Family UNCERTAIN

Passalocrinus Peck, 1936, p. 292 [*P. triangularis; OD]. Small, monocyclic, theca shaped like old-fashioned ice cream cone. Basals 3, elongated, equidimensional; radials 5, short, variable sizes and shapes with 3 largest bearing articulate facets (A, B, and D rays); orals 5, CD oral the largest. No anal plates or anal opening known. Arms and column unknown. [Specimens described by Cronis & Geis, 1940, purported to be immature representatives of the blastoids Mesoblastus glaber and Pentremites princetonensis, are remarkably similar to Passalocrinus. The ontogeny presented did not show a transition from a Passalocrinus-like stage to a recognizable blastoid stage and the matter has not been resolved to date.] L.Miss.-M.Miss., USA (Mo.-Ky.-Okla.-N.Mexico).—Fig. 505, 1. *P. triangularis, L.Miss., Mo.; 1a-f, views of theca from A, E, D, C, and B rays, and ventral, X45 (Peck, 1936). [STRIKEME]

Flexibilia—Morphology

By Raymond C. Moore

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GENERAL MORPHOLOGY

Crinoids included in the class Flexibilia display from beginning to end of their long existence (M.Ord.-U.Perms.) a remarkable unity of important morphological characters, which serves to set them well apart from other crinoid groups. Among the features that appear in almost every taxonomic category the foremost are the following:

1) An aboral cup composed of three infrabasal plates (uncommonly reduced to two plates or fused to a single one) combined with five basals and five radials.
2) The infrabasal circlet typically is composed of a small plate (termed *azygous*, unyoked) and two larger ones each formed by fusion of a pair of antecedent small plates (hence termed *zygous*, yoked), uncommonly, all infrabasals are fused together.
3) In all but a few specimens of one genus (*Forbesiocnus*) the *azygous* infrabasal is located in the C ray.
4) In simpler forms (e.g., lecanocrinids)

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2 In the chapter on Flexibilia the Wenlockian and Ludlovian of Sweden (Goul.) are bracketed as undifferentiated Upper Silurian, whereas in other parts of this volume the Wenlockian is identified as Middle Silurian.
Forbesiocrinus, Onychocrinus, and many others); wherever precisely known, it is at the height of the so-called Y-line of the crown situated at the boundary between laterally united arm plates (associated in many forms with interlocked interradial and interbrachial plates) at the lowermost limit of free arms.

8) Arms universally are uniserial and lacking pinnules, their brachials generally much wider than high, with mostly flattened exterior surfaces. A patelloid process is present on the midline of the brachials of many genera.

9) Arms of a few genera are unbranched but generally they divide one or more times isotonously; heterotomous branching (mostly of biendotomous type) characterizes several forms.

10) Strong incurving of arms at summit of the crown is general.

11) Interradial and interbrachial plates characterize many genera; they exhibit much variation in size and number, as well as in being loosely or very firmly joined to brachials of rays.

12) Except in a very few aberrant forms, the stem is transversely circular and relatively robust, never pentagonal; where moderate to considerable lengths of it are known, its diameter is substantially uniform, but distal tapering characterizes several forms, especially just below the calyx. A differentiated proxistele of wide, thin columnals is present in many genera.

FORM AND STRUCTURE OF CROWN

A large majority of flexible crinoids have a rotund crown, either 1) subspherical, with width and height subequal (most lecanocrinids, nipterocrinids such as Pycnosaccus and Hormocrinus, dactylocrinids such as Aexitrophocrinus, Paramphicrinus, Ainanocrinus, Amphicrinus, ichthyocrinids such as Clidochirus and Metichthyocrinus, and taxocrinids such as Parichthyocrinus, Synerocrinus, and Euonychocrinus); 2) elongate, with width modestly to very distinctly less than height (Lecanocrinus and Miracrinus among lecanocrinids, Nipterocrinus and Cholocrinus among nipteroocrinids, most homalocrinids, dactylocrinids, sagenocrinitids, ichthyocrinids, and taxocrinids); and 3) low round, with width greater than height (Caldenocrinus, Zenocrinus, and Dieurycrinus among dactylocrinids). Illustrations and structural diagrams of all these forms are given with the systematic part of the text.

An examination of the structure of flexible crinoid crowns of all types reveals the anomalous nonflexible nature prevailing in their construction. Most plates of the calyx, including those of the more or less morphologically differentiated aboral cup and lower part of the arms, with associated interradial and interbrachial plates where present, are rigidly united together. Movement between them therefore is nil or at most insignificant. Only distal parts of arm appendages are capable of appreciable inward and outward movements, which can be defined as flexible. Thus, a comparative equivalence in the crown structure of all or nearly all crinoids clearly links the Flexibilia with Camerata, Inadunata, and Articulata. It is prevalence of interplate articulation by means of very short ligament fibers, accompanied by lack of structures providing for muscular articulations of any sort, which separate the flexible crinoids from others. In general, the Flexibilia comprise a readily recognizable assemblage of crinoids distinguished both by their crown structure and by all-but-constant morphological features of their aboral cup and arm construction.

ELEMENTS OF ABORAL CUP AND THEIR RELATIONSHIP TO OTHER PARTS OF WHOLE CRINOID

INFRABASALS

Morphologic features of the infrabasal plates at the base of aboral cups of flexible crinoids are described below according to the inclusion in six arbitrarily differentiated groups, in those numbered (3) and (4) entirely covered by the topmost columnal of the stem, but in others with a small or relatively large part of their distal extremities visible outside of the stem (Fig. 506). It is evident that the different groups lack taxonomic significance, for representatives
MEDIUM-SIZED TO LARGE TRIPARTITE CIRCLET

1) Relatively large tripartite infrabasal circlet with most of plates visible beyond small stem impression. Such an arrangement characterizes *Mysticocrinus* (Lecanocrinidae) (Fig. 506,1), distinguishing it from all other flexible crinoids.

2) Medium-sized tripartite infrabasal circlet not entirely covered by relatively large stem. Crinoids of this group resemble the first except that the stem covers most but not all of the plates, their distal extrem-

**Fig. 506.** Diagrams showing morphologic features of the infrabasal circlet of flexible crinoids (not to scale).
Homalocrinids (Fig. 506,2a-e), nipterocrinids (Fig. 506,3a-c), homalocrinids (Fig. 506,4a,b), dactylocrinids (Fig. 506,5a-c), sagenocrinid (Fig. 506,6), ichthyocrinid (Fig. 506,7), and taxocrinid (Fig. 506,8a-d). Orientation of the azygous plate is constantly in the C ray.

3) Medium-sized tripartite infrabasal circlel entirely concealed by stem. The circlel occupies most but not quite all of the stem impression. Here belong dactylocrinids (Fig. 506,10), ichthyocrinid (Fig. 506,11a-e), and taxocrinids (Fig. 506,12a-f).

4) Small tripartite infrabasal circlel entirely concealed by stem which covers also proximal part of basals. These are mostly dactylocrinids (Fig. 506,13a-d). Cleistocrinus (Fig. 506,14) represents the ichthyocrinids.

5) Externally much enlarged but internally constricted tripartite infrabasal circlel. This is an exceptional arrangement found in three flexible crinoids. The stem covers only proximal parts of exposed infrabasals in Calpioerinus (Fig. 506,15) and Homalocrinus (Fig. 506,16) but most of these plates in Forbesioerinus (Fig. 506,17). In Calpioerinus the infrabasals are so enlarged that they cover not only basals but radial plates.

6) Large, fused infrabasal circlel mostly but not entirely covered by stem. In this group are lecanocrinids (Fig. 506,18a-d) and Nipterocrinus (Fig. 506,19).

**BASALS**

Morphologically viewed, plates of the basal circlel of flexible crinoids may be divided into two groups, based on relative importance as elements of the aboral cup.

1) Basals forming important, even major part of aboral cup, entirely outside and above area of stem impression. In numerous genera they form part of the base and the main part of the sides of the aboral cup. In others they are confined to the sides. Their size is relatively large, little if any smaller than the radials. Distally they invariably slope more or less steeply upward.

Basals of this group especially characterize lecanocrinids, as seen in Mystiocrinus (Fig. 507,1a), Lecanocrinus (Fig. 507,1b), Mira-  
crinus (Fig. 507,1c), Geroldicrinus (Fig. 507,1d), Mespiocrinus (Fig. 507,1e), Cibolocrinus (Fig. 507,1f), and Calycocrinus (Fig. 507,1g). Among nipterocrinid typical representatives of the group are seen in Cholocrinus (Fig. 507,2a), Pycnosaccus (Fig. 507,2b), and Hormocrinus (Fig. 507,2c). Among homalocrinids these relatively large basals occur in Ansiocrinus (Fig. 507,3a), and Asaphocrinus (Fig. 507,3b); in dactylocrinids they are well defined in Lithocrinus (Fig. 507,4a), Nevadacrinus (Fig. 507,4b), and Temnocrinus (Fig. 507,4c). The sagenocrinids are represented by the single genus Sagenocrinites (Fig. 507,5) and ichthyocrinids by the single genus Clidochirus (Fig. 507,6). Among taxocrinids are four genera with large basals outside of the stem impression area, Taxocrinus (Fig. 507,7a), Meristrocrinus (Fig. 507,7b), Protaxocrinus (Fig. 507,7c), and Gnoromicrinus (Fig. 507,7d).

2) Basals forming minor part of aboral cup, largely or entirely covered by stem except for distal extremity of the posterior basal. In this group the aboral cup is not a prominent part of the calyx, being differentiated only by morphologic distinctions.

Most dactylocrinids have basals belonging to this second group, Amphicrinus (Fig. 508,1a), Dactylocrinus (Fig. 508,1b), Aexitrophocrinus (Fig. 508,1c), Ainacrinus (Fig. 508,1d), Euryocrinus (Fig. 508,1e), Dieryocrinus (Fig. 508,1f), Artichthycrinus (Fig. 508,1g), Ramphocrinus (Fig. 508,1h), Caldenocrinus (Fig. 508,1i), and Wachsmuthicrinus (Fig. 508,1j). Sagenocrinids are represented by Forbesioerinus (Fig. 508,3a), and Trampidocrinus (Fig. 508,3b); ichthyocrinids by Ichthyocrinus (Fig. 508,2a), Synaptocrinus (Fig. 508,2b), and Metichthycrinus (Fig. 508,2c). Five genera of taxocrinids have basals almost entirely covered by the stem; they are Parichthycrinus (Fig. 508,4a), Enascocrinus (Fig. 508,4b), Eutaxocrinus (Fig. 508,4c), Euonychocrinus (Fig. 508,4d), Synerocrinus (Fig. 508,4e), and Onychocrinus (Fig. 508,4f).

**ANALS**

Anal plates of flexible crinoids range from a single one to many. They are more or less prominent elements of the posterior side of the aboral cup, also present only.
above the summit of the cup. They form a generally significant part of the calyx. The anals are distinguishable as a radianal (absent in many forms); anal X plate and calyx or tube plates above the X.

Crinoids having a radianal are divisible into three groups differentiated as follows:

1) Radianal primitive, occurring directly below the C radial. Here belong the lecanocrinid *Mysticocrinus* (Fig. 507,1a), the homalocrinid *Anisocrinus* (Fig. 507,3a), the dactylocrinid *Temnocrinus* (Fig. 507,4c),
the sagenocrinitid *Sagenocrinites* (Fig. 507, 5), and the taxocrinid *Protaxocrinus* (Fig. 507,7c).

2) Radial rhombic (or modified to subtriangular, pentagonal, or hexagonal) obliquely at left below the C radial. In this group belong the lecanocrinids *Lecanocrinus* (Fig. 507,1b), *Miracrinus* (Fig. 507,1c), and *Geroldicrinus* (Fig. 507,1d); the nipterocrinids *Cholocrinus* (Fig. 507,2a), and *Pycnosaccus* (Fig. 507,2b); the homalocrinid *Asaphocrinus* (Fig. 507,2d); and the taxocrinid *Gnorimocrinus* (Fig. 507,7d).

3) Radial displaced upward to adjoin the anal X plate on right. Here four genera are recognized: among dactylocrinids, *Nevadacrinus* (Fig. 507,4b) and *Dieuryocrinus* (Fig. 508,1f); sagenocrinids include *Forbesiocrinus* (Fig. 508,3a) and *Trampidocrinus* (Fig. 508,3b). A radial plate is lacking in all other flexibles.

Crinoids having no anal plates at all include the lecanocrinid *Calycocrinus* (Fig. 507,1g), the dactylocrinid *Wachsmuthicrinus* (Fig. 508,1j), and the ichtyocrinids *Ichthyocrinus* (Fig. 508,2a), *Synaptocrinus*
Flexibilia—Morphology

(Fig. 508,2b), and Metichthyocrinus (Fig. 508,2c). The orientation of cups and calyces belonging to these genera is determined by arrangement of plates in the infrabasal circllet.

RADIAL AND ARM PLATES

Radial plates of nearly all flexible crinoids have straight to very gently curved summits. In a few genera, however, the summit is moderately to strongly arcuate and asymmetrical. This latter group, all lecanocrinids, include Mysticocrinus (Fig. 509,1a), Proapsidocrinus (Fig. 509,1b), Prophyllocrinus, and Ancistrocrinus.

Construction of the arms, combined with other morphological features, has considerable taxonomic significance. Three groups of arm types can be recognized among flexibilia, with several subgroups.

1) Arms unbranched. The lecanocrinids Palaeoholopus (see Fig. 525,1) and Permobrachypus (see Fig. 525,4) lack arm bifurcations.

2) Flexible crinoids characterized by isomorphous bifurcation of the arms comprise a second group, which is divisible into subgroups as follows:

2a) Single bifurcation in each ray. Only the lecanocrinids Petrocrinus (see Fig. 521,1) and Mysticocrinus (Fig. 509,1a), Syntomocrinus (see Fig. 521,2), Gaulocrinus (see Fig. 525,5), and Ancistrocrinus (see Fig. 528,4), appear to belong in this subgroup.

2b) Two even bifurcations in each ray. All structures of this type are seen in the lecanocrinids Proapsidocrinus (Fig. 509,1b), Mespilocrinus (Fig. 509,2c), and Cibolocrinus (Fig. 509,2d). Other flexibles of the subgroup include the nipterocrinids Nipterocrinus and Cholocrinus, the dactylocrinids Artichthyocrinus and Nevadacrinitus, and the ichthyocrinid Metichthyocrinus.

2c) Three uneven bifurcations in all branches of each ray. Structures of this type are seen in the nipterocrinids Homocrinus and Pycnosaccus (Fig. 509,3a,b), in the dactylocrinid Temnocrinus (Fig. 510,1a), in the sagenocrinids Trampidocrinus, Sagtenocrinotes, and Forbesiocrinus, in the ichthyocrinids Synaptocrinus and Clidochirus, and in the taxocrinids Taxocrinus, Meristocrinus, Parichthyocrinus, and Eutaxocrinus (Fig. 510,1b).

2d) Two or more even bifurcations in some but not all branches of each ray. Structures of this type are found in the lecanocrinids Lecanocrinus (Fig. 509,2a), Miracrinus (Fig. 509,2b), and Geroldocrinus, in the dactylocrinid Euryocrinus (Fig. 510,2a), Amphicrinus (Fig. 510,2b), and Caldenocrinus, in the ichthyocrinid Ichthyocrinus, and in the taxocrinids Gnorimocrinus and Protaxocrinus.

3) Main arm branches bifurcating isomorphously, then each branch dividing heterotomously. This readily differentiated assemblage is divisible into three subgroups.

3a) Uniendotomous (only two main branches). Here the main branches bear small ones facing each other on inner sides of the main ones, as in Homocrinus (Fig. 509,4a).

3b) Biendotomous (four main branches). The two pairs of main branches bear small arms facing each other so as to form a double-combed pattern. This predominates in the dactylocrinids as illustrated by Aextrophocrinus (Fig. 509,4b), Wachsmuthicrinus (Fig. 509,4c), Dactylocrinus (Fig. 509,4d), Calpio­crinus (Fig. 509,4e), Paramphicrinus (Fig. 510,3a), Lithocrinus, Calpio­crinus, and Zenocrinus. It is also seen in the taxocrinids Synerocrinus (Fig. 510,3b), Enasocrinus, Euonychocrinus, and Onychocrinus.

3c) Uniexoendotomous (two main branches with ramules on both sides of branches). This distinctive type of arm structure is found only in Onychocrinus of the Taxocrinidae.

Subclass FLEXIBILIA Zittel, 1895

[nom. transl. Moore & Laudon, 1943a, p. 64 (ex order Flexibilia Zittel, 1895, p. 165)] [Articulata Zittel, 1879, p. 345, non Miller, 1821, p. 13; suborder Articulata Jaekel, 1894, p. 118; Articulata Imprintata Wachsmuth & Springer, 1885, p. 304(82) (partim); grade Imprintata Both, 1899b, p. 922; order Flexibilida Pears, 1947, p. 10] [Materials for this subclass prepared by R. C. Moore, with additional contributions as noted in text]

Crown ovoid to globose, consisting mainly of closely abutting uniserial arms incurved distally, distinctly differentiated from cup or with proximal brachials and interarm plates merging uninterruptedly with radials.
and two subjacent plate circlets, nearly all joined together by ligaments rather than by solid union. Infrabasals three, small azygous one in C ray and large ones in AB and DE rays, or rarely fused into single disc or entirely resorbed. Five basals and five radials subequal in each circllet. Radial commonly present, either in primitive position directly below C radial or shifted obliquely left. Anal X plate inserted be-
tween posterior radials. Arms nonpinnulate generally branching isotonously or both isotonously and heterotomously, exception­ally atomous. Supplementary small, medium-sized or large polgonal plates may be developed interradially as well as between arm branches (interbrachials). Tegmen flexible, lacking anal sac but in many genera containing five distinct orals (posterior one largest), rows of ambulacrals leading from arm bases to exposed mouth, and large areas of small interambulacral plates. Stem
transversely round, composed of thin columnals, or very rarely crescentic (*Ammonocrinus*); noncirriferous. *M.Ord.-U.Perm.*

Order TAXOCRINIDA Springer, 1913


Crown elongate ovoid, with well-rounded arms not abutting next adjacent neighbors and relatively weak calyx lacking distinct cup, anal X and succeeding longitudinal row of anal plates separated from posterior radials and primibrachs by small-plated flexible perisome instead of joined to them and *CD* basal by close suture. *M.Ord.-U. Penn.*

Representatives of the Taxocrinida are the only Flexibilia known from pre-Silurian deposits anywhere in the world. These most ancient flexible crinoids resemble contemporaneous inadunates in having a steeply conical cup with strongly upflaring infrabasals, large radianal directly beneath the *C* radial, well-developed anal X and row of following anal plates, and slender round arms which are long and isotomously branched at various heights in the crown. Interbrachial plates generally are present but not abundant.

Silurian and youngest crinoids of the Taxocrinida are larger than oldest ones, have more gently upflared cups, display a lateral shift of the radianal or disappearance of this plate (e.g., *Eutaxocrinus*), and diminution of interbrachials without close juxtaposition of the arms. No evolutionary tendency toward greater simplicity of structure or decrease in size is observable.

Superfamily TAXOCRINACEA Angelin, 1878

*[nom transl. Moore & Spring, 1973 (ex Taxocrinidae Angelin, 1878, p. 8)] [incl. Onychocrinidae Jaekel, 1918, p. 79]*

Crown usually elongate, with rays above radials partly or wholly separated all around; posterior interray invariably differentiated by presence of anal plates in tubelike series not incorporated in calyx; branching of arms isotomous, heterotomous, or both. *M.Ord. (Trenton.)-U.Penn. (Missour.)*

Family TAXOCRINIDAE Angelin, 1878

*[Taxocrinidae Angelin, 1878, p. 8]*

Branching of arms isotomous; radial present or absent. *M.Ord. (Trenton.)-U. Miss. (Chester).*

*Taxocrinus* Phillips in Morris, 1843, p. 59

[*Cyathocrinus? macroductylus* Phillips, 1841, p. 29 (=*Isocrinus macroductylus* Phillips, 1841, p. 30); *SD* Worthen in Meek & Worthen, 1866a, p. 271] [=*Isocrinus* Phillips, 1841, p. 30 (group) (**non* von Meyer, 1836); *Isocrinus* Philips, 1841, p. 30 (obj.) (**non* von Meyer, 1837); *Cladocrinites* Austin & Austin, 1843, p. 197 (type, *Poteriocrinius* egertoni Phillips, 1836); *Cladocrinus* Morris, 1843, p. 59 (*nom. van. pro *Cladocrinites*); *Euryalecrinus* Austin & Austin, 1846, p. 66 (*nom. nud.); *Taxocrinites* Steininginger, 1853, p. 37 (*nom. van. pro *Taxocrinus*); *Euryalecrinus Delage & Hérouard, 1904, p. 477 (*nom. van. pro *Euryalecrinus*).* Crown elongate with rays not abutting above interray areas, arms divergent; infrabasals subhorizontal, mostly or entirely concealed by column; posterior basal elongate, with distal extremity hollowed for reception of anal X followed by anal tube; radianal only in upper oblique position when present; interprimibrachs variable, usually well defined between primibrach series of all rays except *CD* interray, distal margin of these plates crescentic, rising toward rays. Primibrachs 3, followed by arm branches which bifurcate additionally above axillary primibrach. Column usually enlarged proximally. *M.Dev., USA (Iowa-Wis.-N.Y.); U.Dev., Eu. (Eng.); L.Miss. (Kinderhook-Osag.), USA (Iowa-Mo.-Ill.-Ohio-Ky.); U.Miss.(Chester), USA (Mo.-Ill.-Ky.-Ala.-Okla.); L.Carb. (Tournais.), Eu. (Belg.-Eng.-Eire-Ger.).—*Fig. 511, 1; 512, 5c, *T. macroductylus* (Phillips), L.Carb. (Pilton beds), Eng. (Devon.); 511, J, plate diagram of cup (radials black, X and higher anals stippled), part of *C*- and *D*-ray arms, anal-plate series, and interprimibrachs of *BC* and *DE* interrays (mod. from Springer, 1920); 512, 5c, lat. view of holotype, rays unspecified, X0.5 (Springer, 1920).—*Fig. 512, 4. T. colletti* White, L.Miss. (Osag.), USA (Ind.); partial plate diagram with edge views of thick brachials (Springer, 1920).—*Fig. 512, 5a, *T. internius* Vachsmuth & Springer, L.Miss. (Kinderhook,); USA (Iowa); tegmental view of holotype showing ambulacral series reaching between large orals, and *D*-ray view of another specimen, X1 (Springer, 1920).—*Fig. 512, 5d. T. ornatus* Springer, L.Miss. (Osag., Burlington Ls.), USA (Iowa); *EA*-interray view of holotype showing strongly incurved distal parts of arms, X1 (Springer, 1920). [=*Chladioerinus Delage & Hérouard, 1903 (nom. null.).]*

*Eutaxocrinus* Springer, 1906, p. 493 [*Taxocrina affinis* Möller, 1856, p. 353; *SD* Springer, 1920,
Fig. 511. Taxocrinidae (radials black, X and higher anals stippled; radianal cross ruled) (p. T768-T773).

[Text continues from p. 357] [Taxocrinus oblongatus ANGELIN, 1878, and T. rigens ANGELIN, 1878, only originally mentioned species, excluded from eligibility as type species because then considered incertae sedis (Code, Art. 67h)]. Very similar to Taxocrinus but with only 2 primibrachs in each ray and with interprimibrachs very few or lacking. U.Sil., Eu.(Sweden); L.Dev., Eu.(Ger.); M.Dev., Eu.
Fig. 512. Taxocrinidae (p. T768, T771-T773).

(Belg.-Ger.)-USA (Iowa-Ill.-N.Y.)-Can. (Ont.); U. Dev., USA (N.Y.); L.Miss., USA (Iowa-Mont.).

---Fig. 511,6; 513,1a-c. *E. affinis (MÜLLER), M.Dev. (Couvin.), Ger. (Eifel); 511,6, plate dia-
gram of cup (radials black, X and higher anals stippled), arms of C and D rays, anal series, and
**Fig. 513.** Taxocrinidae (p. T768-T773).

BC and DE interrays (mod. from Springer, 1920); 513,1a-c, ant., post., and dorsal views, X1.5 (Springer, 1920).—Fig. 513,1d. *E. oblongatus* (ANGELIN), U.Sil.(Wenlock.), Sweden(Gotl.); DE-interradius view of holotype showing biheterotomous branching of arms, X1 (Springer, 1920).—Fig. 513,1e. *E. fletcheri* (WORTHEN), L.Miss. (Kinderhook.), USA(Iowa); C-ray view of crown, X1 (Springer, 1920).

**Gnorimocrinus** WACHSMUTH & SPRINGER, 1880, p. 273 [*Taxocrinus expansus* ANGELIN, 1878, p. 9; SD BATHER, 1899b, p. 923]. Crown low, rotund; infrabasals usually extending slightly beyond stem impression; rhombic radianal obliquely at left beneath C radial. Rays as in *Entaxocrinus* with 2 primibrachs followed by divergent arm branches which bifurcate isotomously; interprimibrachs few or lacking. Stem short, not enlarging near calyx,
terminating distally in branched root. U.Sil., Eu. (Sweden)-USA(Tenn.).—Fig. 511,4; 512,1. *G. expansus (Angelin), Gotl.; 511,4, plate diagram of cup (radials black, X and higher anals stippled, radianal cross ruled), arms of C and D rays, anal series, and minute interprimibrachs (mod. from Springer, 1920); 512,1a,b, post. view of holotype and E-A-interray view of another specimen, X3 (Springer, 1920).

Meristocrinus Springer, 1906, p. 515 [*Taxocrinus (Gnorimocrinus) loveni Wachsmuth & Springer, 1880, p. 273 (=Cyathocrinus interbrachiatus Angelin, 1878, p. 23); OD]. Crown elongate, expanding above radials, with divergent isomous arm branches; infrabasal slightly exposed beyond stem impression; posterior basal somewhat larger than others and truncated for contact with large anal X, which is followed by plates in anal tube bordered on left side by minute platelets of perisome; radianal usually in form of interfibradial directly beneath C radial. Primibrachs 3 each ray; interprimibrachs very few and small, confined to lower part of interfibradial areas, or lacking. Stem large, expanding toward calyx. U.Sil., Eu.(Sweden-Eng.).—Fig. 511,3; 512,3. *M. interbrachiatus (Angelin), Sweden(Gotl.); 511,3, plate diagram of cup (radials black, X and higher anals stippled), arms of C and D rays, and anal series (mod. from Springer, 1920); 512,3a-c, post., B-ray, and C-ray views of holotype, X1.5 (Springer, 1920).

Parichthyocrinus Springer, 1902, p. 94 [*Ichthyocrinus nobilis Wachsmuth & Springer, 1879, p. 254; M]. Crown elongate ovoid, characterized by closely abutting nature of isomous arms above radials; infrabasals prone, resembling columnal but not surrounded by ring of basals; posterior basal elongate; radianal only in upper oblique

**Fig. 514. Synerocrinidae (radials black, X and higher anals stippled) (p. T773-T775).**
position if present. Primibrachs 3; interprimibrachs few and confined to lower part of interray areas. Column enlarging beneath calyx. L.Miss. (Osag.), USA (Iowa-Ill.-Ind.).—Fig. 511,2; 513,2. *P. nobilis (WACHSMUTH & SPRINGER), Burlington Ls., USA (Iowa); 511,2, plate diagram of cup (radials black, X and higher anals stippled), arms of C and D rays, anal series, and 2 interrays (mod. from Springer, 1920); 513,2a,b, ant. and post. views of nearly complete crown and small part of attached stem, X1 (Springer, 1920).—Fig. 513,2c. *P. meeki (HALL), Keokuk Ls., USA (Ill.); dorsal view of complete crown with stem removed, X0.7 (Springer, 1920).—Fig. 513,2d. *P. subovatus (MILLER & GURLEY), Broken Gr., USA (Ind.); partial plate diagram with edge view of thick brachials (Springer, 1920).

Protaxocrinus SPRINGER, 1906, p. 515 [*Taxocrinus ovalis ANGELIN, 1878, p. 8; SD SPRINGER, 1920, p. 345]. Crown elongate, with isotomous arms usually not abutting laterally; infrabasals low, with tips exposed beyond stem impression; posterior basal elongate; radianal in primitive position resembling inferradial directed beneath C radial; anal tube plates tending toward sutural connections with C brachials. Primibrachs 2; interprimibrachs very few, small or lacking. Stem enlarging next to calyx. M.Ord., Can.(Ont.); U.Ord., USA (Mo.-Ill.); L.Sil., USA (Mo.); M.Sil.-U.Sil., USA (Tenn.-Eu. (Swede-Eng.)-Can. (Quebec); L.Dev., USA (W.Va.).—Fig. 511,5; 512,2a,b. *P. ovalis (ANGELIN), M.Sil. (Wenlock.), God.; 511,5, plate diagram of part of cup (radials black, X and higher anals stippled, radianal cross ruled), arms of C and D rays, anal series, and BC and DE interbrachial areas (mod. from Springer, 1920); 512,2a,b, ant. and post. views of holotype, X2 (Springer, 1920).—Fig. 512,2a. P. elegans (BILLINGS), M.Ord. (Trenton.), Can. (Ont.); ant. view of holotype, X1 (Springer, 1920).—Fig. 512,2b. P. laevis (BILLINGS), M.Ord. (Trenton.), Can. (Ont.); post. view of complete crown, X1.5 (Springer, 1920).

Family SYNEROCRINIDAE Jaekel, 1918

[Synerocrinidae Jaekel, 1918, p. 78] [incl. Onychocrinidae Jaekel, 1918, p. 79]

Taxocrinids distinguished by distinctly heterotomous branching of arms above isotomous division on primibrachs 2. L. Miss.-U.Penn.; L.Carb.-L.Carb.

Synerocrinus Jaekel, 1898, p. 47 [*Forbesiocrinus incurvus TRAUTSCHOLD, 1867, p. 31 (=Talantocrinus jaekeli MOORE & PLUMMER, 1940, p. 196); M] [non Synerocrinus MOORE & PLUMMER in MOORE, 1939c, p. 195; nec MOORE & PLUMMER, 1940, p. 90]. Crown elongate ovoid, expanding upward from radials; infrabasals and proximal part of basals covered by stem; posterior basal larger than others and truncate distally for support of anal X which is followed by anal tube; no radial. Arms in each ray branching isotomously on primibrachs 2 and secundibrachs 3, thereafter with strongly heterotomous branching.

Fig. 515. Synerocrinidae (p. T773-T775).
of bi-endotomous type, ramules unbranched, interprimibrachs few. Column large, expanding toward calyx. *U.Carb., Eu.(USSR); Penn., USA(Okla.). —Fig. 514,4; 515,1. *S. incurvus (TRAUT-
schold), Moscov., Moscow basin; 514,4, plate diagram of cup (radials black, X and higher analss stippled), arms of C and D rays, anal series, and BC and DE interprimibrachs (mod. from Springer, 1920); 515,1a,b, post. and dorsal views of synotype, ×1 (Springer, 1920); 515,1c, post. view of another synotype, ×1 (Springer, 1920); 515,1d,e, dorsal view (B ray directed upward) and B-ray view of typical crown, ×1 (Springer, 1920). [=Forbesiocrinus Trautschoeld, 1867 (nom. de Koninck & LeFion, 1854); Forbesiocrinus Meek & Worthen, 1860 (nom. null.).]

Enascoerinus Strimple & Watkins, 1969, p. 231 [*E. exsectus, L.Carb., Eu.(Eire-Ger.-Scot.).—FIG. 514,2; 516,2f-h. *O. exsectus, L.Miss.(Meramec.), USA (Ind.); 514,2, plate diagram of cup (radials black, X and higher anals stippled), arms and ramules of C and D rays, anal series, and BC and DE interbrachials (Moore, n); 515,2, D-ray view of crown, ×1 (Wright, 1954).]

Euonychocrinus Strimple, 1940, p. 101 [*E. dubius; OD]. Crown elongate ovoid with 20 well-separated, transversely rounded arms rising in forked manner from axillary secundibrachs, arm branching isotomous to this level, above which arm pairs give off short rounded unbranched ramules on sides facing each other, thus producing very simple sort of bi-endotomous heterotomy, each ramule-bearing tertibrach commonly separated by one without ramule; like Synerocrinus in having 2 primibrachs and 3 secundibrachs in each arm branch; each interray with small number (3-5) moderately large interprimibrachs; only tips of basals appearing beyond stem impression, posterior one longer than others and supporting anal X followed by transversely rounded anal tube not laterally united to brachials. U.Penn.(Missour.), USA(Kans.-Ill.).—FIG. 514,3; 516,1. E. simplex Strimple & Moore, LaSalle Ls., USA(Ill.); 514,3, plate diagram of cup (radials black, X and higher anals stippled), arms of C and D rays, anal series, and BC and DE interprimibrachs (Strimple & Moore, 1971a); 516,1a-d, BC-interray, DE-interray, post., and dorsal (anal series directed downward) views of holotype, ×1 (Strimple & Moore, 1971a).

Onychocrinus Lyon & Casseday, 1860, p. 77 [*O. exsectus; M] [=Oligocrinus SPRINGER, 1906, p. 519 (type, Forbesiocrinus auriculiformis Hall, 1861a, p. 320; M); Oligocrinus Jakel, 1918, p. 79 (nom. null.)]. Crown low with pentameral outward extension of rays resembling starfish in shape, or rotund to elongate ovoid, especially distinguished by wide separation of rays above areas of small interprimibrachs adjacent to calyx; infrabasals low, with outward extremities commonly visible beyond stem; posterior basal elongate, with distal portion hollowed for reception of anal X which is followed by anal tube; radianal only in upper oblique position, if present. Each ray with 3 or more primibrachs, arms branching isotomously above auxiliary primibrach, thereafter with heterotomous branching, with ramules on both sides of 10 main arm trunks, these ramules commonly with 2 to several bifurcations, producing a unique, highly distinctive type of arm structure. Column enlarging next to calyx. L.Miss.(Osag.), USA(Iowa-Ill.-Ky.)-Can.; U.Miss.(Meramec.-Chester.), USA(Ill.-Ky.-Ala.-Okla.); L.Carb., Eu.(Eire-Ger.-Scot.).—FIG. 514,2; 516,2a-c. O. ramulosus (LYON & Casseday), L.Miss.(Borden Gr.), USA (Ind.); post. view of nearly perfect crown with attached part of stem, ×0.5 (Springer, 1920).—FIG. 516,2b-c. O. ulrichi MILLER & Gurley, L.Miss.(Borden Gr.), USA (Ind.); 516,2b-d, post. dorsal (post. side upward), and ventral (post. side downward) views of crown, ×0.7 (Springer, 1920); 516,2e, partial plate diagram showing edges of thick brachials (Springer, 1920).

Order SAGENOCRINIDA
Springer, 1913

[nom. correct. MOORE IN MOORE, Lalicker, & Fischer, 1952, p. 614 (pro order Sagenocrinidae SPRINGER, 1913, p. 203)].

Crown globose to elongate ovoid with plates of calyx and commonly those of arms, interradial and interbrachial areas united rather firmly together, anal plates of posterior interray (radial, if present, anal X, and higher anal plates) joined firmly to adjoining basals, radials, and brachials instead of marked off by flexible perisome as in Taxocrinida. Cup low bowl shaped, mostly lacking well-defined separation from lower arm and interarm plates; infrabasals visible beyond stem or entirely concealed by it; basals and radials relatively large, upflaring gently or in distal part of radials moderately to steeply; radial in primitive position directly below C radial shifted leftward and upward, or absent; anal X mostly large and reaching above radial summits but may be small or lacking entirely. Arms generally wide, externally

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little rounded, composed of uniserially ar­
ranged short brachials, closely adjoining one
another laterally or separated by interbra­
chials confluent with arm exterior surfaces;
distal extremities of arms typically curved
inward strongly. Stem transversely circular
and tending to taper distally, very rarely
columnals crescentic in outline. L.Sil.-U.
Perm.(Basleo beds).

Comparatively numerous sagenocrinid
genera which abruptly appear in Upper
Silurian deposits of Europe and North
America show such wide diversity of
morphological characters that relationships
to one another and to ancestors probably
belonging among Taxocrinida are highly
conjectural. For example, Lecanocrinus
and Mysticocrinus (the latter misinterpreted
at first by SPRINGER as an inadunate crinoid)
possess few features of contemporary Sage­
nocrinites, Icthyocrinus, Calpiocrinus, and
Lithocrinus—not even in content and ar­
rangement of cup anal plates—yet all are
undoubtedly non-taxocrinid flexible crinoids.
The tripartite pentagonal infrabasal circlet
is horizontal. Branching of the arms is
exclusively isotomous; although in some
later sagenocrinids, like several taxoerinids,
it is heterotomous. Interbrachial plates are
found only in Sagenocrinites, among the
Silurian genera mentioned. Icthyocrinus
has no cup anal plates, Calpiocrinus and
Lithocrinus an X plate only, and the others
both radianal and anal X. These similarities
and differences sufficiently characterize Sag­
enocrinida in general and indicate presence
in the group of more than a single lineage.

Superfamily LECANOCRINACEA
Springer, 1913

[Cup low bowl shaped with flaring sides
and strongly defined even summit formed
by straight facets of radials, which are
subequal in size and adjoin one another
except at CD interray where large anal X
plate generally occurs; radianal typically
rhombic in outline obliquely at left beneath
C radial; anal X may extend high enough
above rim of cup to separate proximal
secundibrachs. Infrabasals sloping upward
or flat to slightly down-sloping in very
shallow basal concavity. Arms formed by
very low and wide brachials, primibrachs
fully equal in width to radials; arms with
two or three isotomous divisions, except in
one genus (Miracrinus) with close sutures
joining rays and branches laterally in proxi­
mal region to make rigid calyx, distal parts
of arms free and strongly incurved over
tegmen. Column transversely circular. U.
Sil.-M.Dev.]
Lecanocrinus Hall, 1852, p. 199 [*L. macropetalus; SD Wachsmuth & Springer, 1880, p. 40] (=Cyrtoicrinus Angelin, 1878, p. 20 (type, C. facietatus; M)]. Infrabasals sloping slightly upward, visible in side view of cup, which has even summit defined by straight, wide articular facets of radials; medium-sized to large rhombic radianal obliquely beneath left margin of C radial; anal X large, may or may not extend above cup summit. Arms wide, free above radials, composed of very low brachials not united by synostosial sutures, with 2 or 3 isomotomous bifurcations in each ray, tips of arms curved inward so as to conceal tegmen. Column circular in section, formed of moderately low heteromorphic columnals with crenulate articular facets and small circular axial canal. U.Sil.-L.Dev., N.Am.-Eu.-Australia.

--- Fig. 517. Lecanocrinus sp.; 1a, plate diagram of cup (radials black, radianal cross ruled, anal X stippled) and post. arms; 1b, long. sec. of cup showing nearly horizontal infrabasals (mod. from Springer, 1920).--- Fig. 518,1a-c. *L. macropetalus, U.Sil. (Rochester Sh.), USA (Rochester, N.Y.); 1a,b, side views of crown, ×1; 1c, slightly oblique dorsal view of cup, ×1 (all Springer, 1920).--- Fig. 518,1d,e. L. facietatus (Angelín), U.Sil. (Wenlock.), Sweden (Gotl.); 1d,e, side views of cup and incomplete crown, ×2 (Springer, 1920).

Geroldicrinus Jaekel, 1918, p. 80 [*Leeanoerinus roemeri Schultze, 1867, p. 153; M]. Like Lecanocrinus but with evenly sloping sides of low truncate conical cup and with infrabasal circlet in shallow concavity entirely covered by stem; radianal variable in shape and size, subtriangular, rhombic, or pentagonal; anal X not reaching above summit of radials, followed by one or 2 small anal plates between primibrachs. Column circular, with finely crenulate articular facets on columnal facets. M.Dev., Eu.(Ger.).--- Fig. 517,4; 518,2. *G. roemeri (Schultze), Eifel; 517,4a, plate diagram of cup (radials black, radianal cross ruled, X and higher anals stippled) and arms of C and D rays; 517,4b, vertical section of cup through A radial and anal X showing attitude of infrabasals; 517,4c,d, partial plate diagrams showing variations in shape of radianal (all Moore, n); 518,2a-c, side, oblique dorsal, and ventral views of typical crown, ×1; 518,2d, dorsal view of cup showing rhombic radianal and infrabasals in steep-sided concavity, ×1 (all Springer, 1920).

Miracrinus Bowsher, 1953, p. 3 [*Lecanocrinus (Miracrinus) perdewi; OD]. Resembles Geroldicrinus in having infrabasal circlet in concavity entirely covered by proximal part of column, but differs from this genus and Lecanocrinus in firmly sutured brachials in all rays to height of nearly twice that of cup, thus producing stout calyx above which free arms curve inward over tegmen; radianal subrhombic obliquely beneath C radial and large anal X which projects well above summit of cup enough to separate proximal secundibrachs of C and D rays. Stem transversely circular, articular facets of columnals with even short crenulae surrounding wide smooth areola, axial canal small, circular. L.Dev.(Helderberg.), USA (Md.).--- Fig. 517,3; 518,4. *M. perdewi (BOWSHER), New Scotland Ls., near Cumberland, Md.; 517,3a, plate diagram (radials black, radianal cross ruled, X and anals stippled) and vertical section through cup (Moore, n); 518,4a-c, ant., post., and summit views of crown (holotype) showing position of boundary between fixed and free brachials (Y, Z, primibrach I), ×2 (Bowsher, 1953).
Mysticocrinus Springer, 1918, p. 666 [*M. wilsoni; OD]. Calyx globose, with rigidly united plates and cup with flat base and roundly curved sides; infrabasal circle subpentagonal, composed of 3 plates, small one in C ray; radials with height greater than width, curved articular facets occupying less than full width of plates, 1 or 2 shoulders of some projected upward in rounded elevation; radianal directly beneath C radial; relatively large and very tall anal X distally pointed and rising above summit of radials. Arms very short, bifurcating isotomously once on primibrach 2, each branch typically with 3 secundibrachs; brachials wide and short, with outer face distinctly curved. [This genus was considered by Springer to be an inadunate, and, in spite of its dicyclic cup and tripartite infrabasal circle, most closely related to pisocrinids. Such interpretation is erroneous. In the nature of its radials and arms Mysticocrinus is most suggestive of undoubted flexible crinoids classified in the family Prophyllocrinidae of the Lecanocrinacea but its possession of a radianal removes it from possible placement there. The genus differs from other members of
the Lecanocrinidae in shape and width of the radial articular facets, shorter and narrower arms, and primitive nature of the radialial, directly below the C radial.] U.Sil., USA(Ind.).—Fig. 517,2; 518,3. *M. wilsoni, Laurel Ls.; 517,2a,b, plate diagram (symbols as in Fig. 517,1a) and long. sec. of cup (anal X at left) (Moore, n); 518,3a-g, dorsal (A ray down), ventral (A ray up), A-ray, C-ray, CD-interray, D-ray, and E-ray views, X4 (Springer, 1926a).

Family NIPTEROCRINIDAE
Jaekel, 1918

[NIpterocrinidae Jaekel, 1918, p. 80]

Crown ovoid, moderately tall, characterized especially by prominence of line at summit of cup (except in Hormocrinus) marking division between radials and free arms; cup typically low bowl shaped or conical with evenly flaring sides, but in both types height may equal diameter; infrabasal circlet sloping upward and visible from side or flat and not visible except in dorsal view, normally tripartite with small infrabasal in C ray, but fused to solid pentagonal plate in type genus; basals small infrabasal in C ray, but fused to large-plated cup from well-rounded moderately slender branching arms separated by interradial and interbrachial platelets; infrabasals fused into pentagonal plate partly visible from sides; basals slightly to distinctly smaller than large radials which have articular facets confined to middle portion of summit, forming scalloped indentation below prominent, subhorizontal shoulders; lack of any anal plates and undivided infrabasal circlet make cup perfectly symmetrical radially preventing identification of Carpenter-lettered rays. Well-rounded relatively slender arms formed by low brachials with straight to somewhat flexuous sutures; isotomous bifurcation on primibrachs 3 followed by isotomous branching at higher levels in each ray; extremely numerous irregular platelets in interray areas denote lofty flexible tegmen. Robust stem of proximal region composed of very low circular columnals, those of intermediate and distal parts of stem somewhat narrower and distinctly taller. L.Miss.(Oisag.), USA(Iowa).—Fig. 519,2; 520,3a, *N. wachsmuthi MEek & Worthen, U.Burlington Ls.; 519,2, plate diagram (radials black), CD interray upward (Springer, 1920, mod.); 520,3b, lat. view of distorted holotype crown, X1; 520,3c, same (reconstr.), X1 (both Springer, 1920).—Fig. 520,3a. N. arboresus Worthen, L.Burlington Ls.; lat. view of crown, X2 (Springer, 1920).

Cholocrinus SPRinger, 1906, p. 517 [*Forbesiocrinus obesus Angelin, 1878, p. 9; M]. Crown elevated ovoid with prominent line between the bowl-shaped cup and transversely rounded arms separated by wide areas of interradial platelets and less prominent interbrachial ones; flat, fairly large infrabasal circlet with 3 plates, small one in C ray, not visible from side; large basals and radials similar to those of NIpterocrinus; rhombic radial obliquely beneath C radial at left, followed above by large anal X, its summit even confluent with shoulders of adjacent radials. Arms branching repeatedly, mostly in isotomous manner but partly heterotomously, initial bifurcation on primibrach 2. U.Sil., Sweden(God.).—Fig. 519,3; 520,4. *C. obesus (Angelín); 519,3, plate diagram (radials black, radialian cross ruled, X and higher anals stippled), CD interray upward (Springer, 1920, mod.); 520,4a,b, A- and B-ray views of holotype crown, X1.5 (Springer, 1920); 520,4c, part of same view as 4b showing diminutive platelets of AB and BC interrays, X2 (Springer, 1920).

Hormocrinus SPRinger, 1920, p. 166 [*Centrocrinus tennesseensis Worthen, 1890, p. 95; OD]. Crown ovoid, with width typically greater than height, with prominent division between large-plated calyx and part of crown formed by rounded branching arms and small-plated interradial areas, but actually this division is above Z line, being formed by summit of large interradial plates and by division between fixed and free brachials, at distal edges of primibrachs 2 (therefore, this
boundary denominated as Y line); posterior inter-ray with large anal X resting on truncated extremity of posterior basal, not accompanied by radial. Arms branching isomorphously at 2 or 3 levels. Column distinctly heteromorphic, nearly uniform in diameter in proximal and intermediate areas but narrowing distally, with noticeable increase in height of columnals. U.Sil., Eu.(Eng.-Sweden)-USA(Tenn.).—Fig. 519,4; 520,2. *H. tennesseensis (WORTHER), Brownspor Ls., USA (Tenn.); 519,4, plate diagram (symbols as in Fig. 519,3), CD interray upward (Springer, 1920, mod.); 520,2,a,b, oblique dorsal (E ray up) and E-ray views of 2 crowns, ×2 (Springer, 1920); 520,2,c, somewhat oblique EA-interray view of crown with attached long tapering heteromorphic stem, ×1 (Springer, 1920).

Pycnosaccus ANGELIN, 1878, p. 13 [*Cyathocrinites scrobiculatus HISINGER, 1840, p. 6; SD SPRINGER, 1920, p. 180] (=Onocrinus BATHER, 1896b, p. 387 (type, O. bucephalus; M]). Similar to Cholocrinus but cup more conical with upsloping infra-basals clearly visible from side, large basals and radials smooth or marked by ridges crossing plates normal to sutures between them; rhombic radial and anal X moderately large. Arms well-rounded laterally, typically slender, branching isomorphously, with initial one on primibrachs 1; interradial areas filled by minute plates. Stem resembles that of Hormocrinus in heteromorphous arrangement of columnals, thicker ones with well-rounded peripheries. U.Sil., Eu.(Eng.-Sweden)-USA(III.-Ind.-Tenn.-N.Y.); L.Dev., USA (W.Va.); U.Dev., NW.Can.—Fig. 519,1; 520,1,d-e. *P. scrobiculatus (HISINGER), U.Sil., Sweden; 519,1, plate diagram (symbols as in Fig. 519,3), CD interray upward (Springer, 1920, mod.); 520,1,d,e, E-ray and CD-interray views of holotype cup, ×1.5 (Springer, 1920); 520,1,f, facet view of B radial (center) showing impressions of minute interradial plates on shoulders next to sutures, ×2 (Springer, 1920).—Fig. 520,1a. P. nodulosus ANGELIN, U.Sil., Sweden(Gotl.); CD-interray view of crown with single primibrach in each ray, ×1.5 (Springer, 1920).—Fig. 520,1b-c. P. tenuibrachiatus SPRINGER, L.Dev.(Keyser Ls.), USA(W.Va.); C- and E-ray views of crown, ×1.5 (Springer, 1920).—Fig. 520,1g. P. patei SPRINGER, U.Sil.(Brownspor Ls.), USA(Tenn.); B-ray view of crown with stem, ×1 (Springer, 1920).

Family MESPILOCRINIDAE Jaekel, 1918

[Mespiocrinidae JAELKEL, 1918, p. 80]

Generally similar to Lecanocrinidae, differing mainly in absence of radial in cup, flat infrabasal circle extending beyond stem impression, commonly tripartite but may be solidly fused. Arms typically very short and crown rotund, with or without tendency toward clockwise torsion of rays. Stem transversely circular, medium sized to slen-
order, commonly heteromorphic and xenomorphic, cirri lacking. *L.Miss.(low.L.Carb.)*—*U.Perm.*

*Mespilocrinus* **DE KONINCK & LE HON, 1854, p. 111 [*M. forbesianus*; SD S. A. MILLER, 1889, p. 262]. Small subglobular crown with short arms twisted spirally clockwise, isotonously bifurcating on primibrach 2 and secundibrachs 2 or 3, tips curved strongly inward; *CD* basal distinctly larger than others and followed by large anal *X* with distally pointed extremity reaching level of proximal secundibrachs; infrabasal circle with width 1.5 to 2 times that of circular stem impression. Stem nearly homeomorphic to distinctly heteromorphic and typically xenomorphic, with quite dissimilar proximal, intermediate, and distal portions. *L.Miss.(Osag.)*, N.Am.; *L.Carb.*

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**Fig. 520. Nipterocrinidae (p. T779-T780).**
Fig. 521. Mespilocrinidae (radials black, anal X stippled) (p. T781-T783).

(Cibolocrinus Weller, 1909, p. 630 [*C. typus; OD] [non Cibolocrinus Weller, 1909b, p. 632-633; nec Wanner, 1916a, p. 211; nec Wanner, 1924, p. 257; nec Wanner, 1934, p. 260; nec Wanner, 1937, p. 190; nec Yakovlev, 1930, p. 377; nec Yakovlev, 1934, p. 278]. Crown sub-globular, with shallow to moderately high bowl-shaped cup forming half or more of crown height; infrabasals 3, small one normally in C ray but found in A ray in type species; medium-sized to large anal X extending well above radial summits separating primibrachs and even proximal secundibrachs of C and D rays. Arms short, branching isomorphously on primibrach 2 and secundibrachs 3 to 5, brachials very low and wide. Stem transversely circular, facets of columnals with narrow crenulate rim. L.Penn.-L.Perm., N.Am.-I.Sib.-S. Am.(Bol.).—Fig. 521,5; 522,1d-g. C. punctatus Moore & Plummer, M.Penn.(Atokan, Marble Falls Ls.), USA(Texas); 521,5, plate diagram of cup (radials black, X stippled) and post. arms (Moore & Plummer, 1940); 522,1d-g, dorsal (A ray down), CD-interray, A-ray, and ventral (E ray up) views of crown, X1.5 (Moore & Plummer, 1940).—Fig. 522,1a-c. *C. typus, L.Perm. (Wolfcamp.), USA(W.Texas); 1a-c, dorsal (A ray down), CD-interray, and ventral (A ray up) views of cup, X1 (Moore & Plummer, 1940).—Fig. 522,1h-l. C. banioni Moore, U.Penn.(Virgil., Brownville Ls.), USA(Okla.); 1h-l, long. sec. of cup (CD interray at left) and ext., int., proximal, and distal views of radial plate, X1.5 (Moore, 1939c).

Loxocrinus Wanner, 1916, p. 251 [*L. globulus; OD]. Crown small, globular, with bowl-shaped cup forming more than half its height, plates of cup massive; infrabasals 2 in type species but may be 3 in others or fused entirely; posterior basal larger than others, with distal curved truncation for reception of medium-sized anal X; radials with slightly inclined articular facets occupying almost but not quite entire width of plate, bearing short arms twisted clockwise as in Mespilocrinus, with isomorphous bifurcations on primibrachs 2 and secundibrachs 2. Stem transversely circular. U. Perm., Indon.(Timor).—Fig. 521,4; 523,1. *L. globulus, Basleso beds; 521,4, plate diagram of cup (radials black, anal X stippled) and post. arms (Wanner, 1916a, mod.); 523,1a-d, CD-interray, A-ray, ventral (A ray up), and dorsal (A ray down) views of crown, X2 (Wanner, 1916a); 523,1e-g, CD-interray, ventral (A ray up), and dorsal (A ray down) views of cup, X2 (Wanner, 1916a).

Petrocrinus Wanner, 1924, p. 92 [*P. beyrichi; OD]. Crown relatively large, ovoid; cup conical to bowl shaped, fused infrabasal cirlet flaring upward peripherally and visible from side; radials
with wide straight articular facets forming very even summit of cup; anal X barely rising above radials. Arms short, composed of wide and unusually tall brachials, sloping evenly upward to pointed tip of crown, arms branching isomorphously in each ray on primibrachs 2, which is followed by only single pairs of secundibrachs, so that total in crown is 10. Stem transversely circular. U.Perms., Indon. (Timor).—Fig. 521,1; 522. *P. beyrichi, Basleo beds; 521,1, plate diagram of cup (radials black, anal X stippled) and post. arms (Wanner, 1924, mod.); 522, CD-interray view of holotype, X 1 (Wanner, 1924).

**Syntomocrinus** WANNER, 1916, p. 256 [*S. sundaeus; OD*]. Crown pear shaped, narrowing upward from very even summit of cup, which is nearly straight sided and gently concave at base, only distal tips of basals visible from side, if at all, small pentagonal infrabasal circlet largely covered by circular stem. Arms composed of wide, short brachials, branching isomorphously on primibrachs 2 or 3, secundibrachs 3 or 4, uppermost arm branches having 3 or 4 tertibrachs, but rarely preserved. U.Perms., Indon. (Timor).—Fig. 521, 2; 523,3. *S. sundaeus*, Basleo beds; 521,2, plate diagram of cup (radials black, anal X stippled) and post. arms (Wanner, 1916a, mod.); 523,3a,b, A-ray and dorsal (A ray down) views of crown, X 1.5 (Wanner, 1916a); 523,3c,d, dorsal (A ray down) and ventral (A ray up) views of cup, X 1.5 (Wanner, 1916a); 523,3e, part of specimen figured in 3c,d, showing A-ray facet, X2 (Wanner, 1916a).

**Family CALYCOCRINIDAE**

Moore & Strimple, 1973

[Calycocrinidae Moore & Strimple, 1973, p. 34]

Lecanocrinids chiefly characterized by development of bilateral symmetry in plane bisecting CD interray and on anterior side
of crown either bisecting A ray or AE inter-ray, this bisymmetry best developed in forms with crown distinctly bent on stem or stem coiled around crown; cup low to tall conical or bowl shaped, with shortest and tallest sides in plane of symmetry; infrabasal circlet reduced to two plates or fused into single plate largely or entirely covered by proximal columnal of stem; basals with distinct tendency for CD basal to be larger than others or reduced to three (AE and AB basals lacking) or with CD basal standing alone, radials subequal in shape and size or distinctly unequal, with margin or articular facets straight or strongly curved; radianal and anal X present or absent. Arms formed by wide short brachials, branching isotomously once or more in each ray. Stem transversely circular in section or unevenly elliptical. M.Dev.; L.Penn.; U.Perm.

**Calycocrinus** WANNER, 1916, p. 260 [*C. curvatus*; OD]. Crown low to moderately tall, subconical to bowl shaped with rounded summit formed by incurved arms; cup with similar sides all around or with posterior and anterior sides quite dissimilar in height and curvature, with posterior side longitudinally convex and anterior side concave; infrabasals solidly fused into pentagonal plate largely covered by stem impression; basals 5, pentagonal in outline and equal in size or with anterior one smaller than CD basal; radials 5 with nearly straight margin of articular facet; without radianal and anal X (Fig. 524). Arms short, formed by wide short brachials, branching isotomously, normally on primibrach 3, and with additional bifurcation in some branches. Stem transversely circular, columnal articula with short peripheral artifacts.
crenulae. L. Penn.(Morrow.), USA(Okla.); U. Perm., Indon.(Timor).—Fig. 525,2; 526,3e-f. *C. curvatus curvatus (=C. curvatus typus Wanner, 1924, p. 96), U. Perm., near Basleo; 525,2, plate diagram of cup (radials black) and post. arms showing bilateral symmetry through A ray and CD interray (Wanner, 1924, mod.); 526,3e-f, CD-interray, A-ray, DE-interray, and ventral (A ray down) views of holotype crown, ×2 (Wanner, 1916a).—Fig. 526,3a,b. *C. curvatus subturbinatus Wanner, U. Perm., Basleo; 3a,b, DE-interray and ventral (A ray down) views of crown, ×1 (Wanner, 1924).

Ammonicrinus Springer, 1926, p. 22 [*A. wanneri; OD]. Crown short, rounded asymmetrically, incurved strongly in plane bisecting AE and CD interrays; infrabasals reduced to 2 subequal, symmetrically disposed and distinctly larger than others, with margins of articular facets rather strongly curved; rhombic radial obliquely at left below C radial (apparently doubled in some specimens); large anal X above CD basal and followed by several smaller anal plates. Arms formed by wide, short and straight or laterally somewhat curved brachials, branching isotomously on primibrachs 6 to 8 with up to 10 secundibrachs in some branches, followed by at least some tertibrachs. Stem coiled almost completely around crown, with distinct impressions of columnals on cup; columnals throughout midlength of stem strongly arched, with crescentic cross section; arthrodial plates which are larger than any of 3 basals adjoining them on posterior side (AB and EA basal lacking); A and E radials symmetrically disposed and distinctly larger than others, with margins of articular facets rather strongly curved; rhombic radial obliquely at left below C radial (apparently doubled in some specimens); large anal X above CD basal and followed by several smaller anal plates. Arms formed by wide, short and straight or laterally somewhat curved brachials, branching isotomously on primibrachs 6 to 8 with up to 10 secundibrachs in some branches, followed by at least some tertibrachs. Stem coiled almost completely around crown, with distinct impressions of columnals on cup; columnals throughout midlength of stem strongly arched, with crescentic cross section; articular facets with transverse ridge and otherwise with nearly smooth surface, indicating synostosal articulation; distal part of stem narrowing to point without holdfast or prolonged in elongate cylindrical columnals; axial canal very diminutive, circular. [SPRINGER was uncertain whether Ammonicrinus belonged to the Inadunata or Camerata, but judged that it most probably was a hexacrinid camerate. A painstaking study by Ubachs (1953) that included dissection of a well-preserved specimen of the type species has served to demonstrate beyond doubt that this crinoid is a lecanocirinean flexible.] M. Dev., Eu.(Ger.).—Fig. 525,3; 525,5. *A. wanneri, Eifel; 525,3, plate diagram (radials black, radianals cross ruled, X and higher anal plates stippled), CD interray upward (Ubachs, 1952); 526,5a-c, opposite sides and edge of enrolled column, distal extremity pointed upward, ×1.5 (Springer, 1926b); 526,5d,e, edge and side views of larger specimen, ×1.5 (Springer, 1926b).

Plagiocrinus Wanner, 1924, p. 110 [*P. toryno­crioides; OD]. Crown symmetrically pear shaped, with nearly straight anterior side, rounded summit, and longitudinally strongly convex posterior side; cup obliquely inclined from stem or bent almost at right angles to it; infrabasal cirelet reduced to small subcrescentic fused plate on posterior side of stem impression, followed on this side by single CD basal (no others in cup); radials 5, quadrangular to pentagonal in outline, with straight margin of articular facet, A and E radials in contact with infrabasal cirelet beneath proximal columnal. Arms varying in width, composed of low, wide brachials, branching isotomously on primibrach 2, and with 1 or 2 additional bifurcations in different branches. Stem unknown but impression at base of cup unevenly elliptical. [Plagiocrinus resembles Ammonicrinus in disposition of its plane of near-bilateral symmetry. It differs from strongly oblique species of Calycocrinus in having only a single basal plate.] U. Perm., Indon.(Basleo).—Fig. 526,6; 526,4d. *P. torynomcrioides, Basleo; 525,6, plate diagram (radials black), CD interray upward (Wanner, 1924, mod.); 526,4d, E-ray view of holotype crown, ×2 (Wanner, 1924).—Fig. 526,4a-c. *P. jackelli Wanner, Basleo; 4a-c, DE-interray, CD-interray, and ventral (A ray down) views of holotype cup, ×1.5 (Wanner, 1924).

Family GAULOOCRINIDAE

Moore & Strimple, 1973


Cup low bowl shaped, with flat to slightly concave base and longitudinally convex sides, becoming subvertical in upper part and curving inward slightly at margins of
radials; infrabasal circlet angularly pentagonal, with small infrabasal in C ray or possibly all plates fused, approximately half of its diameter occupied by shallowly concave stem impression; basals large and very thick, strongly convex both longitudinally and transversely, all pentagonal in outline; radials wider than high, also exceptionally thick, with broad, nearly featureless facets with faint transverse ridge not quite reaching interradial sutures. Arms composed of very wide short brachials, branching isotonously on primibrachs 2, succeeded in each branch by five or more secundibrachs, tertibrachs unknown; arms slope inward with gentle convexity to meet at center of crown. No radianal or anal X in cup. Column transversely circular but otherwise unknown. L.Miss.

Gaulocrinus Kirk, 1945, p. 180 [*Stemmatocrinus trautscholdi Wachsmuth & Springer, 1885, p. 180; OD]. Characters of family. L.Miss.(Osag.), USA(Ind.-Tenn.-?Ky.).—Fig. 525,5; 527,1. *G. trautscholdi (Wachsmuth & Springer), New Providence F., White’s Creek Springs, Tenn.; 525,5, plate diagram (radials black), CD interray upward (Moore, n); 527,1a,b, ventral (presumed A ray up) view showing very thick radials and nature of facets, and part of dorsal view (presumed BC interray down), ×1.5 (Moore, n; U.S. Natl. Museum); 527,1c-g, A to E radials from exterior showing near identity in appearance and broadly scalloped profile of articular facets, ×1.5 (Moore, n; U.S. Natl. Museum); 527,1h, side view of incomplete crown (rays unidentified) showing typical sort of flexible arm structure, ×1.5 (Moore, n; U.S. Natl. Museum).

Family PROPHYLLOCRINIDAE

Moore & Strimple, 1973

[Prophyllocrinidae Moore & Strimple, 1973, p. 15]

Crown moderately small, globose; cup with flat or somewhat concave base formed by pentagonal completely fused infrabasal circlet, surrounded by five equal pentagonal basals, strongly curved longitudinally as well as transversely; radials with articu-
lar arm facets much narrower than width of plates, bordered on one or both sides by pronglike projections, which may be symmetrical or decidedly asymmetrical, with projection on left side of facet most extended; quadrangular radianal directly below C radial, pentagonal anal X on distally truncate CD basal or both of these plates lacking. Arms short, narrow, bifurcating isotomously once or twice. U.Perm.

Prophyllocrinus WANNER, 1916, p. 273 [*P. dentatus; OD]. Cup subglobular, with flattened or concave base, formed of massive plates; pentagonal infrabasal circlet entirely fused; radials with symmetrical or nearly symmetrical upward projections on either side of medially placed articular facet approximately 0.3 width of radial. Arms formed of wide, low brachials with transversely curved faces, branching isotomously on primibrachs 2 or 3 (rarely 4) followed by 2 to 6 secundibrachs in each branch and 0 to 8 tertibrachs; arms bent strongly inward concealing tegmen. Stem transversely circular, diameter 0.4 to 0.8 width of infrabasal circlet, facets with peripheral girdle of short, fine crenulae, axial canal very small, circular.
Wanner (1930b, p. 43) has described and figured an abnormal specimen classed as belonging to *P. cuspidatus* Wanner (1916a) differing from others in having both a rhombic radianal and pentagonal anal X. The radianal occurs directly beneath the C radial, as in *Mysticocrinus*, and accordingly the specimen was compared by Wanner with this genus, which he interpreted as ancestral to *Prophyllocrinus.* U. Perm., Indon. (Timor, Basleo).—Fig. 528,2a; 529,3a,b. *P. cuspidatus* Wanner; 528,2a, plate diagram of specimen classed as abnormal by Wanner because of presence of small plates seemingly representing radianal and anal X (radials black, radianal cross ruled, X stippled) (Wanner, 1930b, mod.); 529, 3a,b, lat. and dorsal views of cup, ×1.5 (Wanner, 1916a).—Fig. 528,2b; 529,3c-e. *P. dentatus*; 528,2b, plate diagram (radials black), ray orientation not identifiable (Wanner, 1916a, mod.); 529, 3c-e, ventral, dorsal, and lat. views of holotype crown, ×2 (Wanner, 1916a).

Ancistrocrinus Wanner, 1924, p. 119 [*A. vermistriatus*; M]. Generally very similar to *Prophyllocrinus*, but cup plates more massive and externally bulbous, infrabasal cirlet in distinct concavity, mostly concealed by proximal columnals, and chiefly distinguished by very asymmetrical radials with distal left portion of each strongly elevated as spikelike projection and rounded articular facet confined to right half of plate. Arms composed of taller than average brachials, branching isomotomously on primibrachs 2. U. Perm., Indon. (Timor, Basleo).—Fig. 528,1; 529,1. *A. depressus* Wanner; plate diagram (radials black), orientation of rays not identifiable (Wanner, 1930b, mod.).—Fig. 529,2. *A. vermistriatus*; 2a,b, lat. and dorsal views of holotype cup, ×1.5 (Wanner, 1924).

Proapsidocrinus Wanner, 1924, p. 116 [*P. permicus*; OD]. Like Ancistrocrinus, but narrowly rounded articular facets of radials submedian, bordered on right by moderate upward projection and on left by very strong one arched inward to meet those of other radials at summit of cup, thus forming deep niches for reception of arms, which branch isomotomously on primibrachs 2 and secundibrachs 2, latter supporting 7 or more tertibrachs on either side. U. Perm., Indon. (Timor, Basleo).—Fig. 528,1; 529,1. *P. permicus*; 528,1, plate diagram (radials black), orientation of rays not identifiable (Moore, n); 529,1a-c, lat., dorsal, and ventral views of holotype incomplete crown, ×1 (Wanner, 1924).
Family PALAEOHOLOPODIDAE
Wanner, 1916

[nom. correct. Moore, herein (pro Palaeoholopidae Wanner, 1916a, p. 279)]

Crown gumdrop shaped, with subvertical, longitudinally nearly straight sides and evenly rounded, very low summit formed by wide and extremely short arms curved inward to meet centrally. Cup consisting of five quadrangular radials surrounding tall cylindrical base presumably formed by fused basal and infrabasal circlets, cup attached to featureless low or moderately tall peduncle, no true stem. Arms unbranched, composed of three to five brachials which tend to be inclined clockwise. *U.* Perm.

**Palaeoholopus Wanner, 1916, p. 279 [*P.* pretiosus; M].** Crown with nearly vertical sides and flatly rounded summit, 0.7 of height formed by 5 quadrangular radials of cup, which has very even summit formed by wide straight articular facets of radials, base of cup consisting of flat circular disc thought to be formed by fused basal and infrabasal circlets; cup attached to stemlike peduncle, which is cylindrical sutureless tube with diameter equal to that of cup and sides confluent with cup. Arms formed by very wide short brachials which are longitudinally convex, arms unbranched, with pointed tips meeting at summit of crown. *U.* Perm., Indon. (Timor).—Fig. 525,1; 526,1. *P.* pretiosus; 525,1, plate diagram (radials black) (Wanner, 1930b, mod.); 526,1a,b, ventral and lat. views of crown, X1 (Wanner, 1916a).

**Permobrachypus Moore & Strimple, 1973 [nom. subst. pro Brachypus Wanner, 1929a, p. 320 (non von Meyer, 1814; nec Swainson, 1824; nec Meigen, 1824; nec Schoenheer, 1825; nec Gray, 1825; nec Fitzinger, 1826; nec Guiling, 1828)].** Essentially similar to *Palaeoholopus* but radials proportionally wider and shorter and arms forming relatively higher more evenly rounded summit of crown. Peduncle very short and with sides tending to flare outward from base of cup. Arms composed of only 3 brachials which progressively decrease in width upward. *U.* Perm., Indon. (Timor).—Fig. 525,4; 526,2. *P.* adhaerens (Wanner); 525,4, plate diagram (radials black) (Wanner, 1930b, mod.); 526,2a-c, 2 lat. and ventral views of holotype crown, X2 (Wanner, 1930b).

Superfamily ICTHYOCRINACEA
Angelin, 1878

[.nom. transl. Moore & Strimple, 1973 (ex Icthyocrinidae)

Fig. 528. Prophylloocrinidae (radials black, anal X stippled, radianal cross ruled) (p. T787-T788).
Family ICTHYOCRINIDAE Angelin, 1878

Characters of superfamily. [The unimportant, even rudimentary nature of the infrabasal circlet was considered by Springer to be a diagnostic feature of this assemblage, but the dominance of fixed ray plates un-associated with interprimibrachs in forming a stoutly built calyx seems more significant.] L.Sil.(Medinan)-L.Miss.(Oasg.).

Ichthyocrinus Conrad, 1842, p. 279 [*I. laevis; M] [=Ichthyocrinus Hall, 1852, p. 195 (nom. van.) (obj.)]. Crown ovoid to pear shaped, expanding upward from base of calyx which is formed by small radials and subjacent cup plates; greatly larger part of calyx composed of interlocking, firmly sutured ray plates; small infrabasal circlet

Crown globose to elongate ovoid, many-armed, with cup not separated from fixed proximal brachials which form much or most of calyx, arms joined together closely, without associated interbrachials, cup anal plates lacking or restricted to radial or anal X. Arms branching isotonously. Stem transversely circular. L.Sil.-L.Miss. or low. L.Carb.
entirely concealed by stem or resorbed; posterior basal not differentiated, orientation of crown being determined by position of small infrabasal in C ray and occurrence of primitive radianal in this ray directly below radial; no anal X or interradial plates. Arms in calyx and above it branching isotomously on primibrachs 2, secundibrachs 3 or more commonly 4. Stem composed of thin, circular columnals tapering abruptly beneath cup or gradually reduced in width, axial canal small, circular or bluntly pentagonal. M.Sil. (Niagaran), USA (N.Y.-Ind.-Ill.)-Eu. (Sweden-Eng.) L.Dev. USA (Tenn.)-Eu. (Czech.). —Fig. 530, 3; 531, 3a-c. *I. laevis, Lockport Ls., USA (N.Y.)-Can. (Ont.); 530, 3, plate diagram of part of calyx (radials black, radianal cross ruled) and arms of C and D rays (mod. from Springer, 1920); 531, 3a,b, dorsal view of crown (CD interray directed upward) and B-ray view of same, specimen from Lockport, N.Y., X2 (Springer, 1920); 531, 3c, AB-interray view of crown from Grimsby, Ont., X2 (Springer, 1920). —Fig. 531, 3d. I. pyri-
Echinodermata—Crinoidea

*Echinodermata—Crinoidea*

**Fig. 531. Icthyocrinidae (p. T790-T793).**


**Cleistocrinus** Springer, 1920, p. 292 [*Calpiocrinus humilis* Angelin, 1878, p. 12; OD]. Lower part of calyx strongly built, shallow bowl shaped, with
gently sloping sides; infrabasal circlet very diminutive or lacking; basals very small, entirely covered by stem, which likewise conceals all radials except in C ray where lower half of radial and radianal plate directly beneath it are included in stem impression; proximal part of primibrachs concealed by stem except in C ray; ray branching isotomously on primibrachs 2, parts of calyx above secundibrachs 2 and free arms unknown; pentagonal anal X in CD interray rests on beveled edges of the D radial and radianal. Stem large, transversely circular, shown by impression on calyx to have facets with long fine crenulae; axial canal quinquestellate. U.Sil., Eu.(Sweden).—Fig. 530,4; 531,1. *C. humilis (ANGELIN), Wenlock Ls., Gotl.; 530,4, plate diagram of calyx (radials black, radianal cross ruled, anal X stippled) and proximal parts of arms (mod. from Springer, 1920); 531,1a-d, ant., post., ventral, and dorsal views of syntype, CD interray directed upward in 1d and downward in 1c, ×2 (Springer, 1920).

Clidochirus ANGELIN, 1878, p. 12 [*C. pyrum; M] [=Clidocrinus WANNER, 1916a, p. 251 (nom. null.) (obj.)]. Crown elongate ovoid to pear shaped, generally resembling Icthyocrinus in appearance, but distinguished by larger plates in lower part of calyx, infrabasals sloping upward and visible from side (but concealed in one species); CD basal larger than others and broadly truncate distally for support of large anal X, which is followed by additional anal. Arms laterally interlocked, divided isotomously on primibrachs 2, secundibrachs 4 and at higher levels. Stem very little tapered next below calyx and subequal in diameter throughout its observed length, formed of low columnals in proximal region but taller ones distally, articular facets distinctly crenulate. L.Sil., USA(Ohio); U.Sil., Eu.(Sweden); L.Dev., USA(W.Va.-N.Y.); U.Dev., USA(Iowa); L.Miss., USA(Ky.).—Fig. 530,2; 531,2c-e. *C. pyrum, U.Sil.(Wenlock), Gotl.; 530,2, plate diagram of lower part of calyx (radials black, anal X stippled), with proximal part of C and D rays separated by anal plates (mod. from Springer, 1920); 531,2c, dorsal view of crown, CD interray upward, ×1 (Springer, 1920); 531,2d,e, ant. and post. views of complete crown with attached stem, ×1 (Springer, 1920).—Fig. 531,2a,b. C. keyserensis SPRINGER, L.Dev. (Helderberg.), USA(W.Va.); 2a,b, post. and dorso-ventral views of complete crown, 2b with CD interray upward, ×1 (Springer, 1920).

Metichthyocrinus SPRINGER, 1906, p. 517 [*Ichthyocrinus burlingtonensis HALL, 1858b, p. 557; M]. Crown subglobular, with smoothly sloping sides of calyx and free arms well inturned at summit; stem concealing subhorizontal infrabasals and basal circlet except for their distal extremities. Arms expanding upward, closely abutting with brachials interlocking. Stem tapering somewhat next below calyx but thereafter nearly uniform in diameter, columnals very thin proximally but much thicker distally with tendency in some species toward heteromorphy. [The type species of this genus is not the form recorded by SPRINGER (1920, p. 320), given as Cyathocrinus tiaraeformis TROOST (nom. nud.) (=Ichthyocrinus tiaraeformis TROOST in HALL, 1858b, p. 558). This is because in his original publication SPRINGER cited a single species as M. burling-
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tonensis HALL (Springer, 1906, p. 522, pl. 6, fig. 15) (=Ichthyocrinus burlingtoni HALL, 1858, p. 557). 
HALL's species is thus fixed as type of Metichthycrinus by monotypy.] L.Miss., 
USA(Iowa-Ind.-Ky.-Tenn.).—Fig. 530,5; 532, 
1a-c. M. tiraeformis (Troost), L.Miss.(Osag., 
New Providence F.), USA(Tenn.); 530,5, plate 
diagram of cup (radials black) and major part 
of C and D ray (mod. from Springer, 1920); 531,1a-c, lat., basal, and summit views of com­ 
plete crown, x1 (Springer, 1920).—Fig. 532, 
1d. M. clarkei (Miller & Gurley), L.Miss. 
(Osag., New Providence F.), USA(Tenn.); lat. 
view of crown, identity of rays unspecified, x1 
(Springer, 1920).

Synaptocrinus Springer, 1920, p. 301 [*Forbesio­ 
crinus nuntius HALL, 1862, p. 124; OD]. 
Crown pear shaped, widest near summit; calyx includes 
cup plates largely concealed by stem, CD basal 
noteably elongate and pointed distally; ray plates bifurcating isomotously, brachials strongly inter­ 
locked; type species distinguished by rounded elevation 
of the median part of each brachial, producing 
appearance of raised branching arms entirely foreign to typical ichthyocrinids. Stem heteromorphic, not appreciably reduced in diam­ 
eter distally. M.Dev., USA(N.Y.); U.Dev., NW. 
Can.—Fig. 530,J; 532,2. *S. nuntius (HALL), 
Hamilton Gr., USA(N.Y.); 530,J, plate diagram 
of part of cup (radials black, anal X stippled) 
and arms of C and D rays (mod. from Springer, 
1920); 532,2a,b, post. view of crown (reconst.) 
and diagrammatic view of base with CD interray 
directed upward, x2 (Springer, 1920).

Superfamily 
SAGENCRIINITACEA 
Roemer, 1854

[nom. transl. Moore & Strimple, 1973 (ex Sagenocrinidae 
Basler, 1938, p. 23; nom. subst. pro Sagenocrinidae 
Roemer in Bronn, 1854, p. 228).]

Crown globose to elongate ovoid, with 
many laterally abutting arms and joined 
together also by interradial and interbrachial 
plates, arms curved inward at top of crown 
above tegmen, which therefore generally 
cannot be seen. Stoutly built calyx 
comprising lower one-half or more of crown 
includes one or several anal plates in posteri­ 
or interray or uncommonly lacks them 
entirely. Stem mostly large, transversely 
circular. U.Sil.-U.Perm.

Family HOMALOCRINIDAE 
Angelin, 1878

[Homalocrinidae Angelin, 1878, p. 11]

Crown small, rotund, with cup (defined 
as including plates below summit of radials) 
not distinctly separated from higher part of 
crown, in this respect clearly differentiated 
from Lecanocrinidae and Nipterocrinidae; 
infibrasals extending beyond stem impres­ 
sion; radial in primitive position directly 
beneath C radial, anal X extending above 
articular facets of adjoining radials. Arms 
gently to somewhat strongly rounded 
transversely, composed mostly of brachials wider 
than high, with only few of them in each 
ray joined together by firm sutures to form 
fixed brachials, branching of arms isomotous 
up to Y level at upper limit of fixed brachi­ 
als and heterotomous above Y line; one or 
two large interprimibrachs between contiguous 
rays or with larger number of small, ir­ 
regularly arranged and shaped interprimi­ 
brachs; interbrachials very few or lacking. 
Stem transversely circular, composed of 
low columns or in intermediate and 
distal regions of columns with height 
early nearly to diameter; axial canal cicular, 
very tiny. [Endotomous branching of arms in upper part of crown is a most 
diagnostic attribute of the family.] U.Sil.

Homalocrinus Angelin, 1878, p. 11 [*H. parabasalis (=Taxocrinus nanus Salter, 1873, p. 126, 
nom. nud.; H. dudleyensis Springer, 1906, p. 482); M] [=Leiocrinus SPRINGER, 1902, p. 95 
type, Calpiocrinus ovatus Angelin, 1878; OD 
(non D'Orbigny, 1850, p. 180)]. Large anal X 
resting on truncated distal margin of posterior 
basal and extending upward so as to separate 
primibrachs of C and D rays; other characters as 
for family. U.Sil., Eu.(Sweden-Eng.).—Fig. 
533,3; 534,2a-k. *H. parabasalis; 533,3, plate 
diagram (radials black, radianal cross ruled, X 
upward) and higher anals stippled), CD interray upward 
(Springer, 1920, mod.); 534,2a-c,h, E-ray, CD­ 
interray, C-ray oblique from below, and dorsal 
(CD interray up) views of specimen from Got­ 
land figured by Angelin, x1.5 (Springer, 1920); 
534,2d-f, A-ray, dorsal (A ray down), and D-ray 
views of specimens from Dudley, Eng., x2 
(Springer, 1920); 534,2g, CD-interray view of 
juvenile crown from Gotland, x2 (Springer, 
1920).—Fig. 534,2i-k. H. liljevalli SPRINGER, 
Sweden(Godl.); 2i,j, dorsal (CD interray up) 
and B-ray views of holotype crown, x2; 2k, un­ 
der side of finely plated tegmen of another speci­ 
men showing 5 centrally placed orals and 
ambulacra passing between them to arms, x2 
(all Springer, 1920).

Anisocrinus Angelin, 1878, p. 13 [*A. interra­ 
dius; M]. Radial directly or somewhat ob­ 
liquely at left below C radial; interrays with very

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large plates resting on shoulders of radials and arched over by fixed brachials, anal X largest of these, distinguished by its position on truncated distal margin of posterior basal and by its contact with radianal; large proximal plates of interrays may be followed by 1 or 2 smaller ones above; Y line at summit of axillary secundibrachs or S. U.Sil., Eu.(Sweden)-N.Am.(Ill.-Ind.-Ky.-Tenn.).—Fig. 533,1; 534,1a-e. *A. interradiatus, Sweden(Gotl.); 533,1, plate diagram (radials black, radianal cross ruled, anal X stippled; y, upper line of fixed brachials), CD interray upward (Springer, 1920, mod.); 534,1a, A-ray view of essentially perfect crown showing upfolded infrabasal circlet and truncate summit formed by infolded arms, X2; 534,1b,c, CD-interray and dorsal (CD interray up) views of incomplete crown, X2 (all Springer, 1920).

Asaphocrinus SPRINGER, 1920, p. 174 [*A. bassleri; OD]. Crown expanding upward, with transversely well-rounded arms not abutting laterally; interray areas with numerous irregularly shaped and arranged plates; infrabasals visible from side, CD basal larger than others and firmly joined to rhombic radianal and large anal X, latter supporting numerous smaller anals in form of sac or tube interlocking laterally with contiguous brachials. Each ray with several isotomous bifurcations of arms at different levels. U.Sil., USA(N.Y.-Ind.-Tenn.).—Fig. 533,2; 534,3a-c. *A. bassleri, Brownsport Ls., Tenn.; 533,2, plate diagram (radials black, radianal cross ruled, X and higher anals stippled), CD interray upward (Springer, 1920, mod.); 534,3a-c, D-ray, A-ray, and DE-interray views of three crowns, X1 (Springer, 1920).—Fig. 534,3d. A. ornatus (HALL), Rochester Sh., N.Y.; CD-interray view of crown showing tubelike appearance of anal plate series, X1.5 (Springer, 1920).

Family SAGENOCRINITIDAE Roemer, 1854

Crown ovoid to pear shaped, elongate cup (radials, anals, and lower plate circlets) not at all set off from bulk of large stout calyx composed of numerous fixed brachials in all rays and prominent many-plated interradial and interbrachial areas; free arms mostly well differentiated from calyx, transversely rounded, separated from one another and bifurcating several times isotomously, distal extremities of arms curved strongly inward at top of crown; infrabasal circlet subhorizontal, largely, or entirely concealed by column; basals and radials commonly not larger than fixed brachials and interbrachials, all massive thick plates firmly joined together; radianal and anal X present in all genera. Stem homeomorphic or distinctly heteromorphic, composed of

**Fig. 533.** Homalocrinidae (radials black, anals stippled, radianal cross ruled) (p. T794-T795).
relatively low columnals which commonly are perforated by quinquestellate axial canal. U.Sil.; Miss.; L.Perms.

**Sagenocrinites** Austin & Austin, 1842, p. 110 [*Actinocrinites? expansus* Phillips in Murchison, 1839, p. 674; M] [=Sagenocrinus Morris, 1843, p. 58 (nom. van.) (obj.); Periechocrinites Austin & Austin, 1843, p. 203 (type, *P. articulosus*; =Actinocrinites? expansus, obj.; OD) (non Bassler, 1938, p. 149); Sageniocrinus Zittel, 1895, p. 130 (nom. null.).] Crown ovoid to biturbinata, small to moderately large; infrabasals somewhat recumbent, not entirely covered by stem impression; basal circllet commonly interrupted in C-ray position by radianal which occurs in primitive position directly beneath C radial and touches small infrabasal; CD basal not larger than others or truncated distally; anal, interradial and interbrachial areas filled by numerous polygonal solid plates in more than one series and characterized by appreciable breadth of these areas; fixed and
free brachials in isotomously branching successions, narrowing upward and with straight to distinctly sinuous interbrachial sutures; each ray or arm branch with 2 primibrachs, 3 or 4 secundibrachs, 5 to 8 tertibrachs, and indefinite number of plates in higher brachitaxes. Stem transversely circular, heteromorphic, not expanding at calyx; columnals penetrated by quinquestellate axial canal. *U.Sil., Eu.(Eng.-Sweden)-USA(Ind.-Tenn.).—Fig. 535,2; 536,1a,b. *S. expansus (PHILLIPS),
Forbesiocrinus de Koninck & Le Hon, 1854, p. 118 [*F. nobilis; M] [=Proguettardicrinus Steinmann, 1908, p. 153 (type, Forbesiocrinus greenei Miller & Gurley, 1896b, p. 57; OD)]. Crown globular to elongate ovoid, medium sized to unusually large, with stout calyx formed by firmly sutured thick cup and ray plates joined laterally with large areas of interradial and interbrachial plates; transversely rounded free arms in upper
part of crown branching isotomously and separated, incurved distally; infrabasal circle barely visible beyond large stem impression externally, very thick, and narrowing internally to small pentagon; only distal extremities of basals exposed, CD largest, with distal margin beveled for contact with anal X at left and upwardly displaced radial at right, these plates followed by numerous other medium-sized polygonal anals in posterior interray; radials approximately equal in size and shape to proximal primibrachs, laterally united with one another except where separated by anals. Both fixed and free arms branching evenly isotomously, composed of brachials with strongly sinuous sutures produced by prominent patelloid processes and sockets on outer parts of their articular facets. Large stem composed of low circular columnals which decrease gradually in diameter for short or considerable distance beneath calyx but after initial taper maintain fairly constant diameter, with or without distinct increase in height of columnals; stem penetrated by quinquestellate axial canal. L.Carb.(Tournais.), Eu.(Belg.-Eng.); L.Miss.(Osag.)-U.Miss.(Meramec.), USA(Iowa-Mo.-Ill.-Ind.-Ky.-Tenn.-Ohio).

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Burlington Ls.(Osag.) at Burlington, Iowa, showing very numerous anal plates, outer ones joined firmly to brachials of C and D rays, X0.5 (Springer, 1920); 537,1, C-ray view of somewhat crushed crown from Tournais., Belg., X0.7 (Springer, 1920); 537,2-7, dissociated calyx and arm plates from Tournais., Belg.; 2a-d, distal, side, prox., and ext. views of basal; 3a-c, distal, side, and prox. views of radial; 4a-c, distal, side, and prox. views of first primibrach; 5, distal view of 2nd secundibrach; 6a-e, distal, side, prox., ext., and int. views of 2nd primibrach; 7a-e, distal, side, prox., ext., and int. views of proximal; all X2 (Springer, 1920).—Fig. 537,8. F. saaffordi Hall. U.Miss.(Meramec.), USA(Ind., Spergen); 8a, int. view of basal part of calyx with radials (A radial upward) and anal, X2; 8b, ext. view of basal circlet (post. basal upward) and stem impression, X2; 8c, int. view of infrabasal and basal circlets (post. side downward), X2; 8d, int. view of infrabasal circlet showing subtriangular rim surrounding axial canal (small infrabasal in A ray), X4; 8e, part of interior showing corrugated edges of thick brachials for attachment to interbrachials, X1.5 (all Springer, 1920).

Trampidocrinus Lane & Webster, 1966, p. 17 [*T. phiala; OD]. Crown medium sized to large, compact, sides of calyx flaring rather evenly outward from stem with free arms above calyx curved strongly inward; notably similar to Forbesiocrinus in general features, including arrangement of large anal X and radial plates above large CD basal but differing radically in broad contact of B and C radials with infrabasals. Isotomous branching of fixed and free arms well defined, as is strongly sinuous interbrachial sutures produced by patelloid processes. Stem very unlike that of Forbesiocrinus and corresponding closely to Nevadacrinus (dactylocrinid flexible crinoid) in having a curved, gently tapered basillarid region composed of 25 to 40 very low columnals with strongly crenulate articula ending distally at a bulbous wedge-shaped column (cuneus) with facial planes disposed at angle of 45° to 55° to each other; beyond cuneus stem is distinctly heteromorphic, composed of moderately tall columnals with longitudinally convex profile alternating with much thinner, straight-sided columnals; curvature and abrupt flexure of stem is in direction of CD interray, thus differing from Nevadacrinus in which curvature and flexure appear to be toward AB interray. L.Perm., USA(Nev.).—Fig. 535,3; 536,2a-c. [*T. phiala; 535,3, plate diagram of calyx (symbols as in Fig. 535,2), lower part of C and D arms, and adjoining interrays (mod. from Lane & Webster, 1966); 536,2a,b, views of crown with part of attached stem from B-ray side (distant arms of A ray at right) and from DE-interray side (CD interray at right), X1 (Lane & Webster, 1966); 536,2c, DE-interray view of holotype (D ray at right), X1 (Lane & Webster, 1966).

Family DACTYLOCIRINIDAE
Bather, 1899

[Actylocrinidae Bather, 1899b, p. 923] [incl. Calpocrinidae Jaekel, 1918, p. 79]

Crown ovoid, moderately elevated, with virtually no distinction between fixed brachials forming upper part of calyx and cup composed of radials and lower plate circlcts; radial normally lacking but anal X commonly distinct and relatively large, followed by other anal plates. Proximal columnal concealing infrabasal circket in most genera, as well as much or all of basal plates and even portions of radials. First and second branching of arms confined to calyx in which brachitaxes and lower plates are fixed, is isotomous; higher branching involves free brachitaxes, which are separated laterally from one another and are strongly heterotomous. Within this family free arms and their free brachitaxes considerably exceed length and number of arms incorporated in the calyx; accordingly, heterotomy prevails over isotomy in arm structure. Interbrachials few or may be absent. U.Sil.-L.Miss.; L.Penn.-U.Perm.

Dactylocrinus Quarstedt, 1876, p. 520 [*Dinero­crinites oligoptilus Pacht, 1852, p. 339; M] [non Dactylocrinus Sladen, 1878, p. 245 ] [=Dinero­crinites Pacht, 1852 (non Phillips in Murchison, 1839) (obj.); Aristocrinus Rowley, 1895, p. 218 (type, A. concaucus; M); Callawayocrinus Rowley, 1895, p. 219 (Aристоcriinus, obj.).] Crown round to elongate, widening upward; base flat, broadly concave, or deeply excavated, with part of radials and all lower plates involved in bowl for reception of stem; infrabasal circket entirely surrounded by basal, which are relatively narrow and notably elongated, CD basal more than others and truncated distally for support of large polygonal anal X; radials with large articul X; radials with large interradial plate and with anal X in posterior interray; no radianal, X followed by several anal plates which are sutturally joined laterally to brachials. Arms branching isotomously in each ray on primibrachs 2 and secundibrachs 3 to 5, in more distal portions characterized by strong heterotomy of bi-endotomous type, with main arm trunks subequal or with inner ones somewhat smaller than outer. Column enlarging proximally. [Name derived from fingerlike appearance of ramules.] M.Dev.-L.Miss., Eu.(Belg­Ger.-W.USSR)-USA (Ohio-Mich.-Mo.-Iowa).—Fig. 538,3a,b; 539,1a,b. *D. oligoptilus (Pacht), U.Dev., USSR; 538,3a,b, plate diagram (radials black and other anal stippled), CD interray.
upward, and section of basal part of cup (Springer, 
1920, mod.); 539,1a, post. side of crown showing 
isotomous divisions of main branches of C and 
D rays with ramules on facing sides (bi-endoto­
mos), also arrangement of anal plates, X 1 
(Springer, 1920); 539,1b, dorsal side of cup 
showing basal concavity, basals entirely concealing 
infrafasals, X 1 (B, basal; R, radial) (Springer, 
1920).—Fig. 538,3c. D. excavatus (Schultze), 
M.Dev., Ger.; vert. sec. of lower part of calyx 
(B, basal; IB, infrabasal; R, radial) (Springer, 
1920).—Fig. 539,1c-e. D. concavus (Rowley), 
M.Dev.(Hamilton), USA(Mo.); D-ray, CD-inter­
ray, and dorsal views, x 1.5 (Springer, 1920).

229 [*Synerocrinus formosus Moore & Plummer, 
1940, p. 94; OD] [=Trautscholdicrinus Moore & 
Plummer in Moore, 1939c, p. 195 (non Yakov­
lev & Ivanov, 1939, p. 66) (type, T. jaekeli; 
OD); Synerocrinus Moore & Plummer in Moore,
1939c, p. 195 (non Jaekel, 1898a); Talanternocrinus Moore & Plummer, 1940, p. 96 (type, T. jaekeli, =Trautscholdicrinus jaekeli, =Forbesiocrinus incurrens Trautschold, 1867, =Senerocrinus incurrens Jaekel, 1898a; OD). Differs from Dactylocrinus chiefly in much smaller number and diminutive size of short ramiules, presence of 4 or more interradial plates between each contiguous pair of rays, and 2 primibrachs, 3 secundibrachs, and 9 or more tertibrachs in each brachitaxis; large anal X with oblique distal facets supporting double series of additional anal plates which are suturally joined to C- and D-ray brachials. Stem medium sized to large, narrowing somewhat beneath proximal region. [In appearance this genus corresponds rather closely to Senerocrinus but differs in having anal plates suturally interlocked with adjacent brachials. Senerocrinus has a tubular anal series not so connected. Moore & Plummer (1940, p. 90)
overlooked this distinction and failed to recognize the heteromous nature of distal parts of the arm branches. They also misconstrued the nature of the type species of Synerocrinw and needlessly
introduced a new generic name called *Trauschooldicrinus*, later changed without explanation to *Talanterocrinus*.—*M.Penn.-U.Penn., USA*(Okla.-Colo.-Texas).—Fig. 538,5; 540,3a,b. *A. formosus* (Moore & Plummer), *M.Penn.* (Desmoines, Millsap Lake F.), USA (Texas, Parker Co.); 538,5, plate diagram (radials black, X and higher anals stippled; y, upper line of fixed brachials), CD interray upward (Moore, n); 540, 3a,b, C-ray view of paratype and D-ray view of holotype, X1 (Moore & Plummer, 1940).—Fig. 540, 3c-e. A. megariei (Moore), *U.Penn.* (Virgil, Brownsville Ls.), USA (Okla., Osage Co.); 3c-e, holotype from above, side, and below (with CD interray upward), X1.5 (Moore, 1939c).


*Calciopircinus Angelin*, 1878, p. 12 [*C. fimbriratus*; SD Springer, 1920, p. 145]. Crown ovoid; chiefly characterized by its highly specialized base with very large infrabasals enveloping basals and to variable extent even radials and part of primibrachs; large anal X resting on truncated extremity of CD basal and followed by other anals; interbrachials consisting of single large plate between adjacent rays or by such plate followed by smaller ones in series. Free arms heterotomous of bi-endotomous type, with small ramules confined to distal region. Column large, short, tapering gradually to encrusting root. [Corresponds to *Homalocrinus* in enlargement of infrabasals externally, but in *Homalocrinus* this is much less extreme. Also, heterotomy of latter genus is endotomous with much larger ramules.] *U.Sil., Eu.(Sweden-Eng.-Czech.).—Fig. 538,2; 540,2. *C. divaricatus* (Angelín), Wenlock Ls., Sweden (Gotl.); 538,2, plate diagram (radials black, X and higher anals stippled; y, upper line of fixed brachials), CD interray upward (mod. from Springer, 1920); 540,2, D-ray view of holotype showing crown and attached stem, X1.5 (Springer, 1920).

*Nevadacrinus* LANE & WEBSTER, 1966, p. 15 [*N. geniculatus*; OD]. Crown small, expanding upward from low bowl-shaped calyx, free arms separated, not touching one another laterally and not sutured united with interbrachials above primibrachs; infrabasal circket relatively large, visible from side, with small plate directly in contact with C radial, as well as large CD basal, which has oblique distal margins for support of 2 anal plates interpreted by authors as anal X at left and upwardly displaced radianal at right (latter here considered very doubtful), these plates followed by additional ones above; anal plates and interprimibrachs joined laterally to brachials by firm sutures. Arms branching isometrically on primibrachs 4 (rarely on primibrach 5), with additional bifurcations on secundibrachs 2 and possibly higher; articular facets of brachials with patelloid processes. Transversely circular stem composed in proximal (basillarid) region by 14 to 16 very low columnals with strongly crenulate articular facets, moderately curved in A-ray direction, jointed distally to very prominent bulbous thick columnal (cuneus) with angularly divergent facets, followed distally by columnals thicker than those in the basillarid region and moderately heteromorphic. [LANE & WEBSTER'S assignment of this genus to the Taxocrinidea is not accepted here, for the rather wide group of anal plates, firmly sutured laterally to radials and brachials is far removed from the linear anal series in form of a tube found in typical Taxocrinida.] *L.Perm., USA*(Nev.).—Fig. 541,4; 542,1. *N. geniculatus*; 541,4, plate diagram (radials black, radianal cross ruled, X and other anals stippled), with part of C and D rays and adjoining interrays (Moore, n); 542,1a,b, AB-interray and D-ray...
Fig. 541. Dactylocrinidae (3-5), Euryocrinidae (1,2,6,7) (radials black, anals stippled, radianal cross ruled) (p. T804-T806, T808-T811).

views of holotype, ×1.5 (Lane & Webster, 1966); 542,1c,d, side view of stem adjacent to crown showing much-enlarged wedge-shaped columnal (cuneus) separating proximal thin columns of basillary region from more distal heteromorphic columnals, and D-ray view of paratype, ×1.5
placed plates in *Nevadacrinus*, *Dactylocrinus*, *Aexitrophoerinus*, and *Lithocrinus*, doubtfully interpreted as radial displaced upward.] U.Perm., Indon. (Timor).—Fig. 541,3; 543,3a.b. *R. singularis*, Basleo; 541,3, plate diagram of calyx (radials black, X and other anals stippled), C and D rays, and adjacent interrays (mod. from Wanner, 1924); 543,3a.b, post. and ant. views of holotype, X1.5 (Wanner, 1924).

*Temnocrinus* Springer, 1902, p. 94 [*Cyathocrinites tuberculatus* Miller, 1821, p. 88; M]. Crown elongate, expanding upward; infrabasals slightly recumbent, almost entirely covered by stem impression, CD basal larger than others and truncate distally for support of large anal X, which is followed by 2 or 3 rows of polygonal plates which interlock sutorially with brachials at sides; proximal plate of C ray identified as lower element of compound radial and defined as radianal in primitive position; all radials followed by fixed brachials which include 2 primibrachs, 3 secundibrachs, and 2 to 5 tertibrachs for each arm branch, sutures between brachials sinuous; interprimibrachs few, followed by perisome passing into tegmen. Proximal part of stem composed of low circular columnals which decrease in diameter downward along with gradual increase in height. U.Sil., Eu.(Eng.).—Fig. 541,5; 543,6a-c. *T. tuberculatus* (Miller), Wenlock Ls., Dudley; 541,5, plate diagram part of calyx (radials black, radianal cross ruled, X and higher anals stippled), C and D rays, and adjacent interrays (mod. from Springer, 1920); 543,6a-c, post. views of two crowns and D-ray view of third, X1, X1, X1.5 (Springer, 1920).

*Wachsmuthierinus* Springer, 1902, p. 95 [*Forbesiocrinus thiemei* Hall, 1861a, p. 317; M]. Crown elongate, expanding upward from radials; infrabasals in central part of stem impression surrounded by basals of subequal size and shape, CD basal identified only by its relation to azygous small infrabasal in C ray, neither radianal nor anal X present. Arms branching isomotously in calyx, on primibrachs 2 and secundibrachs 3, above which strongly marked heterotomy of biendotomous type closely resembles that of *Dactylocrinus*; interprimibrachs none to 4 or more and interbrachials none to I or 2; outer edges of brachials and main arms may interlock laterally even in distal parts of crown as well as in calyx formed by fixed brachials and lower plates. Stem large, expanding proximally. Decr., USSR; L.Miss. (Osag.), USA(Ky.-Ind.-Mo.-Iowa-N.Mex.); low. L.Carb., Eu.(Scot.).—Fig. 538,1; 539,2a-c. *W. thiemei* (Hall), L.Miss.(Osag., Burlington Ls.), USA(Iowa); 538,1a,b, plate diagram (radials black) with D and C rays at left and right above, and vert. sec. of cup (mod. from Springer, 1920); 539,2a,b, side and dorsal views of holotype, rays not identified, X1.5 (Springer, 1920); 539,2c, side view of specimen with part of attached stem.
Fig. 543. Dactylocrinidae (3,6), Euryocrinidae (1,2,4,5) (p. T806, T808-T811).

X1 (Springer, 1920).—Fig. 539,2d. W. spinifer (HALL), L.Miss.(Osag., Burlington Ls.), USA (Iowa); side view of crown with part of attached stem, X1 (Springer, 1920).—Fig. 539,2e. W. spinulosus (MILLER & GURLEY), L.Miss.(Osag., New Providence Sh.), USA(Ky., Lincoln Co.); side view of crown showing brachials interlocked to height of 2nd arm bifurcations, X1 (Springer, 1920).

Zenocrinus MOORE & STRIMPLE, 1973, p. 36 [*Z. zens; OD]. Small, low crown with wide shallow calyx rounded steeply upward at sides in fixed brachials of proximal parts of arms which branch isomtomously on primibrachs 2 and secundibrachs 2 (or exceptionally 3), arms abutting but free above axillary secundibrachs, with strongly heterotomous
branching of bi-endotomous type in upper part of crown, each complete ray with 16 slender arm tips bent inward (indicating 80 or more arm tips in perfect crown); infrabasals and most of basal circlet concealed by large proximal columnals; radials exposed all around, laterally abutting except where separated by CD basal or (?abnormally) arcing over this plate to allow C and D radials to meet; CD interray variable, with anal X followed by 6 additional anals in holotype of type species but with only 2 plates (lower one very large) in paratype; other interrays with single large plate touching radials and separating fixed brachials, with or without 1 to 3 small plates above them; single intersecundibrach in each ray. Stem circular in section, composed of very low columnals with peripherally finely crenulate facets, tapering away from calyx and curved strongly toward A ray. L.Penn.(Morrow.), USA(Okla.). —Fig. 544,3; 545,2. *Z. zeus, Wapanucka Ls., Pontotoc Co., Okla.; 544,3, plate diagram (radials black, radial cross ruled, X and higher anals stippled), CD interray at midline (Moore & Strimple, n); 545,2a, oblique dorsal view of paratype from post. side showing curved and tapered proximal part of stem, X1.5 (Moore & Strimple, 1973); 545,2b,c, D-ray and dorsal views of holotype, latter with CD interray centrally placed above stem, X1.5 (Moore & Strimple, 1973).

**Family EURYOCRINIDAE**

Moore & Strimple, 1973

[Euryocrinidae Moore & Strimple, 1973, p. 16]

Crown rotund to elongate with arm branches in upper part closely appressed or separated; cup, defined to include plates below Z line at summit of radials not at all distinct from remainder of calyx formed by firmly sutured brachials, interbrachials, and anals; chief distinctive feature of the family is prominence of the stoutly built calyx which may have thick plates and considerably exceed upper part of crown formed by relatively short, stubby free arms which tend to branch isotonously rather than heterotomously. Infrabasal circlet surrounded by basals entirely concealed by proximal columnal; CD basal larger than others and typically truncate distally for support of anal X, which may be followed by additional anal plates. Arms in calyx branching isotonously on primibrachs 2, less commonly on 3. Stem transversely circular. [Main distinguishing features of this assemblage are stout nature of the calyx, isotonous branching of the arms, and general absence of interbrachials (exception, Amphiocrinus).]

*M.Dev.-U.Penn.

**Euryocrinus** Phillips, 1836, p. 205 [*E. concavaus; M] [=Euryocrinites Austin & Austin, 1842, p. 109 (nom. van.) (obj.)]. Crown expanding upward from radials, its lower part comprising stout bowl-shaped calyx formed of anals, and fixed brachials and interprimibrachs in addition to cup plates; infrabasal circlet diminutive or resorbed, surrounding basals moderately large with CD basal truncate distally for support of large anal...
**X**, which is followed by others mostly in single series filling **CD** interray and firmly interlocked laterally with brachials. Arms branching isotomously on primibrach 3 and thereafter at higher levels, with branches laterally abutting and tending to be joined firmly; interprimibrachs few, usually limited to single series; interbrachials uncommon but may be present. Column large, expanding toward calyx. *M.Dev., USA (Iowa); U. Dev., USA (Ohio-Mich.); L.Miss., USA (Ky.-Ind.-Tenn.); L.Carb. (Viséan), Eu. (Eng.).*—**Fig. 543, 4a-d. E. barrisi SPRINGER, *M.Dev. (Hamilton), USA (Mich.-Iowa); 4a-c, dorsal, post., and B-ray views of specimens from Michigan, X 1 (Springer, 1920); 4d, B-ray side of crown with attached stem, from Iowa, X 1 (Springer, 1920).**—**Fig. 541, 2; 543, 1. *E. smithi* (WRIGHT), Ayrshire; 541, 2a, diagram of plate arrangement in cup (radials black, X and higher anals stippled); 541, 2b, D-ray view of crown showing anal X (stippled) at right; 543, 1a, side views of crown with attached stem and another crown, X 1 (Wright, 1950).**

**Ainacrinus** WRIGHT, 1939, p. 56 [*Synerocrinus? smithi* WRIGHT, 1934, p. 253; OD]. Crown subglobose to ovoid, with arms infolded at summit; infrabasal circlet moderately large but entirely covered by proximal columnal; **CD** basal broadly truncate for support of anal **X**, followed by one or more other anals in series, laterally joined firmly to brachials. Arms branching isotomously on primibrachs 2, followed by 2 or more additional bifurcations at different levels in various arm branches; interprimibrachs few, normally only 1 or 2 is each interray but may be as many as 4. Stem composed of low circular columnals which expand toward base of calyx. *L.Carb.* (Viséan), Eu. (Eng.).—**Fig. 541, 1a, b; 543, 1. *A. smithi* (WRIGHT), Ayrshire; 541, 2a, diagram of plate arrangement in cup (radials black, X and higher anals stippled) and C and D rays; 541, 2b, D-ray view of crown showing anal X (stippled) at right; 543, 1a, b, side views of crown with attached stem and another crown, X 1 (Wright, 1950).**

**Amphicrinus** SPRINGER, 1906, p. 518 [*A. scoticus* SPRINGER in WRIGHT, 1914, p. 161; SM]. Crown subglobose, consisting mostly of strongly built calyx, small free arms in upper part of crown laterally abutting but not joined together; stem impression covering diminutive tripartite (or fused) infrabasals, basals (except distal extremity of **CD** basal) and most of radials; **CD** interray identified by single plate defined as anal **X** resting on truncated posterior basal, proximal plates of other interrays not touching basals but resting on oblique shoulders of radials; radial lacking. Rays with 2 primibrachs in calyx followed by isotomously branching arms with 3 to 4 or more bifurcations, with tendency toward heterotomy observed in summit portion of crown; sutures between brachials sinuous and above primibrachs commonly with patelloid processes. Stem large, next to crown composed of very low columnals.
with crenulate facets, tapering gradually and curving gently away from cup; columnals pierced by quinquestellate axial canal. *L. Carb.* (Viséan), Eu.(Scot.)-USSR-USA(Okla.).—Fig. 541,7; 543, 5a-c. *A. scoticus*; 541,7, plate diagram (radials black, X and higher anals stippled; y, upper line of fixed brachials), with C and D rays accompanied by adjoining interbrachials (mod. from Springer, 1920); 543,5a,b, post. and dorsal views of somewhat flattened calyx, Eng.(Roscobie), X1 (Springer, 1920); 543,5c, AB-interray view of crown, Scot.(Hurlet Ls.), X1 (Springer, 1920).

**Artichthyoerinus** Wright, 1923, p. 481 [*A. springeri*; OD]. Crown globose to ovoid, generally wider than high; broad shallow calyx formed by rigidly sutured plates; small infrabasal circlet sur-

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**Fig. 546. Euryocrinidae (p. T811).**

**Fig. 547. Euryocrinidae (p. T811-T812).**

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rounded by basals and entirely concealed by proximal columnal, present in sharply indented faceted calyx. Arms with nearly flat outer surfaces with brachials fitted smoothly together laterally or interlocked, articular facets somewhat arcuate; interradials commonly 1 in each interray; small anal X followed by additional plate in posterior interray, orientation of calyx mainly determinable from C-position of small infrabasal. L.Carb.(Visean), Eu.(Scott.).—Fig. 541,6; 543,2. *A. springeri; 541,6, plate diagram (radials black, X and higher anal stippled), with part of C and D rays (Moore, n); 543,2a,b, AB-interray and dorsal views of specimen from Fife, ×1.5 (Wright, 1950).

Caldenocrinus Wright, 1946, p. 33 [*C. curtus; OD]. Crown low, rounded, with shallow bowl-shaped calyx of firmly sutured plates; infrabasals concealed by stem, which also covers basal circlet except distal part of CD basal and encroaches on proximal tips of radials; large anal X followed by one or more additional anals; 4 or 5 moderately large interprimibrachs in other interrays. Arms branching heterotomously above axillary primibrachs 2 but not strongly so. L.Carb.(Visean), Eu.(Eng.).—Fig. 545,la-c. *C. curtus; 545,1a-c. 545,1, plate diagram (radials black, X and higher anals stippled), CD-interray upward (Moore, n); 545,1a, paratype from Roscobie, Fife, dorsal view with CD interray upward, ×1 (Wright, 1954); 545,1b,c, holotype from Seafield Tower Ls., near Kirkcaldy, Fife, B-ray and DE-interray views, ×1 (Wright, 1954).

Dieuryocrinus Wright, 1954, p. 165 [*Euryocrinus duplex Wright, 1942, p. 280; OD]. Lower part of broadly flaring calyx formed by stout sutured plates, rather closely resembling Euryocrinus and Amphicrinus, but with double series of anal plates in CD interray, in which proximal small plate at left is interpreted as anal X and that at right as upwardly displaced radianal. Primibrachs 3, as in Euryocrinus, rather than 2 as in Amphicrinus; free arms of upper crown unknown. Stem impression not indented. L.Carb.(Visean), Eu.(Eng.).—Fig. 542,2; 546,1. *D. duplex (Wright); 542,2a,b, AB-interray and dorsal views of large calyx, CD interray directed upward in 2b, ×0.75 (Wright, 1954); 546,1, plate diagram (radials black, radianal cross ruled, X and higher anals stippled), with part of C and D rays and adjoining interrays (Moore, n).

Paramphicrinus Strimple & Moore, 1971, p. 40 [*Amphicrinus ollahkaeni Strimple, 1939a, p. 4 (364); OD]. Crown rotund, medium-sized, with stoutly built bowl-shaped calyx forming lower half of crown and closely parallel free arms upper half, curving inward at summit so that arm tips nearly meet; infrabasal circlet and all except posterior plate of basal circlet covered by stem, subhorizontal in attitude; only distal edges of radials exposed, those of C and D rays slightly smaller than others and visible parts asymmetrical; no radial but moderately large anal X on truncate extremity of CD basal, followed by 16 to 20 higher anals in double series, interlocking sideward with fixed brachials from primibrach to tertibrach series. Arms broad in proximal portion, branching isomorphously in calyx on primibrachs 2 and secundibrachs 3 in each ray, thereafter displaying well-marked heterotomy of bi-endotomous type, distal parts of all arms narrowing upward, with 80 to 100 arm tips at crown summit, each complete half-ray with 20 arms, interbrachial sutures mostly sinuous; interradial polygonal plates 16 to 20 beginning between first primibrachs with large plate, much smaller distal ones suturedly joined to tertibrachs; interbrachials beginning between proximal secundibrachs and extending upward nearly to distal tertibrachs; 2 small areas of 3 to 5 intertertibrachs in each ray. Stem large, composed of very low crenulate columnals, with quinquelobate axial canal, proximal part tapering gradually and strongly curved toward DE interray or A ray. L.Penn.(Morrow.)-U.Penn.(Missour.),
USA (Okla.-Ark.-Ill.-Kans.)—Fig. 544,2; 547,1. *P. oklahomaensis* (STRIMPLE), U.Penn. (Missour.), USA (Okla.-Ill.); 544,2, plate diagram of post. side of crown (radials black, X and higher anals stippled), showing anal plates of CD interray (center) flanked by C and D rays on right and left, based on specimen from LaSalle Ls., Ill.; 547,1a-d, views of crown from Missour. (LaSalle Ls.), Ill., from below (B ray upward), post. side, B-ray side, and obliquely from above (DE interray located centrally), all ×0.9 (Strimple & Moore, 1971); 547,1e-f, holotype from Missour. (Stanton Ls.), near Bartlesville, Okla., viewed from above (C and D rays centrally placed at left and right of midline above) and dorsal view (A ray directed upward) showing proximal column with stellate axial canal, ×0.9 (Strimple, 1939a).—Fig. 547,1g,h. *P. poundi* (STRIMPLE), Missour. (Stanton Ls.), USA (Kans., Montgomery Co.); ventral and dorsal views of holotype, CD interray directed upward, ×3.5 (Strimple, 1939a).

Order UNCERTAIN
Family EDRIOCRINIDAE
S. A. Miller, 1889

[Edriocrinidae S. A. Miller, 1889, p. 214] [Materials for this family prepared by H. L. STRIMPLE]

Stalkless crinoids attached by base of cup, at least during youthful stages. Basals four, commonly fused, anal X in line with radials; arms broad, incurring distally, formed of very short brachials. L.Dev.-M. Dev.

Edriocrinus Hall, 1858, p. 278 [*E. pocilliformis* HALL, 1859, p. 121; SD MILLER, 1889, p. 242]. Cup thought to be pseudomonocyclic, i.e., infra-basals probably present in ontogeny but fused or resolved in process of producing base for attachment to foreign objects. Arms strikingly similar to those of flexible crinoids. [Some evidence indicates that some individuals, or even species, became free in full maturity and used the rigid arms for limited locomotion. Some species (e.g., *E. sacculus*) developed a long fused basal cone that could have been buried in a soft marl of the substrate, and yet others (e.g., *E. dispansus*, Fig. 548,1b) have a broad flat base suitable for resting on soft substrate without becoming mired.] L.Dev. (Helderberg.), USA (N.Y.-Md.-Va.-W.Va.-Tenn.-Mo.-Okla.); L.Dev.-M.Dev., Eu. (Boh.); M. Dev., Afr. (Alg.).—Fig. 548,1a. *E. sacculus* Hall, L.Dev. (Oriskany), Md.; adult showing attachment scar, ×1.3 (Moore & Laudon, 1944).—Fig. 548,1b,c. *E. dispansus* Kirk, L.Dev. (Linden), Tenn.; 1b,c, lat. and ventral view of cup, ×1.3 (Moore & Laudon, 1944).