Proceedings of the Iowa Academy of Science

Volume 84 | Number

Article 5

1977

New Species of Arrectocrinus Knapp from Southwestern Iowa and Southeastern Nebraska

Roger K. Pabian
University of Nebraska

Harrell L. Strimple
University of Iowa

New Species of *Arrectocrinus* Knapp from Southwestern Iowa and Southeastern Nebraska

ROGER K. PABIAN[1] and HARRELL L. STRIMPLE[2]

PABIAN, ROGER K. and HARRELL L. STRIMPLE (Conservation and Survey Division, University of Nebraska, Lincoln, Nebraska 68588 and Department of Geology, The University of Iowa, Iowa City, Iowa 52242). Proc. Iowa Acad. Sci. etc. _____ New species of *Arrectocrinus* Knapp from southwestern Iowa and southeastern Nebraska. Partial crowns of *Arrectocrinus hopperi* n.sp. show that the formerly poorly known arms of this genus are biserial and probably did not expand distalward. The *Arrectocrinus* range zone is lowered to include the Beil Limestone Member of the Lecompton Formation (Virgilian). Possible affinities of *Arrectocrinus* with *Erisocrinus* are examined.

INDEX DESCRIPTORS: Pennsylvanian, Virgilian; Wolfcampian; Beil Limestone; Lecompton Formation; Curzon Limestone; Topeka Formation; *Arrectocrinus* range zone; Cass County, Nebraska; Montgomery County, Iowa; *Arrectocrinus hopperi. A. stanleyi, A. comminutus.*

Knapp (1969, p. 364) defined the genus *Arrectocrinus* on the basis of a partial crown and dorsal cup originally described as the holotype and paratype respectively of *Delocrinus abruptus* by Moore and Plummer (1940, p. 289-292; pl. 18, figs. 3,4; text-fig. 59). Pabian and Strimple (1969, p. 273, 274; pl. 38, figs. 12-15) subsequently described *Arrectocrinus comminutus* on the basis of a single dorsal cup. Aside from these meager reports, the genus is not well known or abundant in Virgilian or Wolfcampian rocks of the midcontinent. The extensive collection of late Pennsylvanian crinoids from the midcontinent made by W. D. White of Omaha, Nebraska, and now reposited at the University of Nebraska State Museum (UNSM) has yielded seventeen additional specimens of *Arrectocrinus* from Iowa and Nebraska. These specimens represent both new taxa and previously described forms, all of which shed additional light on the morphology, relationships and range of this genus.

SYSTEMATIC PALEONTOLOGY

Phylum Echinodermata Laske, 1778
Subphylum Crinozoa Matsumoto, 1929
Class Crinoidea Miller, 1821
Subclass INADUNATA Wachsmuth & Springer, 1885
Order CLADIDA Moore & Laudon, 1943
Suborder POTERIOCRININA Jaekel, 1918
Superfamily ERISOCRINACEA Wachsmuth & Springer, 1886
Family CATACRINIDAE Knapp, 1969
Subfamily ARRECTOCRININAE Knapp, 1969

Description. — After Knapp, 1969, p. 363. Base deeply concave, infrabasals being steeply downflared in primitive members and subhorizontal in more advanced genera; sides of cup erect; anal plate followed by one tube plate; proximal tips of radial plates above basal plane; arms ten, biserial.

Genus *Arrectocrinus* Knapp, 1969

Arrectocrinus Knapp, 1969, p. 364; Moore and Strimple, 1973, p. 22.
Metarrectocrinus Knapp, 1969, p. 364; Moore and Strimple, 1973, p. 22.

Type species. - *Delocrinus abruptus* Moore and Plummer, 1940, p. 289-292.

Diagnosis. - After Knapp, 1969, p. 364. Deep basal invagination; infrabasal plates moderately downflaring.

Other species included.–*Arrectocrinus comminutus* Pabian and Strimple 1974; *A. hopperi* Pabian and Strimple, new species; *A. stanleyi* Pabian and Strimple, new species; *Delocrinus major* Weller, 1909; *Delocrinus texanus* Weller, 1909.

Remarks. - Knapp, 1969, p. 350, text-fig. 3, suggested that *Arrectocrinus* may have developed from *Graffhamicrinus* and (p. 364) indicated that the deep basal concavity and steeply downflared infrabasals of *Subarrectocrinus* suggest ancestry with the Graffhamicrininae. Moore and Plummer (1940, p. 285) indicated *Subarrectocrinus perexcavatus* (= *Delocrinus perexcavatus)* to be atypical of delocrinids, believing that it had uniserial arms (as typical of *Endelocrinus*) but a cup with none of the characters of *Endelocrinus*. We suggest *Subarrectocrinus* is not in a lineage developing from *Gaffhamicrinus*, and may eventually prove to be descended from *Contocrinus*. Lane and Burke (1976) clearly indicated that the topography of biserial articular surfaces was derived from uniserial articular surfaces. Other examples showing derivation of biserial from uniserial arms have been shown by Bather (1900); Ubaghs (1953); Laudon (1967); Brower (1974) and Burdick and Strimple (1973). No cases of uniserial arms developing from biserial have ever been demonstrated.

Though deep, the basal concavity of *Arrectocrinus* is not constricted but forms a broad funnel. The typical delocrinid-graffhamicrinid basal invagination is both deep, narrow, and somewhat rounded in contour. *Arrectocrinus* has "erect" cup walls whereas the graffhamicrinids and delocrinids show much more rounded contours.

Arrectocrinus has short, stubby primibrachials followed by a large first secundibrachial, a wedge-shaped second secundibrachial, with a fully biserial arrangement by the third secundibrachial. The lineage suggested by Knapp (1969, text-fig. 3) would require arms going from biserial to uniserial and back to biserial. The small primibrachials and rapidity with which a biserial state is reached may suggest closer affinities to *Erisocrinus*. Many specimens of *Erisocrinus* show broad, shallow, funnel-like basal concavities that are similar to that of *Arrectocrinus*. It is not suggested that *Arrectocrinus* developed from *Erisocrinus*, which would necessitate reinsertion of anal X into the cup. *Erisocrinus*, however, may have had its ancestry in a form like *Arrectocrinus* with the former becoming the more populous and successful genus.

Range. – Upper Pennsylvanian (Virgilian) — Lower Permian (Wolfcampian); Iowa, Nebraska, Texas.

Arrectocrinus hopperi Pabian and Strimple, new species. Plate 1, figs. 1-5

Description. – This species is represented by one partial crown and four cups. The five infrabasal plates are arranged to form a deep paraboloid; the proximal area is covered by a columnar cicatrix with a pentalobate lumen; the medial portions of the infrabasals are very

1. Conservation and Survey Division, University of Nebraska, Lincoln, Nebraska 68588.
2. Department of Geology, The University of Iowa, Iowa City, Iowa 52242.

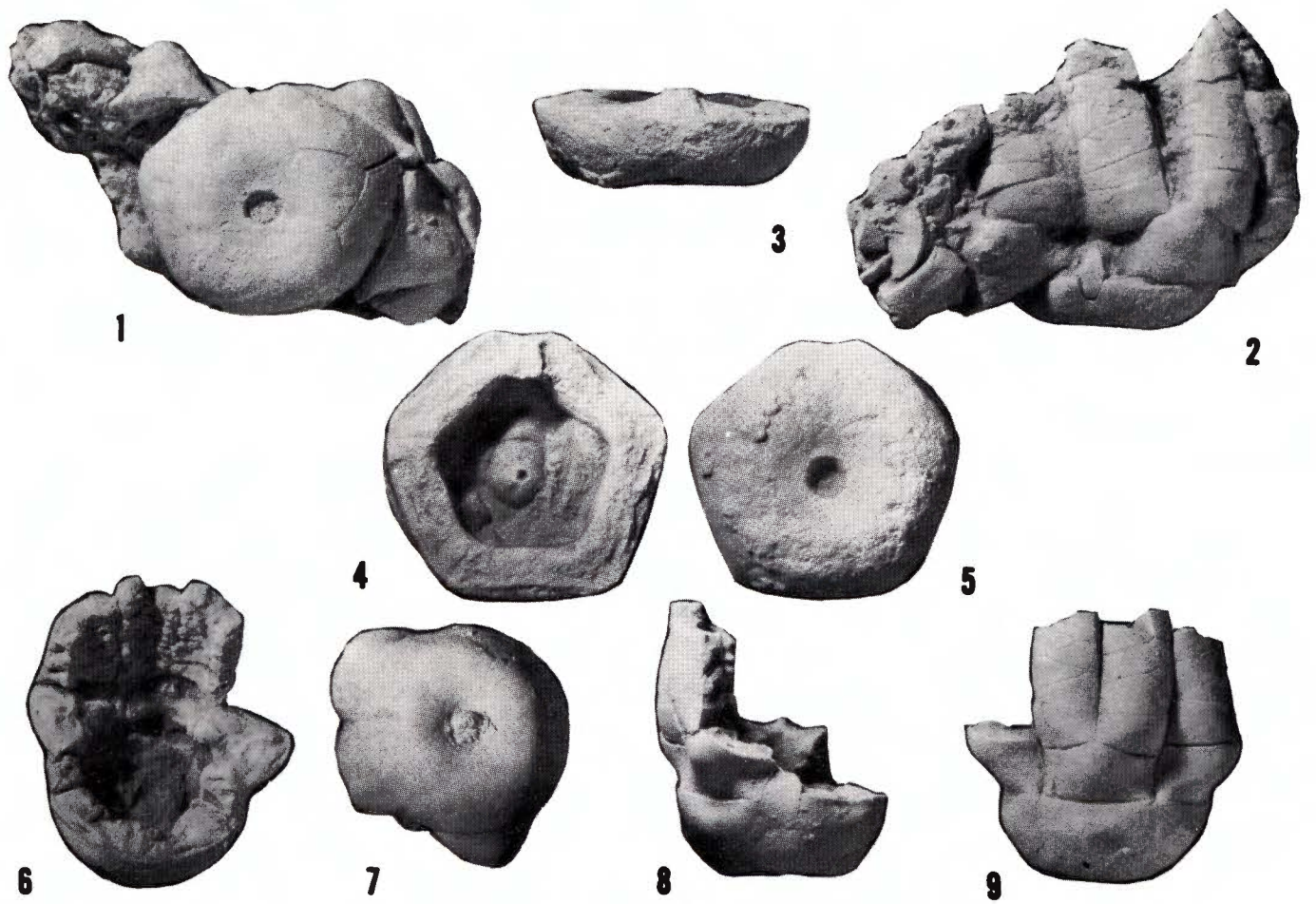

Plate 1. Arrectocrinus *from Iowa and Nebraska. 1,2.* Arrectocrinus hopperi *Pabian and Strimple, new species, holotype (partial crown) from Beil Limestone Weeping Water, Nebraska, viewed from base and CD interray (posterior), X2. 3-5.* A. hopperi, *paratype cup from same location, viewed from CD interray (posterior), summit, and base. 6-9.* Arrectocrinus stanleyi *Pabian and Strimple, new species, holotype (partial crown) from Ervine Creek Limestone Member, Deer Creek Formation, Mills County, Iowa, viewed from summit, base, CD interray (posterior) and left lateral, X2.*

steeply downflared, following which there is a sharp geniculation causing the distal portions to be nearly flat lying. There are five basal plates; AB, BC, DE, and EA are pentagonal — CD being truncated distally from reception of the six-sided anal X plate. The proximal portions of the basals slope downward at about 15 degrees, creating a broad funnel-like basal concavity. The cup rests on a plane formed by the medial portion of the basals. The distal ends of the basals rise gently to about 1/3 the height of the cup. There are five epaulette-shaped radials; their proximal tips reach just to the basal plane of the cup and then curve upward in a nearly circular arc, with the distal ends nearly vertical. C and D radials are separated by the anal X plate. The entire cup surface is smooth.

The radial articular facets are nearly level. There is a well-developed outer marginal ridge. The outer ligament furrow is deep and narrow. There is a sharp outer ligament ridge that borders a deep ligament pit. The transverse ridge is not strongly defined but is finely denticulate. There is a deep lateral furrow that rises to a high oblique ridge. The adsutural slopes rise at about 45 degrees and terminate at a sharp lateral ridge from which a muscle area slopes into a bow-like central pit that is connected to a broad intramuscular notch by a narrow intramuscular furrow.

Table 1. *Measurements of holotype and paratype specimens of Arrectocrinus hopperi Pabian and Strimple.*

	Holotype, UNSM-15699	UNSM-15700	UNSM-15701	UNSM-15702	UNSM-15711
Diameter of cup, posterior-anterior	13.1	17.8	15.4	9.9	18.7
Height of cup, (anterior)	4.7	5.3	5 7	2.8	6.0
Diameter of infrabasal circlet	2.9	4.0	4.0	2.1	—
Length, AB basal	4.3	5.5	6.8	3.1	—
Width, AB basal	4.8	6.2	7.0	3.7	6.5
Length, A radial	5.9	6.3	6.4	3.6	6.4
Width, A radial	6.4	11.3	10 3	7.4	11.2
Length, Anal X	3.0	3.4	3.7	1.9	4.4
Width, Anal X	1.5	2.7	2.3	1.0	2.7

There are probably ten arms; these rise from an axillary, nearly pentagonal, slightly protruded PBr 1. SBr 1 is trapezoidal; SBr 2 is cuneiform, and brachials above SBr 3 are fully biserial.

Remarks. – *Arrectocrinus hopperi* is named for Hopper Brothers Quarries, the managers of which have allowed the authors and their collaborators free access to their quarries. The holotype was collected from a Hopper Quarry. *A. hopperi* appears to be the earliest known representative of this genus. It differs from *A. abruptus* Moore and Plummer in having a very low-profiled cup and from *A. comminutus* Pabian and Strimple by having a smooth cup surface.

Material studied. – Holotype UNSM-15699 and paratypes UNSM-15700-15702 Beil Limestone Member (Horizon 10 of Burchett and Reed, 1967, p. 39) and paratype UNSM-15711 (Horizon 12 of Burchett and Reed, 1967, p. 39), Lecompton Formation, Shawnee Group, Virgil Series, Upper Pennsylvanian, near the quarry in SW/4, SW/4, Sec. 35, T. 11 N., R. 11 E., Cass County, Nebraska.

Arrectocrinus stanleyi Pabian and Strimple, new species.
Plate 1, figs. 6-9

Description. – This species is based on three cups with a portion of the lower parts of arms intact. The cup is relatively deep. There are five infrabasal plates, the proximal portion of which seems to be confined to a narrow, deep concavity though it is covered by proximal columnals. The medial portions are steeply downflared but distally bend sharply so that they slope downward gently in that area. There are five basals; AB, BC, DE, and EA are pentagonal and CD is truncated distally to accommodate the wide, barrel-shaped anal X plate. The proximal 1/3 of the basals slope downward to the basal cup plane, which is rather narrow; they then rise in a sharp, parabolic arc to about half the height of the cup. The five epaulette-shaped radials do not reach the basal plane; they rise upward at about 75 degrees forming a more or less prominent bulge at about ¾ the height of the cup; they then slope inward to the cup summit. C and D radials are separated by an anal X plate. The cup surface is smooth.

Radial articular facets are plenary and flat lying. The outer marginal ridge is narrow but sharp; the outer ligament furrow is shallow but well defined. The ligament pit is a distinct notch; the transverse ridge is broad and slightly denticulate. The deep lateral furrow rises to a blunt oblique ridge. The adsutural slope rises at about 30 degrees to a somewhat triangular muscle area that slopes into a very deep central pit which connects to a wide intramuscular notch by a very wide furrow.

There are apparently ten arms; the axillary primibrachs 1 are somewhat protruded pentagonal plates; SBr 1 is a large trapezoidal plate and biserial arrangement takes place by SBr 2 in the D ray and SBr 3 in the E ray.

Table 2. *Measurements of holotype and paratype of Arrectocrinus stanleyi Pabian and Strimple.*

	Holotype UNSM-15698	Paratype UNSM-15698a
Diameter of cup (Posterior-Anterior)	13.9	13.2
Height of cup (Anterior)	5.3	—
Diameter of infrabasal Circlet	3.6	—
Length, AB Basal	6.1	—
Width, AB Basal	6.8	5.1
Length, A Radial	5.2	5.1
Width, A Radial	8.5	8.2
Length, Anal X	3.6	—
Width, Anal X	2.4	—

Remarks. — *Arrectocrinus stanleyi* can be differentiated from *A. hopperi* in having a much higher cup with somewhat inflated radials. It differs from *A. comminutus* in having a smooth cup. *A. stanleyi* appears most closely related to *A. abruptus* Moore and Plummer and possibly gives rise to that lower Permian species from which it differs by having a much shallower basal concavity and radial plates that slope inward near the cup summit. The species is named for Jack Stanley, operator of the quarry in Mills County, Iowa from which the holotype was collected.

Material studied. — Holotype UNSM-15698 and paratype UNSM-15698a from Ervine Creek Limestone, Deer Creek Formation (probably correlative with Horizon 18 of Hershey *et al.*, 1960, p. 63), Shawnee Group, Virgil Series, Upper Pennsylvanian, exposed in the Jack Stanley Quarry, NW/4, NW/4, Sec. 27, T. 71 N., R. 43 W., Mills County, Iowa. Hypotype, UNSM-16501, Beil Limestone Member, Lecompton Formation (Horizon 4 of Hershey *et al.*, 1960, p. 74, 75), Shawnee Group, Virgil Series, Upper Pennsylvanian, exposed in Kaser Construction Company Quarry, NE/4, Sec. 27, T. 73 N., R. 38 W., Montgomery County, Iowa.

Arrectocrinus comminutus Pabian and Strimple, 1974

Remarks. — Two cups in the presently considered collection can be assigned to *Arrectocrinus comminutus*. Both are somewhat smaller than the holotype, and have slightly more rounded profiles in the basal area; however, the radial platesshow the same attitude as the holotype. This suggests that during ontogeny the cup maychange from a medium bowl shape in young individuals to a nearly truncate cone shape in more mature individuals.

Material studied. — Holotype, UNSM-7986, Curzon Limestone Member, Topeka Formation, Shawnee Group, Virgil Series, Upper Pennsylvanian, SE/4, Sec. 17, T. 10 N., R. 14 E., Cass County, Nebraska. Hypotypes, UNSM-16502 and UNSM-16503, Beil Limestone Member (Horizon 4 of Hershey, *et al.*, 1960, p. 74-75), Lecompton Formation, Shawnee Group, Virgil Series, Upper Pennsylvanian, exposed in Kaser Construction Company Quarry, NE/4, Sec. 27, T. 73 N., R. 38 W., Montgomery County, Iowa.

ACKNOWLEDGMENTS

Doris Peabody, Conservation and Survey Division, University of Nebraska, typed the manuscript. Darkroom facilities were also furnished by Conservation and Survey Division. The manuscript was critically reviewed by Terrence Frest, University of Iowa.

LITERATURE CITED

BATHER, F.A., 1900. The Crinoidea. p. 99-204. In: Lankester, E.R. (ed.), *Treatise on Zoology*, v. 3 (Adam and Charles Black: London).

BROWER, J.C., 1974. Ontogeny of camerate crinoids. Univ. Kans. Paleont. Contrib. 72: 1-53.

BURCHETT, R.R., and REED, E.C., 1967. Centennial guidebook to the geology of southeastern Nebraska. Conservation and Survey Division, University of Nebraska. 83 p.

HERSHEY, H.G., BROWN, C.N., VAN ECK, O., and NORTHUP, R.C., 1960. Highway construction materials from the consolidated rocks of southwestern Iowa. Iowa Highway Research Board Bull. 15: 151 p.

KNAPP, W.D., 1969. Declinida, a new order of late paleozoic inadunate crinoids. Jour. Paleont. 43(3): 340-391.

LANE, N.G., and BURKE, J.J., 1976. Arm movement and feeding mode of inadunate crinoids with biserial muscular arm articulation. Paleobiology 2(3): 202-208.

LAUDON, L.R., 1967. Ontogeny of the Mississippian crinoid *Platycrinites bozemanensis* (Miller & Gurley), 1897. Jour. Paleont. 41: 1492-1497.

MOORE, R.C., and PLUMMER, F.B., 1940. Crinoids from the Upper Carboniferous and Permian strata in Texas. Univ. Texas Bull. 3945: 1-468.

MOORE, R.C., and STRIMPLE, H.L., 1973. Lower Pennsylvanian (Morrowan) crinoids from Arkansas, Oklahoma, and Texas. Univ. Kans. Paleont. Contrib., Art. 60: 1-84.

PABIAN, R.K., and STRIMPLE, H.L., 1974. Crinoid studies. Part I. Some Pennsylvanian crinoids from Nebraska. Part II. Some Permian crinoids from Nebraska, Kansas, and Oklahoma. Bull. Amer. Paleont. 64(281): 249-337.

UBAGHS, G., 1953. Classe des Crinoïdes. p. 658-773. In: Piveteau, J. (ed.), *Traite de Paleontologie*, v. 3 (Masson et cie: Paris).

WELLER, S., 1909. Permian crinoid fauna from Texas. Jour. Geol. 17: 623-635.