, 1955, p. 17 [**N. mamillatus*; OD]. Calyx conical; fixed portions of arms weakly grouped and separated by 1 or 2 elongate interprimibrachs. Tegmen large-plated, with central anal tube. Free arms biserial, stout, unbranched, 4 in each ray. *L. Carb.*, Eu.; *L. Miss.*, N.Am. (USA).—FIG. 267,2. **N. mamillatus*, Lake Valley F. (Osag.), USA (N. Mexico); 2a-d, drawings of theca from A-ray, CD-interray, dorsal, and ventral sides (radials black, anals and interbrachials stippled), $\times 1.3$ (Bowsheer, 1955b).

Teliocrinus WACHSMUTH & SPRINGER, 1881, p. 146 (320) [**Actinocrinus umbrosus* HALL, 1858b, p. 590; OD] [= *Calathocrinus* HALL, 1861b, p. 12 (non VON MEYER, 1848) (type, *Actinocrinus (Calathocrinus) erodus* HALL, 1861b, p. 12)]. Calyx steeply conical; interprimibrachs numerous, separated from tegmen by fixed brachials, which with interbrachials form flange at arm level. Free arms moderately long, biserial, simple, very numerous (up to 16 in ray), and closely crowded together. Tegmen convex, with strong nodose central anal tube. Column covered with vertical rows of angular processes. *L. Miss. (Osag.)*, N.Am. (USA).—FIG. 268,1. **T. umbrosus* (HALL), USA (Iowa); 1a, lat. view of crown, $\times 1$ (Wachsmuth & Springer, 1897); 1b,c, A-ray and tegmental views of theca, $\times 1$ (Wachsmuth & Springer, 1897); 1d, plate diagram of calyx and arms (radials black, anals and interbrachials stippled) (Bowsheer, n).

Subfamily PHYSETOCRININAE

Ubaghs, new subfamily

[=physetocrinid section BROWER, 1967, p. 676 (vernacular)]

Fixed portions of arms usually weakly grouped, not protuberant, tending to be in lateral contact in advanced members; tegminals typically small; no anal tube. *L. Carb.*

Physetocrinines throughout their history retained a small-plated tegmen with no anal tube. Otherwise, their evolutionary trends closely paralleled those of the cactocrinine group. *Teliocrinus* and *Strotocrinus* are judged to represent end products of similar evolutionary trends in unrelated crinoid lineages (BROWER, 1967).

Physetocrinus MEEK & WORTHEN, 1869, p. 158 [**Actinocrinus ventricosus* HALL, 1858b, p. 595; SD WACHSMUTH & SPRINGER, 1881, p. 157]. Calyx cup conical to basin shaped, more or less elevated, distinctly lobed at arms level in early species, slightly so in later and more advanced species; interbrachials narrowly connected with tegmen. Tegminals relatively large (primitive con-

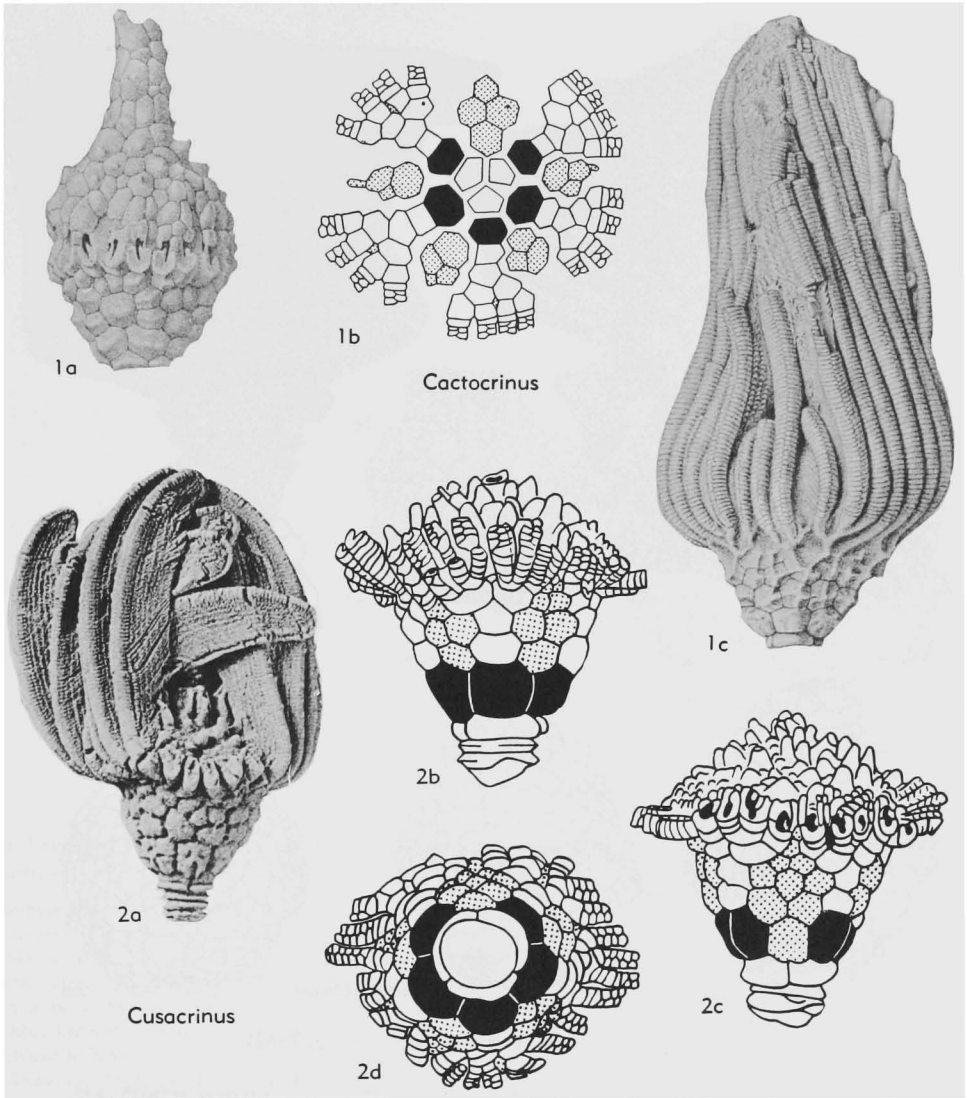


FIG. 266. Actinocrinitidae (Cactocrininae) (p. T458-T459).

dition) to smaller and smaller (advanced condition). Free arms biserial, simple, 4 in each ray, rather strongly grouped in early forms, slightly grouped in advanced members, but never forming rim around theca; bifurcating series branching on every brachial until full complement of arms is developed. *L.Miss.(Osag.)*, N.Am.; *L.Carb.*, G. Brit.-E.Australia.—FIG. 269, 1. **P. ventricosus* (HALL), Burlington Ls., USA (Iowa); 1a, CD-interray views of crown with attached stem, $\times 1$ (Wachsmuth & Springer, 1897); 1b, c, A-ray and ventral views of theca, $\times 1$ (Wachsmuth & Springer, 1897); 1d, plate diagram of calyx

and arms (radials black, interbrachials stippled) (Bowsler, n).

Strotocrinus MEEK & WORTHEN, 1866, p. 253 [*Actinocrinus perumbrosus* HALL, 1860c, p. 7; SD S. A. MILLER, 1889, p. 284]. Calyx large, steeply conical; fixed brachials, and interbrachials forming very prominent flange at arms level from which arise very numerous (up to 30 in each ray) rather short, unbranched, biserial free arms. Tegmen flat or very slightly convex, composed of many minute irregular plates. *L.Miss.(Osag.)*, N.Am.(USA).—FIG. 270, 1a, b. **S. perumbrosus* (HALL), USA (Iowa); A-ray and tegmental sides

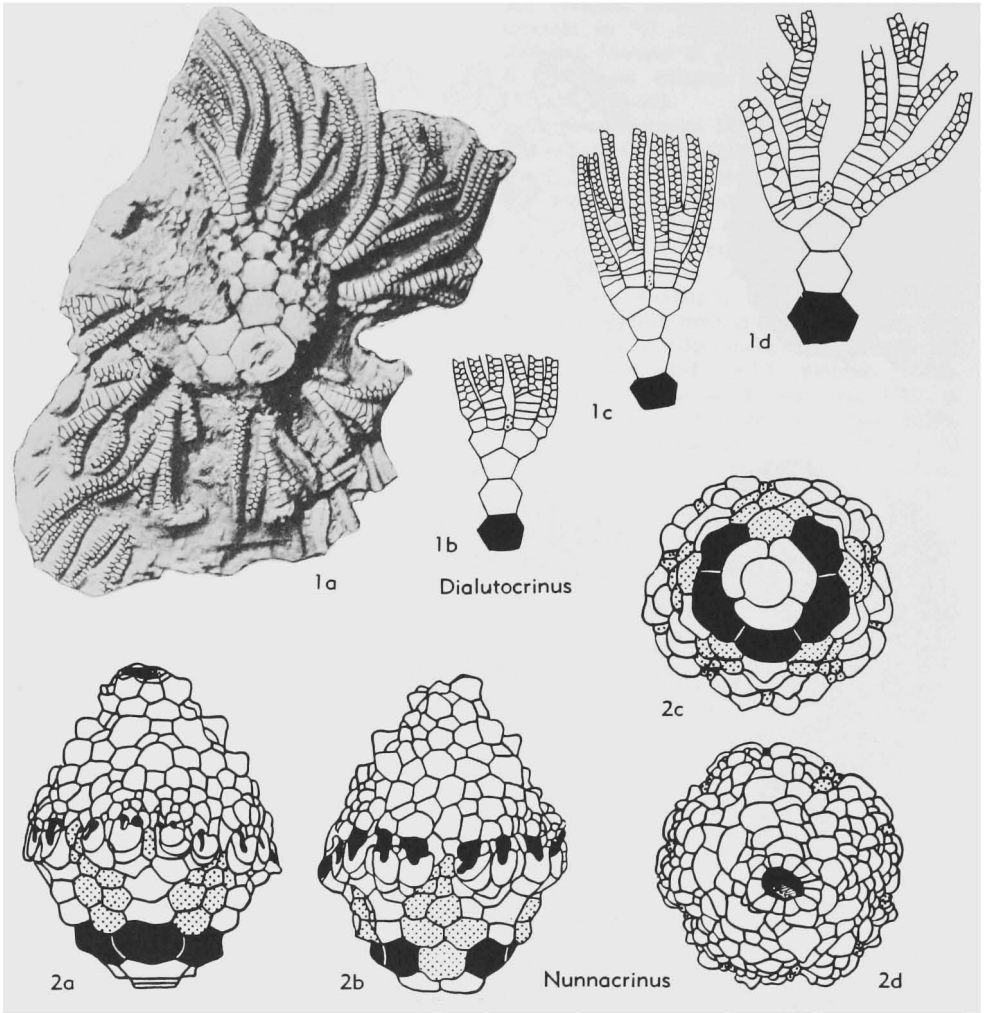


FIG. 267. Actinocrinitidae (Cactocrininae) (p. T460).

of theca (radials black, interbranchials stippled), $\times 1$ (drawn from Wachsmuth & Springer, 1897).
 —FIG. 270,1c. *S. glyptus* (HALL), USA (Iowa); oblique view of crown from below with attached stem, $\times 1$ (Wachsmuth & Springer, 1897).

**Superfamily CARPOCRINACEA
 de Koninck & Le Hon, 1854**

[*nom. transl.* UBAGHS, herein (*ex* Carpoocrinidae DE KONINCK & LE HON, 1854, p. 115)]

Basals three, generally equal; first primibrachs ordinarily quadrangular; primanal generally followed by three plates in next higher row. *M.Sil.-U.Sil.*; *M.Dev.-L.Carb.*

**Family CARPOCRINIDAE
 de Koninck & Le Hon, 1854**

[*nom. correct.* UBAGHS, herein, *pro* Carpoocrinidées DE KONINCK & LE HON, 1854, p. 115] [=Carpocriniens PICTET, 1857, p. 326 ("tribu") (*partim*); Desmidocrinidae ANGELIN, 1878, p. 5; Habrocrinidae ANGELIN, 1878, p. 3; Barrandocrinidae ANGELIN, 1878, p. 7; Carpoocrinidae ZITTEL, 1879, p. 344; Methabocrinidae UBAGHS, 1958a, p. 52]

Fixed secundibrachs one to three in each half-ray, exceptionally more; interprimibrachs one to many, connecting with or separated from tegmen; CD interray primitively and typically with median series of anal plates. Tegmen solid, with orals and ambulacrals ordinarily distinct. Free arms simple, usually two in each ray, uniserial

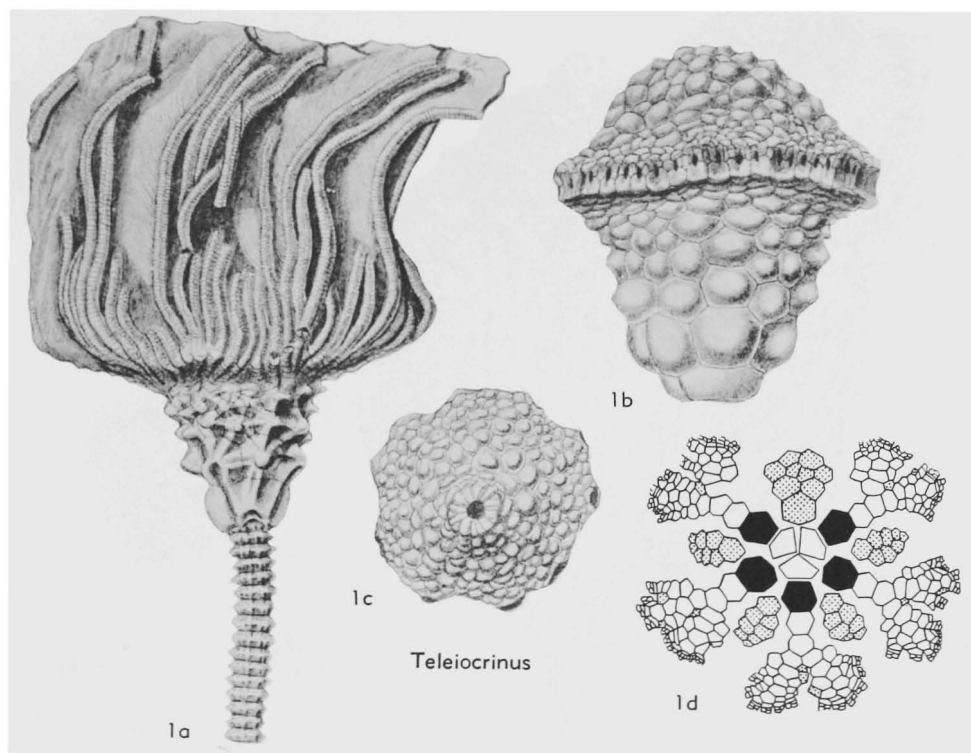


FIG. 268. Actinocrinitidae (Cactocrininae) (p. T460).

or biserial; brachials simple or compound. Column cylindrical. *M.Sil.-U.Sil.*; *M.Dev.*

Carpocrinus MÜLLER, 1840, p. 33 [**Actinocrinites simplex* PHILLIPS, in MURCHISON, 1839, p. 673; SD ROEMER, 1855, p. 237] [= *Carpocrinus* AGASSIZ, 1842, p. 3 (*nom. null.*); *Phoenicocrinites* AUSTIN & AUSTIN, 1843, p. 205 (*obj.*); *Carpocrinites* GEINITZ, 1846, p. 550 (*nom. van.*); *Abracrinus* D'ORBIGNY, 1850, p. 47 (*obj.*); *Habrocrinus* ANGELIN, 1878, p. 3 (*nom. subst. pro Abracrinus*); *Pionocrinus* ANGELIN, 1878, p. 4 (type, *P. pulchellus*; SD BASSLER, 1938, p. 153); *Leptocrinus* ANGELIN, 1878, p. 3 (type, *L. raridigitatus*; M); *Phoenicocrinus* SPRINGER, 1913, p. 194 (*nom. van.*)]. Calyx conical to cyathiform; basals equal or unequal; 1st primibrachs 4- to 6-sided; interbrachial areas narrow, in contact with tegmen; CD interray wide, with prominent median series of anal plates leading to anus. Tegmen with ambulacrals distinct near center; posterior oral well differentiated, others small or undistinct; no anal tube. Free arms 2 to 4 in each ray; outer rami of some species reduced, without pinnules and resembling large proximal pinnules; brachials compound, bi- or hyperpinnulated. *M.Sil.*, *Eu.-N.Am.*—FIG. 271,2a. **C. simplex* (PHILLIPS),

Wenlock., Eng.; part of crown, $\times 1$ (Bather, 1900a).—FIG. 271,2b,c. *C. ornatus* (ANGELIN), Gotl.; E-ray view (Stockholm Mus. Ec. 11299), $\times 1.5$, and CD-interray view (Stockholm Mus. no. Ec. 11300), $\times 1$ (Ubaghs, n).

Acacocrinus WACHSMUTH & SPRINGER, 1897, p. 515 [**A. elrodi*; OD]. Calyx short and rotund; basals equal; 1st interprimibrachs large, followed by smaller plates connecting with tegmen; CD interray wide, composed of numerous plates arranged generally in 3 longitudinal rows. Arms free from 2nd or 3rd secundibrach, 2 in each ray, simple, uniserial, with wedge-shaped brachials. *M.Sil.*, *M.Dev.*, N.Am.(USA).—FIG. 272,2. **A. elrodi*, Niagaran, USA(Ind.); side view of holotype crown, $\times 2$ (Wachsmuth & Springer, 1897).

Barrandocrinus ANGELIN, 1878, p. 7 [**B. scepterum*; M]. Crown melon shaped, with permanently pendent arms, calyx cyathiform; basals subequal; radials irregularly shaped; interbrachial areas with 1 followed by 2 plates and indefinitely numerous, variously shaped platelets; primanal large, supporting 3 plates in next row; all interradial (including posterior) and interbrachial areas connecting with tegmen. Tegmen dome shaped, moderately high, with 10 large summit plates.

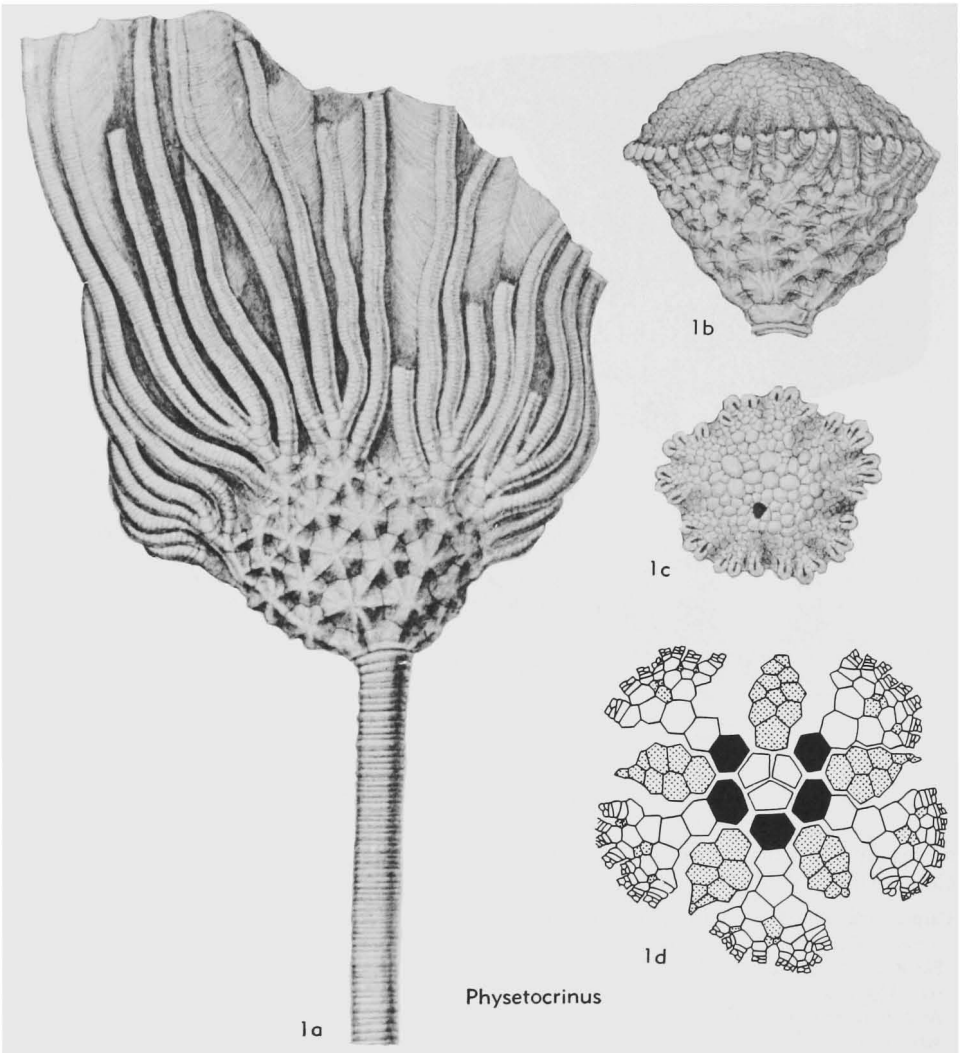


FIG. 269. Actinocrininitidae (Physetocrininae) (p. T460-T461).

Brachial insertions very large, secondarily extended over calyx; free arms 10, biserial, with very short, cuneate brachials; pinnules close-set, folded at midlength and attached together to form a firm external protective pavement enclosing 10 brachial chambers; very distal parts of pinnules free and allowing entrance of seawater into chambers; exhalant common aperture at apex of crown. Nudinodals concealing internodals of stem proximally; columnals all alike distally; radicular cirri present. *U.Sil.*, Eu.(Sweden).—FIG. 273, 1. **B. sceptrum*, Gotl.; 1a, lat. view of crown, $\times 1.5$; 1b, apical view of crown showing exhalant central aperture, $\times 1.5$; 1c, crown with 2 pendent arms removed, $\times 1.5$; 1d, lat. view of

theca, $\times 2$; 1e, cross section of crown showing brachial chambers formed by rigid portions of pinnules, $\times 2$; 1f, plate diagram of calyx (radials black, interbrachials and anals stippled) (all Ubaghs, 1956).

Bohemiocrinus WAAGEN & JAHN, 1899, p. 15 [**B. pulverens*; M] [= *Bohemiocrinus* SHARPE, 1899 (Zool. Rec. 36), p. 15 (*nom. null.*); *Vletavicrinus* WAAGEN & JAHN, 1899, p. 98 (type, *V. haueri*; M)]. Calyx vase shaped, elongate, basally rounded; basals equal; radials irregular; fixed secundibrachs 7 or 8; interbrachial areas long, narrow, many-plated, separated from tegmen by fixed pinnulars; CD interray without median series of anal plates, with only 1 plate resting on primanal. Free arms

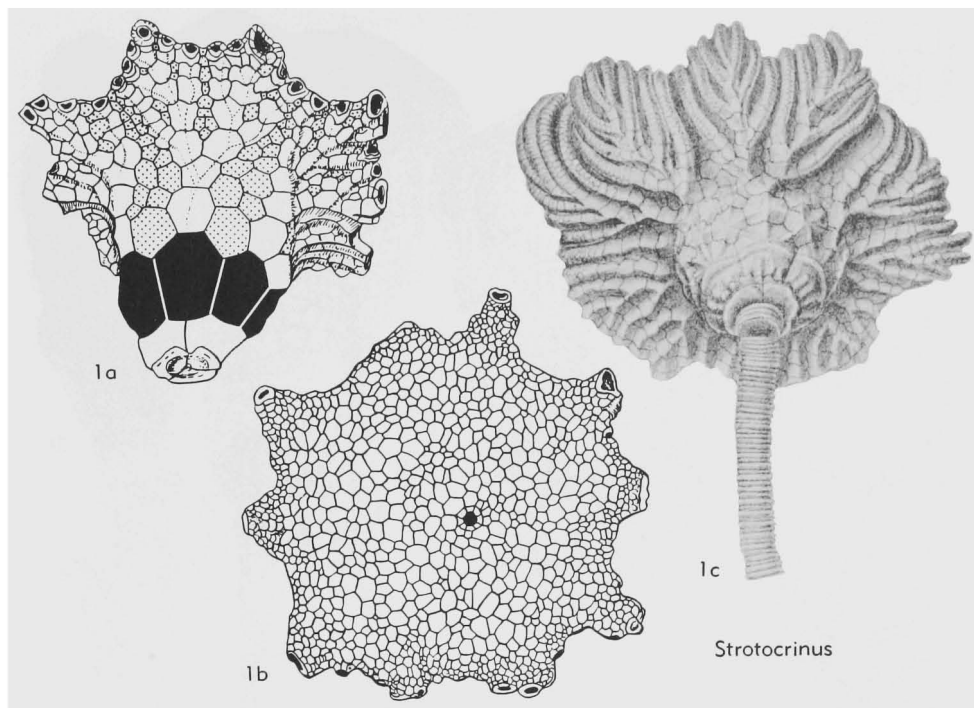


FIG. 270. Actinocrinitidae (Physetocrininae) (p. T461-T462).

2 in each ray (unknown in *Bohemiocrinus*, but isotomously branching and composed of compound brachials in *Vletavicrinus*, herein taken as synonym). *U.Sil.*, Eu.(Boh.).—FIG. 271,1. **B. pulverens*; 1a-c, drawings of theca from A-ray, CD-interray, and dorsal sides (radials black, anals and interbrachials stippled), $\times 0.7$ (Ubaghs, n); 1d, lat. view of crown with attached stem (type of *Vletavicrinus haueri*, Vienna Museum 2156), $\times 1$ (Ubaghs, n).

Cylicocrinus S. A. MILLER, 1892, p. 31 [**C. canaliculatus*; M]. Calyx truncate conical; basals generally equal; radials very large; fixed primibrachs small; one large interprimibrach followed by very small plates connecting with tegmen in each interray; CD interray wide, 3 plates in 2nd and 3rd rows, connected with smaller plates merging with tegmen. Tegmen convex, composed of ambulacrals and minute interambulacrals. Free arms and stem unknown. *M.Sil.*, N.Am.—FIG. 271,3. **C. canaliculatus*, Niaganan (Laurel Ls.), USA(Ind.); 3a,b, A-ray and CD-interray views of calyx, $\times 1.5$ (Springer, 1926a).

Desmidocrinus ANGELIN, 1878, p. 5 [**D. pentadactylus*; SD SPRINGER, 1926a, p. 43]. Calyx conical to cyathiform; basals equal or unequal; fixed tertibrachs present in all species and quarti-brachs in some; fixed portions of rays isotomously or heterotomously branched; interbrachial areas

composed of few plates, mostly small and very narrowly connected with tegmen; 1st interprimibrachs large; CD interray wider than others, with non-ridged median series of 4 or 5 anal plates passing to tegmen. Free arms 3 to 12 (ordinarily 3 to 8) in each ray, composed of extremely short brachials arranged in zigzag. Nudinodals concealing internodals at least in proximal portion of stem; axial canal small, pentalobate in cross section. *U.Sil.*, Eu.-?N.Am. [American species referred to this genus differ markedly from typical representatives found in Europe.]—FIG. 272,1. **D. pentadactylus*, Sweden (Gotl.); 1a, B-ray view of complete crown with short part of attached stem (Stockholm Museum Ec. 11366), $\times 1.5$ (Ubaghs, n); 1b, CD-interray view of incomplete crown (Stockholm Museum Ec. 11377), $\times 1.5$ (Ubaghs, n); 1c, plate diagram of part of calyx (radials black, anals and interbrachials stippled) (Ubaghs, n).

Methabocrinus JAEKEL, 1918, p. 37 [**M. erraticus*; OD]. Calyx moderately high, truncate conical; basals unequal; fixed secundibrachs (one in each half-ray) in contact all around, except in CD interray; single large interprimibrach in each interray; CD interray with three plates in row above primanal followed by a few plates in contact with tegmen. Tegmen solid, composed of central posterior oral plate surrounded by four orals, five

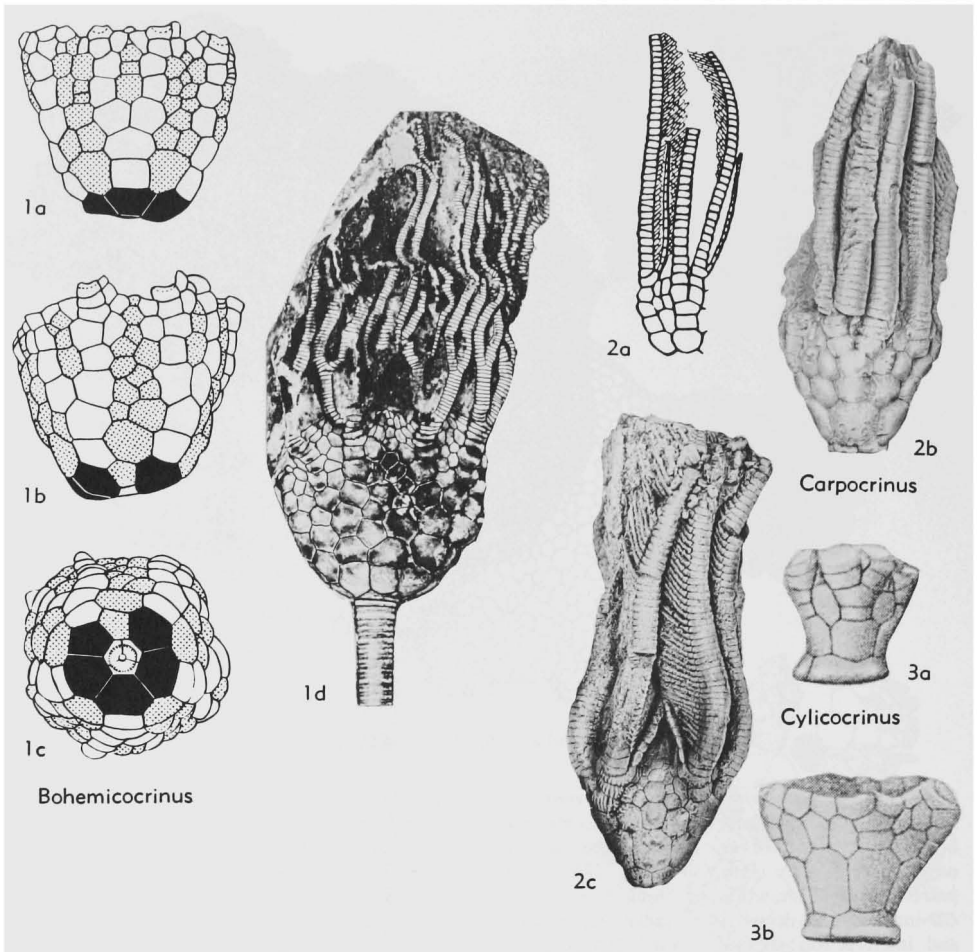


FIG. 271. Carpocrinidae (p. T463-T465).

interambulacra in exsert position and few smaller elements in anal interray. Free arms unknown, resting in ten vertical compartments of tegmen bounded by partitions. *U.Sil.*, N.Eu.—FIG. 274, 1. **M. erraticus*, Ger.; 1a-c, D-ray, CD-interray, and tegmental views of holotype theca, $\times 5$ (Ubahgs, 1958a); 1d, plate part of calyx (radials black, primanal and other interbrachial plates stippled), $\times 5$ (Ubahgs, n).

Family BATOCRINIDAE
Wachsmuth & Springer, 1881

[*nom. transl.* WACHSMUTH & SPRINGER, 1897, p. 361 (ex section Batocrinites WACHSMUTH & SPRINGER, 1881, p. 267 [93])] [=Batocrininae JAEKEL, 1918, p. 35] [Materials for this family prepared by N. GARY LANE]

Theca variable in shape; basals three, equal; one to 15 interprimibrachs in each interray may or may not be in contact with

tegen; primanal in line with radials and succeeded by three anal plates in next range, three to 19 anal plates may or may not be in contact with tegmen; first fixed brachial externally quadrangular, or axillary in advanced genera; second fixed brachial typically axillary; one to five fixed secundi-brachs and none to five fixed tertibrachs in each half-ray, latter commonly present in C and D rays, rarely in A ray. Free arms biserial, unbranched, single or paired from each ambulacral opening into theca, 10 to 40 and typically unequal in number in different rays of same individual. Anal opening at end of long, slender central or sub-central anal tube; oral and radial dome plates distinct. *L.Miss.-U.Miss.*

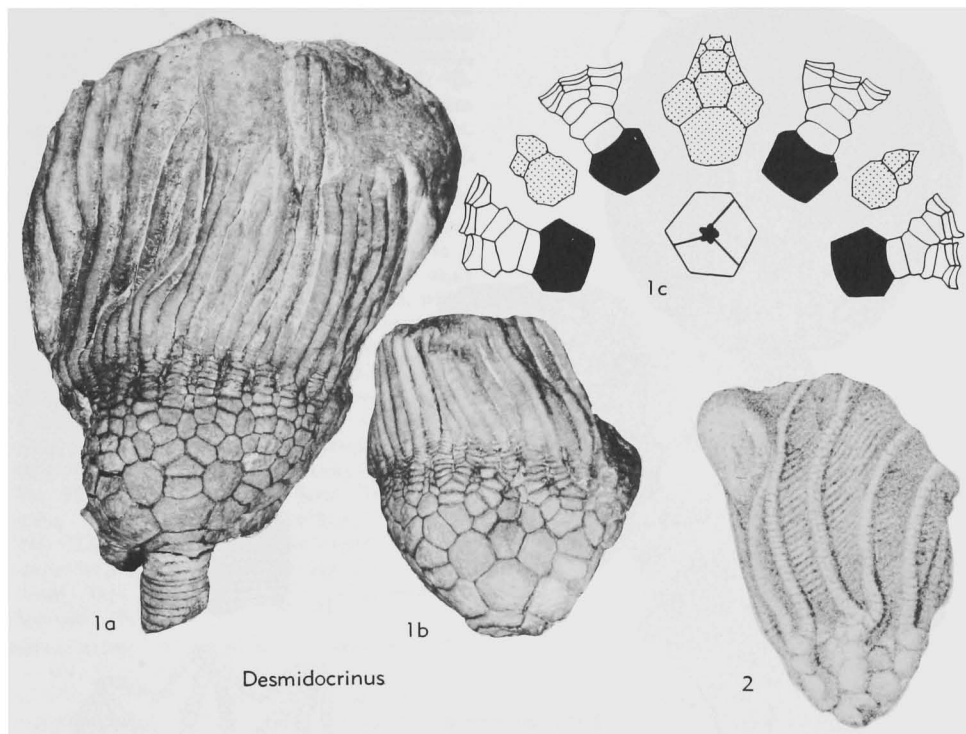


FIG. 272. Carpocrinidae (p. T463, T465).

Batocrinus CASSEDAY, 1854, p. 237 [**B. icosidactylus*; SD WACHSMUTH & SPRINGER, 1881, p. 340]. Calyx low, broad, plate sutures distinct or beveled; nodes, granules, or ridges on ray plates; basal circling low, broad; 1 to 4 interprimibrachs to interray; primanal followed by 3, and 1 to 3 additional, anal plates; all interray areas arched over by fixed brachials and separated from tegmen; arm facets large, horizontally directed, with distinct peripheral transverse and vertical articular ridges. Tegmen high, conical, with prominent spinose or tuberculate plates; anal tube long, central, typically with some spinose plates. Free arms 18 to 22. *U.Miss.(Meramec.)*, USA (Ind.-Ill.-Ky.-Mo.-Tenn.-Va.).—FIG. 275,6. **B. icosidactylus*, Ind.; 6*a,b*, lat. and dorsal views of theca, $\times 1$ (Wachsmuth & Springer, 1897).

Abatocrinus LANE, 1963, p. 696 [**Actinocrinus turbinatus* HALL, 1858b, p. 587; OD]. Calyx relatively high, sides straight or gently convex; cup plates smooth, convex, or nodose, unornamented; basal and radial circlings relatively high and prominent; 3 to 5 plates in each interray and 6 to 9 anal plates above primanal; all interrays arched by fixed brachials and not in contact with tegmen; arm facets small, slightly concave, with fine radial striations; anal tube stout and central, tegmental plates convex or nodose. Free arms 18

to 26, single, except for rare paired arms in most advanced species; 2 to 4 arms in *A* ray, 4 to 7 in *C* and *D* rays. *L.Miss.(Kinderhook.-Osag.)*, USA (Mo.-Ill.-Ky.-Iowa-Ind.-Tenn.).—FIG. 275, 2. **A. turbinatus* (HALL), 1*a*; 2*a,b*, post. and lat. views of theca, lat. views of crown, $\times 1$ (Wachsmuth & Springer, 1897).

Alloprosalocrinus CASSEDAY & LYON, 1862, p. 29 [**A. conicus*; SD WACHSMUTH & SPRINGER, 1881, p. 288] [= *Conocrinites* TROOST, 1850*a* (*nom. nud.*); *Conocrinus* SHUMARD, 1868 (*nom. van. pro Conocrinites* TROOST)]. Calyx low, flat, concave centrally, sutures not impressed; 1st fixed primibrach present or absent, partially eliminated from cup in some specimens; interprimibrachs 1 to 3, 3 anals above primanal, all interrays arched by fixed brachials. Tegmen high, conical, plates nodose; anal tube subcentral or slightly in front of tegmen center. Free arms 10 to 12, *C* or *D* rays may have more than two arms; arm facets large, crescent shaped, each facet composed of parts of 2 fixed brachs. *L.Miss.(Osag.)*, USA (Ind.-Ky.-Tenn.-Ala.).—FIG. 275,3. **A. conicus*, Borden Gr., Ky., Ind.; 3*a-c*, ant., post., and dorsal views of theca, $\times 1$ (Wachsmuth & Springer, 1897).

Azygocrinus LANE, 1963, p. 698 [**Actinocrinus dodecadactylus* MEEK & WORTHEN, 1861, p. 131;

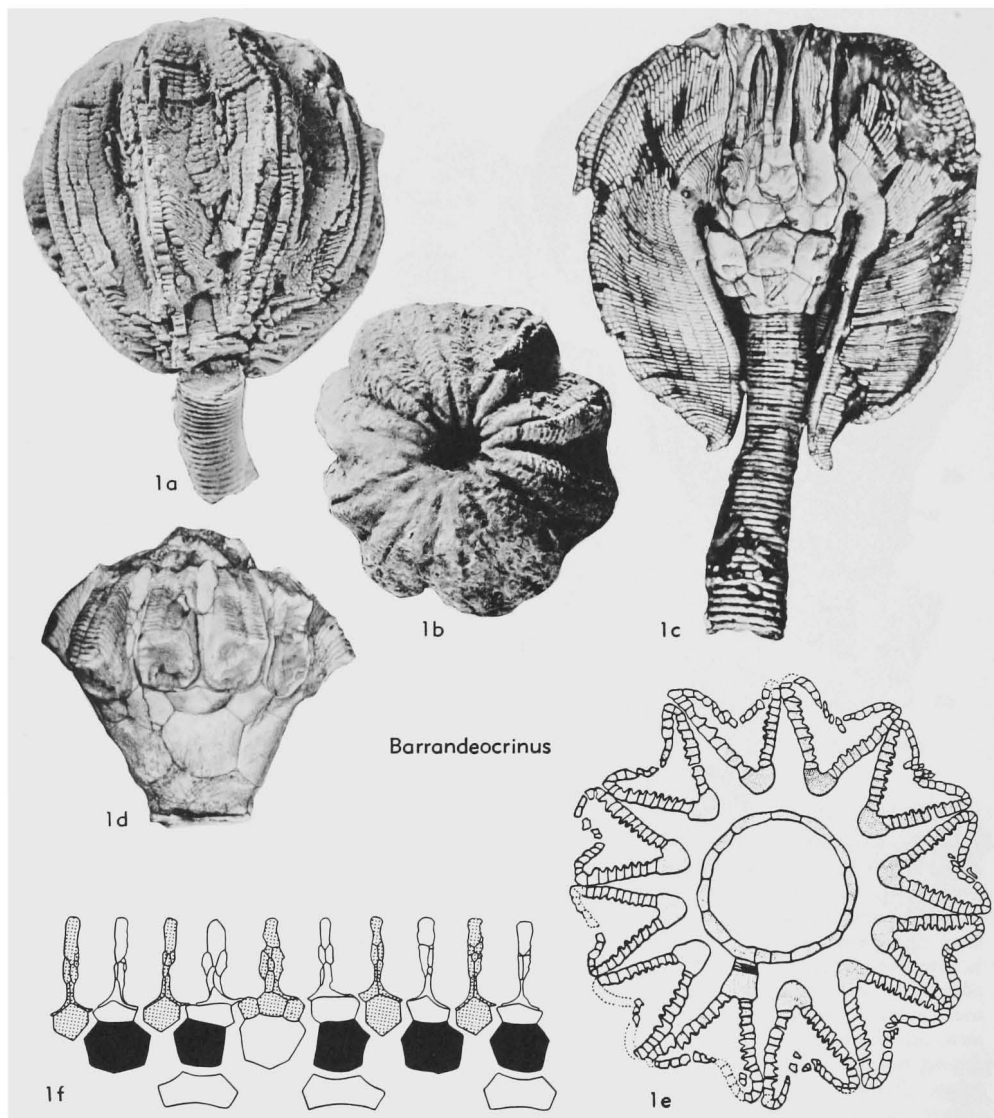


FIG. 273. Carpocrinidae (p. T463-T464).

OD]. Calyx subspherical, with flat smooth plates and indistinct sutures; aboral cup low bowl shaped, basal cirlet inconspicuous, not flanged; 1 to 5 interprimibrachs arched by fixed brachials, primanal followed by 3 to 11 anals which may or may not be arched by fixed brachials; arm openings 12 to 23; arm facets small, depressed or flush with surface of fixed brachials. Tegmen low, rounded, plates smooth; anal tube short, situated toward posterior side of tegmen. Arms simple. *L. Miss. (Osag.)*, USA (Mo.-Iowa-Ill.).—FIG. 275, 4. **A. dodecadactylus* (MEEK & WORTHEN), Burlington Ls., Iowa; 4a,b, post. and ventral views of theca, $\times 1$ (Wachsmuth & Springer, 1897).

Dizygocrinus WACHSMUTH & SPRINGER, 1897, p. 413 [*Actinocrinus indianaensis* LYON & CASSEDAY, 1860, p. 75; OD]. Calyx small, bowl shaped, sutures impressed; ray plates granulose, nodose, or bearing ridges; basal cirlet low, broad, extended proximally into rim; 2 to 5 interprimibrachs in each interray, 5 to 12 anals above primanal; anal plates but not regular interprimibrachs commonly in contact with tegmen; arm facets small, semicircular, elevated above surrounding fixed brachials. Tegmen low, with convex sides and nodose plates; anal tube short, slender. Free arms 14 to 20, commonly 16, paired, with 2 biserial arms from each ambulacral

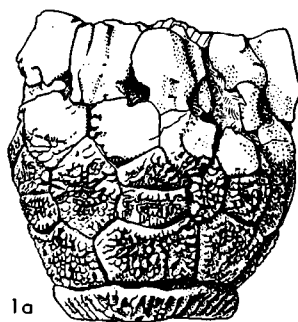
opening into calyx; all or only some arms in an individual may be paired; arms slightly spatulate at distal tips. *L.Miss.(Osag.)-U.Miss.(Meramec.)*, USA (Ind.-Ill.-Mo.-Ky.-Tenn.).—FIG. 275,7. **D. indianaensis* (LYON & CASSEDAY), *L.Miss.(Borden Gr.)*, Ind.; 7a,b, lat. view of crown and post. view of theca, $\times 1$ (Wachsmuth & Springer, 1897).

Eretmocrinus LYON & CASSEDAY, 1859, p. 241 [**E. magnificus*; M]. Calyx low, broad; basals low, forming projecting rim at base of calyx; 1 to 3 interprimibrachs in each interray; 4 to 7 anals above primanal, not in contact with tegmen, which is asymmetric, bulging, and highest anteriorly, flattened posteriorly; *CD* oral large, central; anal tube short and curved in some species. Free arms 12 to 26; *C* and *D* rays only may have more than 4 arms; distal parts of arms greatly widened and without pinnules. *L.Miss.(Kinderhook.-Osag.)*, USA (Iowa-Ill.-Mo.-Ind.-Ky.-N.Mexico-Tenn.).—FIG. 275,8a. **E. magnificus*, Tenn.; lat. view of theca, $\times 1$ (Wachsmuth & Springer, 1897).—FIG. 275,8b. *E. remibrachiatus expansus* WACHSMUTH & SPRINGER, *Osag.(Burlington Ls.)*, Iowa; dorsal view of crown, $\times 1$ (Wachsmuth & Springer, 1897).

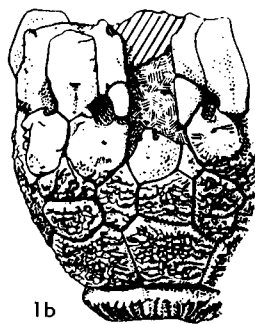
Eutrochocrinus WACHSMUTH & SPRINGER, 1897, p. 408 [**Actinocrinus christyi* SHUMARD, 1855, p. 191; OD]. Calyx narrow proximally, abruptly expanded above level of radials; interprimibrachs 2 to 15 in each interray, may or may not be in contact with tegmen; 9 to 13 anals above primanal, in contact with tegmen; interbrachials commonly present between secundibrachs, and rarely between tertibrachs. Tegmen almost flat peripherally, rising centrally to form stout, central, long anal tube. Free arms short, incurved, 18 to 40, single or paired from each ambulacral opening into calyx. *L.Miss.(Osag.)*, USA (Iowa-Ill.-Mo.).—FIG. 276,1. **E. christyi* (SHUMARD), Burlington Ls., Iowa; 1a,b, lat. view of crown and post. view of theca, $\times 0.7$ (Wachsmuth & Springer, 1897).

Globocrinus WELLER, 1920, p. 330 [**Batocrinus unionensis* WORTHEN, 1890, p. 84; OD]. Like *Dizygocrinus* except that primibrachs 1 are ankylosed with primaxils or eliminated from calyx, and commonly 2 rather than 3 anals present next above primanal. Free arms unknown. *U.Miss.(Meramec.-Chester.)*, USA (Ill.).—FIG. 275,5. **G. unionensis* (WORTHEN), Chester.; 5a,b, lat. and dorsal views of theca, $\times 1$ (Weller, 1920).

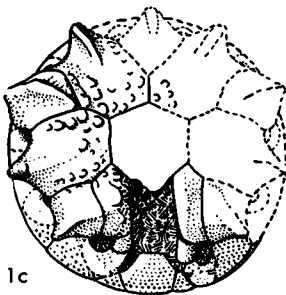
Macrocrinus WACHSMUTH & SPRINGER, 1897, p. 446 [**Actinocrinus konincki* SHUMARD, 1855, p. 194; OD]. Calyx small; calyx high, with straight or slightly concave sides, base broad, flat; basals high, radials and first interprimibrachs nodose; 1 to 4 interprimibrachs in each interray arched by fixed brachials; 3 to 5 anals above primanal, in contact with tegmen; interray areas of cup depressed and ray areas elevated, giving lobed aspect



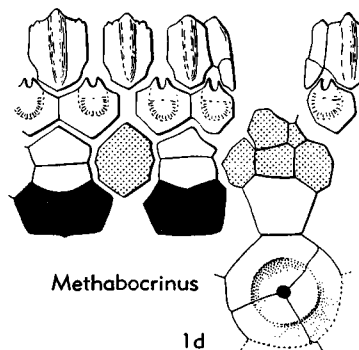
1a



1b



1c



Methabocrinus

1d

FIG. 274. Carpoocrinidae (p. T465-T466).

to calyx. Tegmen high, conical; anal tube central, long, and slender. Free arms stout, short, 12 to 20, commonly with fewer than 4 arms in *A*, *B*, and *E* rays. *L.Miss.(Osag.)*, USA (Iowa-Ill.-Ind.-

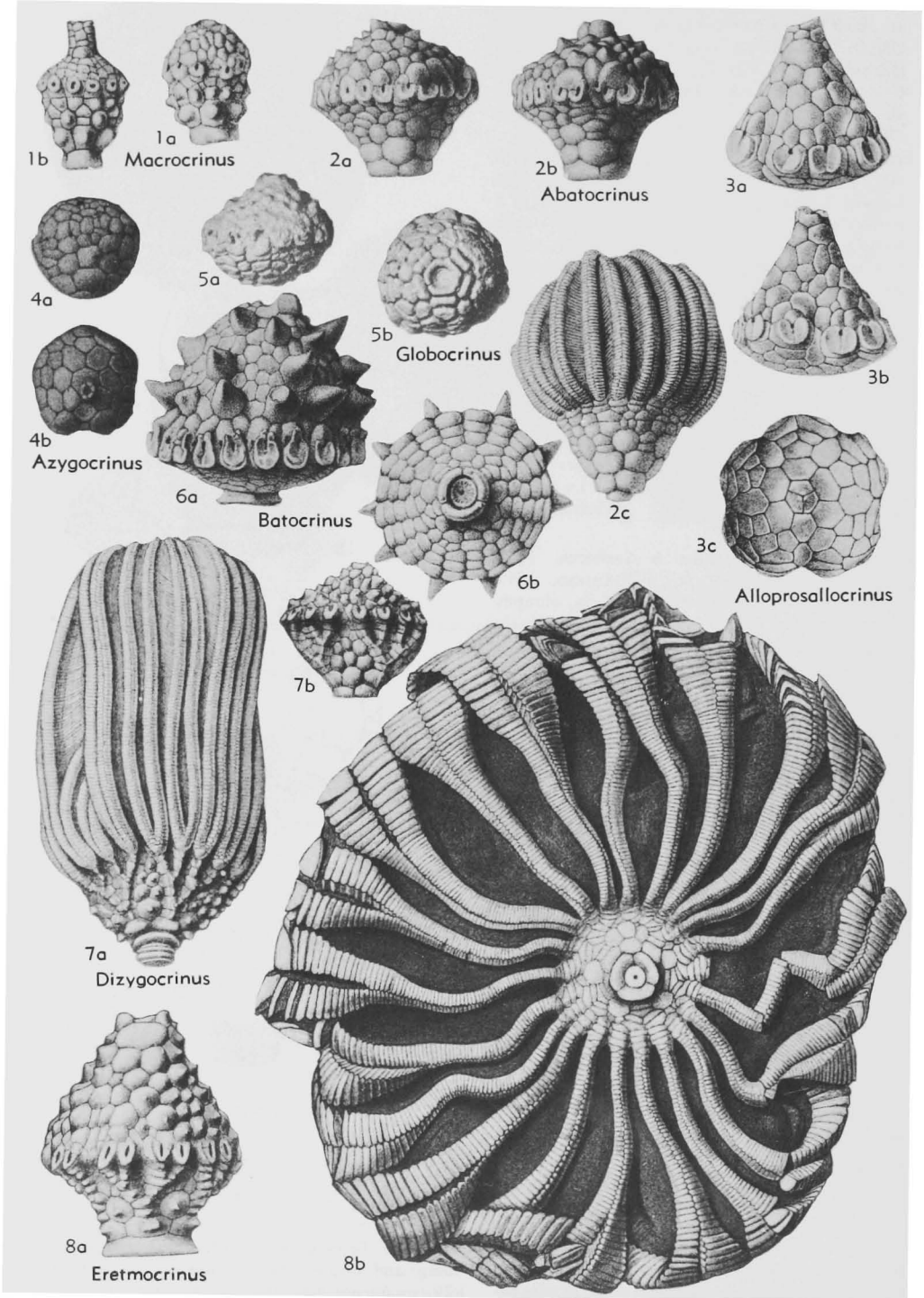


FIG. 275. Batocrinidae (p. T467-T469, T471).

Mo.).—FIG. 275, 1. **M. konincki* (SHUMARD), Burlington Ls., Iowa; 1a, b, post. and ant. views of theca, $\times 1$ (Wachsmuth & Springer, 1897). —FIG. 276, 2. *M. jucundus* (MILLER), Borden Gr., Ind.; 2a, b, ant. view of theca with anal tube, and crown, $\times 0.7$ (Wachsmuth & Springer, 1897).

Uperocrinus MEEK & WORTHEN, 1865, p. 153 [**Actinocrinus pyriformis* SHUMARD, 1855, p. 192; OD] [= *Lobocrinus* WACHSMUTH & SPRINGER, 1897, p. 434 (type, *Actinocrinus Nashvillae* TROOST, 1850a); *Hyperocrinus* BATHER, 1897 (Zool. Rec. 34), p. 117 (nom. van.)]. Radial and basal circlets prominent; rays grouped, interrays depressed and in contact with tegmen; interprimibrachs and anals numerous, in several ranges; anal tube stout, large, commonly long and central; arm openings into calyx large, distally directed, without fixed pinnular openings. Free arms 10 to 22. *L.Miss.(Osag.)*, USA (Iowa-Ill.-Mo.-Ind.-Ky.-Tenn.).—FIG. 276, 3. **U. pyriformis* (SHUMARD), Burlington Ls., Iowa; 3a, b, lat. view of crown and post. view of theca, $\times 0.7$ (Wachsmuth & Springer, 1897).

Family COELOCRINIDAE Bather, 1899

[Coelocrinidae BATHER, 1899b, p. 922] [Materials for this family prepared by N. GARY LANE]

Calyx commonly lobed at arm-base region; interprimibrachs few, commonly three in each interray, in contact with tegmen; CD interray wide, with median row of large anals. Anal opening flush with tegmen or raised on low protuberance, but without anal tube; fixed pinnular openings absent. Free arms single or paired, biserial, two to eight in each ray. Column transversely round, with small, pentagonal axial canal. *M.Dev.-L.Miss.(Osag.)*.

Coelocrinus MEEK & WORTHEN, 1865, p. 273 [**Actinocrinus (Amphorocrinus) concavus* MEEK & WORTHEN, 1861, p. 132; OD] [= *Sphaerocrinus* MEEK & WORTHEN, 1865b, p. 154 (non ROEMER, 1858) (obj.)]. Crown small, base of calyx flat to concave, basals not visible in side view; radials large. Tegmen flat. Arms 12. *L.Miss.(Osag.)*, USA (Ill.-Iowa).—FIG. 277, 2. **C. concavus* (MEEK & WORTHEN), Burlington Ls., Ill.; 2a-c, dorsal, ventral, and lat. views of theca, $\times 1$ (Wachsmuth & Springer, 1897).

Agaricocrinus HALL, 1858, p. 560 [**A. tuberosus* HALL, 1858b, p. 561; SD MILLER & GURLEY, 1897, p. 11] [= *Agaricronites* TROOST, 1850a (nom. nud.); *Agaricocrinites* TROOST, 1850a (nom. nud.); *Agaricocrinus* AUSTIN, 1851, p. 282 (nom. nud.)]. Theca small to large, calyx conical or hemispherical; base flat or concave, basals and commonly radials not visible in side view; interprimibrachs and anals elongate. Orals and radial dome plates nodose, CD oral commonly large.

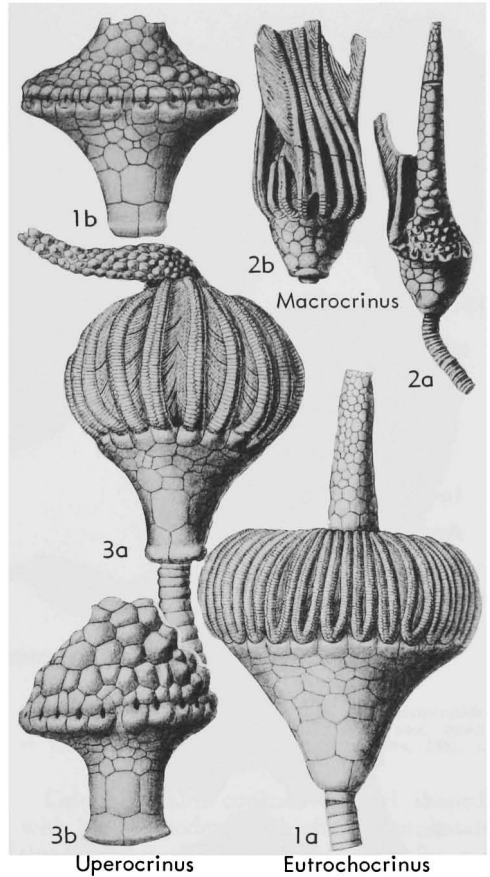


FIG. 276. Batocrinidae (p. T469, T471).

Free arms long, ponderous, commonly 10, or with 2 to 4 arms in C and D rays. *L.Miss.(Kinderhook-Osag.)*, USA (Tenn.-Ky.-Ark.-Iowa-Mo.-Ill.-Ind.).—FIG. 277, 4. **A. tuberosus*, Keokuk Ls., Iowa; 4a-c, CD-interray, dorsal, and ventral views of theca, $\times 1$ (Hall, 1858b).

Aorocrinus WACHSMUTH & SPRINGER, 1897, p. 470 [**Dorycrinus immaturus* WACHSMUTH & SPRINGER in MILLER, 1889, p. 240; OD]. Calyx small, conical to biturbinate; basals small, visible in side view; CD interray protuberant along median line, CD oral generally nodose. Free arms single, strong, grouped, 2 to 4 in each ray; brachials commonly spinose. *M.Dev.-L.Miss.(Osag.)*, USA (N.Y.-Mich.-Tenn.-Iowa-Ind.-Mo.-Ohio-Pa.), ?Eu.—FIG. 277, 1. **A. immaturus* (WACHSMUTH & SPRINGER); Hampton F., Iowa; 1a, b, lat. view of partial crown and stem, and CD-interray view of crown, $\times 1$ (Wachsmuth & Springer, 1897).

Dorycrinus C. F. ROEMER, 1854, p. 207 [**D. mississippiensis*; M]. Basals large, calyx distinctly lobed at arm-base regions. Anal opening excentric, opening laterally; CD oral, or CD oral and 5

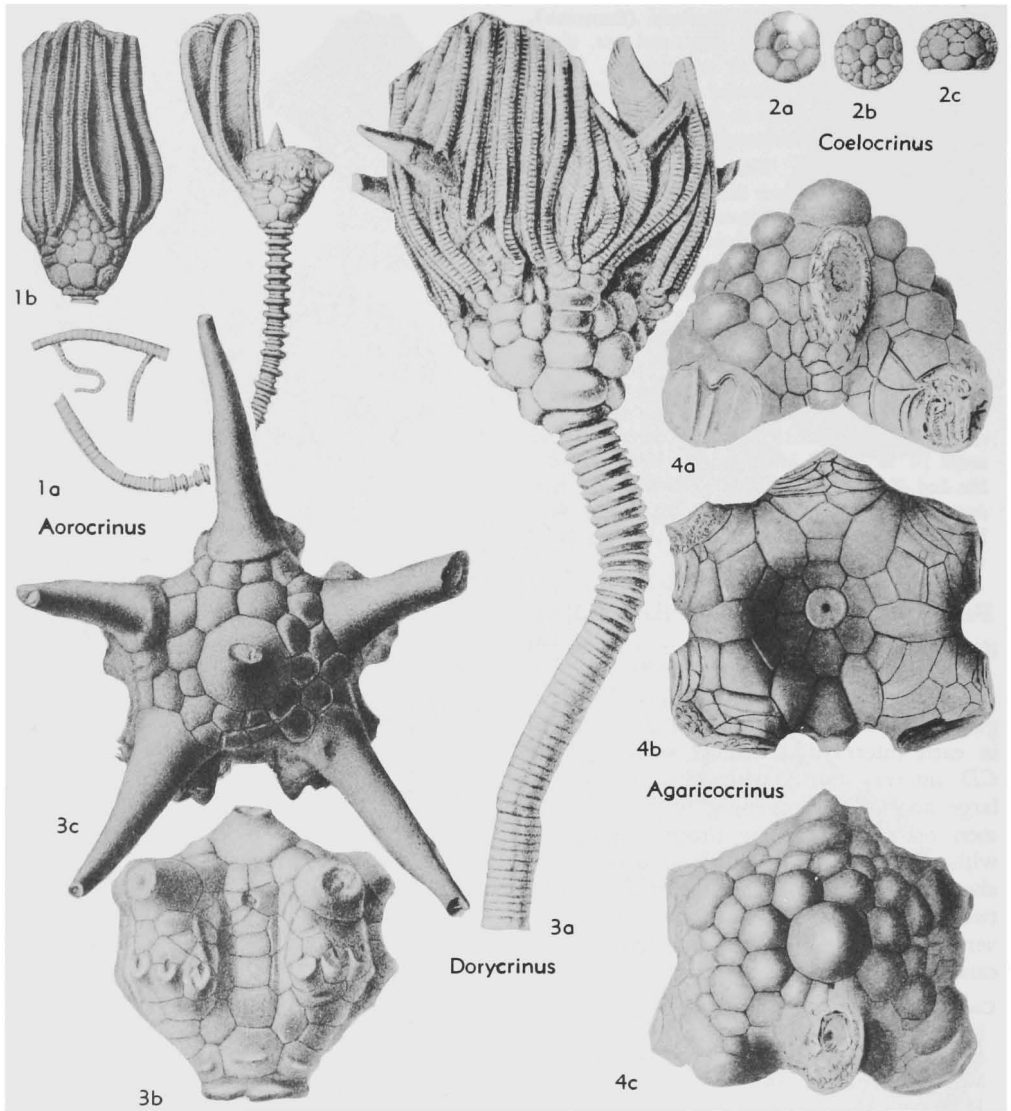


FIG. 277. Coelocrinidae (p. T471-T472).

radial dome plates bearing short to long, smooth or barbed spines. Free arms 16 to 20 pairs, commonly fewer paired arms in *A*, *B*, and *E* rays than in *C* and *D* rays; small spines on every 2nd to 4th free brachial. *L. Miss. (Kinderhook-Osag.)*, USA (Iowa-Mo.-N. Mexico-Ind.-Ky.-Tenn.-Ill.).—FIG. 277, 3. **D. mississippiensis*, Keokuk Ls., Iowa; 3a-c, *D*-ray view of crown and stem, *CD*-interray and ventral views of theca, $\times 1$ (Wachsmuth & Springer, 1897).

Family UNCERTAIN

Sunwaptacrinus LAUDON, PARKS, & SPRENG, 1952,

p. 569 [*S. brazeauensis*; OD]. Calyx rapidly expanding, flaring abruptly distally, with arm bases forming lobes; basals 3, equal; 1st primibrachs quadrangular; fixed secundibrachs 1 in each half-ray, axillary; fixed tertibrachs at least 2 in each arm; 1st interprimibrachs large, followed by few small plates in contact with tegmen; primanal followed by 3 plates, widely connected to tegmen, which is high, with long stout anal tube. Arms biserial immediately beyond calyx, branching isotomously more than once; 1st bifurcation high above theca. *L. Miss.*, N. Am. (Can.). [This genus was placed by LAUDON, PARKS, & SPRENG (1952) among Batocrinidae, but

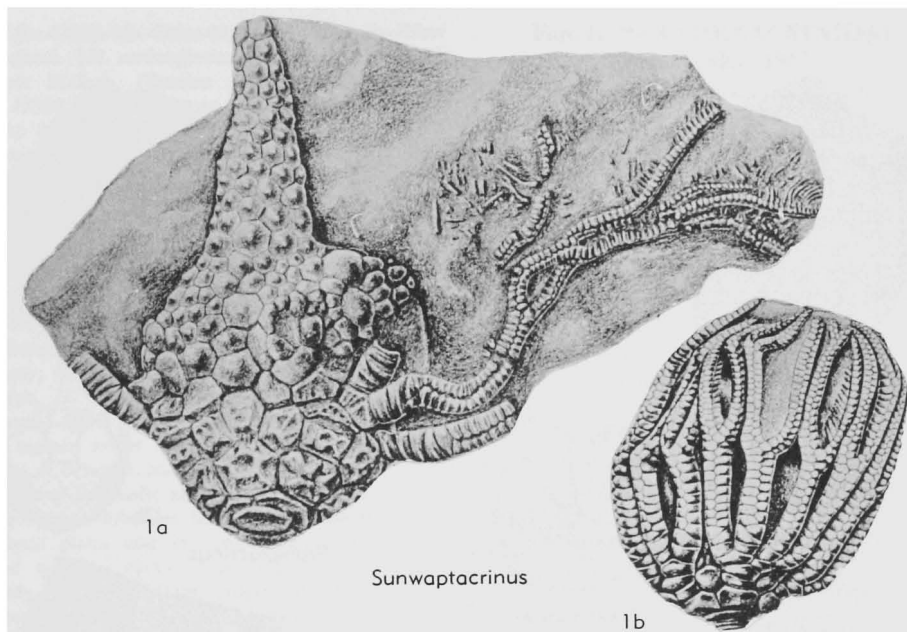


FIG. 278. Family Uncertain (p. T472-T473).

considered as exhibiting a stage of evolution between Devonian desmidocrinids and typical Mississippian batocrinids. It was excluded by LANE (1963) from Batocrinidae, because of its possession of free arm branching isotomously at least twice. It is here considered as a rather isolated form, with possible, yet undetermined, desmidocrinid affinities.]—FIG. 278, 1. **S. brazeauensis*, Banff F., Alberta; 1a, post. view of holotype, $\times 1.5$; 1b, lat. view of paratype, $\times 1.5$ (Laudon, Parks, & Spreng, 1952).

Superfamily HEXACRINITACEA Wachsmuth & Springer, 1885

[*nom. correct.* STRIMPLE, 1975, p. 27 (*pro* Hexacrinitacea UBAGHS, 1953, p. 740, *nom. transl. ex* family Hexacrinitidae WACHSMUTH & SPRINGER, 1885, p. 93 [315])]]

Calyx essentially confined to basals, radials, and primanals; basals equal, three, two, or fused together; radials large; interprimibrachs typically reduced in size or lacking; radial articular facets for reception of arms generally occupying only small part of radial summit. Arms slightly incorporated in calyx or not at all; primibrach series tending to be markedly reduced. Anal tube small or absent. Stem circular or elliptical in section. *U.Sil.-U.Perm.*

Family HEXACRINITIDAE Wachsmuth & Springer, 1885

[*nom. correct.* BASSLER, 1938, p. 24 (*pro* Hexacrinitidae WACHSMUTH & SPRINGER, 1885, p. 93 [315]), *nom. transl. ex* section Hexacrinites WACHSMUTH & SPRINGER, 1881, p. 56, 230]

Calyx medium conical to bowl shaped, with low to moderately high tegmen; basals three, subequal; primibrachs typically not incorporated in calyx but commonly joined with interprimibrach tegminal plates; primanal generally of approximately same size as radials. Tegmen stout, composed of small to medium-sized plates, orals and ambulacrals commonly distinct; anus opening directly through tegmen or at end of short tube. Arms two in each ray, branching. Column circular in cross section. *U.Sil.-U.Dev., ?Penn.*

Hexacrinites AUSTIN & AUSTIN, 1843, p. 19 [**Platycrinus interscapularis* PHILLIPS, 1841, p. 28; M] [=Hexacrinites AUSTIN & AUSTIN, 1844, p. 48 (type, *H. melo*; M) (=Platycrinus interscapularis PHILLIPS, 1841, p. 28 (obj.); Triplacrinites GOLDFUSS in SCHULTZE, 1866, p. 67 (type, *T. exculptus*, =Hexacrinites pateraeformis SCHULTZE, 1866, p. 67); Triplacrinus ZITTEL, 1879, p. 365 (*nom. van.*)]. Primibrachs 1 or 2 in each ray, so reduced in some species as to be concealed by 1st secundibrachs which rest directly on radials; anus subcentral or marginal on tegmen. Free arms (known only in a few species) 2 in each ray, uniserial, simple or bearing ramuli on one or both sides. *U.Sil.-U.Dev., ?U.Carb.(?Penn.)*,

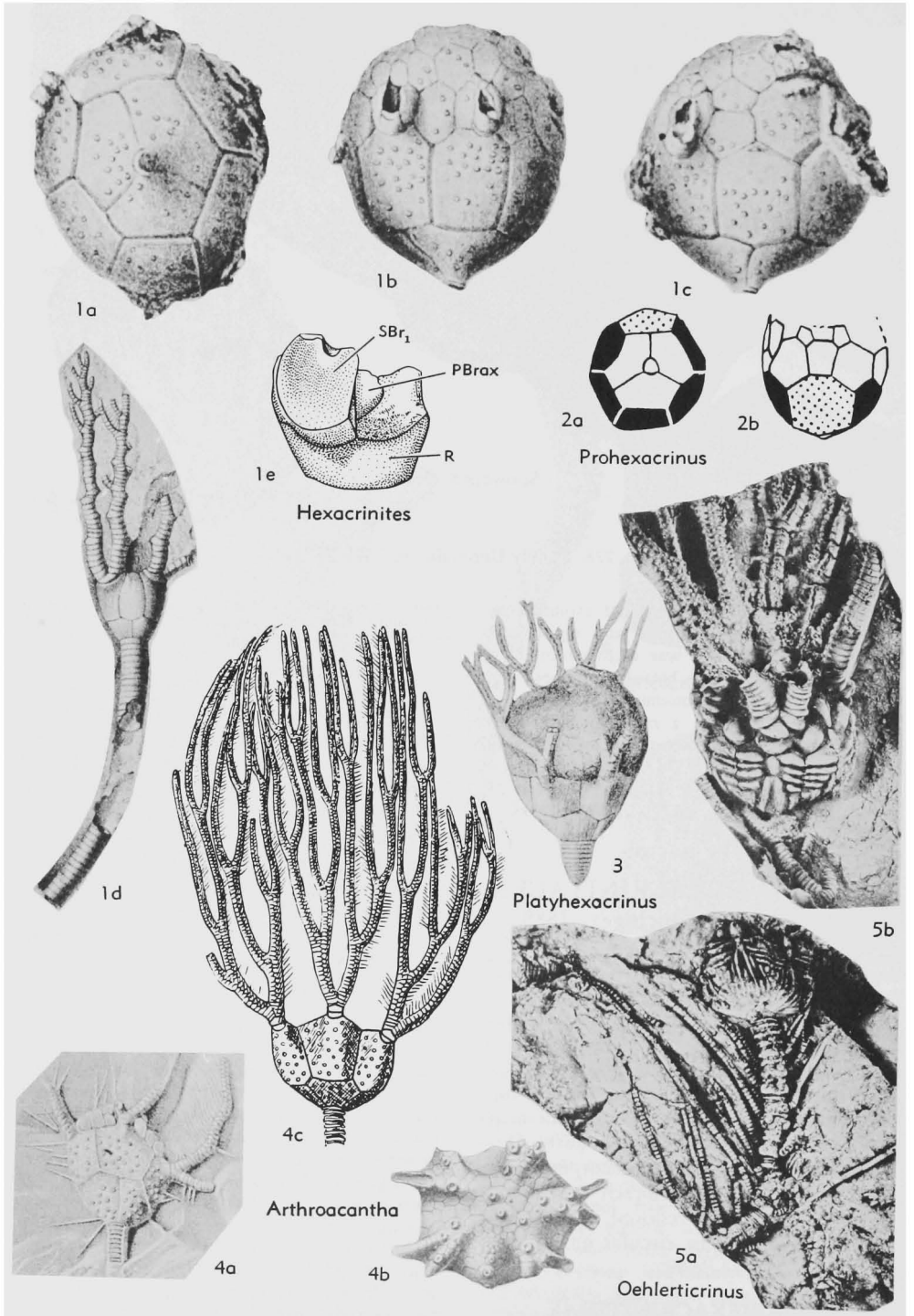


FIG. 279. Hexacrinidae (p. T473, T475).

W.Eu.-USSR-Sib.-China-N.Am.-?E.Australia-?New Zealand. [*H. carboniferous* (YAKOVLEV & IVANOV) from M.Carb. (Russian stratigraphical column) of USSR is very different from typical species and may belong to another lineage.] —FIG. 279, *1a-c*. **H. interscapularis* (PHILLIPS), M.Dev., Eng.; aboral, ant. and post. views of theca, $\times 1$ (Austin & Austin, 1843-49). —FIG. 279, *1d*. *H. limbatus* (MÜLLER), M.Dev., Ger.; $\times 1$ (Schultze, 1867). —FIG. 279, *1e*. *H. verrucosus* (DEWALQUE), U.Dev., Belg.; radial (*R*), and primaxil (*PBrAx*) concealed by first secundibrachs (*SBr₁*), $\times 2$ (Ubahgs, n).

Arthroacantha WILLIAMS, 1883, p. 84 [**A. ithacensis*; OD] [= *Hystericinus* HINDE, 1885, p. 158 (type, *H. carpenteri*, p. 162; M); *Arthroacantha* HINDE, 1886, p. 273 (*nom. van.*)]. Primibrachs 2, tegmen rather low; interradial tegminal plates 1 to 3 or even more, well developed, joined to proximal brachials; anus excentric on slight swelling; pitted tubercles bearing movable spines on calycal plates and in some species on brachials and tegminal plates. Free arms biserial, isotomously branching. Stem transversely round, nodals typically cirriferous. *L.Dev.-U.Dev.*, W.Eu.-N.Am. (USA). —FIG. 279, *4a*. **A. ithacensis*, U.Dev. (Portage F.), USA (N.Y.); lat. view of theca, $\times 1$ (Wachsmuth & Springer, 1897). —FIG. 279, *4b*. *A. depressa* (WACHSMUTH & SPRINGER), U. Dev. (L.Chemung.), USA (N.Y.); tegmen, $\times 1$ (Goldring, 1923). —FIG. 279, *4c*. *A. schwerdii* (FOLLMANN), L.Dev. (Ems.), Ger.; crown, $\times 0.7$ (Schmidt, 1942).

Oehlerticrinus LE MENN, 1975, p. 243 [**O. seillouensis*; OD]. Primibrachs 2, incorporated in cup; interbrachials rather well developed, one to several per interray; primanal supporting 1 to 4 plates; plates of cup strongly ornamented. Free arms dichotomous or heterotomous, with compound brachials. Column heteromorphic and cirriferous. *L.Dev.-M.Dev.*, Eu.-N.Afr. —FIG. 279, *5a*. **O. seillouensis*, L.Dev., France; calyx with part of column, $\times 1$ (Le Menn, 1975). —FIG. 279, *5b*. *O. lefretensis* LE MENN, M.Dev., France; calyx and part of arms, $\times 1$ (Le Menn, 1975).

Platyhexacrinus W. E. SCHMIDT, 1913, p. 301 [**P. inornatus*; SD W. E. SCHMIDT, 1915, p. 119]. Like *Arthroacantha*, but without movable spines on radials and basals. *L.Dev.-M.Dev.*, Eu.-Sib. —FIG. 279, *3*. **P. inornatus*, M.Dev. (L.Couvin.), Ger.; $\times 1$ (Schmidt, 1913).

?**Prohexacrinus** YAKOVLEV, 1946, p. 154 [**P. arcticus*; OD]. Primibrachs 2 in each ray, well developed, incorporated in calyx; 1st interprimibrachs large, followed by 2 smaller plates in next range. ?*U.Sil.*, USSR. [This genus, based on poorly preserved material, should perhaps be placed among Carpoocrinacea.] —FIG. 279, *2*. **P. arcticus*, limestones on Es-to-vis River (N. Urals; *2a,b*, dorsal and post. views of theca (radials black, primanal stippled), $\times 1$ (Yakovlev, 1946a).

Family PARAHXACRINIDAE Shevchenko, 1967

[Parahexacrinidae SHEVCHENKO, 1967, p. 76]

Theca fungiform to spheroidal; basals three, or fused together into large hexagonal plate, with depressed columnal insertion; radials large, directly supporting either brachial facets or proximal fixed brachials, which are very low and irregular; one intersecundibrach in each ray may be present; primanal generally smaller than radials. Tegmen rather high, dome shaped, consisting of small and large plates with five differentiated orals and ambulacra commonly distinct; anus directly through tegmen more or less excentric. Arms four to eight in each ray, invariably paired, probably slender, tending to form more or less continuous wreath around tegmen. Stem circular to elliptical in cross section; nudinodals entirely or partially concealing very short internodals. *L.Dev.*

Parahexacrinus SHEVCHENKO, 1967, p. 77 [**P. fungiformis*; OD]. Theca fungiform in outline; basals fused, subhorizontal, barely visible in side view; radials directly carrying 4 pairs of brachial facets. Tegmen as high as calyx or slightly higher, composed of 5 orals, each surrounded by 4 ambulacra and 1 large interambulacral. Stem subelliptical in transverse section, with dichotomizing crenulae on columnals. *L.Dev.* (*lower Kshitut beds*), C.Asia (SE.Tien Shan). —FIG. 280, *1*. **P. fungiformis*; *1a,b*, A-ray and CD-interray views of holotype theca, $\times 1.5$; *1c*, plate diagram of calyx (radials black, primanal stippled), $\times 1.5$; *1d,e*, side view of columnals, and columnar articular facet, $\times 2$ (all Shevchenko, 1967).

Agathocrinus SHEVCHENKO, 1967, p. 84 [**A. globosus*; OD]. Theca subspheroidal; basals distinct, visible in side view; each radial carrying directly 2 groups of short irregular proximal brachials, separated by intersecundibrachs; 2 paired brachial facets in each ray. Tegmen somewhat higher than 0.3 total height of theca, many-plated; anus lateral. Column circular in cross section, with nondichotomizing crenulae. *L.Dev.* (*upper Kshitut beds*), C.Asia (SE.Tien Shan). —FIG. 280, *2*. **A. globosus*; *2a,b*, D-ray and CD-interray views of theca, $\times 3$; *2c*, plate diagram of calyx (radials black, primanal stippled), $\times 3$; *2d,e*, side view and articulum of columnals, $\times 3$ (all Shevchenko, 1967).

Amonohexacrinus SHEVCHENKO, 1967, p. 82 [**A. adelius*; OD]. Calyx low conical or low bowl shaped, with rounded tegmen; basals fused, visible in side view; radials directly supporting low and

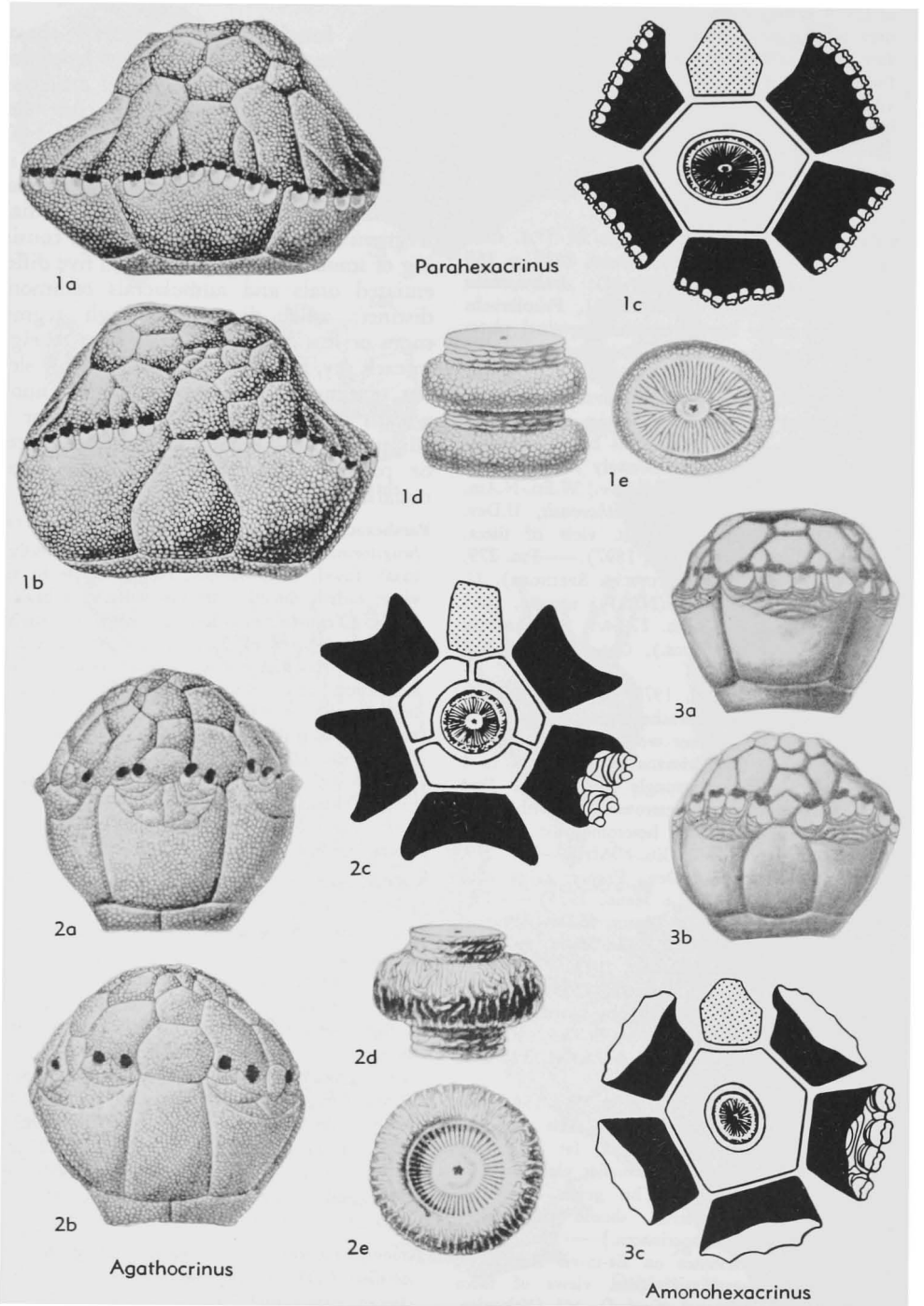


FIG. 280. Parahexacrinidae (p. T475, T477).

irregular brachials; 4 arm facets in each ray, median ones joined into pair. Tegmen (apical part not preserved) comprising peripheral circlet of 20 ambulacrals and 5 interambulacrals. Stem elliptical in cross section, columnals with flabelliform crenulae. *L.Dev.(up. low. Kshtut beds)*, C.Asia (SE.Tien Shan).—FIG. 280,3. **A. adelius*; 3a,b, E-ray and CD-interray views of holotype theca, $\times 2$; 3c, plate diagram of calyx (radials black, primanal stippled), $\times 2.2$ (all Shevchenko, 1967).

Family DICHOCRINIDAE

S. A. Miller, 1889

[Dichocrinidae S. A. MILLER, 1889, p. 214] [=Dichocrininae, Talarocrininae UBAGHS, 1953, p. 741] [Materials for this family prepared by N. GARY LANE]

Calyx small; basals two, equal, with A-CD interbasal suture; radials five, separated on posterior side by primanal. Tegmen variable in height and prominence, with hypertrophied wing plates, or secondarily simplified to five orals, in advanced genera. Free arms primitively uniserial and two to each ray, becoming biserial and four to six in each ray in advanced forms. Stem round transversely and straight, or coiled and bilateral. *L.Miss.-U.Perm.*

Dichocrinus MÜNSTER, 1839, p. 31 [**D. radiatus*; M] [=Dichocrinites GEINITZ, 1846, p. 560 (obj.) (nom. van.); Cotyledonocrinus CASSEDAY & LYON, 1862, p. 56 (type, *C. pentalobus* CASSEDAY & LYON); Edwardocrinus D'ORBIGNY, 1850, p. 157 (type, *Platycrinus ornatus* M'COY, 1844, p. 176); Edwardocrinus D'ORBIGNY, 1852 (nom. correct.)]. Calyx small, bullet shaped, composed of 2 equal basals and primanal in line with radials. Tegmen formed of numerous small interambulacrals and ambulacrals, with 5 central orals, CD oral enlarged; anal opening in CD interrayer of tegmen on small protuberance or at end of short, conical anal tube. Free arms isotomous, uniserial or biserial, erect or pendent, branching on primibrachs 2; secundibrachs 2 or 3 axillary in some species or additional branching may occur high above calyx. Column round, straight. *L.Carb., Eu.* (Eng.-Eire-Belg.-USSR), *L.Miss., N.Am.(USA)*.—FIG. 281,1a,b. *D. crassitestus* WHITE, USA (Iowa); 1a,b, ant. view of crown and post. view of theca with anal tube, $\times 1$ (Wachsmuth & Springer, 1897).—FIG. 281,1c,d. **D. radiatus*, Eng.; ant. and post. views of calyx, $\times 1$ (Wright, 1956a).

Camptocrinus WACHSMUTH & SPRINGER, 1897, p. 779 [**C. myelodactylus*; OD]. Crown like *Dichocrinus*; stem coiled, bilateral, with short columnals round proximally, becoming crescentic or lozenge-shaped distally, with concave side of stem crown at center of coil, bent back on stem typically

covered by long round cirri on paired or single nodals, typically confined to 2 rows at or near margins of flattened columnal sides. *L.Miss.-Perm., USA-Eu.* (Scot.-USSR)-Indon. (Timor).—FIG. 281,2. **C. myelodactylus*, L.Miss.(Borden Gr.), USA(Ind.); 2a,b, lat. view of crown with attached stem and lat. view of stem, $\times 1$; 2c, lat. view of columnals and cirri, $\times 3$ (Springer, 1926b).

Neodichocrinus WANNER, 1937, p. 84 [**N. nanus*; OD]. Calyx like *Dichocrinus*. Tegmen composed of 5 orals, among which CD oral is enlarged; anal opening between primanal and CD oral. *U.Perm., Indon.(Timor)*.—FIG. 281,3. **N. nanus*; 3a,b, post. and ventral views of theca, $\times 5.5$; 3c, dorsal view of theca, $\times 4.8$ (Wanner, 1937).

Paradichocrinus SPRINGER, 1926, p. 51 [**Dichocrinus polydactylus* CASSEDAY & LYON, 1862, p. 18; OD]. Calyx similar to *Dichocrinus* but typically larger. Tegmen high, conical, composed of numerous large interambulacrals, ambulacrals, and 5 orals; anal opening near summit of tegmen. Free arms biserial, branching exotomously several times above axillary primibrachs 2. *L.Miss.(Osag.)*, USA(Ind.).—FIG. 281,6a. **P. polydactylus* (CASSEDAY & LYON); post. view of theca, $\times 1$ (Springer, 1926b).—FIG. 281,6b. *P. planus* SPRINGER; lat. view of crown, $\times 1$ (Springer, 1926b).

Pterocrinus LYON & CASSEDAY, 1859, p. 301 [**Asterocrinus capitalis* LYON, 1857, p. 472; OD] [=Codonocrinites TROOST, 1850a (nom. nud.); Codonocrinus SHUMARD, 1868 (nom. van.); Asteroocrinus LYON, 1857, p. 472 (non MÜNSTER, 1839)]. Calyx low, bowl shaped, basally concave in some species; basals large and convex or small and flattened; radials low, strongly convex or flat, deeply excavated and scalloped distally; primanal narrow, high or triangular and confined between C and D radials. Tegmen high, pyramidal or distally flattened; 5 axillary tegminal ambulacrals hypertrophied, variable in shape, produced into massive, thin bladeliike, or forked wing plates; anal opening at summit of tegmen. Free arms short, 4 or 6 in each ray, biserial, confined to area between hypertrophied wing plates, with primibrachs 1 very small, axillary, and commonly not visible, or lacking; secundibrachs 1 axillary, partly or completely supported by radial; abmedial terti-brach 1 in contact with lateral edge of radial, or 2nd lateral axillary secundibrach present in youngest species; single intersecundibrach may be present between adjacent radials. *U.Miss., USA* (Ky.-Ill.-Ind.).—FIG. 281,7a. **P. capitalis* (LYON), Ky.; D-ray view of crown, $\times 1$ (Springer, 1926b).—FIG. 281,7b. *P. coronarius* (LYON), Ky.; ventral view of crown, $\times 1$ (Springer, 1926b).—FIG. 281,7c. *P. bifurcatus* WETHERBY, Ky.; dorsal view of crown, $\times 1$ (Wachsmuth & Springer, 1897).

Stomiocrinus WANNER, 1937, p. 84 [**S. sub-*

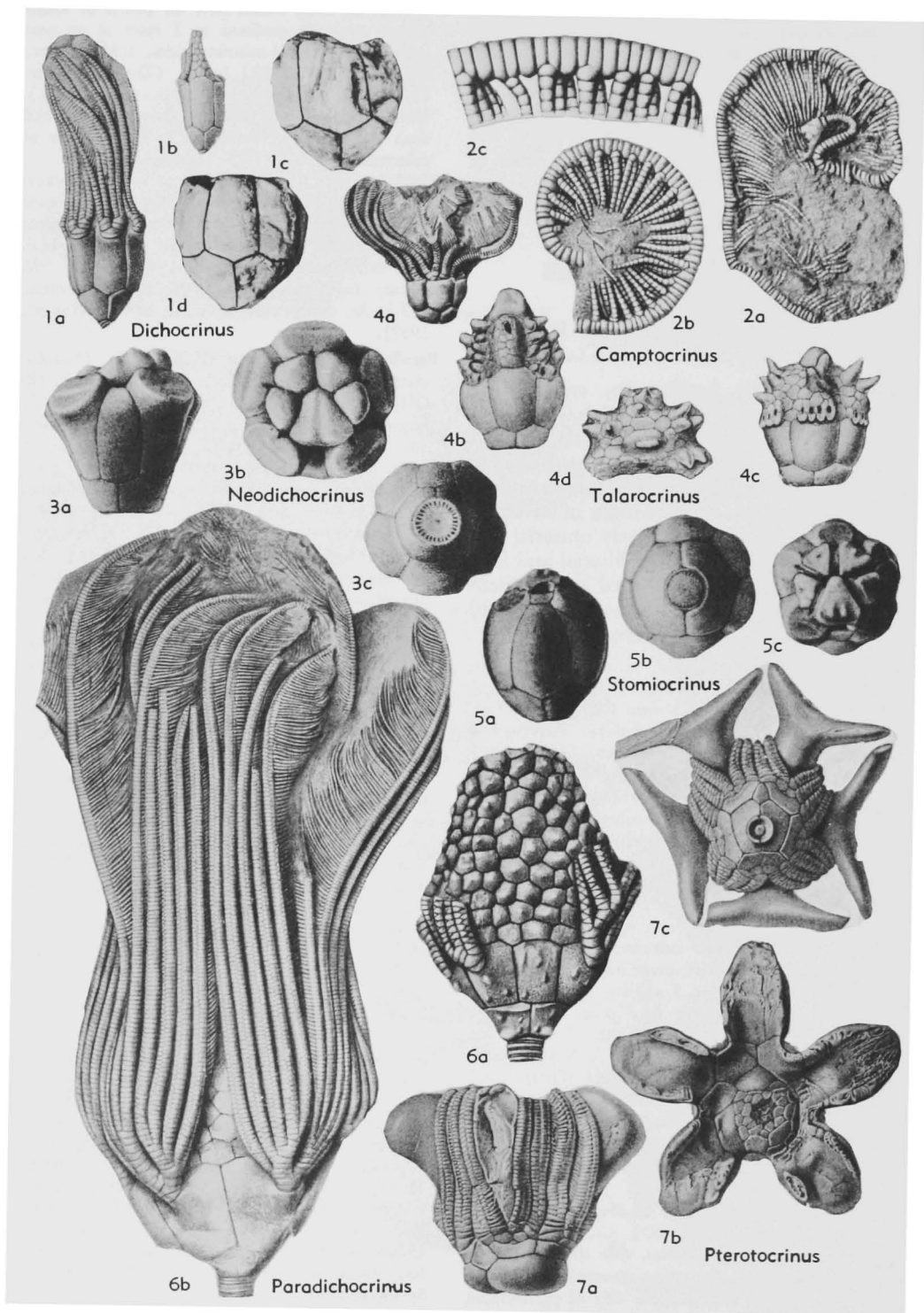


FIG. 281. Dichocrinidae (p. T477, T479).

globosus; OD]. Like *Neodichocrinus* except orals not in contact medially. *U.Perm.*, Indon.(Timor). —FIG. 281,5. **S. subglobosus*; 5a-c, post., dorsal, and ventral views of theca, $\times 2$ (Wanner 1937).

Talarocrinus WACHSMUTH & SPRINGER, 1881, p. 259(85) [**Dichocrinus cornigerus* SHUMARD, 1857, p. 72; OD] [= *Daemenocrinites* TROOST, 1850a (*nom. nud.*); *Daemenocrinus* BATHER, in LANKESTER, 1900a, p. 202 (*nom. nud.*); *Doliolocrinites* TROOST in HALL, 1858 (*nom. nud.*); *Doliolocrinus* WACHSMUTH & SPRINGER, 1881, p. 231 (405), (*nom. nud.*)]. Calyx like *Dichocrinus* except plates more massive. Tegmen as high as cup, with large central CD oral, anal opening high on tegmen, laterally directed. Arms with primibrachs 1 axillary, very small; secundibrachs 1 in contact with lateral edge of radial facet; arms biserial, 4 in each ray. *U.Miss.*, USA (Ill.-Ind.-Ky.-Mo.-Va.-Ala.). —FIG. 281,4a. *T. pateri* MILLER & GURLEY, Ky.; lat. view of crown, $\times 1$ (Springer, 1926b). —FIG. 281,4b-d. **T. cornigerus* (SHUMARD), Ala.; post., ant., and ventral views of theca, $\times 1.5$ (Wachsmuth & Springer, 1897).

Family ACROCRINIDAE Wachsmuth & Springer, 1885

[Acrocrinidae WACHSMUTH & SPRINGER, 1885, p. 315]
[= Acrocrininae UBAGHS, 1953, p. 741] [Materials for this family prepared by R. C. MOORE and H. L. STRIMPLE]

Crown ovoid to pyriform, with height exceeding greatest width; arms (where known) erect or pendent, biserial, pinnulate; calyx subconical, vase-like, tall ovoid, or subglobular, with two equal basals separated by suture between them oriented anteroposteriorly as in *Dichocrinidae*; radials five, laterally adjoining one another except C and D radials, which are separated by primanals; radials and basals not in contact but set apart by few to very many intervening supplementary plates collectively designated as intercalaries; tegmen flat to gently convex, with or without differentiated orals and having few or extremely numerous small plates, anal vent near posterior margin, inconspicuous or located at tip of anal pyramid. Column transversely circular, homeomorphic or heteromorphic, with columnal articular facets peripherally crenulate; axial canal diminutive, circular to distinctly quinquelobate in section. [The outstanding attribute of this family is the presence of intercalaries in calices of all genera. These may be arranged in moderately regular alternating circlets or appear

quite irregular, with proximal plates notably smaller than distal ones. The advent of intercalaries in a late Paleozoic group of camerate crinoids suggests evolutionary reversion to cystoidlike structure of the calyx and divergence of genera in significant morphological features indicates unusual plasticity of the stock.] *L.Miss.-U.Penn.*, up.*L.Carb.-M.Carb.*

Subfamily ACROCRININAE Wachsmuth & Springer, 1885

[*nom. trans.* UBAGHS, 1953, p. 741 (*ex* Acrocrinidae WACHSMUTH & SPRINGER, 1885, p. 315)]

Calyx with very wide, low radials or width of these plates only moderately exceeding height, mainly characterized by gently scalloped articular facets that reach to interradial sutures; primanal in cirlet of radials and similar to them in shape, or subpentagonal in outline narrowing upward; basals clearly visible from side; intercalaries numerous, most distal cirlet containing 12, 15, or 18 plates, of which seven or eight (including subanals) are located interradially and others radially. Arms erect or pendent. *U.Miss.(Chester.)* or up.*L.Carb.(Visean)-L.Penn.(Morrow.)*.

Acrocrinus YANDELL, 1855, p. 135 [**A. shumardi*; M]. Calyx urn shaped, with usually low, wide radials and primanal; distal articular facet of radials supporting minute axillary primibrachs 1 and 2 secundibrachs 1, latter followed by axillary secundibrach 2; most distal cirlet of intercalaries including 10 small subradials and 8 in interradial positions, those of CD interray comprising 2 small subanals and 2 distinctly larger intercalaries next to them on either side. Arms erect. Stem homeomorphic, composed of very low columnals. *U.Miss.(Chester.)*, N.Am.(USA); up.*L.Carb.(Visean)*, Eu.(Eng.). —FIG. 282,1;283,3. **A. shumardi*, up.Chester.(Glen Dean Ls.), USA (Grayson Co., Ky.); 282,1, diagram showing radial cirlet and primanal next above cirlet of 18 most distal intercalaries (radials black, distal intercalaries shaded) (Moore & Strimple, 1969); 283,3a, lat. view of holotype crown (rays not identified), $\times 1$ (Wachsmuth & Springer, 1897); 283,3b, lat. view of small crown, $\times 1$ (Springer, 1926b).

Amphoracrocrinus MOORE & STRIMPLE, 1969, p. 9 [**Acrocrinus amphora* WACHSMUTH & SPRINGER, 1897, p. 808; OD]. Similar to *Acrocrinus* but differing in its notably taller and narrower radials and primanal, in having only 12 plates in most distal cirlet of intercalaries (5 subradial, 7 interradial, latter including single subanal), and espe-

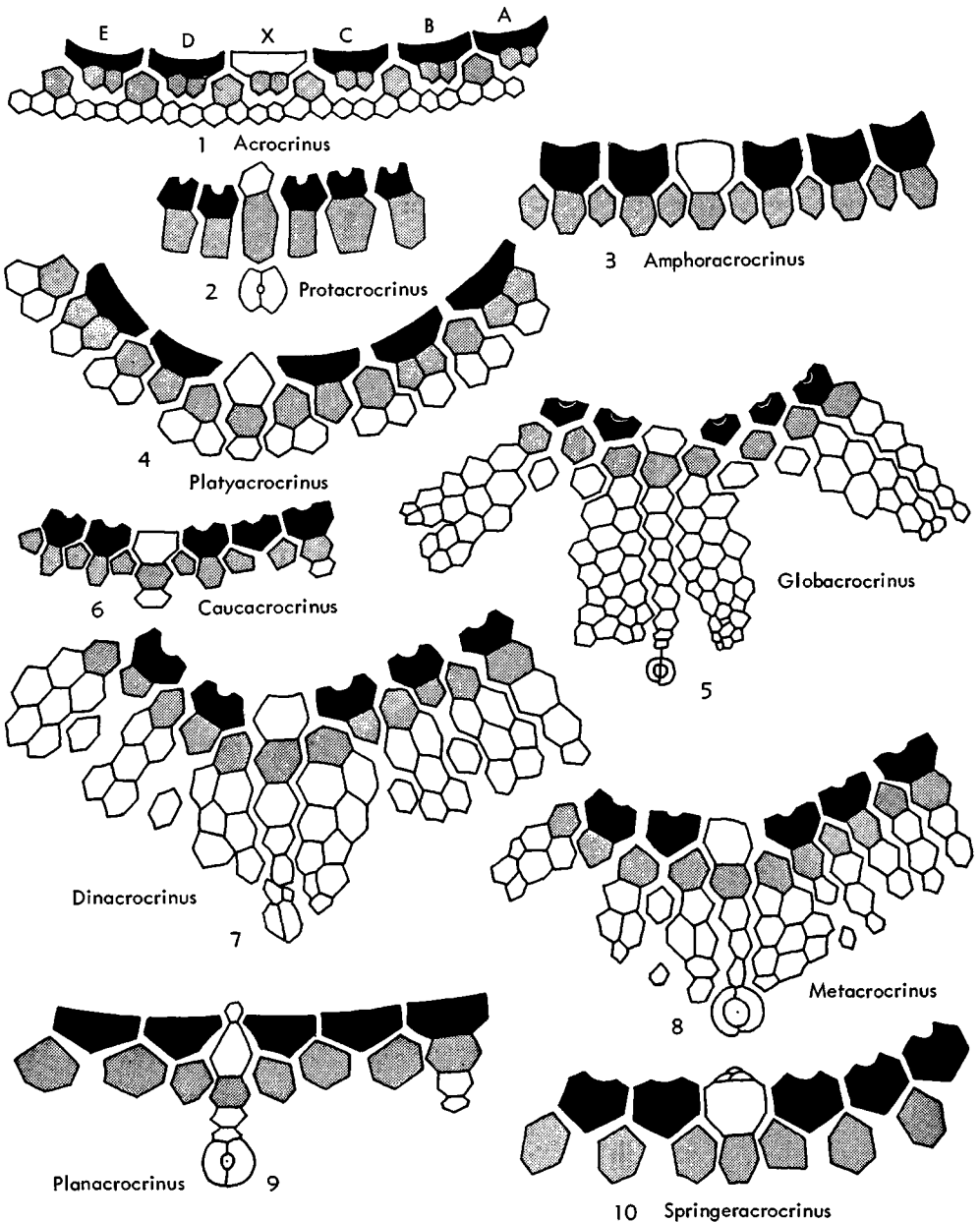


FIG. 282. Diagrams of acrocrinid plate structure: Acrocrinidae (Acrocrininae) (1,3,4), (Planacrocrininae) (9), (Globacrocrininae) (2,5-8,10) (Moore & Strimple, 1939). [Explanation: radials black, distal intercalaries shaded, others and bipartite basal circlet unshaded.]

cially in its robust, long, pendent arms. Tegmen formed by extremely numerous small plates without differentiated orals and lacking anal pyramid. *U. Miss. (up. Chester.)*, USA (Ala.).—FIG. 282,3; 283,2. **A. amphora* (WACHSMUTH & SPRINGER),

Gasper F.; 282,3, diagram showing radial circlet and primanal next above circlet of 12 most distal intercalaries (radials black, distal intercalaries shaded) (Moore & Strimple, 1969); 283,2a, view of tegmen, post. side down, $\times 4$ (Wachsmuth &

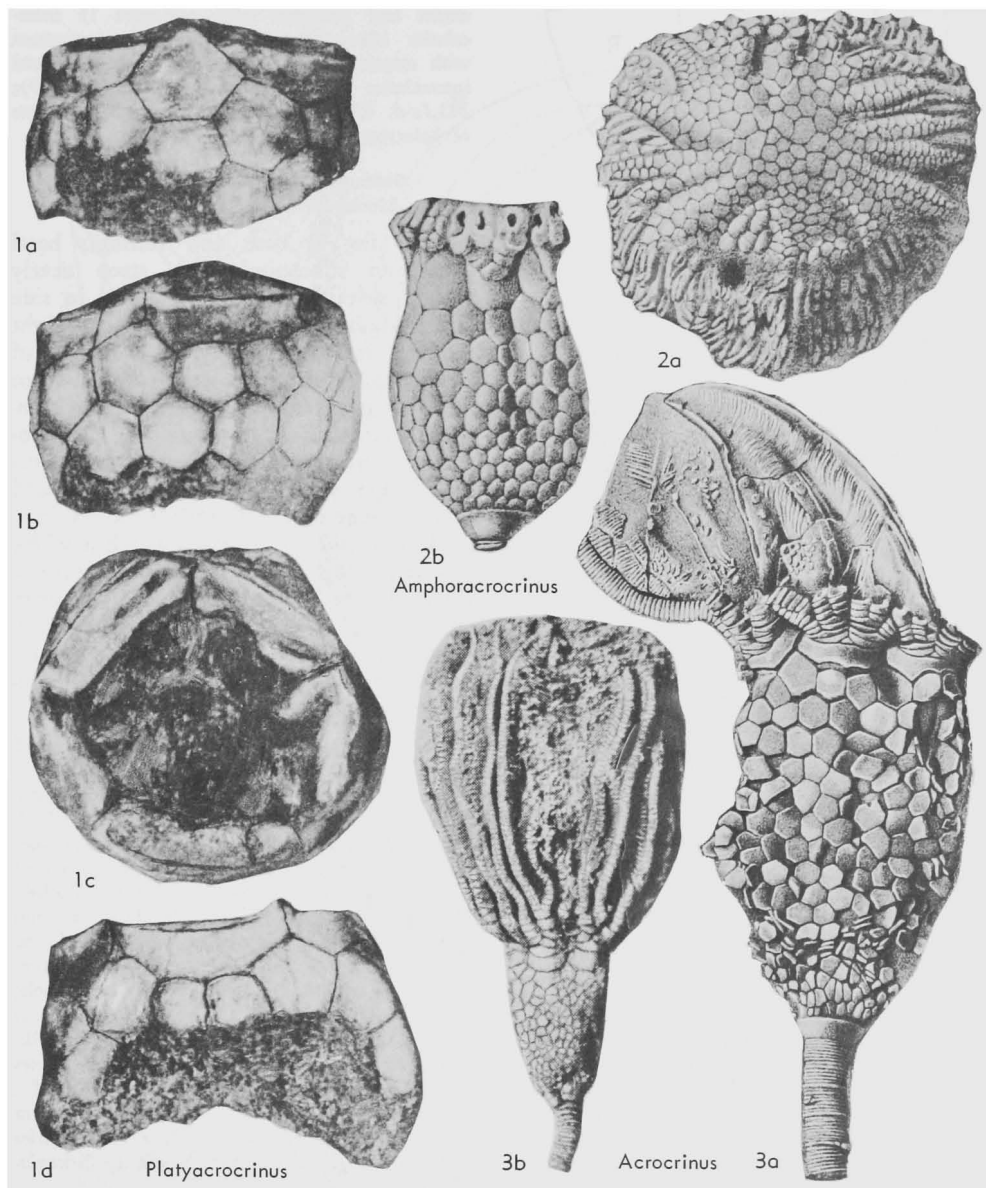


FIG. 283. Acrocrinidae (Acrocrininae) (p. T479-T482).

Springer, 1897); 283,2b, C-ray view of calyx, $\times 2$ (Springer, 1926b).

Platyacrocrinus MOORE & STRIMPLE, 1969, p. 10 [**Acrocrinus brentwoodensis* MOORE & PLUMMER, 1938, p. 222; OD]. Radials most similar to those of *Acrocrinus* in being very low and wide; primal distinctive in its subpentagonal shape, narrower than radials, with distal tip projecting slightly above rim of calyx; intercalaries fewer and relatively larger than in other genera of subfamily,

most distal circlet containing 15 plates, of which 8 are subradial (single ones beneath *C* and *D* radials, pairs of plates beneath other radials) and 7 interradial in position, with 3 plates in *CD* interray (including subanal). Tegmen, lower part of calyx, arms, and stem unknown. *L.Penn. (Morrow.)*, USA (NW.Ark.).—FIG. 282,4; 283, 1. **P. brentwoodensis* (MOORE & PLUMMER), Bloyd F. (Brentwood Ls.), near Woolsey, Washington Co., Ark.; 282,4, diagram showing radial

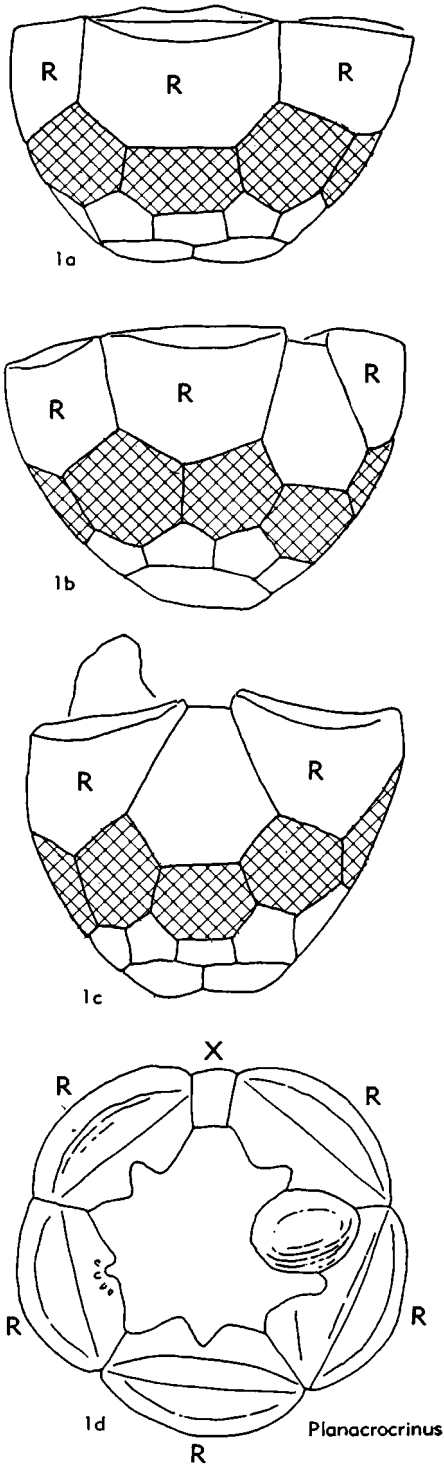


FIG. 284. Acrocrinidae (Planacocrininae) (p. T482).

circlet and primanal with subjacent 15 intercalaries bilaterally symmetrical in arrangement with respect to *A-CD* axis (radials black, distal intercalaries shaded) (Moore & Strimple, 1969); 283, *1a-d*, *CD*-, *A*-ray, ventral, and *B*-ray views of holotype, $\times 3$ (Moore & Plummer, 1938).

Subfamily PLANACROCRININAE
Moore & Strimple, new subfamily

Calyx flat at base and summit, bowl shaped to subconical with steep nearly straight sides; basals clearly visible in side view; radials wider than high, with straight articular facets occupying full width of plates and extending well inward from outer margin, resembling facets of such inadunate crinoids as *Delocrinus* and *Cromyocrinus* in presence of ligament fossae, transverse ridge, muscle-attachment areas, and intermuscular notch; *C* and *D* radials separated by hexagonal primanal which is wider in lower third and narrowest at summit slightly below level of radial facets or even with them; circlet of most distal intercalaries comprising eight plates, only *A* radial having one directly beneath it; tegmen and arms unknown. *L. Penn.* (Morrow.).

Planacrocrinus MOORE & STRIMPLE, 1969, p. 15 [**P. ambix*; OD]. Characters of subfamily. *L. Penn.* (Morrow., Brentwood Ls.-Wapanucka Ls.), USA (NE. Okla.-S. Okla.).—FIG. 282, 9; 284, 1. **P. ambix*, Wapanucka Ls., S. Okla.; 282, 9, diagram of plate arrangement in summit part of calyx (radials black, distal intercalaries shaded) (Moore & Strimple, 1969); 284, *1a-d*, *A*- and *D*-ray, *CD*-interray, and ventral views of holotype (camera lucida drawings, *R*, radials, distal intercalaries cross hatched), $\times 16.5$ (Moore & Strimple, 1969, mod.).—FIG. 285, 1. *P. conicus* MOORE & STRIMPLE, Brentwood Ls., Greenleaf Lake, NE. Okla.; *1a-c*, *A*- and *B*-ray, and *DE*-interray views of holotype (camera lucida drawings), $\times 10$; *1d, e*, ventral and *CD*-interray views of same (camera lucida drawings, *R*, radials; distal intercalaries cross hatched), $\times 21$ (after Moore & Strimple, 1969).

Subfamily GLOBACROCRININAE
Moore & Strimple, 1969

[*Globacrocrininae* MOORE & STRIMPLE, 1969, p. 21]

Distinguished from other subfamilies of Acrocrinidae by narrow, strongly arcuate radial articular facets; basals visible or not visible from side; distalmost ring of intercalaries composed of six to 12 plates, subradial intercalaries ranging from none to five, some genera with longitudinal series

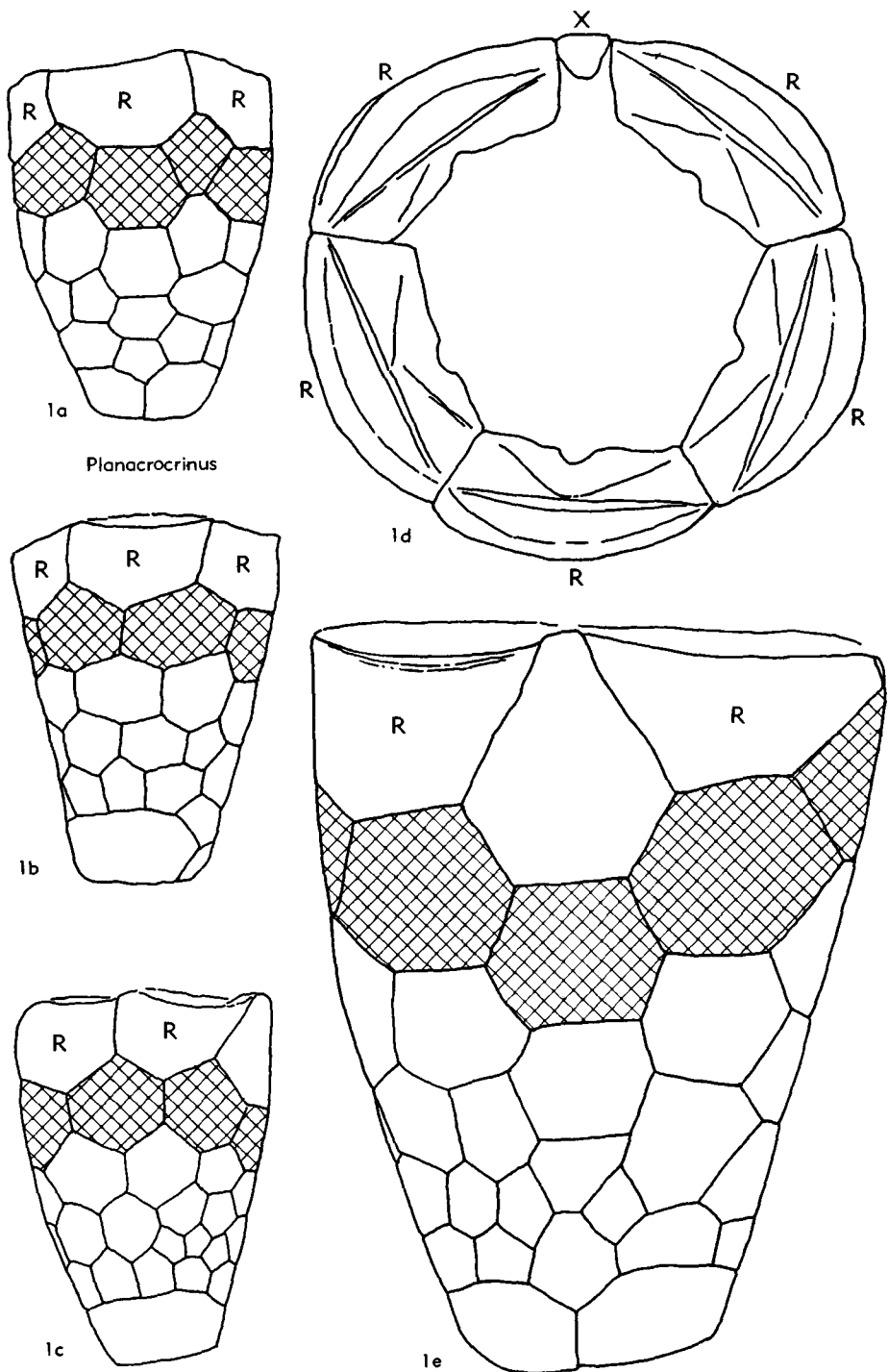


FIG. 285. Acrocrinidae (Planacrocrininae) (p. T482).

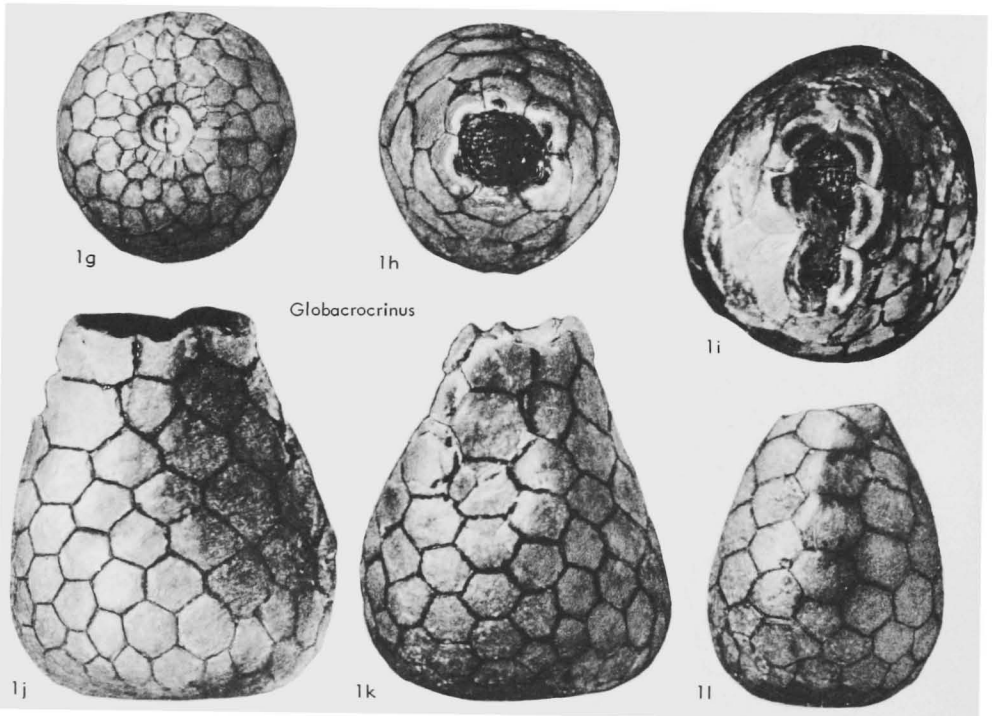
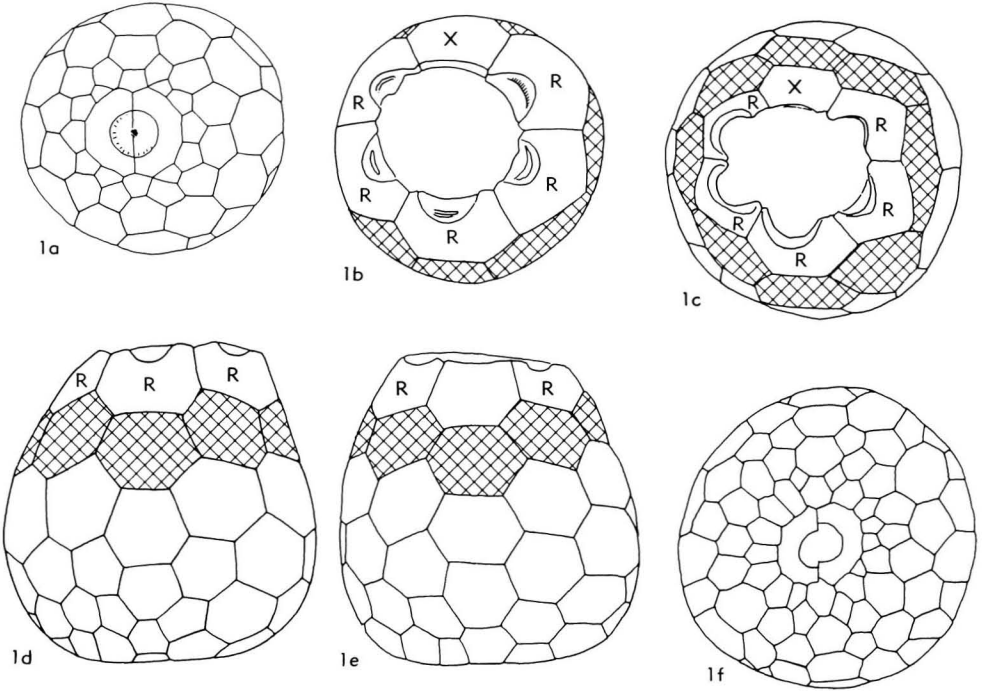


FIG. 286. Acrocrinidae (Globacrocrininae) (p. T485).

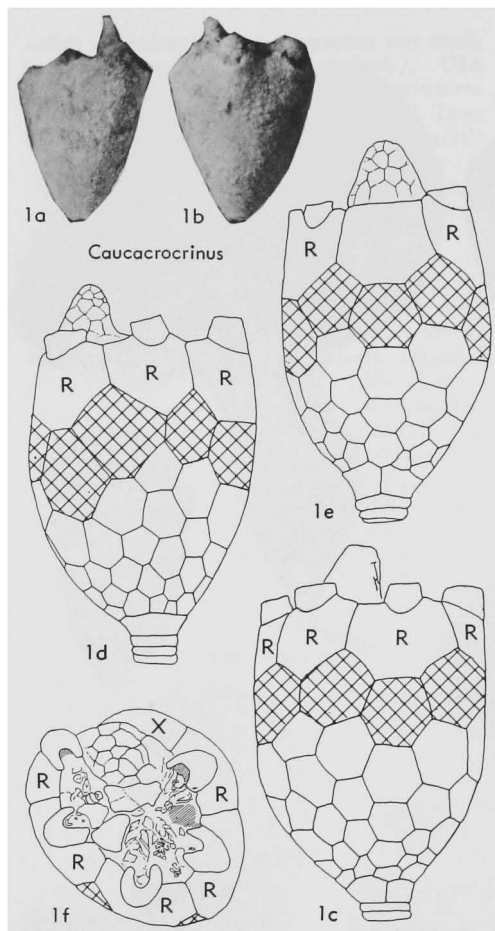


FIG. 287. Acrocrinidae (Globacrocrininae) (p. T485).

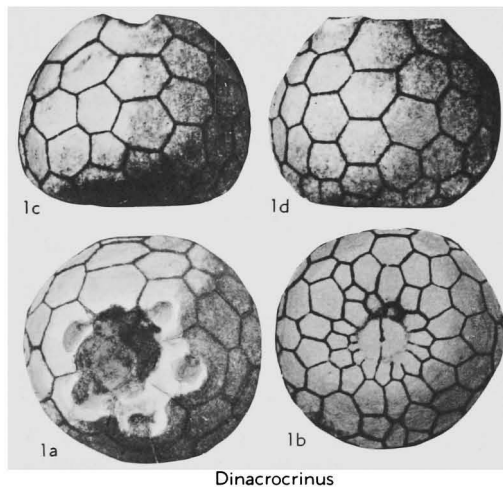
of superposed intercalaries beneath one to three radials in addition to primanal series present in all; tegmen with distinct orals, of which posterior one is largest, and commonly showing low anal pyramid near *CD* border. *L.Miss.-U.Penn.(Missour.)*.

Globacrocrinus MOORE & STRIMPLE, 1969, p. 21 [**Acrocrinus pimum* MOORE & PLUMMER, 1938, p. 218; OD]. Calyx pear shaped to globose, small to very diminutive basals not visible from side; radials with height and width subequal, little larger than distalmost intercalaries, which form circlet of 8 plates with subradial one confined to *A* ray, (including subanal) interradian in position, longitudinal series of intercalaries beneath *A* radial and primanal. Tegmen with orals and anal pyramid. Stem slightly heteromorphic, at least next to calyx. Arms unknown. *L.Penn.(Morrow.)-M.Penn.(Desmoines.)*, USA (Okla.).—FIG. 282,5; 286,1g-l. **G. pimum* (MOORE & PLUMMER),

L.Penn.(Morrow., Brentwood Ls.), USA (Okla.); 282,5, diagram showing plate arrangement of calyx with 8 distalmost intercalaries (radials black, distal intercalaries shaded) (MOORE & STRIMPLE, 1969); 286,1g,h,l, dorsal, ventral and *CD*-interray views of paratype calyx, $\times 2.7$ (MOORE & PLUMMER, 1938); 286,1i-k, ventral, *C*-ray, and *CD*-interray views of holotype, $\times 2.7$ (MOORE & PLUMMER, 1938).—FIG. 286,1a-f. *G. rotundus* MOORE & STRIMPLE, *L.Penn.(Morrow., Wapanucka Ls.)*, USA (Okla.); 1a,b, camera lucida drawings of dorsal and ventral sides of paratype, $\times 10$ (MOORE & STRIMPLE, 1969); 1c-f, camera lucida drawings of holotype, ventral, *A*-ray, *CD*-interray, and dorsal views $\times 5.4$ (*R*, radials; distal intercalaries cross hatched) (MOORE & STRIMPLE, 1969, mod.).

Caucacrocrinus MOORE & STRIMPLE, 1969, p. 28 [**C. urnula*; OD]. Diminutive calyx urn shaped, basals upflaring, visible from side; distalmost intercalaries with 4 (*A, C, D, E* rays) subradial or exceptionally 5 (including *B* ray), otherwise as in *Globacrocrinus*. *U.Penn.(Missour.)*, USA (Ill.).—FIG. 282,6; 287,1. **C. urnula*, LaSalle Ls., Livingston Co., Ill.; 282,6, plate diagram of distal part of calyx (radials black, distal intercalaries shaded) (MOORE & STRIMPLE, 1969); 287,1a,b, side views of holotype calyx looking toward *A* ray and *CD* interrady, $\times 6.5$; 287,1c-f, *AB*-interray, *B*-ray, *CD*-interray, and ventral views of holotype (photos and camera lucida drawings, *R*, radials; distal intercalaries cross hatched), $\times 8.5$ (MOORE & STRIMPLE, 1969, mod.).

Dinacrocrinus MOORE & STRIMPLE, 1969, p. 36 [**Acrocrinus expansus* STRIMPLE, 1951e, p. 192; OD]. Calyx rotund, truncate at summit of radials, basals not visible from side; differing from *Globacrocrinus* in occurrence of 12 intercalaries next beneath radial circler, 5 subradial,



Dinacrocrinus

FIG. 288. Acrocrinidae (Globacrocrininae) (p. T485-T486).

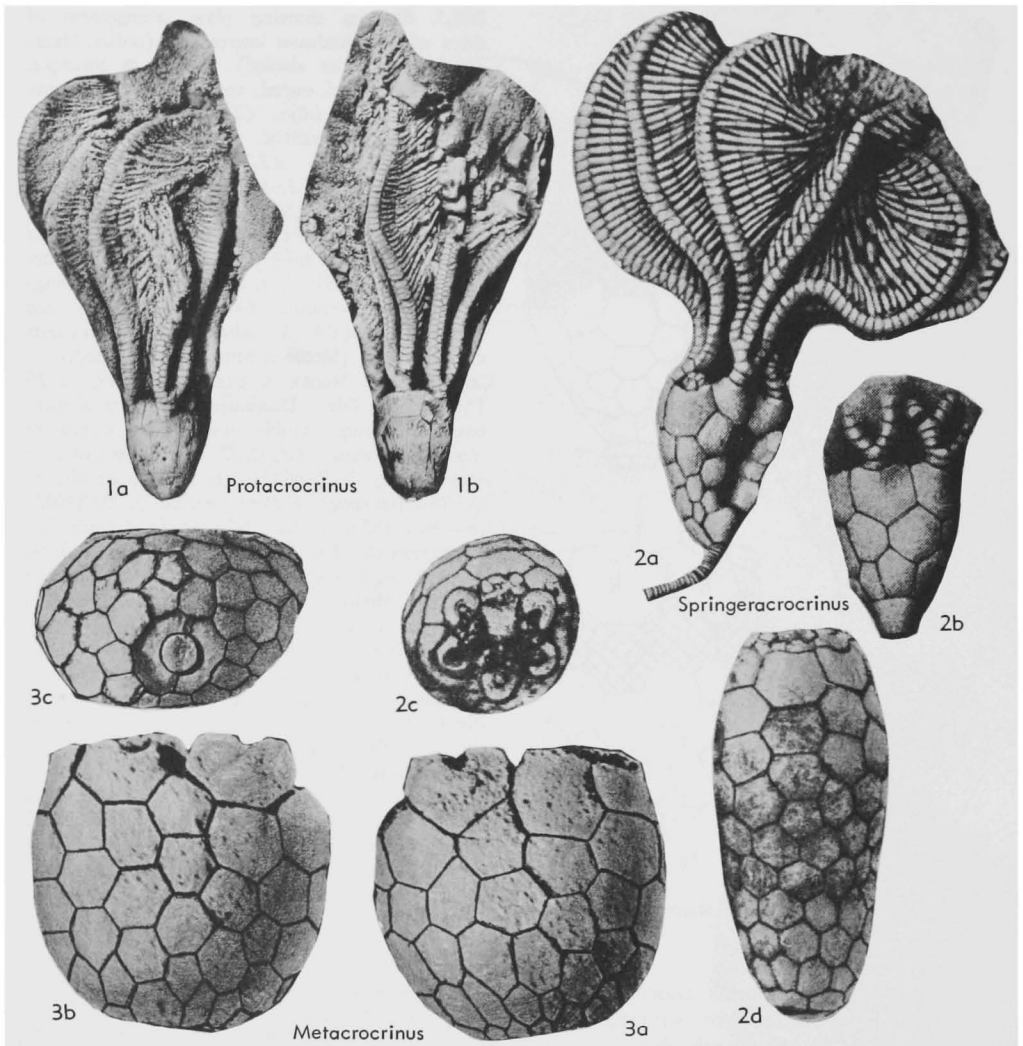


FIG. 289. Acrocrinidae (Globacrocrininae) (p. T486-T487).

with longitudinal series of intercalaries under *A* radial and primanal. *M.Penn.(Desmoines.)-U. Penn.(Missour.)*, USA (Okla.-Ill.).—FIG. 282,7; 288,1. **D. expansus* (STRIMPLE), M.Penn.(Desmoines., Oologah Ls.), USA (Okla.); 282,7, diagram of calyx plates showing 12 distalmost intercalaries (radials black, distal intercalaries shaded) (Strimple, 1951, mod.); 288,1a-d, ventral, dorsal, CD-interray, and *A*-ray views of holotype, $\times 3$ (Strimple, 1951e).

Metacrocrinus MOORE & STRIMPLE, 1969, p. 35 [**Acrocrinus pumpkinsis* STRIMPLE, 1949b, p. 900; OD]. Differs from *Dinacrocrinus* only in absence of intercalary next beneath *D* radial. *M.Penn.(Desmoines.)*, USA (Okla.).—FIG. 282,

8; 289,3. **M. pumpkinsis* (STRIMPLE), M.Penn. (Lake Murray F., Pumpkin Creek Ls.), S. of Ardmore, Carter Co.; 282,8, diagram of calyx plates (radials black, distal intercalaries shaded) (Strimple, 1949b, mod.); 289,3a-c, *D*-ray (slightly left of midline), *EA*-interray, and dorsal views of holotype, $\times 4$ (Strimple, 1949b).

Protacrocrinus MOORE & STRIMPLE, 1969, p. 38 [**Acrocrinus primitivus* LAUDON & BEANE, 1937, p. 252; OD]. Crown pyriform, with 10 biserial arms bearing long slender pinnules. Calyx deep bowl shaped, evenly rounded at base, truncate at top, composed of 5 small radials subequal in height and width, primanal rising slightly above summit of radials, 6 tall intercalaries directly beneath

radials and primanal. Stem impression very small, stem unknown. *L.Miss.(Kinderhook.)*, USA (Iowa).—FIG. 282,2; 289,1. **P. primitivus* (LAUDON & BEANE), Hampton F., LeGrand, Tama Co., Iowa; 282, 2, diagram of calyx plates (radials black, distal intercalaries shaded) (Moore & Strimple, 1969); 289,1a,b, views of holotype crown from *D*- and *B*-ray sides, $\times 2.25$ (Moore & Strimple, 1969).

Springeracrocrinus MOORE & STRIMPLE, 1969, p. 41 [**Acrocrinus intermedius* SPRINGER, 1926b, p. 43; OD]. With characters of subfamily but all distal intercalaries located interradially, none directly beneath radial, 1 intercalary beneath primanal, sum of 7 plates in this circlet. *L.Miss.(Osag.)-U.Miss.(Chester.)*, USA (Iowa-Ill.); *U.Carb.(Moscow.)*, Eu.(USSR).—FIG. 282,10; 289,2a,b. **S. intermedius* (SPRINGER), low.Chester.(Renault F.), Ill.(Monroe Co.); 282,10, diagram of calyx plates (radials black, distal intercalaries shaded) (Moore & Strimple, 1969); 289,2a,b, *C*-ray view of crown and *E*-ray side of calyx, both $\times 3.4$ (Springer, 1926b).—FIG. 289,2c,d. *S. mjaatschkowensis* (YAKOVLEV), U.Carb.(Myachkova F.), USSR (Moscow basin); ventral and *CD*-interray views of calyx, $\times 4.5$ (Yakovlev & Ivanov, 1956).

Suborder GLYPTOCRININA Moore, 1952

[Glyptocrinina MOORE, 1952 in MOORE, LALICKER, & FISCHER, p. 614]

Basal circlet pentagonal; radials adjoining each other all around. *M.Ord.-U.Perm.*

Superfamily GLYPTOCRINACEA Zittel, 1879

[*nom. transl.* UBAGHS, herein (*ex* Glyptocrinidae ZITTEL, 1879, p. 374)]

Calyx conical to subglobose, plates generally with stellate ornamentation; basals five; fixed secundibrachs two to eight or even more in each ray; fixed tertibrachs present in some species; interprimibrachs numerous and well defined; intersecundibrachs numerous, less definite; primanal followed by three plates in next row above; median anal ridge present. Tegmen composed of many small plates; anus opening directly through it. Rays ordinarily not branching beyond tertibrach series; brachials uniserial or biserial. Column cylindrical; axial canal pentagonal. *M.Ord.-U.Sil.*

Family GLYPTOCRINIDAE Zittel, 1879

[Glyptocrinidae ZITTEL, 1879, p. 374]

Characters of superfamily. *M.Ord.-U.Sil.*

Glyptocrinus HALL, 1847, p. 281 [**G. decadactylus*; M] [= *Icosidactylocrinites* OWEN, 1843 (*nom. nud.*); *Icosidactylocrinus* SHUMARD, 1868, p. 372 (*nom. subst. pro Icosidactylocrinites*); *Glyptocrinites* CARPENTER, 1884, p. 929 (*nom. van. pro Glyptocrinus*)]. Secundibrachs 2 in each ray; fixed tertibrachs passing to free arms. Arms 20, simple or branching once, uniserial; brachials cuneate externally. *M.Ord.-U.Sil.*, N.Am.—FIG. 290,1. **G. decadactylus*, M.Ord., USA; 1a,b, *E*-ray and *CD*-interray views of slightly crushed crown, $\times 2$ (Ubaghs, n); 1c, tegmen, $\times 2$ (Wachsmuth & Springer, 1897); 1d, plate diagram of part of calyx (radials black, interbrachials stippled) (Ubaghs, n).

Periglyptocrinus WACHSMUTH & SPRINGER, 1897, p. 277 [**P. billingsi*; OD]. Similar to *Glyptocrinus*, but basals larger and arms biserial. *M.Ord.*, N.Am.—FIG. 291,1. **P. billingsi*; Trenton., Can.; *CD*-interray view of crown with attached stem, $\times 1$ (Wachsmuth & Springer, 1897).

Pycnocrinus S. A. MILLER, 1883, p. 219 [**Glyptocrinus shafferi* S. A. MILLER, 1875, p. 277; OD]. Secundibrachs numerous; fixed pinnules as many as 5 or 6 in each ray, 1st one borne by fixed secundibrachs 2 (outer) and 2nd one by fixed secundibrachs 4 (inner). Arms 10, branching once or twice, uniserial. *M.Ord.-U.Ord.*, N.Am.—FIG. 291,2a. **P. shafferi* (S. A. MILLER), U.Ord., USA (Ohio); type crown and stem, $\times 2$ (Wachsmuth & Springer, 1897).—FIG. 291,2b-d. *P. dyeri* (MEEK), U.Ord., Cincinnati., USA (Ohio); 2b, lat. view of almost complete crown with attached stem, $\times 1$ (Wachsmuth & Springer, 1897); 2c, *AB*-interray view of theca showing fixed pinnules, $\times 1$ (Springer, 1917); 2d, tegmen, $\times 1.25$ (Springer, 1917).

Superfamily MELOCRINITACEA d'Orbigny, 1852

[*nom. correct.* UBAGHS, herein (*pro* Melocriniticae UBAGHS, 1953, p. 741, *nom. transl.* *ex* Melocrinidae D'ORBIGNY, 1852, p. 141)]

Calyx generally higher than wide, typically expanding from relatively narrow base to zone of greatest width at level of arms; basals, four; median ray ridges present in primitive members; interprimibrachs numerous, well defined; primanal followed by three plates in next row; tegmen composed of many, generally undifferentiated plates, anus opening directly through it or at end of tube; plate ornamentation largely stellate. Rami two to four in each ray, branching isotomously or heterotomously; brachials uniserial, biserial, or compound. Column cylindrical. *U.Ord.-U.Dev.*

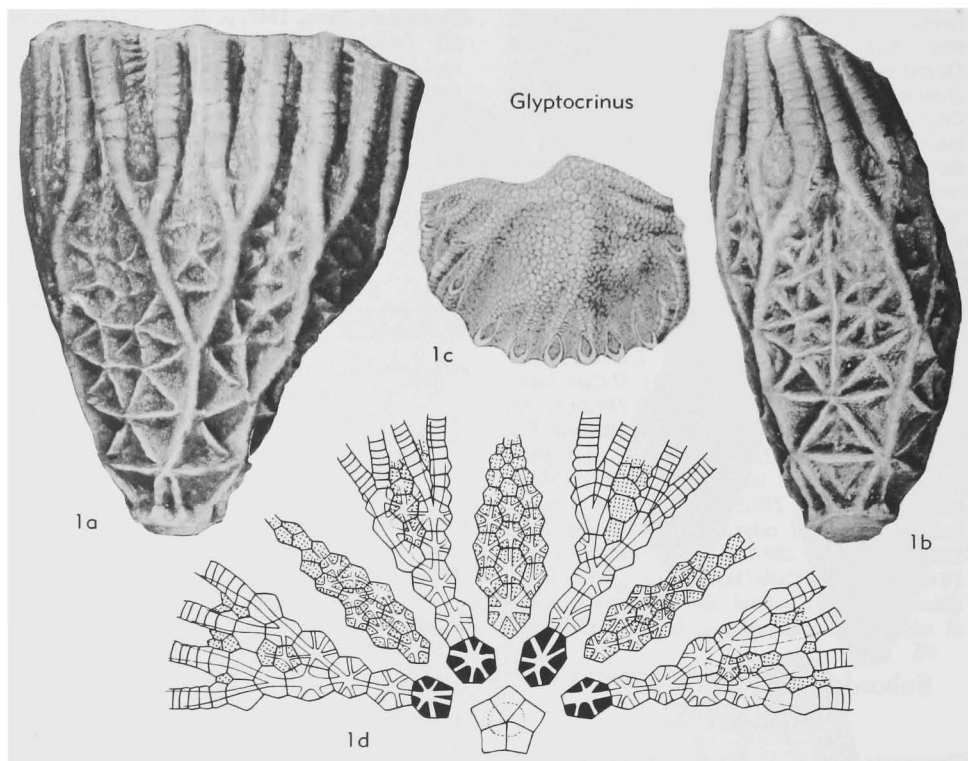


FIG. 290. Glyptocrinidae (p. T487).

Family SCYPHOCRINITIDAE Jaekel, 1918

[*nom. correct.* UBAGHS, 1953, p. 741 (*pro* Scyphocrinidae JAEKEL, 1918, p. 31)] [=Camarocystidae ZITTEL, 1895, p. 154; Camarocystida HAECKEL, 1896a, p. 168]

Secundibrachs numerous, many of them incorporated in calyx; interbranchials separated from tegmen by fixed pinnulars; posterior side slightly differentiated in calyx; rami two in each ray, isotomously branching. ?*L.Sil.*; *U.Sil.*-*L.Dev.*

In view of the very distinctive morphological features of this family, chiefly represented by its type genus, coupled with mass accumulation of well-preserved crowns and other skeletal parts, including the distinctive bulbous holdfasts known as loboliths or *Camarocrinus*, the very restricted stratigraphic range and wide repartition of these crinoids in Europe, Asia, North Africa, and North America are very noteworthy. In Bohemia, where *Scyphocrinites* was recognized first, this genus is located in the Pridoli Formation ($e\beta 2$), which extends from the zone of *Pristiograptus ultimus* to

the zone of *Monograptus angustidens*. It has about the same range in Germany (Harz, Kellerwald, Thuringia), Bulgaria, and Poland, whereas in North Africa it reaches a little higher level, in the zone of *Monograptus uniformis*. It has also been reported from the Upper Silurian of England (Cornwall), France, Spain (eastern Pyrenees), USSR (Podolia, Khazakstan), Burma, and China. In North America (Tennessee, Missouri, Oklahoma, West Virginia) the recorded occurrence is Silurian (Decatur? and Henryhouse formations) and Lower Devonian (Helderbergian). Interpretation of *Scyphocrinites* as a pelagic crinoid provided with float (*Camarocrinus*), which ranged the globe very widely, appearing and disappearing abruptly within a relatively short time span, accords with geographic, stratigraphic, morphologic, and paleontologic evidence (see HAUDE, 1972). It should receive recognition as an exceptionally precise age indicator useful for correlation of remotely separate marine deposits.

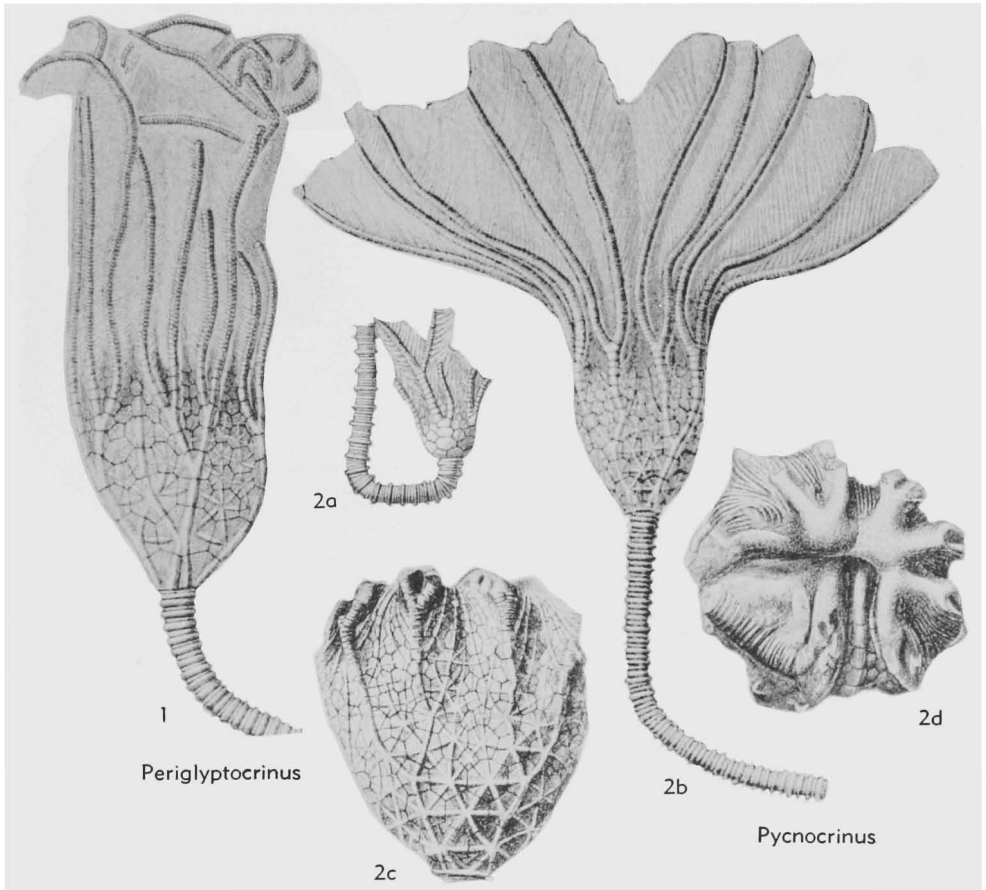


FIG. 291. Glyptocrinidae (p. T487).

Scyphocrinites ZENKER, 1833, p. 25 [**S. elegans*; M] [= *Scyphocrinus* GEINITZ, 1846, p. 549 (*nom. van. pro Scyphocrinites* (obj.)) (*non Scyphocrinus* HALL, 1847); *Scyphocrinites* ROEMER in BRONN, 1855, p. 255 (*nom. null.*); *Siphocrinus* KREJCI, 1860, p. 751 (*nom. null.*); *Lobolithus* BARRANDE in BIGSBY, 1868, p. 192 (*nom. nud.*) (holdfast); *Camarocrinus* HALL, 1879b, p. 205 (type, *C. stellatus* HALL, 1879b; SD MILLER, 1889, p. 230) (holdfast); *Camerocrinus* FRIČ, 1904, p. 277 (*nom. van. pro Camarocrinus*)]. Calyx large, expanding or contracting toward arm bases, with interradian areas depressed or protuberant, largely formed of fixed pinnulars; fixed secundibrachs 10 to 20 or even more, 1st pinnule borne by fixed secundibrach 2 (outer) and 2nd pinnule by fixed secundibrachs 4 (inner). Anal tube strong, sub-central on tegmen. Free arms composed of very short brachials arranged uniserially or biserially. Column ending distally either in small encrusting root or (more typically) in large bulbous chambered structure designated separately as *Lobolithus*

or *Camarocrinus* with walls of minute irregular plates, having their origin in bifurcations and modifications of innumerable root-branches; axial canal of stem quinquelobate to sharply quinque-stellate. [For description and illustration of the holdfast, see section on morphology of fossil crinoids, p. T88.] ?*L.Sil.*, *U.Sil.-L.Dev.*, Eu.-N. Am.(USA)-N.Afr.-Asia.—FIG. 292,1a-d. **S. elegans*; 1a, side view of crown (diagram.) from L.Dev.(Bailey Ls.), USA(Mo.), $\times 0.7$ (Springer, 1917); 1b-d, median secs. of pluricolumnals from proxistele, mesistele, and dististele regions, specimens from L.Dev.(Bailey Ls.), USA(Mo.), $\times 2$ (Springer, 1917).—FIG. 292,1e. *S. sp.*, U.Sil., N.Afr.; tegmen and anal tube, $\times 1$ (Ubaghs, n). —FIG. 292,1f. *S. sp.*, L.Dev., USA; plated bulbous holdfast (*Camarocrinus*), $\times 0.5$ (Hall, 1879b).—FIG. 292,1g. *S. ulrichi* (SCHUCHERT), L.Dev.(Helderberg.), USA(Okla.), upper part of large bulb (not included in figure) showing distal part of stem and branches merging into plated area, $\times 1$ (Springer, 1917).

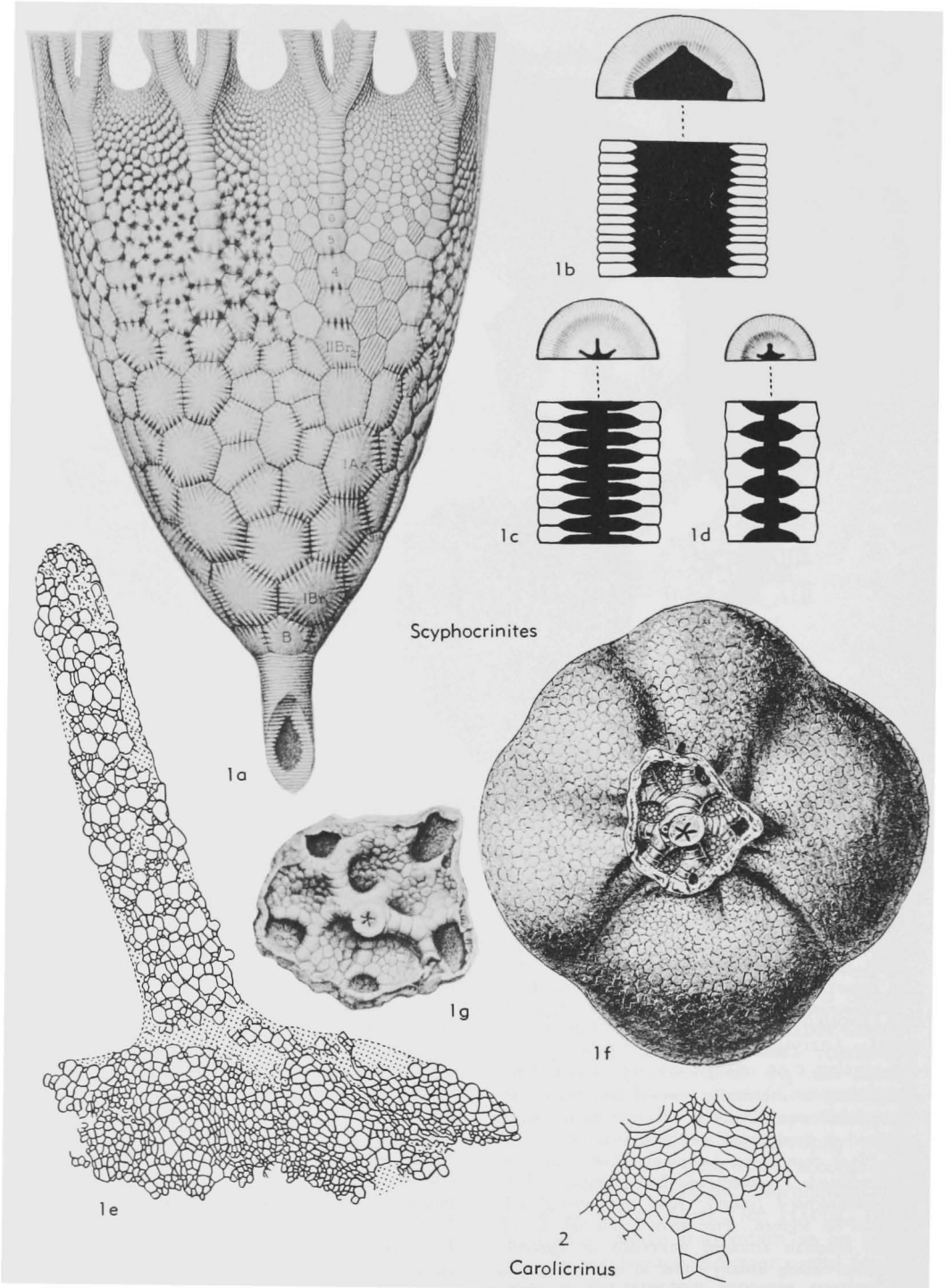


FIG. 292. Scyphocrinitidae (p. T489, T491).

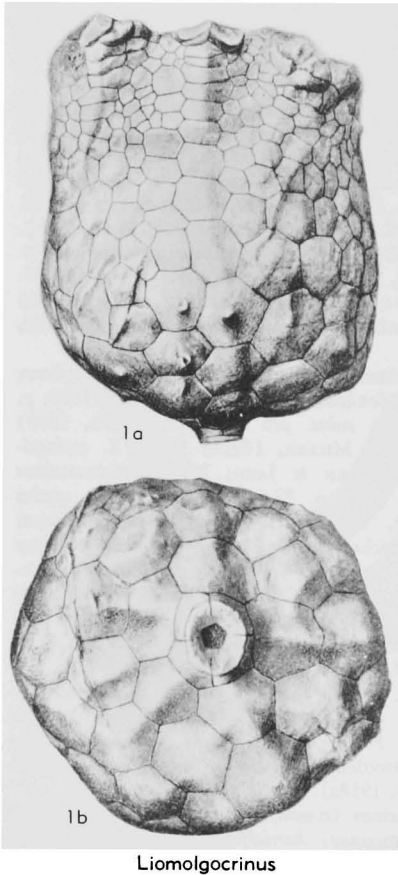


FIG. 293. Scyphocrinitidae (p. T491).

[*Lobolithus* BARRANDE, 1868 (in BIGSBY, Thesaur. Silur., p. 192) has been treated by authors as a generic name, even though not associated by anyone with a named species. BARRANDE (1887, p. 1), ZITTEL (1895, p. 154), WAAGEN & JAHN (1899, p. 189) and other authors have referred to these fossils in French vernacular as *lobolithes* (loboliths in English, *Lobolithen* in German), a term commonly used in Bohemia since the middle of the 19th century. Thus, *Lobolithus* has no standing in zoological nomenclature.]

?*Carolicrinus* WAAGEN & JAHN, 1899, p. 22 [**C. barrandei*; M]. Similar to *Scyphocrinites* but having proximal biserial brachials incorporated in calyx; free arms compactly biserial. Base in type specimen possibly abnormal. [This genus, imperfectly known, may be a mere synonym of *Scyphocrinites*.] *U.Sil.*, Eu.(Boh.).—FIG. 292,2. **C. barrandei*, Boh.; biserial fixed brachials and pinnulars, $\times 0.7$ (Waagen & Jahn, 1899).

Liomolgocrinus STRIMPLE, 1963, p. 103 [**L. dissutus*; OD]. Theca ovoid, with rapidly expanding

base, widest at about 2nd range of interprimibrachs, and contracting slightly from there to near arm-bases; fixed secundibrachs apparently less than 10 in half-ray; wide interradian areas; fixed pinnules undifferentiated from interbrachials; thecal plates flat or low convex. Arms and stem unknown. *L.Dev.*, USA(Okla.).—FIG. 293,1. **L. dissutus*, Helderberg.; 1a,b, D-ray and dorsal views of theca, $\times 1$ (Springer, 1917).

Family PARAMELOCRINIDAE Ubahgs, 1958

[Paramelocrinidae UBAGHS, 1958b, p. 261]

Secundibrachs numerous, few of them incorporated in calyx; interbrachials merging with tegmen; CD interray slightly larger than others, with three plates in second range. Arms two to each ray, isotomously branching, biserial. *U.Sil.*

Paramelocrinus UBAGHS, 1958, p. 261 [**P. angelini*; OD]. Characters of family. *U.Sil.*, Sweden(Gotl.).—FIG. 294,1. **P. angelini*; 1a, plate diagram of part of calyx (radials black, anals and interbrachials stippled) (Ubahgs, n); 1b, lat. view of holotype crown, $\times 2.7$ (Ubahgs, 1958b).

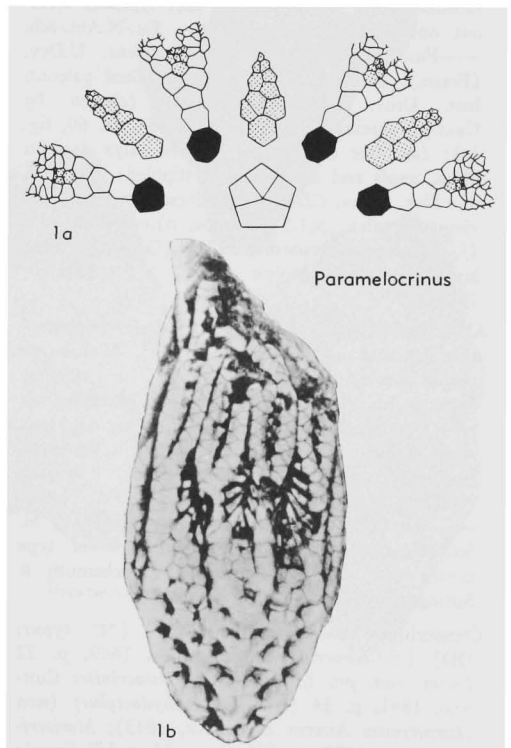


FIG. 294. Paramelocrinidae (p. T491).

Family MELOCRINITIDAE
d'Orbigny, 1852

[*nom. correct.* BASSLER, 1938, p. 26 (*pro* Melocrinidae d'ORBIGNY, 1852, p. 141)] [=Ctenocrinidae C. F. ROEMER, 1855, p. 228]

Secundibrachs two or three in each ray, rarely more; interprimibrachs merging with tegmen; presence of intersecundibrachs and interteribrachs dependent on degree of brachial incorporation in calyx; primanal generally followed by median row of anal plates; anal tube may be present. Free arms four in each ray, undivided or exotomously branching; inner pair of arms primitively distinct, secondarily fusing into stout biserial ramuli-bearing trunk; outer pair progressively reduced and disappearing in ultimate members. Column with sharply defined nodals and internodals. *U.Ord.-U.Dev.*

Melocrinites GOLDFUSS, 1831, p. 197 [**M. hieroglyphicus*; SD C. F. ROEMER, 1855, p. 251] [=*Melocrinus* AGASSIZ, 1836, p. 197 (*nom. van. pro Melocrinites*); *Castanocrinus* C. F. ROEMER, 1855, p. 228, 252 (type, *Melocrinites gibbosus* GOLDFUSS, 1831, p. 211; OD)]. Intersecundibrachs absent or reduced; anus subcentral, directly through tegmen or moderately protruding. One ramuli-bearing trunk in each ray, typically without outer rami. *M.Dev.-U.Dev.*, Eu.-N.Am.-Sib.—FIG. 295,1a-e. **M. hieroglyphicus*, U.Dev. (Frasn.), Stolberg, Ger.; lectotype, Geol.-paleont. Inst. Univ. Bonn (unnumbered) (chosen by UBAGHS, herein, orig. GOLDFUSS, 1831, pl. 60, fig. 1c); 1a, plate diagram of part of calyx (radials black, anals and interbranchials stippled) (Ubaghs, n); 1b-e, A-ray, CD-interray, dorsal, and tegmental views of calyx, $\times 1.5$ (Ubaghs, n).—FIG. 295, 1f. *M. aequus* SCHMIDT, M.Dev.(Couvin.), Ger.; lat. view of incomplete crown, $\times 1$ (Schmidt, 1942).

Alisocrinus KIRK, 1929, p. 343 [**Mariocrinus warreni* RINGUEBERG, 1888, p. 133; OD]. Median ray ridges present; fixed secundibrachs 2 or rarely 3; fixed teribrachs may be present; interbranchials well developed. Tegmen, so far as known, low, many-plated, anus excentric. Free arms subequal, undivided, uniserial, pinnulate, typically 4 in each ray; free brachials cuneate. *U.Ord.-M.Sil.*, N.Am.—FIG. 295,2. **A. warreni* (RINGUEBERG), M. Sil.(Niagaran), USA(N.Y.); lat. view of type crown with attached stem, $\times 1$ (Wachsmuth & Springer, 1897).

Ctenocrinus BRONN, 1840, p. 547 [**C. typus*; OD] [=Ctenocrinites STEININGER, 1849, p. 22 (*nom. van. pro Ctenocrinus*); *Astrocrinites* CONRAD, 1841, p. 34 (type, *A. pachydactylus*) (*non Astrocrinites* AUSTIN & AUSTIN, 1843); *Mariocrinus* HALL, 1859, p. 104 (type, *M. nobilissimus*); *Astrocrinus* BATHER, 1900a, p. 161 (*nom. van.*

pro Astrocrinites) (*non Astrocrinus* MORRIS, 1843); *Clonocrinus* OEHLERT, 1879, p. 3 (type, *C. bigsbyi*) (*non* QUENSTEDT, 1876); *Lindstroemocrinus* JAEKEL, 1918, p. 31 (type, *Trochocrinites gottlandicus* PANDER in HELMERSEN, 1858, p. 312)]. Median ray ridges more or less developed; secundibrachs generally 2; intersecundibrachs few or absent; excentric anal tube present in some if not all species. Inner arms of each ray partially or entirely united in stout, biserial, ramuli-bearing trunks, without pinnules; outer arms more or less reduced and similar to ramuli, which are numerous, pinnulate, with uniserial, biserial or compound brachials. *U.Sil.-M.Dev.*, Eu.-N.Am.-S.Am.—FIG. 296,1a. *C. gottlandicus* (PANDER), U.Sil.(Ludlov.), Sweden (Gotl.); crown with proximally united inner rami, $\times 2$ (Ubaghs, 1958b).—FIG. 296,1b. **C. typus*, L.Dev.(Siegen.), Ger.; entirely united arm trunks of lectotype crown, $\times 1$ (Schmidt, 1937).

Promelocrinus JAEKEL, 1902, p. 1067 [**P. anglicus*; M] [=?Zenkericrinus WAAGEN & JAHN, 1899, p. 102 (*nom. subst. pro Xenocrinus* JAHN, 1892) (*non* S. A. MILLER, 1881a) (type, *Z. melocrinoides* WAAGEN & JAHN; M); ?*Proctenocrinus* JAEKEL, 1918, p. 32 (*nom. nud.*) (no species named)]. Median ray ridges faint or absent; secundibrachs typically 2. Inner arms of each ray uniserial, generally larger, not pinnuliferous, bearing 1 to several uniserial or biserial pinnuliferous ramuli on outer side; outer rami generally smaller, undivided, uniserial or biserial, pinnuliferous. *M. Sil.-U.Sil.*, Eu.-N.Am.(USA).—FIG. 295,3a. **P. anglicus*, M.Sil.(Wenlock.), Eng.; CD-interray view of crown, $\times 1$ (Springer, 1926a).—FIG. 295,3b. *P. fulminatus* (ANGELIN), U.Sil.(Wenlock.), Sweden; CD-interray view of crown, $\times 2.5$ (Ubaghs, 1958a).

Trichotocrinus OLSSON, 1912, p. 27 [**Melocrinus (Trichotocrinus) harrisi*; M]. Main arm trunks bearing 1) pinnulate ramuli and 2) ramuliferous branches at irregular intervals; branches and trunks without pinnules; brachials of branches biserial, those of ramuli biserial or compound; outer rami present or absent. *U.Dev.*, N.Am.(USA).—FIG. 296,2a. *T. lutheri* GOLDRING, Portage beds, N.Y.; arm trunk, $\times 1$ (Goldring, 1923).—FIG. 296,2b. **T. harrisi*, Portage-Ithaca beds, N.Y.; ray structure (Olsson, 1912a).

Family UNCERTAIN

Cytocrinus ROEMER, 1860, p. 46 [**C. laevis*; M] [=Turbinocrinus WACHSMUTH & SPRINGER, 1881, p. 237 (*nom. nud.*); *Turbinicrinites* WOOD (*ex* TROOST MS), 1909, p. 44 (type, *T. verneuili*; OD)]. Calyx conspicuously lobed, having same structure as in *Melocrinites*, but arms apparently extended into 5 uniserial trunks; anal tube excentric. Arms and column unknown. *M.Sil.* (Niagaran), N.Am.(USA).—FIG. 297,1. **C. laevis*, Beech River Ls., Tenn.; 1a,b, lat. and tegmental views of theca, $\times 2$ (Springer, 1926a).

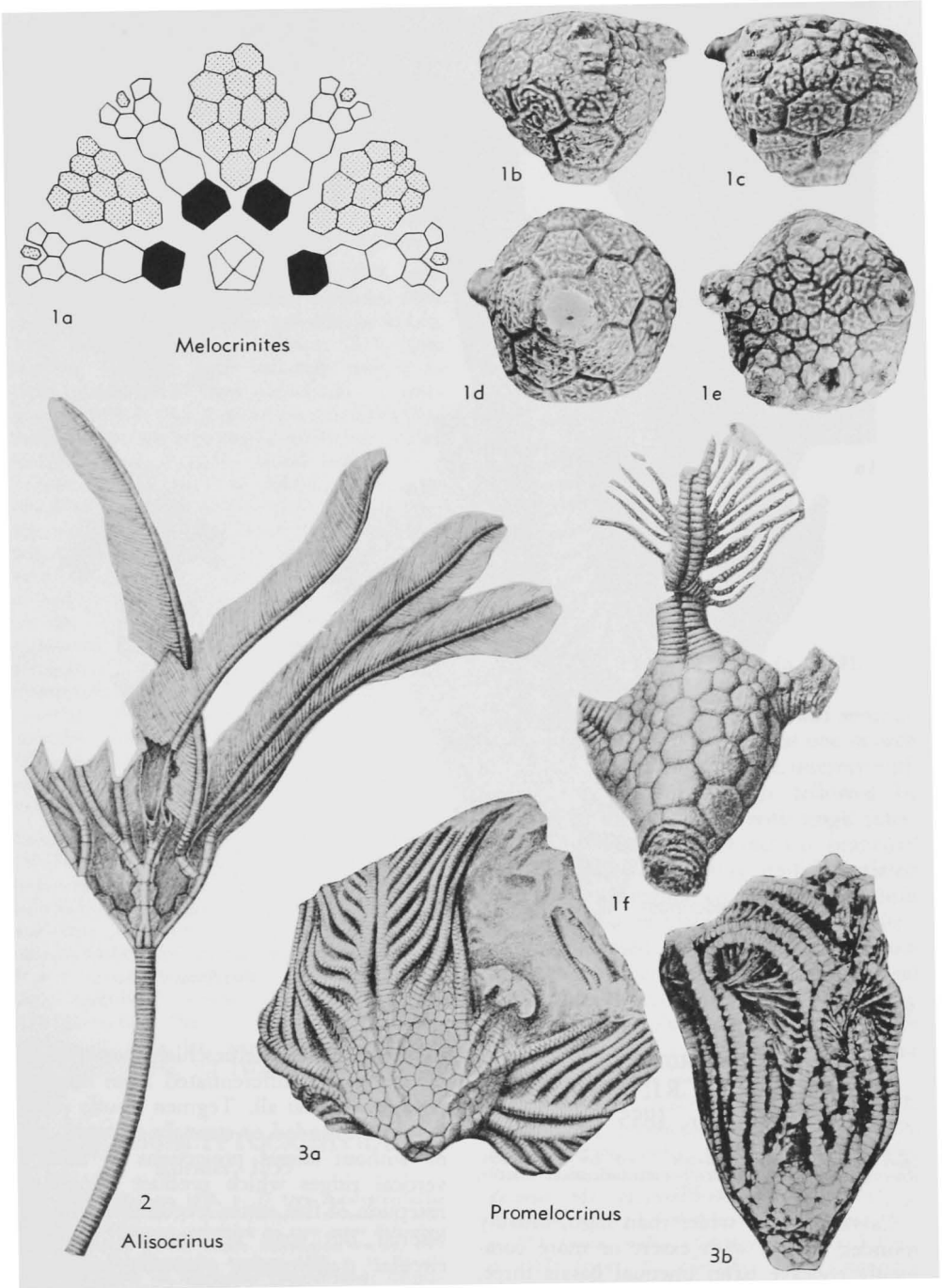


FIG. 295. Melocrinitidae (p. T492).

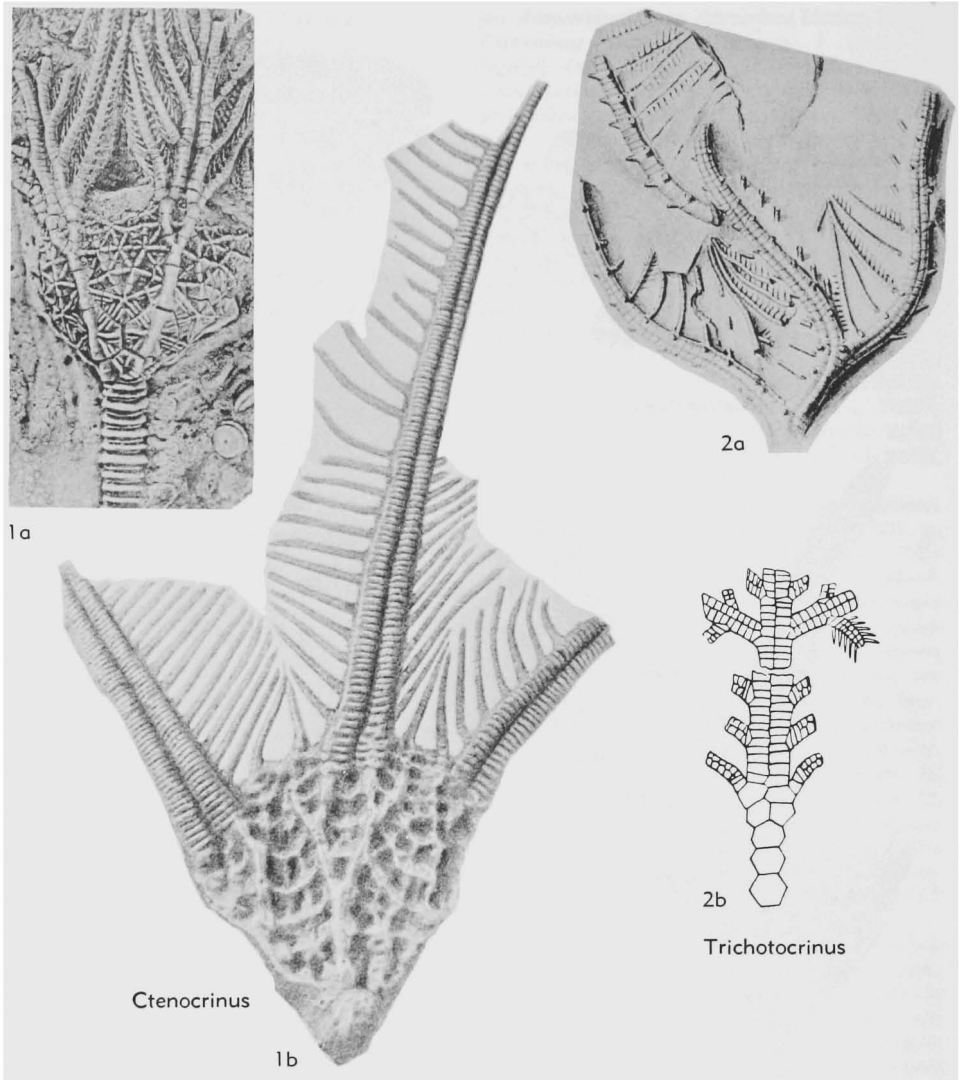


FIG. 296. Melocrinitidae (p. T492).

Superfamily
EUCALYPTOCRINITACEA
Roemer, 1855

[*nom. transl. et correct.* UBAGHS, herein (*ex* Eucalyptocrinitidae ROEMER, 1855, p. 229)] [=Dolatocrinidae UBAGHS, p. 742]

Calyx typically wider than high, broadly rounded below, with exsert or more commonly concave base; unequal basals three, four, or fused together; evenly pentamerous radial circler composed of five plates commonly wider than high, laterally adjoining one another all around; fixed brachials

firmly joined to interbrachials, posterior side of cup barely differentiated from other interrays or not at all. Tegmen stoutly plated, low and rounded or strongly elevated, with or without lateral projections in form of vertical ridges which produce alcoves for reception of free arms; free brachials mostly biserial but may be uniserial. Column circular transversely, generally heteromorphic, some genera with laterally flanged columnals or nodals bearing cirri; attached generally by many-branched radix. *M.Sil.* *M.Dev.*

Family CLONOCRINIDAE

Bather, 1899

[Clonocrinidae BATHER, 1899b, p. 922] [=Corymbocrinidae ANGELIN, 1878, p. 18]

Basals four; fixed primibrachs two, fixed secundibrachs one or two, and fixed tertibrachs varying in number in each ray; fixed quartibrachs also may be present; interprimibrachs rather few and large; posterior side undifferentiated in cup. Free arms four in each ray, biserial. *U.Sil.-L.Dev.*

Clonocrinus QUENSTEDT, 1876, p. 638 [**C. gothlandicus*; M] [=*Corymbocrinus* ANGELIN, 1878, p. 18 (type, *Eucalyptocrinus polydactylus* M'COY, 1849, p. 249; SD BASSLER, 1938, p. 73)]. Basal concavity including basals and major part of radials; quadrangular fixed primibrachs 1, fixed secundibrachs 2, and more or less numerous fixed tertibrachs in each ray, passing to free arm plates; interprimibrachs in single vertical series of 2 or 3 large plates followed by smaller and irregular elements; intersecundibrachs few. Arms branching isotomously several times; distal pinnulars without oral grooves. Stem transversely round, heteromorphic, with nodals covering internodals at least proximally. *U.Sil., ?L.Dev., W.Eu.-N.Am.*

—FIG. 298, *1a, b*. **C. gothlandicus*, U.Sil., Sweden (Gotl.); *1a*, portion of holotype crown, $\times 1$ (Ubaghs, n); *1b*, lat. view of complete crown (Stockholm Museum Ec. 11843) (Ubaghs, n). —FIG. 298, *1c*. *C. sp.*; vert. sec. of theca and proxistele (radials black, interbrachials stippled) (Ubaghs, n). —FIG. 298, *1d*. *C. sp.*, plate diagram of part of calyx (symbols as in Fig. *1c*) (Ubaghs, n).

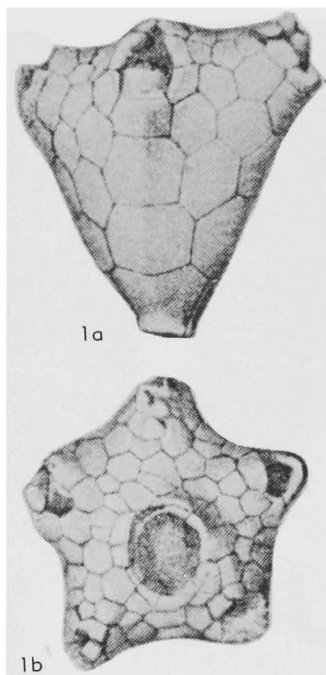
Technocrinus HALL, 1859, p. 139 [**Mariacrinus* (*Technocrinus*) *andrewsi*; SD WACHSMUTH & SPRINGER, 1881, p. 117 (291)]. Base convex; 1st primibrachs hexagonal; fixed secundibrachs 1; and fixed tertibrachs 1 or 2 in each half-ray; interprimibrachs in upward sequence 1, 2, 1 or 2, 0 or 1; no intersecundibrachs. Arms long, simple. Stem transversely circular. *U.Sil.-L.Dev., N.Am. (USA)*. —FIG. 298, 2. **T. andrewsi*, L.Dev. (Oriskany), Md.; lat. view of holotype crown with attached stem, $\times 1$ (Wachsmuth & Springer, 1897).

Family EUCALYPTOCRINITIDAE

Roemer, 1855

[*nom. correct.* BASSLER, 1938, p. 27 (pro Eucalyptocrinidae ROEMER, 1855, p. 229)] [=Polycrinidae D'ORBIGNY, 1852, p. 141 (invalid because containing no type genus *Polyacrinus* —non *Polyacrinus* JAEKEL, 1918); Polycrinidae PICTET, 1857 (vernacular); Calyptocrinidae ANGELIN, 1878, p. 14 (invalid because containing no type genus *Calyptocrinus*); Calyptocrinidées DE LORIGL, 1884, p. 59 (vernacular)]

Calyx typically with narrow, moderately deep basal concavity having sides composed of four basals and proximal parts of radials;



Cytocrinus

FIG. 297. Family Uncertain (p. T492).

fixed primibrachs one or two, fixed secundibrachs two, and fixed tertibrachs one in each ray, followed by free arms; each interray with single large interprimibrach followed by two smaller ones, each ray with single interbrachial between secundibrachs of branched fixed brachs; *CD* interray undifferentiated from others. Tegmen elevated, stoutly built of relatively large plates in circlets or alternating, disposed around central hollow cylinder, produced laterally to form vertical partitions between arm alcoves or lacking these. Transversely circular column with small pentastellate axial canal and radicular holdfast. *M.Sil.-M.Dev.*

Eucalyptocrinites GOLDFUSS, 1831, p. 214 [**E. rosaceus*; M] [=*Eucalyptocrinus* AGASSIZ, 1836, p. 197 (*nom. van.*) (obj.); *Hypanthocrinites* PHILLIPS in MURCHISON, 1839, p. 672 (type, *H. decorus*; M); *Hypanthocrinus* MORRIS, 1843, p. 59 (*nom. van.*); *Eucalyptocrinites* GEINITZ, 1846, p. 551 (*nom. null.*); *Crinocystites* HALL, 1864, p. 317 (type, *C. chrysalis*; M); *Crinocystites* HAECKEL, 1896a, p. 69 (*nom. van.*)]. First primibrachs invariably present in Silurian species, may be absent in Devonian representatives; single interbrachial plate in each ray subequal in shape and size to pairs of distal interprimibrachs in each

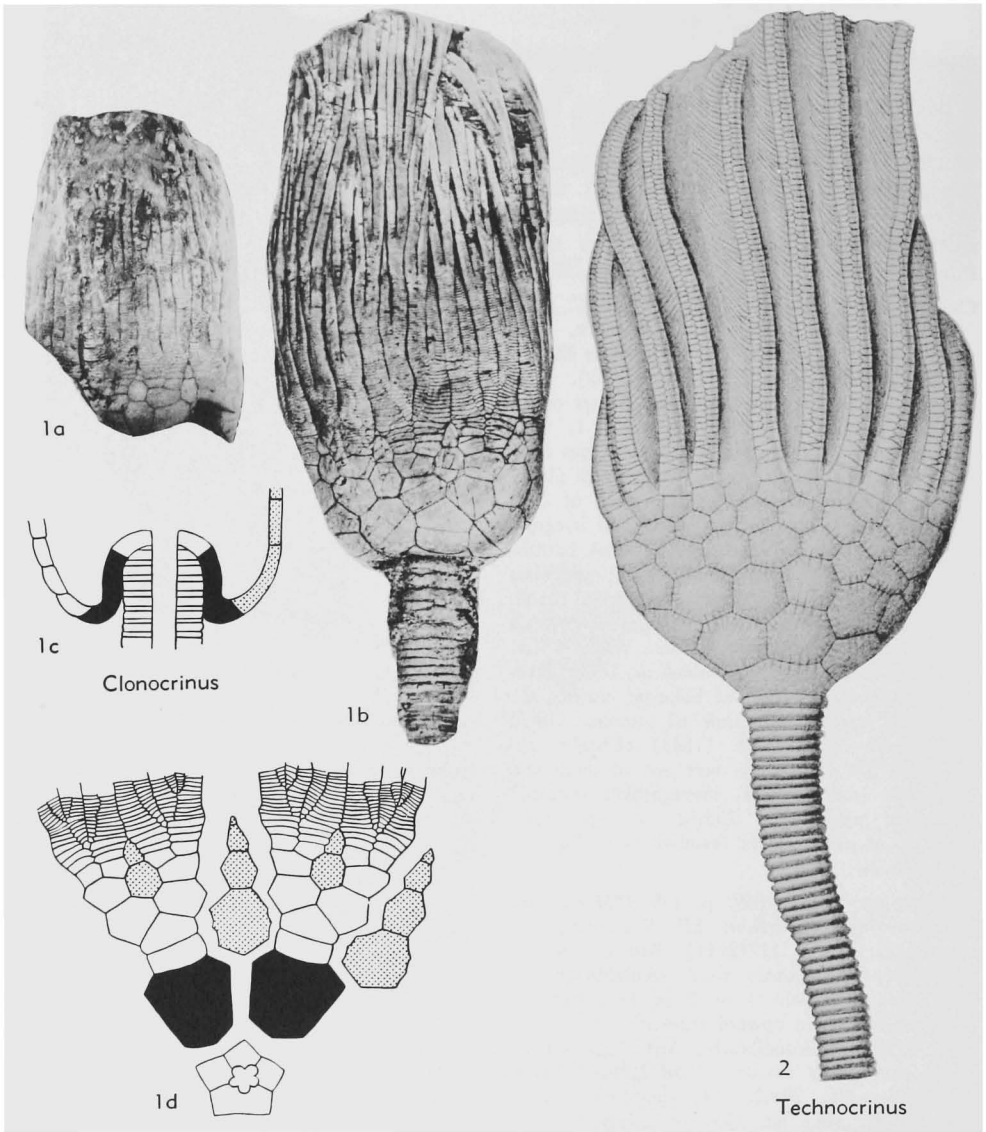


FIG. 298. Clonocrinidae (p. T495).

interray. Tegmen composed of 1) 4 large plates forming roof over viscera (recorded only from *E. crassus*), 2) 10 high, riblike plates resting against 4 lower tegmental plates (which they conceal) and cup, 3) shorter ribbed plates capping higher riblike ones to form apex of tegmen and meeting around central opening, which may be protected by special anal plates or raised on anal tube. *M.Sil.-M.Dev.*, Eu.-N.Am.(USA)-Australia-Asia(Sib.).—FIG. 299,1a-c. **E. rosaceus*, M. Dev., Ger.; crown with arm pairs removed in front, viewed from side, summit, and base, $\times 1$

(Schultze, 1867).—FIG. 299,1d. *E. proboscidalis* (MILLER), U.Sil.(Cedarville Dol.), USA(Ohio); side view of holotype theca and part of attached stem with articular side columnal (black) in lower corner, $\times 1$ (Foerste, 1920).—FIG. 299,1e. *E. sp.*, plate diagram of cup (radials black, interbrauchs stippled) (Ubaghs, n).—FIG. 299,1f. *E. crassus* (HALL), M.Sil.(Niagaran), USA(Ind.); summit view of theca, showing 4 plates which roof viscera (Macurda, 1968).

Callocrinus D'ORBIGNY, 1850, p. 45 [**Eugeniocrinites? costatus* HISINGER, 1837, p. 90; M] [=Cal-

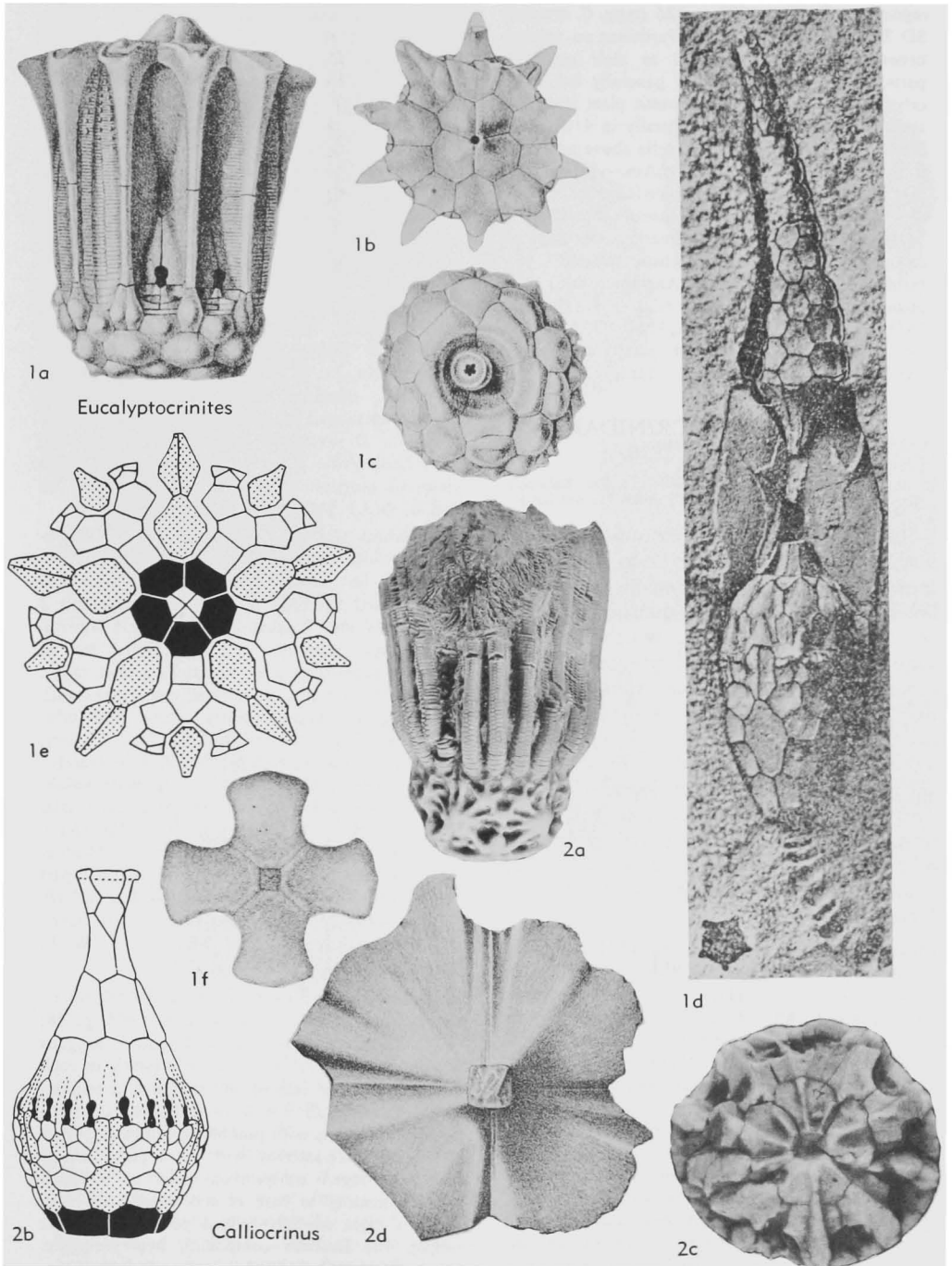


FIG. 299. Eucalyptocrinidae (p. T495-T498).

liocrinites CHAPMAN, 1857, p. 304 (*nom. van.*);
Cryptodiscus HALL, 1867b, pl. 11, fig. 8 (type, *C.*

bilobus WELLER, 1897, p. 749; SD WELLER); *Cal-*
licrinus ANGELIN, 1878, p. 14 (*nom. van.*); *Chi-*

cagocrinus WELLER, 1900, p. 126 (type, *C. ornatus*; SD BASSLER, 1938, p. 65)]. Partitions on tegmen between arm pairs restricted to their proximal parts; large spinose processes generally borne by calyx and tegminal plates; summit plate circlet of anal tube may be extended laterally in 4 winglike lobed expansions forming umbrella above arm tips. *U.Sil.-L.Dev.*, NW.Eu.-USSR-N.Am.—FIG. 299, 2a-c. **C. costatus*, U.Sil., Sweden (Gotl.); 2a, side view of crown (Stockholm Museum, Ec. 12088), $\times 1$ (Ubahgs, n); 2b, diagrammatic composition of calyx (radials black, interbrachials stippled), $\times 1$ (Ubahgs, n, adapted from Angelin, 1878); 2c, plates at distal end of anal tube, $\times 4$ (Angelin, 1878).—FIG. 299, 2d. C. sp., U.Sil., USA (N.Y.); top of umbrellalike summit plates of tegmen (= *Cryptodiscus* HALL), $\times 1$ (Hall, 1865).

Family DOLATOCRINIDAE S. A. Miller, 1890

[Dolatocrinidae MILLER, 1890, p. 34] [=section Dolatocrinites WACHSMUTH & SPRINGER, 1897, p. 264 (vernacular)]

Basals three, unequal or commonly fused; fixed primibrachs one or two and fixed secundibrachs one to seven in each ray; brachitaxes as far as fixed quartibrachs may be incorporated in calyx, which tends to acquire perfect pentamerous symmetry; interradials not exceeding three or four ranges, first one large, none to two next above, extra interprimibrachs in *CD* interray of some genera; intersecundibrachs generally and intertibrachs rarely developed. Tegmen stout, with or without anal tube. Free arms simple or branching, composed of biserial or compound brachials. Column cylindrical, relatively large, may bear lateral flanges. *L.Dev.-M.Dev.*

Dolatocrinus LYON, 1857, p. 482 [**D. lacus*; M] [= *Cacabocrinites* TROOST, 1850a, p. 419 (*nom. nud.*); *Cacabocrinus* HALL, 1862, p. 137 (*nom. subst. pro Cacabocrinites* TROOST); *Stereocrinus* BARRIS, 1878, p. 282 (type, *S. triangulatus*; SD S. A. MILLER, 1889, p. 283)]. Calyx broadly rounded, higher than tegmen, with nearly to perfect pentamerous symmetry, plates smooth in some species but tending in most to elaborately sculptured patterns; basals generally fused, slightly exsert and visible from side, plane, or most commonly in moderately deep concavity; fixed brachials including 1 or 2 primibrachs, and 1 or 4 secundibrachs in each half-ray; brachitaxes of tertibrachs, quartibrachs uncommon in most species; fixed pinnulars typically present near summit of cup, with prominent pinnule openings at border of tegmen; first interprimibrach commonly largest plate of calyx; *CD* interray usually not differentiated in calyx by increase in number of plates, but in some species this

interray may have larger plates than in others. Tegmen flat or low convex, stoutly built of medium to large, irregularly arranged plates, with or without rounded central prominences; subcentral anal tube generally not preserved in fossils. Free arms mostly 10 to 20, rarely more, composed of biserial brachials. Column strongly heteromorphic, nodals lacking cirri but commonly bearing ridgelike to vertically extended flanges. *L.Dev.-M.Dev.*, N.Am.(USA).—FIG. 300, 1a-c. **D. lacus*, L.Dev. (Jeffersonville Ls.), Ky.; *A*-ray, dorsal, and tegminal views of holotype theca, $\times 1$ (Wachsmuth & Springer, 1897).—FIG. 300, 1d. *D. sp.*, plate diagram of calyx (radials black, interbrachials stippled) (Kesling & Mintz, 1963a).—FIG. 300, 1e. *D. grandis* MILLER & GURLEY, L.Dev. (Onondaga Ls.), Ky.; detail of interray showing 12 fixed pinnule openings, $\times 2$ (Springer, 1921a).—FIG. 300, 1f-h. *D. exculptus* MOORE & JEFFORDS, M.Dev. (Ludlowville F.), N.Y.; facetal and 2 side views of pluricolumnals with vertical flanges on nodals, $\times 3.5$ (Moore & Jeffords, 1968).

Clarkeocrinus GOLDRING, 1923, p. 179 [**Cacabocrinus troosti* HALL, 1862, p. 138; OD]. Basals ankylosed but sutures between them commonly visible; fixed brachials in each ray comprising 2 primibrachs and 2 secundibrachs; 1st interprimibrach large, reaching well up toward top of primaxil, supporting 2 or 3 plates in next range. Tegmen many-plated, at least in type species with very long and slender nearly central anal tube. Free arms 4 in each ray, forking 2 or 3 times; brachials compound, each bearing 2, 3, or (rarely) 4 to 6 pinnules. Column with conspicuous nodals, each carrying a whorl of 5 very long cirri; axial canal circular. *M.Dev.*, USA (N.Y.)-Eu. (Ger.).—FIG. 301, 1a. **C. troosti* (HALL), Moscow F., N.Y.; side view of crown and proximal part of column, $\times 1$ (Goldring, 1923).—FIG. 301, 1b. *C. spriesterbachi* W. E. SCHMIDT, Couvin., Ger.; crown and proximal part of column, $\times 1$ (W. E. Schmidt, 1942).

Comanthocrinus SPRINGER, 1921, p. 4 [**Stereocrinus indianensis* MILLER & GURLEY, 1897, p. 38; OD]. Calyx very low; basals depressed, azygous one in *ED* interray; fixed 1st primibrach in each ray, more or less reduced and irregular in outline; fixed secundibrachs 3 to 7 in each half-ray; fixed pinnulars present, with pinnule openings at border of tegmen; *CD* interray with extra plate in 2nd row and ridged conspicuous series of tegminal plates extending to base of subcentral anal tube. Tegmen high, strongly bulged posteriorly. Arms simple, 10; brachials compound, hyperpinnulate. Heteromorphic stem divided into well-defined cirrinodals and inconspicuous internodals. *L.Dev.-M.Dev.*, N.Am.(USA).—FIG. 302, 1. **C. indianensis* (MILLER & GURLEY), M.Dev. (Hamilton), Ky., N.Y.; 1a-c, dorsal, *DE*-, and *CD*-interray views of theca, $\times 2$ (Springer, 1921a);

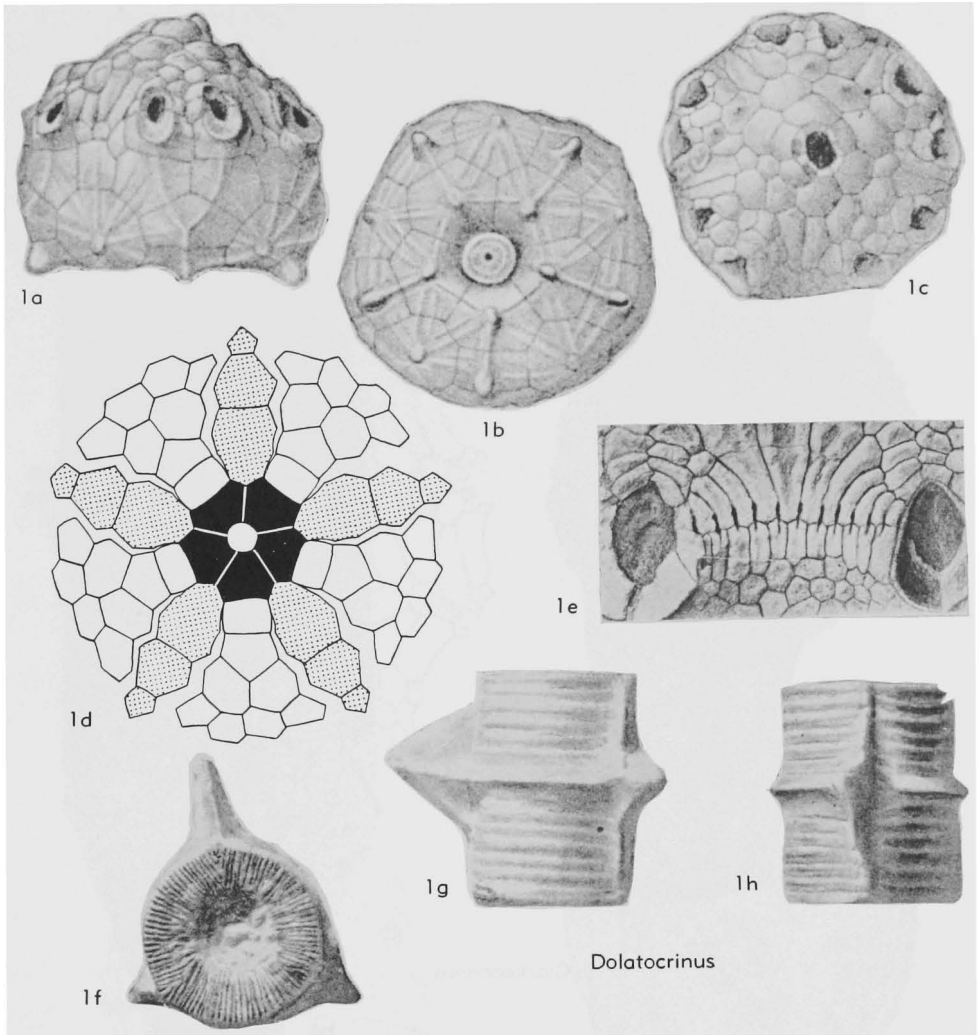


FIG. 300. Dolatocrinidae (p. T498).

1d, plate diagram of calyx (radials black, interbranchials stippled), $\times 2$ (Springer, 1921a, mod.). **Craterocrinus** GOLDRING, 1923, p. 185 [*C. ruedemanni*; OD]. Calyx depressed, plates ornamented with low radiating wrinkles; basals 3, azygous one in *AB* interray, or fused; fixed primibrachs 2 in each ray; fixed secundibrachs 1 to 3 (usually 2), and fixed tertibrachs 2 to 5 or even more in each half-ray; fixed pinnulars few, with 2 to 4 pinnule openings between arm bases; 1st interprimibrach large, separated from distal small interprimibrachs by 1, 2, or 3 ranks of fixed tertibrachs; *CD* interray not differentiated in calyx. Tegmen low-arched, with interambulacral areas slightly depressed; anal opening subcentral. Free

arms biserial, typically 4 in each ray. *L.Dev.*, N.Am.(USA).—FIG. 302,2. **C. ruedemanni*, Onondaga Ls., N.Y.; 2a,b, dorsal and tegmental views of theca, latter showing scar made by attached parasitic gastropod around anal opening, $\times 1$ (Goldring, 1923); 2c, plate diagram of calyx (radials black, interbranchials stippled) (Goldring, 1923, mod.).

Family POLYPELTIDAE Angelin, 1878

[Polypeltidae ANGELIN, 1878, p. 27]

Theca large, calyx bowl shaped and many-plated; allometric growth-zone near base of calyx resulting either in inverted

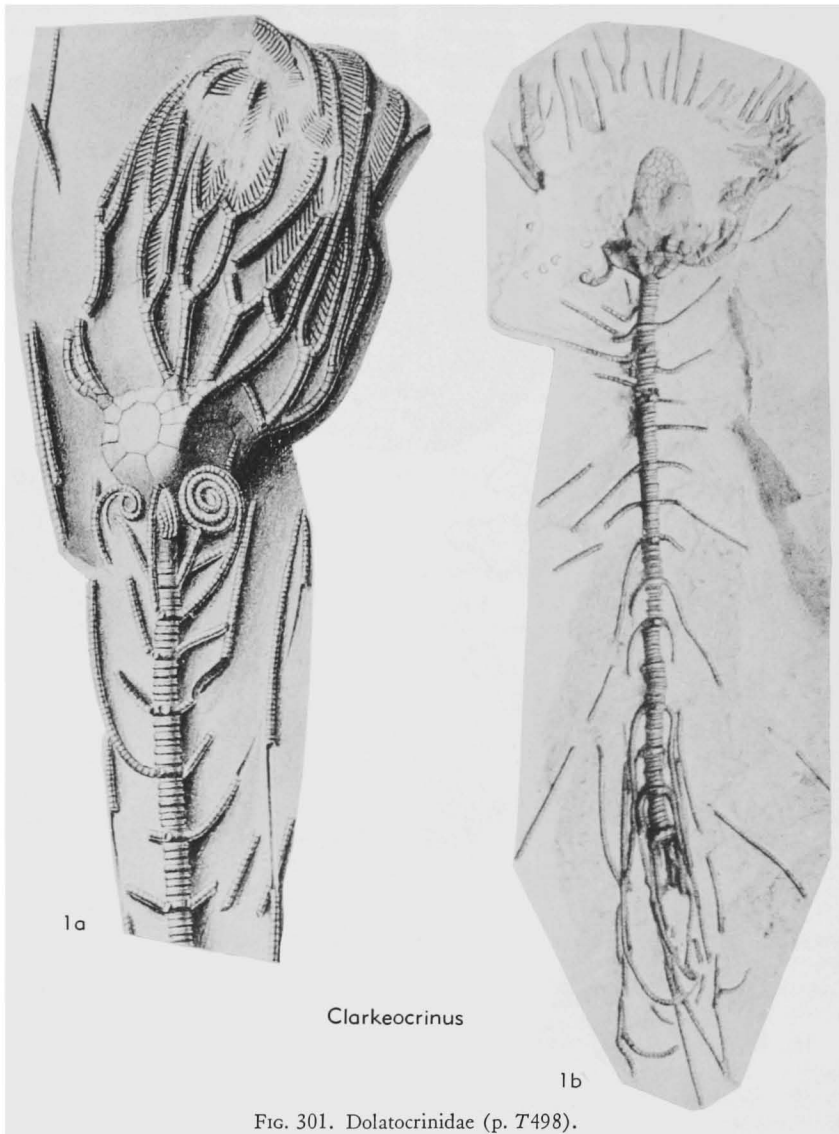


FIG. 301. Dolatocrinidae (p. T498).

position of lower calycal plates or in progressive covering of proximal thecal elements by stem facet; basals three, unequal (azygous one in *AE* interray), either internal only or atrophied (at least in external aspect); large number of ray plates incorporated in calyx; fixed primibrachs one or two in each ray; fixed secundibrachs, if arms divide, two in each half-ray, otherwise numerous; last fixed brachitaxis proximally uniserial, distally biserial; interprimibrachs, intersecundibrachs and intertertibrachs (if

present) few to many, connecting with tegmen or not; generally two interprimibrachs in second range and three in posterior interray. Tegmen low, many-plated. Free arms biserial, typically simple or weakly branching. Large cylindrical stem, with quinquelobate axial canal. *U.Sil.-L.Dev.*

Polypetes ANGELIN, 1878, p. 27 [**P. granulatus*; M]. Calyx pyriform to wide bowl shaped; basals atrophied (at least not visible externally in adult specimens); radials more or less deeply notched by axial canal; fixed primibrachs 2 in each ray;

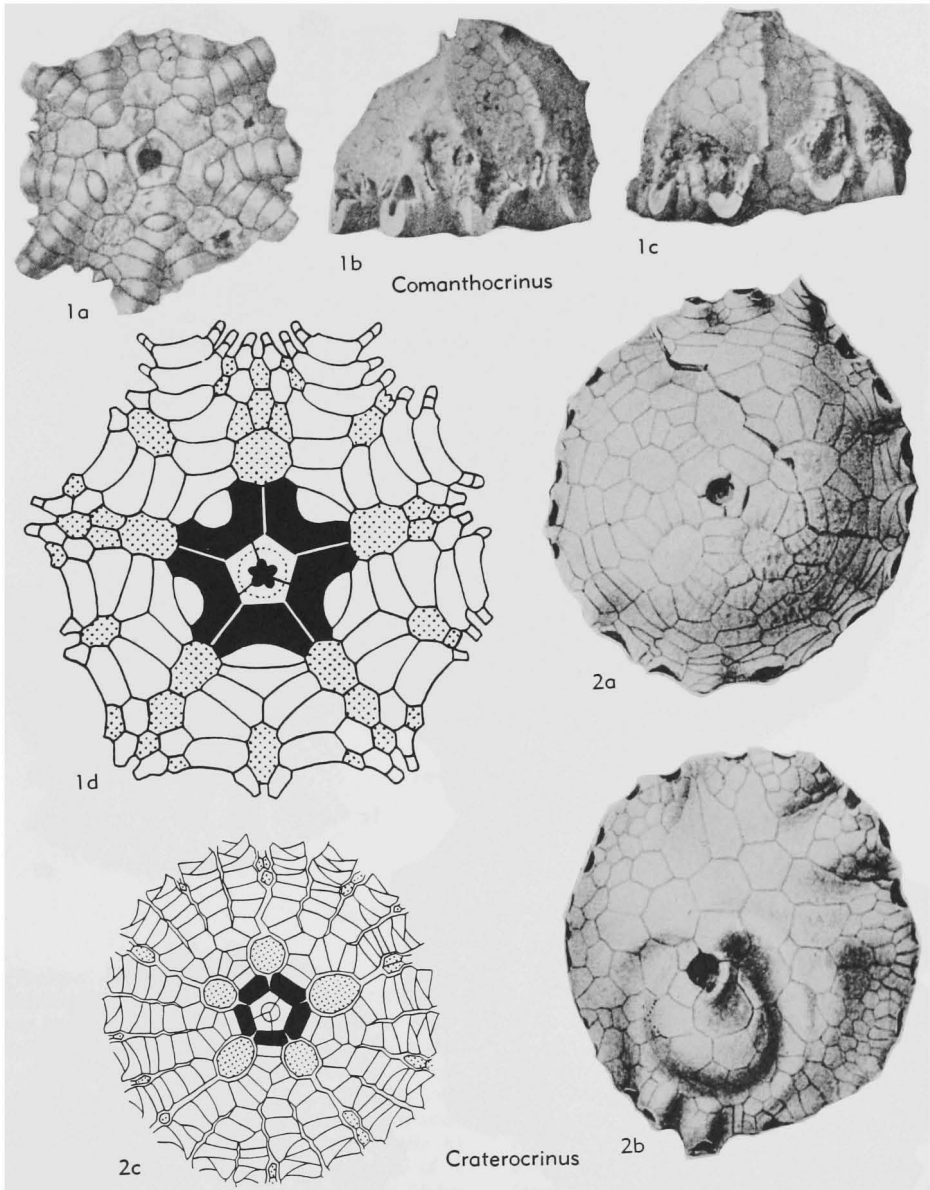


FIG. 302. Dolatocrinidae (p. T498-T499).

fixed secundibrachs 2 and fixed tertibrachs numerous in each half-ray; proximally uniserial, distally biserial; interprimibrachs, intersecundibrachs and intertertibrachs in narrow vertical series, connecting with tegmen; CD interray with few extra plates. Arms 40, heavy, isotomously branching at least once; pinnules short, distal pinnules without oral groove. Stem transversely round, heteromorphic, with short nodals covering extremely thin interprimibrachs, at least proximally. *U.Sil.*,

Sweden (Gotl.).—FIG. 303, 1. **P. granulatus*; 1a, lat. view of lectotype crown (Stockholm Museum, Ec. 6150), $\times 1.5$ (Ubaghs, 1956b); 1b, dorsal view of small theca, $\times 1.5$ (Ubaghs, 1956b); 1c, plate diagram of calyx (radials black, interbrachials stippled) (Ubaghs, 1956b, mod.).

Hadrocrinus LYON, 1869, p. 445 [**H. discus*; SD WACHSMUTH & SPRINGER, 1897, p. 327]. Similar to *Polypeltes* but having only 1 fixed primibrach in each ray, more definite interprimibrachs, inter-

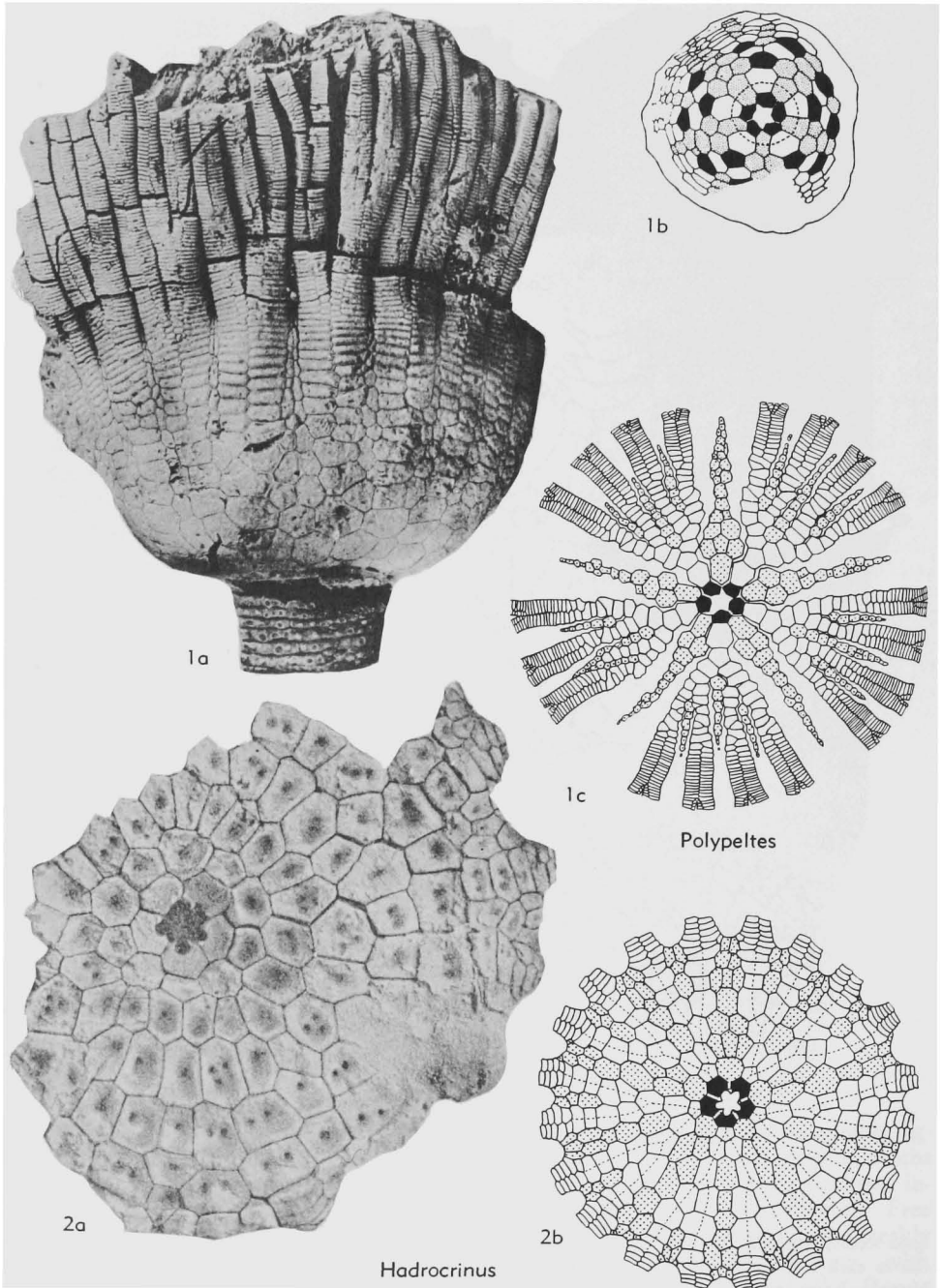


FIG. 303. Polypeltidae (p. T500-T502).

secundibrachs and intertertibrachs and only 20 arm bases. Free arms and stem unknown. *L.Dev.*, N.Am.(USA).—FIG. 303,2. **H. discus*, Jeffer-

sonville Ls., Ky.; 2a, dorsal view of part of theca, $\times 0.9$ (Springer, 1921a); 2b, plate diagram of calyx (radials black, interbrachials stippled)

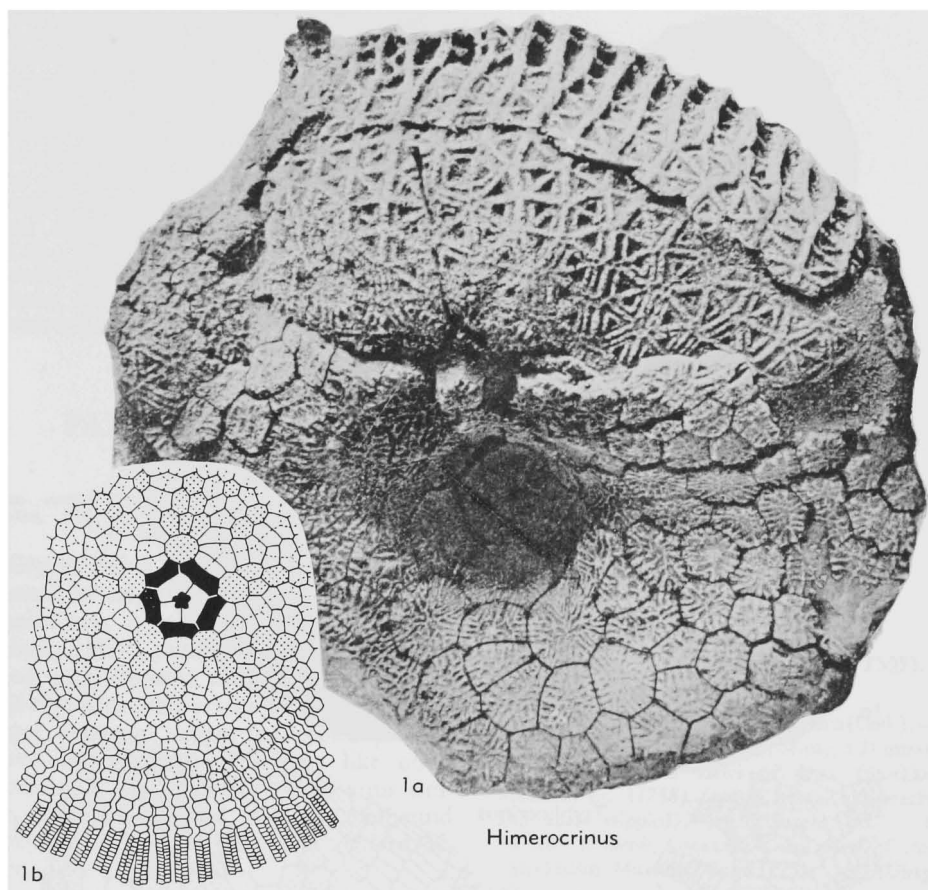


FIG. 304. Polypeltidae (p. T503).

(Springer, 1921a, mod.).

Himerocrinus SPRINGER, 1921, p. 12 [**Hadrocrinus plenissimus* LYON, 1869, p. 445; OD]. Calyx broadly rounded; plates with profuse and highly sculptured ornamentation (at least in type species); basals forming inverted cone; azygous basal in *AE* interray; fixed brachials extremely numerous, each ray dividing 3 to 5 (exceptionally 6) times before becoming free, at intervals of 2 plates for 1st 3 bifurcations, and longer higher up; primaxils somewhat reduced in size, and irregular in shape; interprimibrachs few, 2 in 2nd row, but 3 in *CD* interray, not connecting with tegmen; interbranchials few, located in proximal part of theca; gonioporoids present between cup plates. Tegmen low, composed of innumerable elements. Free arms simple, small, biserial, 16 to 17 in each ray. Column with conspicuous nodals characterized by flanged peripheral rim studded with projecting cogs, overhanging and even concealing thin internodals. *L.Dev.*, N.Am.(USA).

—FIG. 304, I. **H. plenissimus* (LYON), Jeffersonville Ls., Ky.; 1a, oblique dorsal view of theca, $\times 0.9$ (Springer, 1921a); 1b, plate diagram of calyx (radials black, interbranchials stippled) (Springer, 1921a, mod.).

Trybliocrinus GEINITZ, 1867, p. 284 [**Glyptocrinus* (in error for *Trybliocrinus*) *flatheanus*; M] (= *Hadrocrinus hispaniae* W. E. SCHMIDT, 1932, p. 7)] [= *Tribliocrinus* SPRINGER, 1913, p. 191 (*nom. null.*)]. Calyx wide bowl shaped; basal region deeply concave, forming inverted cone comprising basals, radials and primibrachs (in advanced growth stages); fixed part of rays composed of 2 primibrachs and numerous secundibrachs; fixed secundibrachs proximally uniserial, distally biserial; interprimibrachs and intersecundibrachs numerous, connecting with tegmen; *CD* interray commonly not differentiated. Tegmen low, composed of prismatic plates, many of them with bulbous expansions forming an underlying structure; anus opening directly through tegmen;

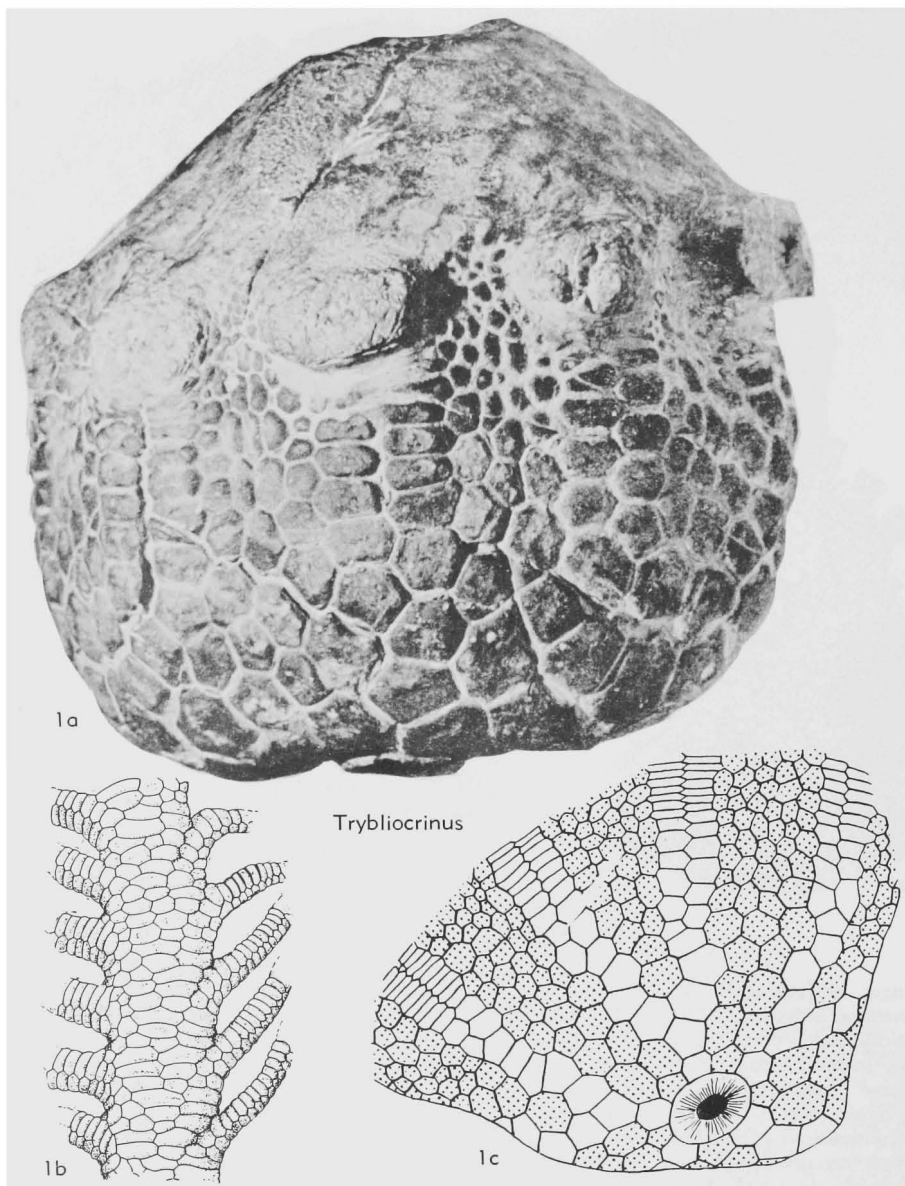


FIG. 305. Polypeltidae (p. T503-T504).

vessel system within tegminal plates. Free arms 10, stout, biserial, with pinnulated biserial ramules alternating along opposite sides; oral sides of arms and ramules roofed by stratified covering plates. Column composed of regular alternation of 1 nodal and 1 to 3 internodals; distal part provided with branching radicular cirri. Coelomic canal system, probably for respiration, present in column as radial canals between columnals, in cup as gonioporoids, in tegmen as lacunae be-

tween lower parts of tegminal plates. *L.Dev.*, Eu. (Spain-?Ger.).—FIG. 305, 1. **T. flatheanus* GEINITZ, *L.Ems.*, Spain; 1a, lat. view of theca, $\times 1$ (Breimer, 1962); 1b, portion of arm, aboral view, $\times 3$ (Breimer, 1962); 1c, oblique lat. view of calyx (interbranchials stippled), $\times 0.7$ (Schmidt, 1932).

Family UNCERTAIN

Abathocrinus STRIMPLE, 1963, p. 109 [**Maria-*

crinus? rotundus SPRINGER, 1926a, p. 29; OD]. Calyx shallow conical; basals diminutive, confined to small concavity, number not known; radials relatively large, in contact with each other all around; fixed primibrachs 2 in each ray; fixed secundibrachs 2 in each half-ray; brachial openings directed outward; interprimibrachs few, 2 in 2nd row, merging with tegminal plates; posterior inter-ray not differentiated in calyx. Tegmen high, rounded, many-plated, pierced by small subcentral anal opening. Free arms and stem unknown. *M.Sil.*, N.Am.(USA).—FIG. 306, *l*. **A. rotundus* (SPRINGER), Niagaran (Decatur Ls.), Tenn.; *1a, b*, DE-interray and dorsal views of theca, $\times 2$ (Springer, 1926a).

Superfamily PATELLIOCRINACEA Angelin, 1878

[*nom. correct.* BROWER, 1973, p. 331 (*pro* Patelliocrinaceae UBAGHS, 1953, p. 742, *nom. transl. ex* Patelliocrinidae ANGELIN, 1878, p. 1)]

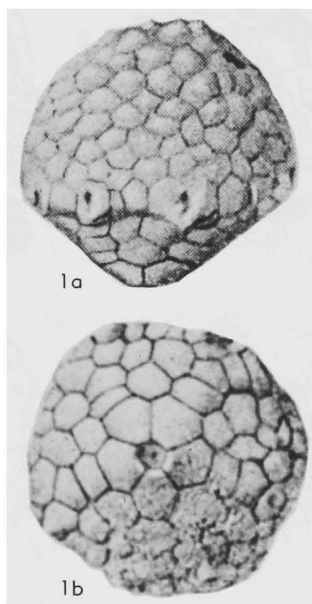
Glyptocrinina with few brachials incorporated in calyx; radials large; fixed primibrachs two, generally much smaller than radials; first primibrachs quadrangular; fixed secundibrachs one to three in each half-ray; interprimibrachs few, first usually large; primalan supporting typically three plates but tending to become like other proximal interprimibrachs. Free arms simple, uniserial, biserial or with compound brachials. Column cylindrical. *U.Ord.-M.Dev.*

Family STELIDIOCRINIDAE Angelin, 1878

[Stelidiocrinidae ANGELIN, 1878, p. 21]

Calyx low to medium conical; basals five; interprimibrachs two between each pair of rays, in vertical succession, followed by single interrarial tegminal plate; one intersecundibrach in each half-ray followed by one interambulacral on tegmen; primalan supporting three plates directly; posterior side of theca marked off by median series of rather large plates leading to laterally placed anus, protected during life by valvular pyramid of small plates. Tegmen low, solid, composed of 14 large plates. Free arms ten, biserial. Column cylindrical. *U.Sil.*

Stelidiocrinus ANGELIN, 1878, p. 21 [**S. capitulum*; SD WACHSMUTH & SPRINGER, 1881, p. 99(273)] [= *Chytrocrinus* JAEKEL, 1918, p. 33 (type, *Stelidiocrinus laevis* ANGELIN, 1878, p. 21; M)].



Abathocrinus

FIG. 306. Family Uncertain (p. T504-T505).

Characters of family. *U.Sil.*, Sweden(Gotl.).—FIG. 307, *1a-d*. **S. capitulum*; A-ray, CD-interray, dorsal, and ventral views of theca (Stockholm Museum, Ec. 11738) (radials black, interbrachials and anals stippled), $\times 4$ (Ubaghs, n).—FIG. 307, *1e*. *S. laevis* ANGELIN; C-ray view of crown (Stockholm Museum, Ec. 11775), $\times 3$ (Ubaghs, n).

Family PATELLIOCRINIDAE Angelin, 1878

[Patelliocrinidae ANGELIN, 1878, p. 1]

Calyx conical or subglobose to subcylindrical; basals ordinarily three, unequal, azygous one in *AE* or *ED* interrays; one genus with all basals fused together; CD interray usually little or not at all differentiated in calyx; tegmen rarely preserved, probably incompetent, consisting of numerous plates differentiated into ambulacrals and interambulacrals in genera where it is known. Free arms uniserial, biserial, or made of compound brachials. Column typically cylindrical. *U.Ord.-M.Dev.*

Patelliocrinus ANGELIN, 1878, p. 1 [**P. pachydactylus*; SD WACHSMUTH & SPRINGER, 1881, p. 102(276)]. Calyx conical to subglobose; fixed secundibrachs 2 in each half-ray, other secundibrachs free; 1st interprimibrach large, followed

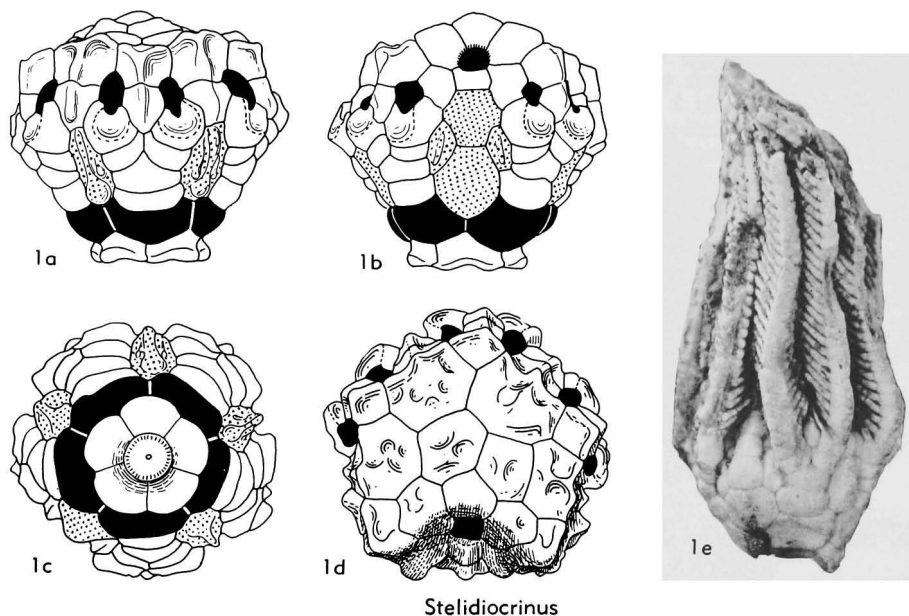


FIG. 307. Stelidiocrinidae (p. T505).

by 1, 2, or several small plates narrowly in contact with tegmen; *CD* interray little or not differentiated in calyx. Free arms 10, simple, biserial; 1st pinnule may be distinctly larger than others. *U.Sil.*, Eu.(Sweden-Eng.)-N.Am.—FIG. 308,1. **P. pachydaetylus*, Gotl.; 1a, *AE*-interray view of slightly reconstructed holotype (Stockholm Museum, Ec. 11586), $\times 2$ and 1b, plate diagram of part of calyx (based on Stockholm Museum, Ec. 11592) (radials black, interbrachials stippled) (Ubaghs, n).

Allocrinus WACHSMUTH & SPRINGER in MILLER, 1889, p. 222 [**A. typus*; OD]. Calyx low bowl shaped, basally excavated; 1st interprimibrach very large followed by 1 or 2 small plates connected with tegmen; *CD* interray little differentiated in calyx or not at all; fixed brachials small, including 1 or 2 secundibrachs. Free arms 10, simple, more or less stout; brachials compound, hyperpinnulated. Columnals rather long, with narrow, pentagonal axial canal. *M.Sil.*(*Niagaran*), N.Am.(USA).—FIG. 309,1a. **A. typus*, Beech River F., Tenn.; lat. view of crown, $\times 2$ (Springer, 1926a).—FIG. 309,1b,c. *A. longidaetylus* SPRINGER, Beech River F., USA(Tenn.); *CD*-interray and dorsal views of theca, $\times 2$ (Springer, 1926a).

Briarocrinus ANGELIN, 1878, p. 1 [**B. inflatus*; SD JAEKEL, 1918, p. 38] [= *Angelinocrinus* JAEKEL, 1918, p. 38 (type, *Briarocrinus angustus* ANGELIN, 1878, p. 1)]. Calyx high bowl shaped; radials and fixed primibrachs large, unequal, irregular in outline; fixed secundibrachs 2 or 3, 1st 2 in lateral contact in each ray, 3rd ones free or

united by single small intersecundibrachs; interbrachials generally 1 in each interray, small, resting on 1st primibrachs or primaxils or even higher according to species, in contact with tegmen or not; primanal generally larger than interprimibrachs, followed by tegminal series of large plates, may rest on adjacent radials. Free arms 10, simple, massive, with compound, hyperpinnulated brachials. *U.Sil.*, Sweden(Gotl.).—FIG. 308,2a,b. **B. inflatus*; lat. views of holotype crown (Stockholm Museum, Ec. 11415), (radials black, interbrachials stippled in 2b), $\times 1.5$ (Ubaghs, n).—FIG. 308,2c. *B. sp.*; *C*-ray view of crown (radials black, anals and interbrachials stippled) (Stockholm Museum, Ec. 11417), $\times 1.5$ (Ubaghs, n).

Centriocrinus BATHER, 1899, p. 922 [*nom. subst. pro Centriocrinus* WACHSMUTH & SPRINGER, 1881, p. 104(278) (*non* AUSTIN & AUSTIN, 1843, p. 6)] [**Actinocrinus pentaspinus* LYON, 1869, p. 453; OD]. Calyx subcylindrical, as wide as high, flat below; basal disc forming circular collar around stem, showing no traces of interbasal sutures; radials very large, followed in each ray by 2 relatively small fixed primibrachs and in each half-ray by 2 still smaller fixed secundibrachs; 1st interprimibrach large, with 2 small plates in next row, and very narrow plate connected with tegmen in 3rd row; *CD* interray differentiated by extra anal plate in 2nd range. Free arm bases in each ray close together. Columnal facet very small. All other parts unknown. *M.Dev.*, N.Am.(USA).—FIG. 308,3. **C. pentaspinus* (LYON), Jeffersonville Ls., Ky.; 3a,b, dorsal and lat. views of

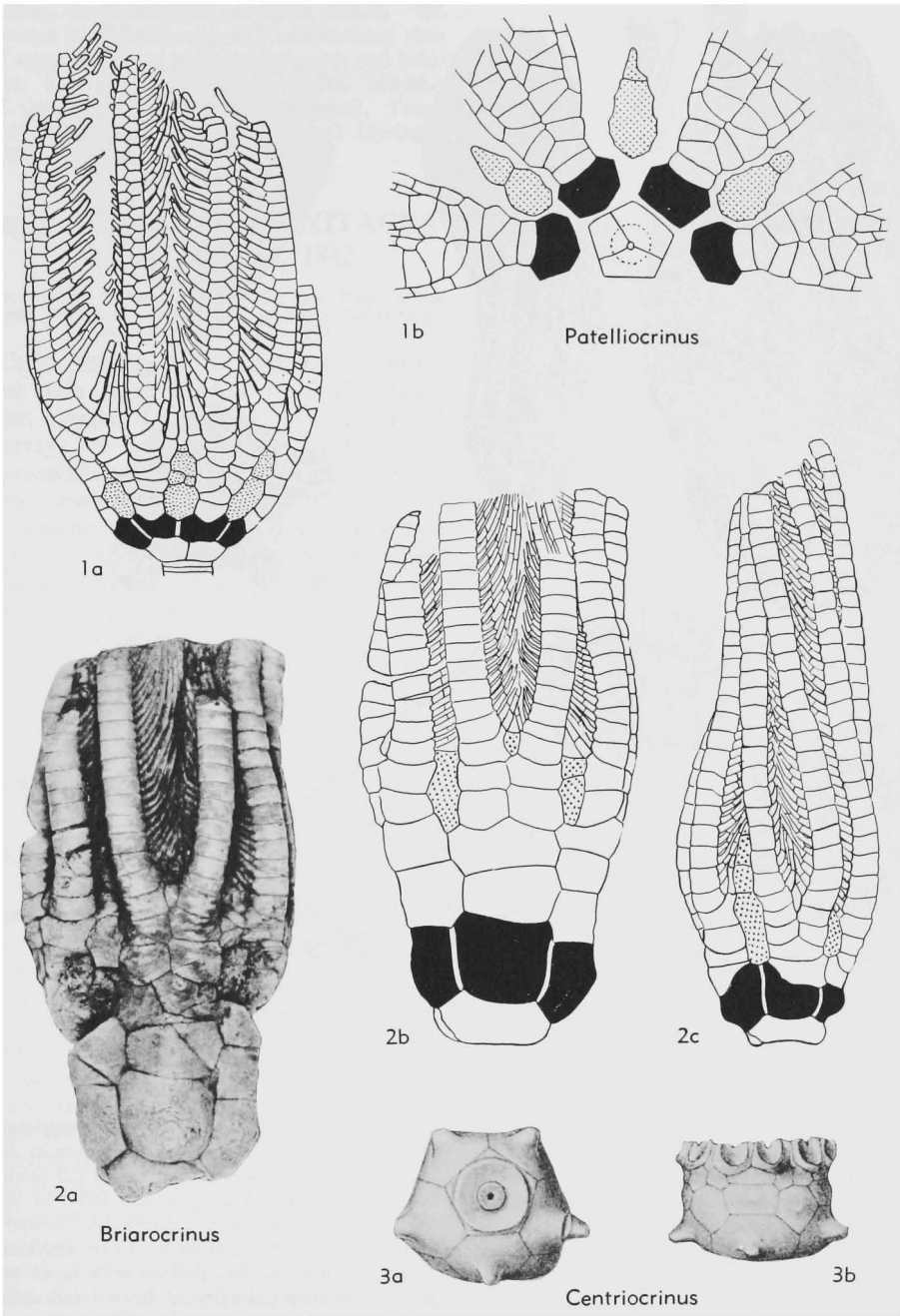


FIG. 308. Patelliocrinidae (p. T505-T506).

holotype, $\times 1$ (Wachsmuth & Springer, 1897).
Eopatelliocrinus BROWER, 1973, p. 332 [**E. scyphogracilis*; OD]. Calyx conical; basals 3, erect, forming part of cup wall; CD interray wider than others; primanal followed by 3 plates; anal inter-

ray ridge present. Free arms 10, uniserial. Column round or pentagonal in cross section. *U.Ord.*, N.Am.(Ill.-Mo.).—FIG. 310, I. **E. scyphogracilis*, Girardeau, Mo.; holotype, lat. view, $\times 3$ (interbrachials stippled) (Brower, 1973).

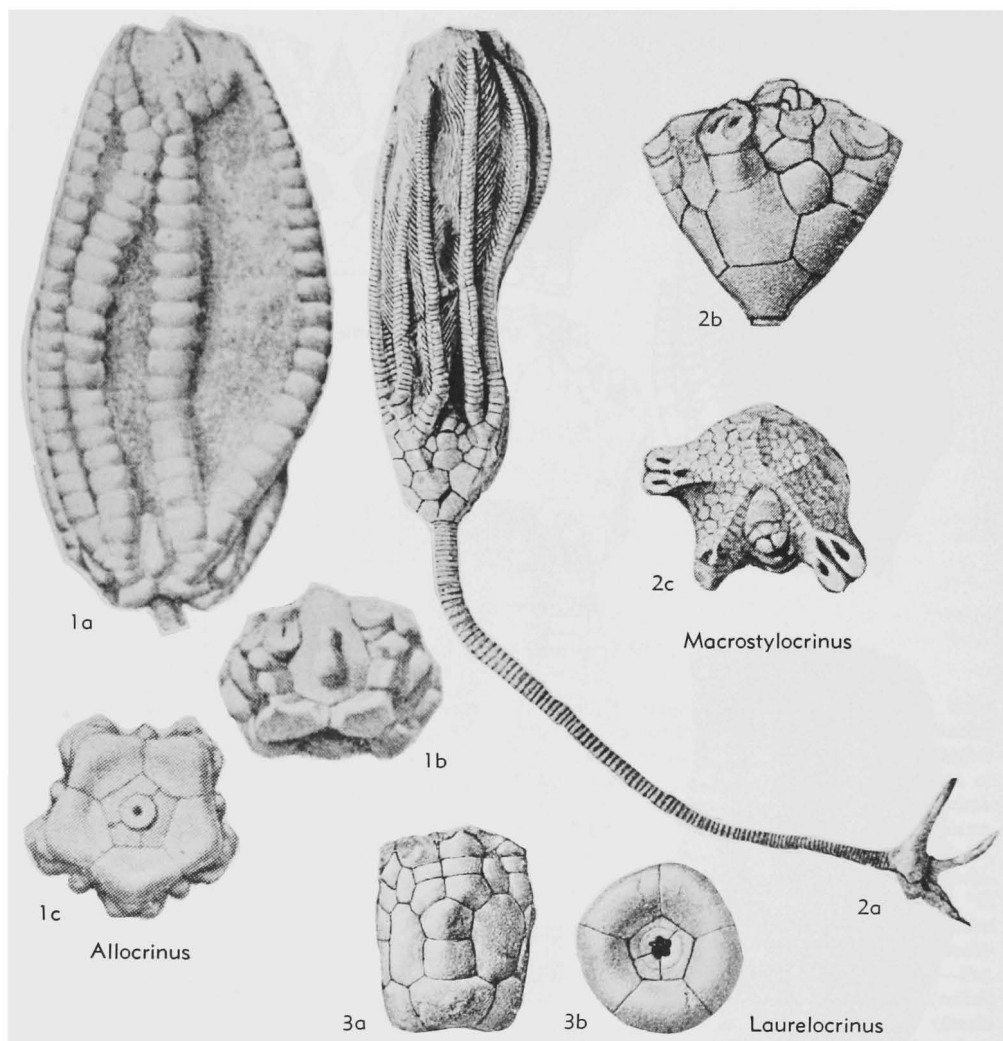


FIG. 309. Patelliocrinidae (p. T506, T508).

Laurelocrinus SPRINGER, 1926, p. 32 [*L. paulensis*; OD]. Calyx elongate cylindrical or slightly contracting upward; basals small, forming with radials broad, flattened, or shallow concave disc; radials very large; fixed secundibrachs 3; 1st interprimibrach large and elongate, with or without small plate above it; single intersecundibrach may occur in each ray; posterior side not differentiated in cup. Free arm bases 4 in each ray, but free arms, tegmen, and column unknown. Columnal facet circular, with large lumen. *M.Sil.*(*Niagaran*), N.Am.(USA).—FIG. 309,3. **L. paulensis*, Laurel Ls., Ind.; 3*a,b*, lat. and dorsal views of theca, $\times 1$ (Springer, 1926*a*).

Macrostylocrinus HALL, 1852, p. 203 [*M. ornatus*; M] [= *Loveniocrinus* JAEKEL, 1918, p. 37 (type,

L. gotlandicus; M)]. Calyx conical to subglobose; fixed secundibrachs 1 or 2; interprimibrachs few, connected with tegmen, 1st one large; CD interray much wider than others; primalanal followed by 3 to 5 plates in next range. Tegmen low, composed of small irregular pieces, with narrow ambulacral tracks and more or less distinct orals; anus marginal. Free arms generally 10, biserial and simple, recumbent and as many as 23 to 25 in a Devonian species. Column with small axial canal; whorls of cirri may be present. [In one or perhaps two rays of the type and only known specimen of *Loveniocrinus* one of the proximal pinnules is replaced by an arm, bringing to 3 the number of arms in this ray; such difference is judged not sufficient to warrant a generic distinction.] *U.Ord.-*

L.Dev., Eu.-N.Am.(USA).—FIG. 309,2a. **M. ornatus*, M.Sil.(Niagaran), N.Y.; CD-interray view of complete crown with attached stem and hold-fast, $\times 1$ (Springer, 1926a).—FIG. 309,2b,c. *M. granulatus* HALL, M.Sil.(Niagaran), Tenn.; post. and tegminal views of theca, $\times 3$ (Springer, 1926a).

Superfamily PLATYCRINITACEA Austin & Austin, 1842

[*nom. correct.* BROWER, 1973, p. 397 (*pro* Platycrinitaceae UBAGHS, 1953, p. 742, *nom. iransil. ex* family Platycrinoidea AUSTIN & AUSTIN, 1842, p. 109)]

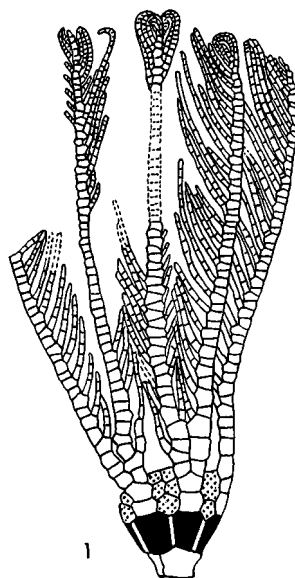
Calyx tending to be confined to lowermost two plate circlets (patina); basals three, unequal (small one normally in *AE* interrayer), or fused together; brachials and interbrachials generally little represented in calyx, proximal brachials tending to stand out clearly from radials although joined firmly to calyx, tegmen, or both by interradially situated plates; posterior side slightly or not at all differentiated in calyx. ?*U.Ord.*, *Sil.-Perm.*

Family MARSUPIOCRINIDAE Bronn, 1855

[Marsupiocrinidae BRONN, 1855, p. 22] [=family Marsupiocrinoidae AUSTIN & AUSTIN, 1842, p. 109 (invalid family-group name based on nominal genus which is a junior homonym); Marsupiocrinidae AUSTIN & AUSTIN, 1843, p. 198 (rejected for same reason); Cypellocrinidae BATHER, 1899b, p. 922; Marsupiocrinidae BATHER, 1900a, p. 156; Marsupiocrinidae JAEKEL, 1918, p. 38]

Calyx flat to low bowl shaped; basals 3, unequal, or fused; fixed primibrachs one in each ray, small, trigonal, axillary; first fixed secundibrachs on either side of it resting on radials, with one to several following brachials, wholly incorporated in calyx; fixed secundibrachs, if arms divide further, one or two; single large interbrachial between adjoining rays, succeeded by smaller plates which may be restricted to tegmen. Tegmen flat to low conical, many-plated, with or without well-defined ambulacra, and directly pierced by subcentral anus. Free arms 2 to 4 to each ray, simple, stout, biserial. Column circular in section, with nudinodals and interradials; axial canal large, pentagonal or quinquelobate. *M.Sil.-L.Dev.*

Marsupiocrinus MORRIS, 1843, p. 54 [**Marsupiocrinites coelatus* PHILLIPS in MURCHISON, 1839, p. 672; M] [=*Marsupiocrinites* PHILLIPS in MURCHISON, 1839, p. 672 (*non* DE BLAINVILLE, 1830) (type, *M. coelatus*; M); *Cupellaecrinites* TROOST,



Eopatelliocrinus

FIG. 310. Patelliocrinidae (p. T507).

1850a, p. 419 (*nom. nud.*) (type, *C. buchii*; SD BASSLER, 1938, p. 78); *Cupellaecrinus* SHUMARD, 1865, p. 361 (*nom. van.*); *Cupellaecrinus* MEEK & WORTHEN, 1866a, p. 172 (*nom. van.*); *Cypellocrinus* BATHER, 1899b, p. 921 (*nom. van.*) (*non* BATHER in LANKESTER, 1900, p. 177); *Marsupiocrinus* BATHER, 1899b, p. 173 (*nom. van.*)]. Characters of family. *M.Sil.-L.Dev.*, Eu.-N.Am.

M. (Marsupiocrinus). Four arms per ray, no basal rim, broad basal invagination involving both basals and radials, gently convex base, and greatly elongated interbrachials. *M.Sil.-L.Dev.*, Eu.-N.Am.—FIG. 311,1. **M. (M.) coelatus* (PHILLIPS), M.Sil.(Wenlock.), Eu.(Eng.); *Ia,b*, lat. and dorsal views of crown, $\times 1$ (Springer, 1926a); *Ic*, plate diagram of part of calyx (radials black, interbrachials stippled) (Ubaghs, n).

M. (Amarsupiocrinus) FREST, 1975, p. 569 [**Marsupiocrinus striatissimus* SPRINGER, 1926a, p. 61; OD]. Generally two arms per ray, pronounced basal rim surrounding column facet, nearly planar base, and subquadrate interbrachials. *M.Sil.*, N.Am.(USA).—FIG. 311,2. **M. (A.) striatissimus* (SPRINGER), M.Sil.(Niagaran), Tenn.; *2a,b*, aboral and lat. views of calyx, $\times 0.67$; *2c*, aboral side of crown, $\times 0.67$ (Springer, 1926a).

Family HALALOCRINIDAE Jaekel, 1895

[Hapalocrinidae JAEKEL, 1895, p. 94] [=Cococrinidae ZITTEL, 1895, p. 124 (*partim*); Cococrinidae BATHER, 1899b, p. 922; Thalocrinidae, Agriocrinidae JAEKEL, 1918, p. 91]

Primibrachs two in each ray, exceptionally fewer or more, generally well developed;

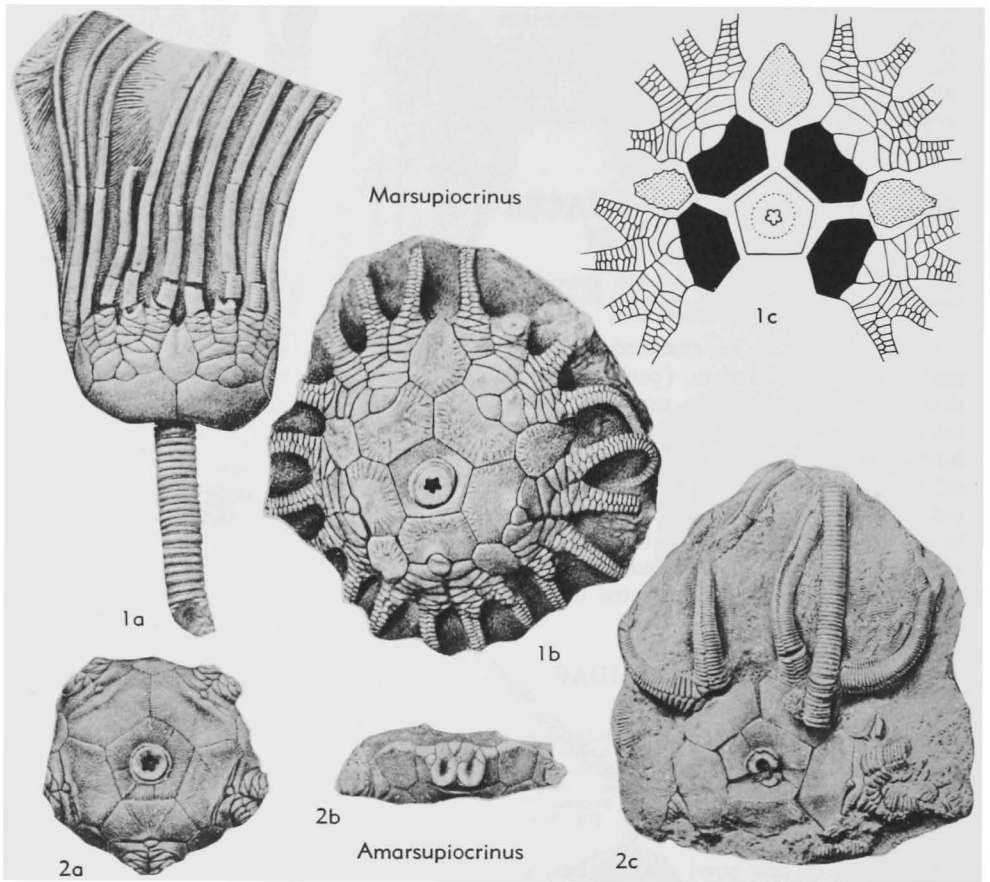


FIG. 311. Marsupiocrinidae (p. T509).

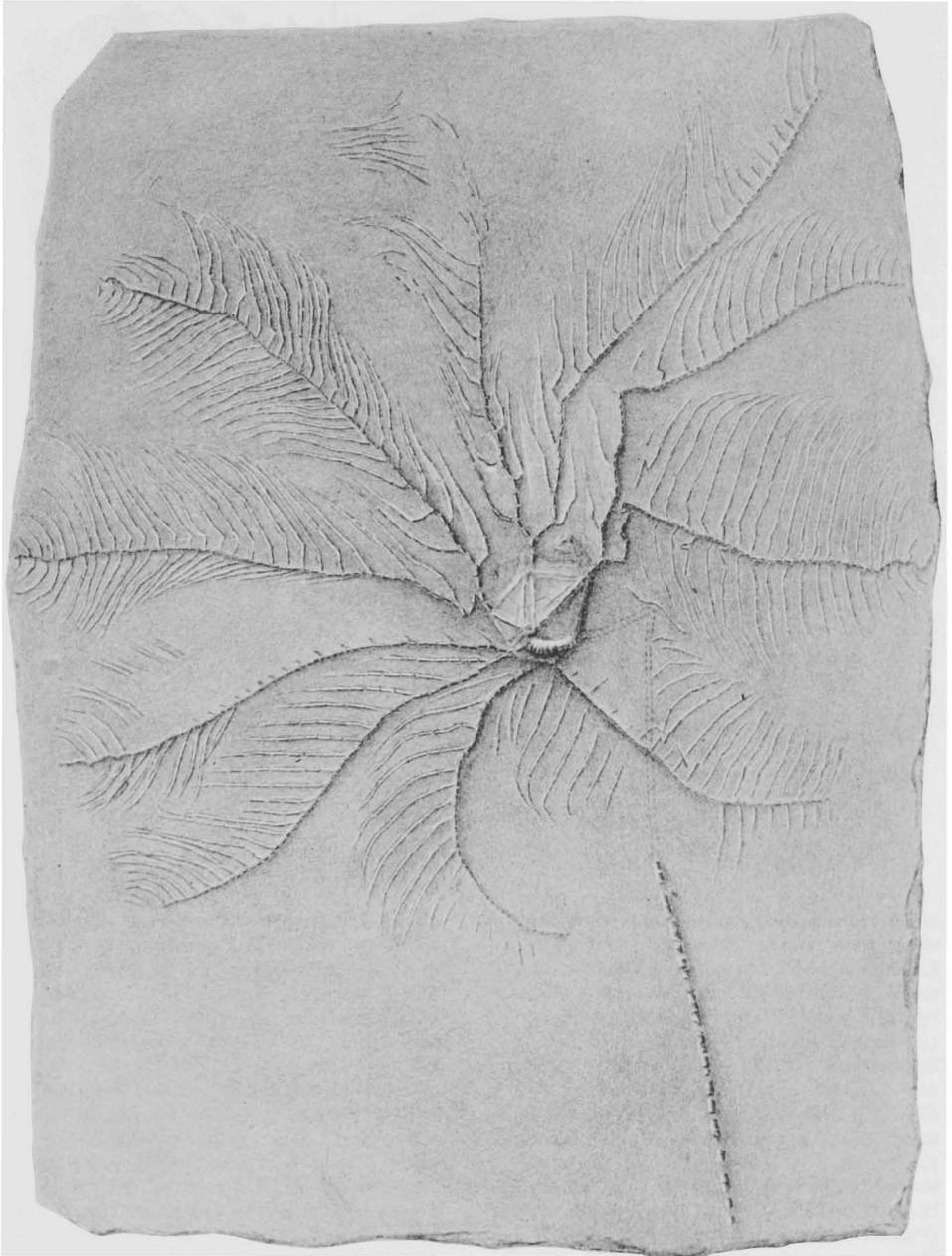
secundibrachs more than two in each half-ray. Tegmen mainly composed of five orals; ambulacral tracts ordinarily distinct, but tending to become covered by orals which themselves tend to remain in apposed apical position; no differentiated axillary ambulacrals and no interambulacrals; mouth subtegminal or suprattegminial; anal tube absent or incipient. Free arms generally two in each ray, simple or forking, proximally uniserial, then biserial or composed of compound brachials. Column typically cylindrical; axial canal small and round. ?*U.Ord.*, *Sil.-M.Dev.*; ?*U.Perm.*

Hapalocrinus JAEKEL, 1895, p. 95 [**H. elegans*; M] [= *Agriocrinus* JAEKEL, 1895, p. 103 (type, *A. frechi*; SD BASSLER, 1938, p. 36)]. Primibrachs 2, exceptionally 3 or 5; arms uniserial, forking once or more; brachials quadrangular, generally elongate, with pinnule on each or every other one;

tegmen unknown. *L.Dev.*, Eu.—FIG. 312, I. **H. elegans*, Bundenbacher Schiefer, Ger.; oblique dorsal view of crown, $\times 0.7$ (Jaekel, 1895).

Amblacrinus D'ORBIGNY, 1849, p. 104 [**Platycrinus rosaceus* ROEMER, 1844, p. 63; SD BASSLER, 1938, p. 38] [= *Cococrinus* MÜLLER in ZEILER & WIRTGEN, 1855, p. 20 (obj.)]. Primibrachs 2, 1st one slightly incorporated in calyx; interprimibrachs 1 in each interray, pentagonal, posterior one larger than others. Tegmen composed of 5 large orals, with little or no differentiation of posterior oral; ambulacra suprattegminial in narrow grooves along interoral sutures; mouth subtegminal; anus between posterior oral and posterior interprimibrach. *M.Dev.*, Eu.—FIG. 313, I. **A. rosaceus* (ROEMER), Couvin., Ger.; 1a-c, lat., dorsal, and tegminial views of theca, $\times 1$ (Springer, 1926a).

Bogotacrinus W. E. SCHMIDT, 1937, p. 5 [**B. scheibei*; OD]. Primibrachs 3 in each ray, primaxils bearing bilaterally heterotomous rami; brachials compound and generally bipinnulated. *Sil.*



1

Hapalocrinus

FIG. 312. Hapalocrinidae (p. T510).

or *L.Dev.*, S.Am.(Colom.).—FIG. 313,2. **B. scheibei*; arms of ray (radial black, pinnules omitted), $\times 1.3$ (Schmidt, 1937).

Cantharocrinus BREIMER, 1962, p. 117 [**C. minor*; OD]. Small basal in *AE* or *CD* interray; primi-

brachs 2, 1st one slightly incorporated in calyx; single hexagonal interprimibrach in each interray, but 3 in posterior interray. Tegmen composed of 5 triangular orals, posterior one largest; ambulacral tracts covered by alternating platelets, not reaching

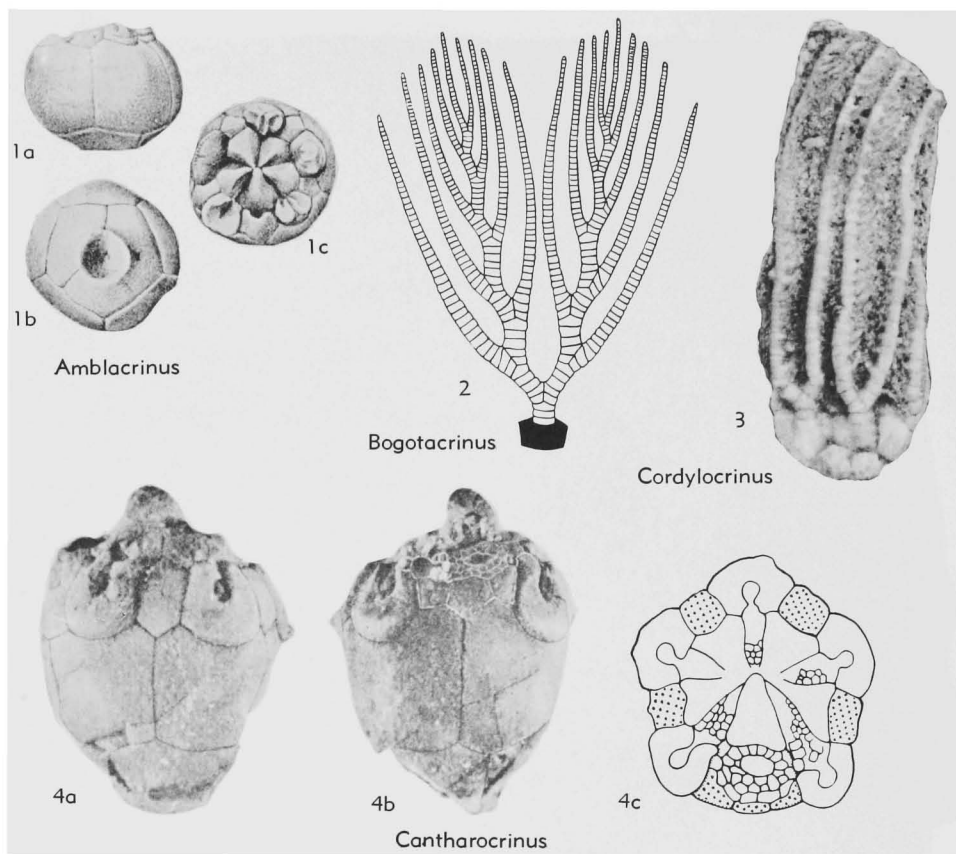


FIG. 313. Hapalocrinidae (p. T510-T512).

center; mouth subtegmenal; anus surrounded by many small plates. Arms and stem unknown. *L.Dev.-M.Dev.*, Eu.(Spain).—FIG. 313,4. **C. minor*, L. Ems., León Prov.; 4a-c, AB-, CD-inter-ray, and tegmenal views of holotype theca, $\times 4$ (interbrachials stippled) (Breimer, 1962).

Clematocrinus JAEKEL, 1898a, p. 47 [**Actinocrinites? retarius* PHILLIPS in MURCHISON, 1839, p. 674; M]. Primibrachs 2, joined to calyx; 1st interprimibrachs relatively large. Free arms simple, 10 to 20; brachials cuneate in zigzag or biserial. Stem with whorls of cirri. *M.Sil.*, Eu.-N.Am.-?Australia.—FIG. 314,1. **C. retarius* (PHILLIPS), Wenlock Ls., Eng.; lat. view of complete crown with attached stem, $\times 3$ (interbrachials stippled) (Bather, 1900a, mod.).

Cordylocrinus ANGELIN, 1878, p. 3 [**C. comtus*; M]. Primibrachs 2 in each ray; arms incorporated in calyx up to 2nd secundibrachs (at least in type species); 1st interprimibrachs large. Tegmen, known only in *C. plumosus* (HALL), many-plated and bearing anal cone. Arms simple, with compound, bipinnulate brachials. Column with whorls

of cirri (at least in some species). *U.Sil.-L.Dev.*, Eu.-N.Am. [The characters shown by the tegmen of *C. plumosus* (HALL) do not fit well with the family diagnosis. One has to be cautious about reference of this species to *Cordylocrinus*.]—FIG. 313,3. **C. comtus*, U.Sil., Sweden(Got.); lat. view of crown, $\times 3$ (Ubaghs, n).

Culicocrinus MÜLLER in ZEILER & WIRTGEN, 1855, p. 23 [**Platycrinus nodosus* MÜLLER in ZEILER & WIRTGEN, 1855, p. 15; M] [=Protoeuryale MÜLLER in ZEILER & WIRTGEN, 1855, p. 24 (type, *P. confluentina*; M); *Cylicocrinus* BATHER in LANKESTER, 1900a, p. 156 (nom. van. pro *Culicocrinus*)]. Primibrachs 2 and proximal secundibrachs incorporated in calyx by 5 large interprimibrachs. Tegmen composed of 5 orals, generally ornamented by protuberances; posterior oral differentiated; anus in notch of posterior oral. Free arms biserial, forking once or twice. ?*U.Ord.*, N.Am.; *L.Dev.*, W.Eu. [The position of this genus among Hapalocrinidae is somewhat uncertain.]—FIG. 314,2. **C. nodosus* (MÜLLER), U.Ems., Ger.; 2a, lat. view of theca and part of

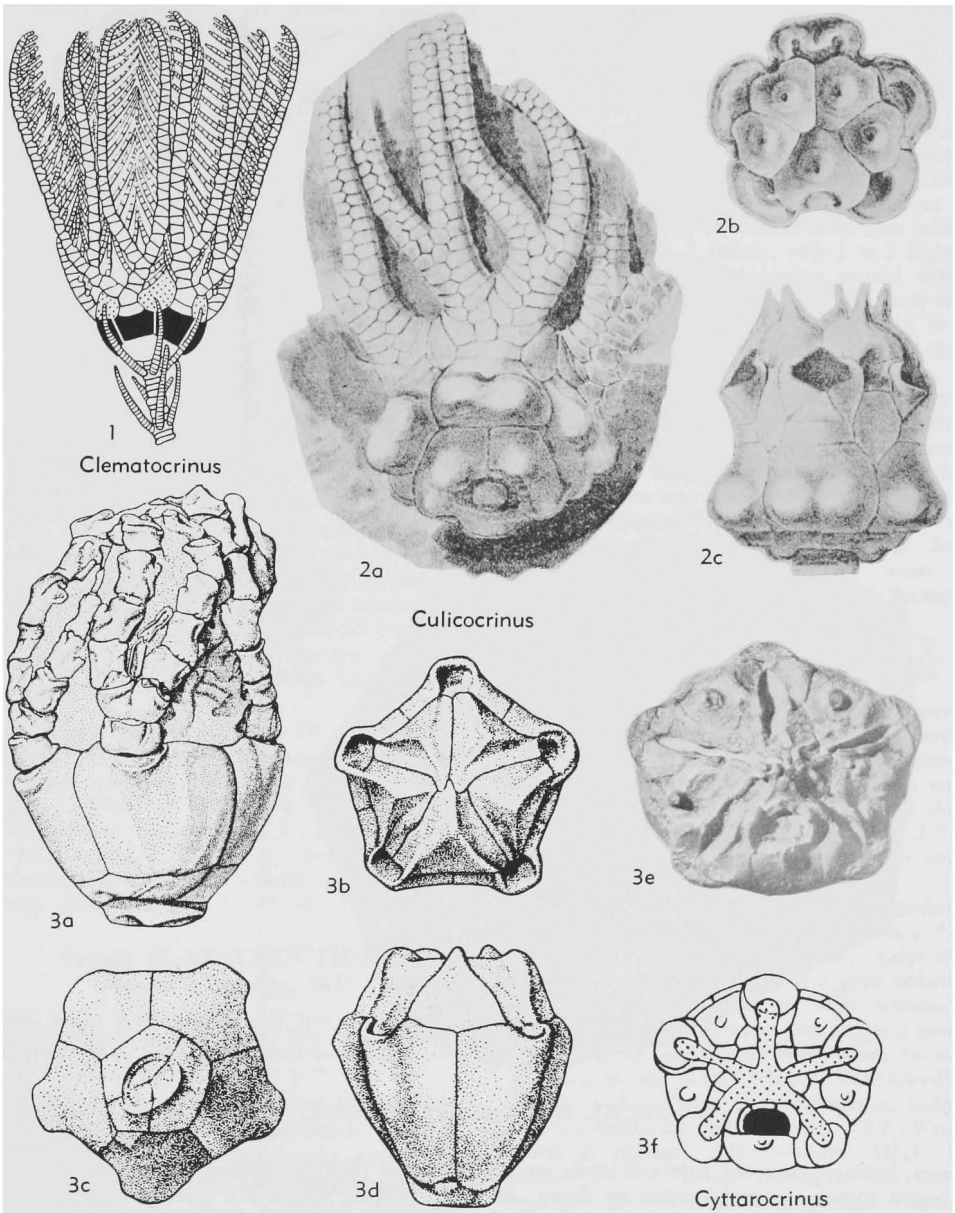


FIG. 314. Hapalocrinidae (p. T512-T514).

free arms, $\times 2$ (Müller, in Zeiler & Wirtgen, 1855); 2*b,c*, theca in tegmental and lat. views, $\times 3$ (Müller, in Zeiler & Wirtgen, 1855).

Cyttarocrinus GOLDRING, 1923, p. 265 [*Platycrinus eriensis* HALL, 1862; OD]. Small basal in *AE* or *AB* interray; primibrachs 1 or 2; interprimibrachs comparatively large, largest in *CD* interray. Tegmen (in *C. jewetti* GOLDRING) composed of 5 orals and 2 interambulacra in each interray,

bordering each interprimibrach; ambulacra and ?mouth suprattegmental; anus large, bordered above by posterior oral, narrow interambulacra on each side, and below by posterior interprimibrach. Free arms simple, uniserial. [This diagnosis combines features of both *C. eriensis* and *C. jewetti*; however, it is far from proved that these species are congeneric, as admitted by GOLDRING (1923). The type species is based on an incomplete speci-

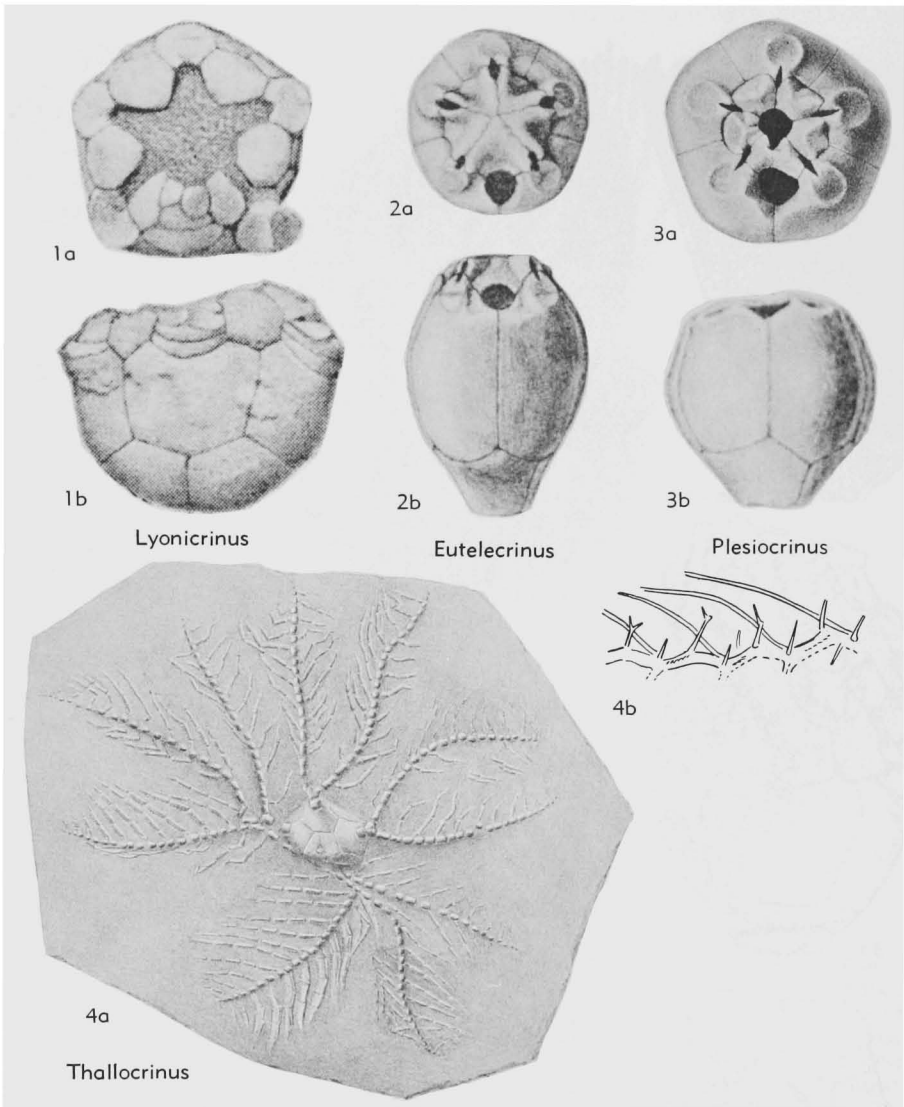


FIG. 315. Hapalocrinidae (p. T514-T515).

men, lacking a stem and right half of the crown; neither tegmen nor stem insertion are shown. An ontogenetic series assumed to belong to *C. eriensis* and described by KOENIG (1965) suggests that the tegmen of *Cyttarocrinus*, as in *Amblacrinus*, is composed of 5 orals, with interoral sutures at bottom of shallow troughs; in these immature crinoids the stem cicatrix is elliptical. If this assumption be correct, *C. jewetti*, which closely resembles *Lyonicrinus bacca*, ought probably to be transferred to the latter genus and the diagnosis of *Cyttarocrinus* changed accordingly.] *L.Dev.-M.Dev.*, Eu.-N.Am.(USA).—FIG. 314,3a. *C.

eriensis (HALL), Hamilton Sh., N.Y.; *D*-ray view of holotype crown, $\times 4$ (Koenig, 1965).—FIG. 314,3b-d. *C. sp. cf. C. eriensis* (HALL), Moscow F., USA(N.Y.); ventral, dorsal, and lat. views of immature specimens, $\times 15$ (Koenig, 1965).—FIG. 314,3e,f. *C. jewetti* GOLDRING, Hamilton Gr., USA(N.Y.); tegmen, photograph and diagram, $\times 4$ (mouth and ambulacral areas stippled) (photo courtesy Buffalo Museum; diagram, mod. from Koenig, 1965).

?*Eutelecrinus* WANNER, 1916, p. 23 [**E. piriformis*; OD]. Theca distally constricted; tegmen composed of 5 large orals. *U.Perm.*, Indon.(Timor.).

[Genetic relations of this genus with Silurian and Devonian hapalocrinids are uncertain.]—FIG. 315,2. **E. piriformis*; 2a,b, tegminal and CD-interray views of theca, $\times 2$ (Wanner, 1937).

Lyonocrinus SPRINGER, 1926, p. 48 [**Coccoocrinus bacca* ROEMER, 1860, p. 51; OD]. Small basal in DE interray; primibrachs 2, joined to adjacent interprimibrachs or interambulacrals. Tegmen composed of 4 plates interambulacral in position, separated by open clefts and surrounding central open space (peristome), which during life may have been partly occupied by a posterior plate and covered by superoral plates; ambulacra suprategminal, flanked by adambulacrals and probably closed by covering plates; 1 large posterior plate bordered by 2 small ones supporting short lateral anal protuberance. Free arms 10, simple, uniserial. *M.Sil.*, N.Am.(USA).—FIG. 315,1. **L. bacca* (ROEMER), Niagaran (Beech River F.), Tenn.; 1a,b, tegminal and B-ray views of theca, $\times 3$ (Springer, 1926a).

?**Plesiocrinus** WANNER, 1937, p. 74 [**P. piriformis*; OD]. Like *Euteleocrinus* but with central tegminal opening between orals, probably covered during life by superoral plates. *U.Perm.*, Indon.(Timor.). [Genetic relations of this genus with Silurian and Devonian hapalocrinids are uncertain.]—FIG. 315,3. **P. piriformis*; 3a,b, tegminal and CD-interray views of holotype theca, $\times 2$ (Wanner, 1937).

Thallocrinus JAEKEL, 1895, p. 106 [**T. hauchecornei*; M]. Similar to *Hapalocrinus* but with movable spines on ventral side of free arms. *L.Dev.*, Eu.(Ger.).—FIG. 315,4a. **T. hauchecornei*, Bundenbacher Schiefer; type, $\times 1$ (W. E. Schmidt, 1932).—FIG. 315,4b. *T. procerus* W. E. SCHMIDT, Bundenbacher Schiefer; portion of arm with spines, enl. (W. E. Schmidt, 1934).

Family PLATYCRINITIDAE Austin & Austin, 1842

[*nom. correct.* BASSLER, 1938, p. 23 (pro family Platycrinoidae AUSTIN & AUSTIN, 1842, p. 109)] [=Platycrinidae AUSTIN & AUSTIN, 1843, p. 199] [Materials for this family prepared by N. GARY LANE]

Calyx confined to patina of five radials, and three unequal basals which may be fused; posterior side commonly not differentiated; orals distinct; interambulacrals and ambulacrals important tegminal elements but absent in youngest genera; first primibrachs typically axillary. Arms biserial, pinnulate. Column transversely round proximally, elliptical and twisted distally, with synarthrial articulation, fulcral ridge following long diameter of columnals; axial canal small, round. ?*U.Sil.*, *Dev.-Perm.*

Platycrinites MILLER, 1821, p. 73 [**P. laevis*; SD MEEK & WORTHEN, 1865c, p. 160] [=Platycrinus

AGASSIZ, 1836, p. 197 (obj.) (*nom. van.*); *Centrocrinus* AUSTIN & AUSTIN, 1843, p. 6 (type, *Platycrinites gigas* GILBERTSON, in PHILLIPS, 1836, p. 204); *Atocrinus* M'COY in GRIFFITH, 1842, p. 11 (type, *A. milleri*). Calyx bowl shaped; basals 3, unequal, small one typically in AE interray, or fused with others; radials large, with narrow articular facets. Tegmen flat or pyramidal, composed of numerous plates, orals distinct; anal opening excentric, directly through tegmen or at end of short or long anal tube. Arms with primibrachs 1 or rarely 2 axillary, with 1 to 5 higher, heterotomous divisions, becoming biserial above distal axillary of branches; proximal brachials like free arm plates but fixed to tegmen by 1 to 3 interradials. ?*U.Sil.*, *L.Dev.-U.Perm.*, Eu.-N.Am.-Indon.(Timor.).—FIG. 316,2a,b. **P. laevis*, L. Carb., Eng.; lat. views of crown and partial crown with anal tube, $\times 0.9$ (Wright, 1955).—FIG. 316,2c-e. *P. burlingtonensis* (OWEN & SHUMARD), L.Miss.(Osag., Burlington Ls.), USA(Iowa); lat. views of crown and theca, ventral view of theca, $\times 0.9$ (Wachsmuth & Springer, 1897).—FIG. 317,4. *P. saffordi* (HALL), L.Miss.(Osag., Burlington Ls.), USA(Iowa); 4a,b, lat. views of crown and theca, $\times 0.7$ (Wachsmuth & Springer, 1897).

[Revision of M'COY's species of Irish crinoids by G. SEVASTOPOLO, Univ. of Dublin, has resulted in transfer of *Edwardsocrinus* D'ORBIGNY, 1849, from *Platycrinites* to *Dichocrinus* (G. SEVASTOPOLO, pers. comm.).]

Brahmacrinus SOLLAS, 1900, p. 264 [**B. ponderosus*; OD]. Calyx as in *Platycrinites*; primibrachs and secondibrachs in sutural contact with tegminal interambulacrals and interbrachials. Tegmen with subcentral anal tube. Arms free above 1st tertibrachs. *L.Carb.*(*Tournais.*). Eng.—FIG. 317,5. **B. ponderosus*; 5a,b, post. and BC-interray views of theca, $\times 0.7$ (Sollas, 1900).

Eucladocrinus MEEK, 1872, p. 373 [**Platycrinites* (*Eucladocrinus*) *montanaensis* MEEK, 1872a, p. 373 (*nom. imperf. pro montanaensis*); M]. Calyx like *Platycrinites*. Arms consisting of 2 main uniserial rami in each ray, covered by large ambulacral plates, forming tubular extensions of thecal cavity and giving off on alternate sides short, biserial, pinnulate ramuli. *L.Miss.*(*Osag.*), USA(Iowa-Ill.-Mont.).—FIG. 316,3. **E. montanaensis*, Lodgepole Ls., Mont.; lat. view of crown, $\times 0.9$ (Wachsmuth & Springer, 1897).—FIG. 317,3. *E. pleuroviminus* (WHITE), Burlington Ls., Iowa; lat. view of crown, showing strongly elliptical twisted stem, $\times 0.7$ (Wachsmuth & Springer, 1897).

Neoplaticrinus WANNER, 1916, p. 32 [**N. dilatatus*; OD]. Aboral cup and lateral anal opening as in *Pleurocrinus*. Tegmen with 5 orals and few interambulacral plates, lacking interambulacrals; anal opening between CD oral and C and D radials. Arms unknown. *U.Perm.*, Indon.(Timor.).—FIG. 317,2. **N. dilatatus*; 2a-c, post., post., and ventral views of theca, $\times 0.7$; 2d, ventral view of theca, $\times 1$ (Wanner, 1937).

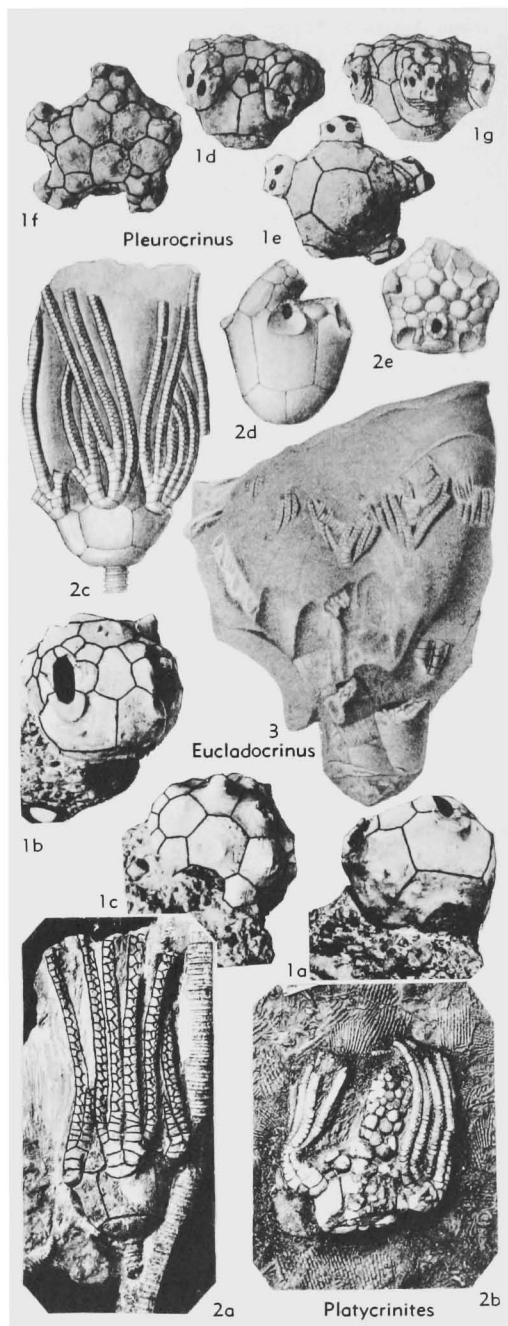


FIG. 316. Platyrcrinidae (p. T515-T516).

Oenochoacrinus BREIMER, 1962, p. 124 [**O. princeps*; OD]. Small basal in *CD* or *AE* position; posterior interray wider than others. Tegmen composed of 5 central orals, of which *CD* oral

is largest, and 5 large axillary ambulacral plates in radial position; anal opening bounded below by 3 small plates. *L.Dev.-M.Dev.*, Spain.—FIG. 317,6. **O. princeps*, L.Dev.; 6a-d, post., dorsal, ventral, and ant. views of theca, $\times 2$ (Breimer, 1962).

Plemnocrinus KIRK, 1946, p. 435 [**P. beebei*; OD]. Calyx low, basin shaped or flat; radials widest medially, distally constricted into protruding neck. Arms with hypertrophied primaxil forming with 2 fused secundibrachs in each half-ray short trunk that bears 2 uniserial, heterotomously branching rami; ramuli biserial, pinnulate. *L.Miss.(Osag.)*, USA (Iowa-Ill.-Mo.).—FIG. 317,1. **P. beebei*, Burlington Ls., Iowa; 1a-c, lat. and dorsal views of crown, ventral view of theca, $\times 0.7$ (Kirk, 1946d).

Pleurocrinus AUSTIN & AUSTIN, 1843, p. 6 [**Platyrcrinites mucronatus* AUSTIN in AUSTIN & AUSTIN, 1843, p. 22; OD (conditional) AUSTIN & AUSTIN, 1843, p. 25] [= *Medusacrinus* AUSTIN & AUSTIN, 1843, p. 25] [*Platyrcrinites mucronatus* AUSTIN & AUSTIN, 1843; SD BASSLER, 1938, p. 130)] [*Pleurocrinus* was originally proposed by AUSTIN & AUSTIN as a "division" of the genus *Platyrcrinites* and therefore originally had subgeneric rank. These authors apparently believed that a "division" did not need a type species, because they state (1843, p. 25), "Did we consider it expedient to elevate it to generic distinction we should take the *mucronatus* [*Platyrcrinites mucronatus*] as the type of our proposed genus *Pleurocrinus*." This statement is taken as a clear indication that *Platyrcrinites mucronatus* is to be considered the type species of *Pleurocrinus*.] Like *Platyrcrinites* except anal opening just above *C* and *D* radials is laterally directed, with or without intervening small plates between opening and radials. *L.Carb.-U.Perm.*, N.Am.-Eu.-Indon.(Timor).—FIG. 316,1a-c. **P. mucronatus* (AUSTIN), L.Carb., Eng.; oblique, lat., and ventral views of theca, $\times 0.9$ (Wright, 1956).—FIG. 316,1d-g. *P. coronatus* (GOLDFUSS), L.Carb., Eng.; post., dorsal, ventral, and ant. views of theca, $\times 0.9$ (Wright, 1956a).

ORDER, SUBORDER, SUPERFAMILY, and FAMILY UNCERTAIN

Becharocrinus TERMIER & TERMIER, 1956, p. 316 [**Triacrinus paradoxus* TERMIER & TERMIER, 1950; OD] [*nom. subst. pro Triacrinus* TERMIER & TERMIER, 1950, p. 84 (*non* MÜNSTER, 1839)]. Based on an apparently abnormal trirayed specimen; probably actinocrinid. *U.Carb.(low.Westphal.)*, N.Afr.(Alg.).—FIG. 318,1. **B. paradoxus* (TERMIER & TERMIER); 1a,b, lat. and tegmental views, $\times 2$ (Termier & Termier, 1950).

Coronocrinus HALL, 1859, p. 124 [**C. polydactylus*;

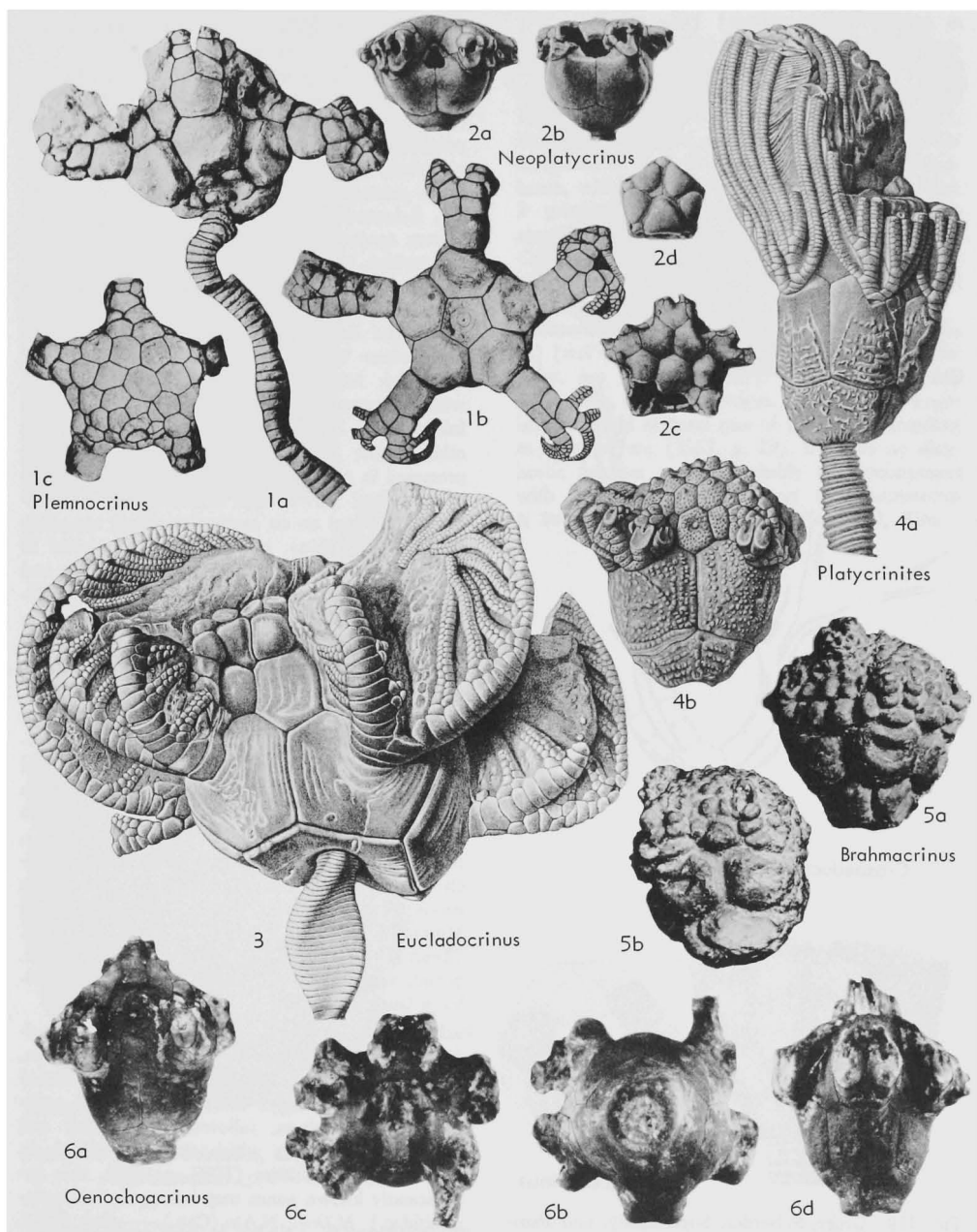


FIG. 317. Platyrcrinitidae (p. T515-T516).

M]. Based on fragment of large, very broad and many-plated theca; tegmen slightly depressed or elevated, composed of numerous small plates; arms (only bases of some preserved) numerous, biserial, proceeding abruptly from calyx margin; column and base unknown. [According to GOLDRING (1923), may be same as *Himerocrinus*]. *L.Dev.*,

USA(N.Y.).—FIG. 318.2. **C. polydactylus*, Helderberg.; lat. view of holotype, $\times 1$ (Goldring, 1923).

Craspedocrinus DAHMER, 1921, p. 292 [**C. schmidti*; M]. Genus based on very small poorly preserved specimens; presence of infrabasals uncertain; median ray and anal ridges distinct;

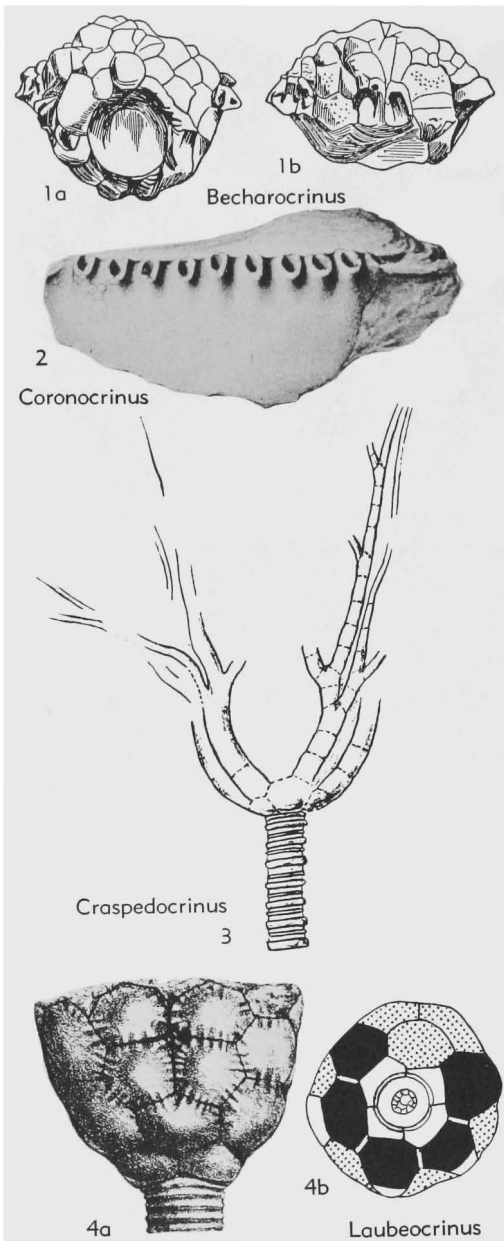


FIG. 318. Order, Suborder, Superfamily, and Family Uncertain (p. T516-T518).

?radials separated all around; interradial areas many-plated; arms pinnulate, uniserial, isotomously branching; brachials slightly higher than wide; stem transversely round, heteromorphic; axial canal quinquelobate. [Doubtfully referred by DAHMER to Reteocrinidae; may be early post-larval growth stage of an unknown genus and

species.] *L.Dev.*, Eu.(Ger.).—FIG. 318,3. **C. schmidti*, Rammelsberger Schichten; crown and part of stem, $\times 5$ (Dahmer, 1921).

Helicocrinus CHAPMAN, 1903, p. 107 [**H. plumosus*; M]. Monocyclic; basals 3; primibrachs ? 3; tegmen fairly high, vaulted over with numerous polygonal plates; rami 2 per ray, simple, densely pinnulate; brachials apparently cuneate in zigzag. Stem pentagonal, with small cirri at intervals. *Sil.*, E.Australia. [Based on a single incompletely known specimen. Possibly a haplocrinid.]

Katarocrinus WAAGEN & JAHN in JAEKEL, 1918, p. 32 (no species named). [Placed by JAEKEL, 1918, in family Spyridiocrinidae along with *Spyridiocrinus* and *Beyrichocrinus*.] *L.Dev.*, Eu.(Czech.).

Laubeocrinus WAAGEN & JAHN, 1899, p. 31 [**L. barrandei*; M]. Monocyclic; calyx bowl shaped, with 4 unequal basals; primanal in radial circlet, followed by 2 plates, which in turn support 2 other plates; single rather large interprimibrach preserved in each interray, resting on radials; stem round; distal part of cup, tegmen, and arms unknown. [Based on an incomplete calyx; according to BATHER (1900a), may be an actinocrinitid of uncertain position; placed by BASSLER (1938) and BASSLER & MOODEY (1943) among Actinocrinitidae.] *Sil.*, Eu.(Czech.).—FIG. 318,4. **L. barrandei*; 4a,b, lat. and basal views, $\times 2$ (anals and interbrachials stippled) (Waagen & Jahn, 1899).

Mitrocrinus MILLER & GURLEY, 1894, p. 22 [**M. wetherbyi*; OD]. Based on six-rayed crinoid with low bowl-shaped calyx, 3 equal basals, 3 interprimibrachs between rays, small primanal in radial circlet followed by 2 plates. Tegmen high, orals distinct and anal tube excentric. Arms and stem not preserved. [According to BATHER (1900a), this genus may be founded on an abnormal periechocrinid or carpocrinid; it was made type genus of a monotypical family, Mitrocrinidae, by MILLER & GURLEY, 1894, p. 22.] *M.Ord.*, USA (Tenn.).—FIG. 319,1. **M. wetherbyi*; 1a-c, dorsal, ventral, and CD-interray views, $\times 1$ (Miller & Gurley, 1894b).

Pachyocrinus BILLINGS, 1859, p. 22 [**P. crassibasalis*; M] [= *Pachyocrinus* SCUDDER, 1882, *Nom. Zool. suppl. list*, p. 243 (*nom. van.*)]. Founded on single part of calyx comprising 4 small proximal (?basal) plates, followed by 5 thick and large (?radial) plates which alternate with them. [According to HUDSON (1907, p. 120), this insufficiently known genus may belong to Eucalyptocrinitidae.] *M.Ord.*, N.Am.(Can.).—FIG. 319,2. **P. crassibasalis*, Chazyan; holotype, $\times 2$ (Hudson, 1907).

Patinocrinus JAEKEL, 1918, p. 36 (no species named). [Proposed for *Stelidiocrinus* WACHSMUTH & SPRINGER, ?date (*non* ANGELIN), by JAEKEL (1918) and defined as a patelliocrinid with depressed tripartite base, radials and primibrachs low and wide, several secundibrachs, single large interprimibrach in each interray, and 2 anal plates

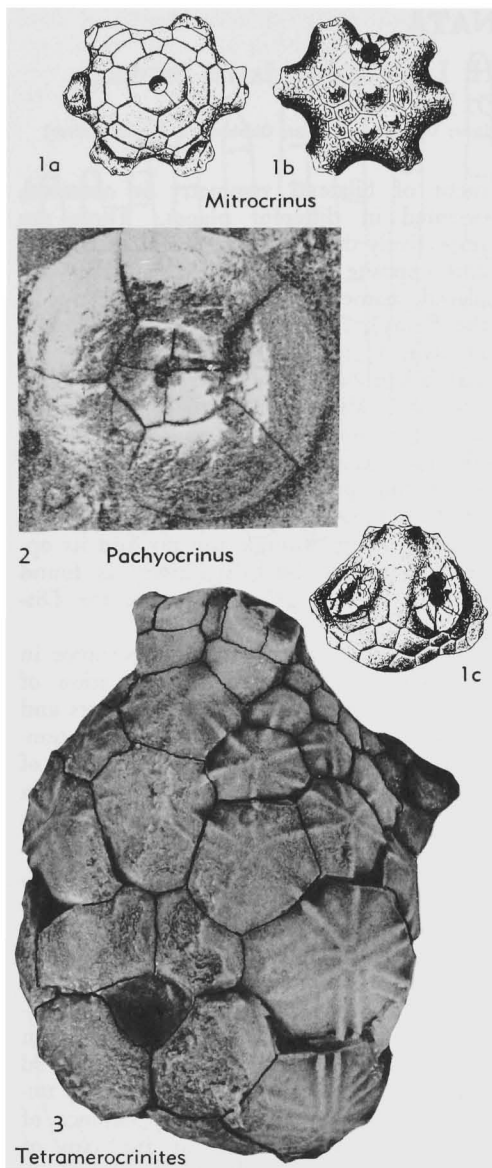


FIG. 319. Order, Suborder, Superfamily, and Family Uncertain (p. T518-T519).

located above level of radials.] ?Occurrence (unknown).

Phillipsocrinus M'COY, 1844, p. 183 [**P. caryocrinoides*; M]. Basals 4; radial circling composed of 7 plates among which 5 support primibrachs, and others followed by 2 plates; single interprimibrach between primibrachs; ornamentation stellate. [Probably based on abnormal actinocrinitid. Type specimen apparently lost (GEORGES SEVASTOPULO, personal commun.).] *L.Carb.*, Eire.

Tetramerocrinites AUSTIN & AUSTIN, 1843, p. 203 [**T. formosus*; M] [= *Tetracrinites* AUSTIN & AUSTIN 1842, p. 110 (*nom. nud.*); *Tetramerocrinites* AUSTIN & AUSTIN, 1842, p. 110 (*nom. nud.*); *Tetramerocrinus* HUXLEY & ETHERIDGE, 1865, p. 129 (*nom. subst. pro Tetramerocrinites*)]. Basals 4, 3 subequal and 4th smaller; radial circling composed of 8 plates; one ray with single primibrach, which is axillary; other rays probably with 2 primibrachs; ornamentation stellate. [Genus apparently based on abnormal actinocrinitid.] *L. Carb.*, Eire.—FIG. 319,3. **T. formosus*, Tournais., oblique lat. view of calyx, lectotype, $\times 2$ (Sevastopulo, n).

Trochocrinites PORTLOCK, 1843, p. 345 [**T. laevis*; M] [= *Trochocrinus* BATHER, 1900a, p. 168 (*nom. subst. pro Trochocrinites*)]. Camerate, probably monocyclic, with axial ridges. [Founded on single internal mold of basal part of the calyx; according to RAMSBOTTOM (1961, p. 29), it shows no diagnostic features and is probably not synonymous with *Periechocrinus*, as stated by WACHSMUTH & SPRINGER (1881).] *U.Ord.*(*Caradoc.*), Eire.