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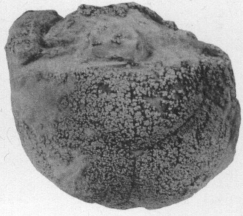
**NEW PENNSYLVANIAN CRINOIDS FROM  
CLARK COUNTY, NEVADA**

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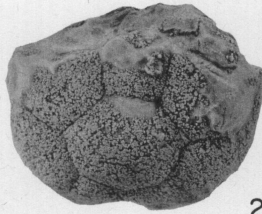
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**N. GARY LANE**

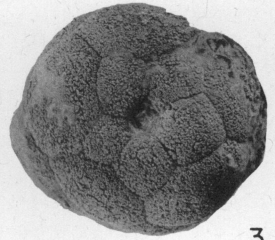
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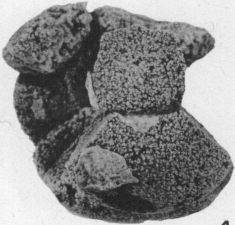
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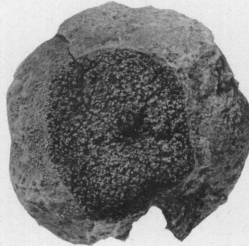
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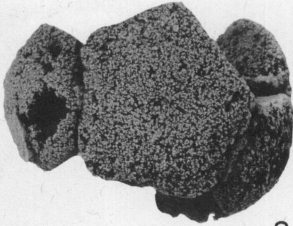
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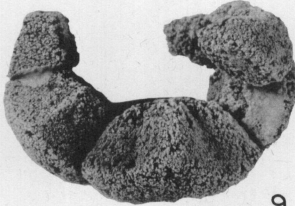
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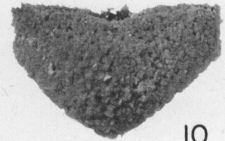
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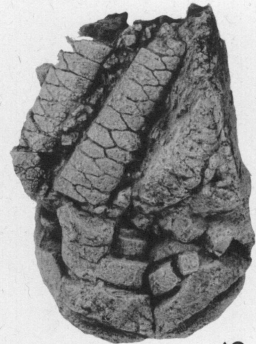
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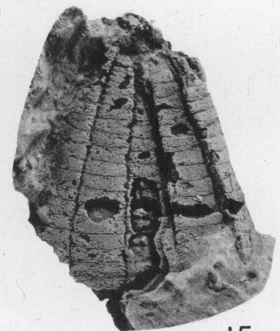
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## NEW PENNSYLVANIAN CRINOIDS FROM CLARK COUNTY, NEVADA

N. GARY LANE

University of California, Los Angeles

**ABSTRACT**—Four new species and one new genus of Pennsylvanian cladoid inadunate crinoids are described from the Bird Spring and Callville Formations of Clark County, Nevada. *Synarmocrinus brachiatus*, n. gen., n. sp. is from Atokan age beds of the Bird Spring Formation at Indian Springs, Nevada. The new genus exhibits lower brachials that are incorporated firmly into the dorsal cup and represents the only known cladoid inadunate with this condition, and the only post-Ordovician crinoid of the Subclass Inadunata that has fixed brachials. *Polusocrinus pachyplax*, n. sp. and *P. calyculoides*, n. sp. are from the lower part of the Callville Formation at Sloan and Frenchman Mountain, respectively, and are judged to be of Morrowan age. *Parulocrinus vetulus*, n. sp. is from the upper part of the *Rhipidomella nevadensis* (Meek) Zone at the base of the Bird Spring Formation at Arrow Canyon and indicates that the upper part, at least, of this zone is Early Pennsylvanian in age.

### INTRODUCTION

**T**HE four species of cladoid inadunate crinoids described below are from the Bird Spring and Callville Formations of Clark County, Nevada. Although each new species is from a different locality, all provide useful data for establishing the age of the beds in which they are found. The species on which a new genus is erected throws light on the phyletic significance of arm development in this group of crinoids.

The new species of *Parulocrinus*, *P. vetulus*, based on a partial crown from Arrow Canyon, was found in the upper part of the *Rhipidomella nevadensis* (Meek) Zone, which is next above the base of the Bird Spring Formation in northern and western Clark County. The large, distinctive species of *Rhipidomella* Oehlert was found to range several feet stratigraphically above the crinoid occurrence. *Parulocrinus* Moore & Plummer and related genera such as *Ulocrinus* Miller & Gurley and *Ethelocrinus* Kirk are not known from beds older than the Morrowan Epoch in the midcontinent region; consequently,

this occurrence provides evidence that the upper part of the *R. nevadensis* Zone should not be older than Early Pennsylvanian.

Two new species of *Polusocrinus* Strimple from the Callville Formation at Sloan and Frenchman Mountain, Nevada are typical of this genus that previously has not been found in beds older than Late Desmoinesian in Oklahoma. Because both species are known well below the lowest occurrence of *Chaetetes* Fischer and associated *Profusulinella* Rauser-Cernousova & Beljaen, the new species of *Polusocrinus* can be no younger than early Atokan and are probably Morrowan in age. Close association of *Polusocrinus pachyplax*, n. sp. at Sloan with a *Schizophoria texana* Girty brachiopod faunule that is also judged to be Morrowan in age serves to confirm this age assignment.

The fourth new species of crinoid described below is placed in a new genus, *Synarmocrinus*, in the Family Cromyocrinidae. The genus is distinctive in having proximal brachials in firm lateral contact; therefore, these are termed

### EXPLANATION OF PLATE 112

All figures unretouched,  $\times 1.5$ , unless otherwise indicated

- FIGS. 1-3**—*Polusocrinus calyculoides* Lane, n. sp. Holotype (UCLA 34981), right-anterior, posterior, and basal (posterior lower left) views respectively.  
**4-10**—*Polusocrinus pachyplax* Lane, n. sp. 4, 8, 9, posterior, basal, and side views of paratypes (UCLA 34984 to 34988), 5, 6, 7, 10, holotype (UCLA 34994-6), IAx, IB<sub>r1</sub>, and radial views, respectively,  $\times 3$ .  
**11-13**—*Parulocrinus vetulus* Lane, n. sp. Holotype (UCLA 34980), posterior, ventral, and basal views, respectively.  
**14, 15**—*Synarmocrinus brachiatus* Lane, n. gen., n. sp. 14, holotype (UCLA 34978), left-posterior view,  $\times 1$ , 15, paratype (UCLA 34979), arm tips.

"fixed brachials" and are judged to constitute part of the dorsal cup. Incorporation of brachials into the dorsal cup is common in flexible and camerate crinoids but hitherto was not known in post-Ordovician inadunates. All Ordovician inadunates with fixed brachials belong to the homocrinid stock of the Order Disparata, comprising monocyclic inadunates, and include such genera as *Eustenocrinus* Ulrich and *Heterocrinus* Hall (Moore & Laudon, 1943). This is the first assignment of crinoids having fixed brachials incorporated into the dorsal cup to the cladoid inadunates, which possess infrabasal plates.

The reader should not construe that *Synarmocrinus* is a primitive genus of crinoid, which is related somehow to Ordovician forms but which survives into the Pennsylvanian. The large, bowl-shaped dorsal cup; presence of two distinct anal plates termed anal-X and radial; large, wide, pinnulate arms; and wide subhorizontal radial facets all indicate evolutionary advancement comparable to the level attained by most other late Paleozoic cladoid inadunates. Rather, the genus is interpreted to have evolved along a unique line toward increasing rigidity of the lower brachials until they became immovable and fixed. Relationship with genera of the Cromyocrinidae is indicated by the presence of 10 wide, uniserial arms that branch isotomously in IBrr<sub>1</sub>. Age assignment of *Synarmocrinus*, n. gen., to the Atokan is confirmed by associated fauna, especially species of *Fusulinella* Möller that occur both above and below the crinoid-yielding bed.

Morphologic terms and abbreviations are in accord with Moore, Lalicker, & Fischer (1952) except that *fixed-brachial* is used instead of *cup-brachial*. The writer is indebted to Raymond C. Moore, University of Kansas, who read a preliminary draft of the description of the new genus and offered pertinent suggestions concerning the name and significance of this crinoid. Takeo Susuki and Mrs. Opal Kurtz, Department of Geology, University of California, Los Angeles, respectively, provided the photographs and drafting. Field work in connection with this study was subsidized by the Research Committee, University of California, Los Angeles.

SYSTEMATIC PALEONTOLOGY  
Family CROMYOCRINIDAE Jaekel, 1918  
*SYNARMOCRINUS* Lane, n. gen.

*Type species.*—*Synarmocrinus brachiatus* n. sp., here designated.

*Diagnosis.*—Five RR, BB, and IBB in dorsal cup; two anal plates; IBrr<sub>1</sub> axillary, supporting 10 massive, wide uniserial arms; proximal

brachials fixed into dorsal cup by lateral interlocking with adjacent brachials.

*Comparisons.*—No other genus of the Order Cladoidea has proximal fixed brachials incorporated into the dorsal cup. Several genera assigned to the Cromyocrinidae by Strimple (1961) have 10 massive uniserial arms, such as *Dicromyocrinus* Jaekel, *Mantikosocrinus* Strimple, *Ulocrinus* Miller & Gruley, and *Cryphiocrinus* Kirk. All but *Ulocrinus* have three rather than two anal plates in the cup, and all but *Cryphiocrinus* have upflaring infrabasals visible in side view. None of the aforementioned genera exhibits a dorsal cup arrangement such as is reported here. The new genus, *Synarmocrinus*, is judged to have closest relationship to *Dicromyocrinus* because of the shape of the dorsal cup and the similarity of the free arms. The latter genus has wide, low brachials and its type species, *D. ornatus*, has nodose ornamentation. In order to derive *Synarmocrinus* from *Dicromyocrinus* one anal plate must be eliminated from the cup, and the proximal brachials must become joined in close sutural contact. Relationship of the new genus to *Dicromyocrinus* is not surprising because the latter is known from the Moscovian (Middle Pennsylvanian) of Russia, and the collecting locality for *Synarmocrinus* has yielded such typical Russian Moscovian genera as *Ascopora* Trautschold, *Rhombotrypella* Nikiforova, *Choristites* Fischer, *Komia* Korde, and *?Platycrinites* Miller.

The new generic name *Synarmocrinus* is from the Greek prefix *syn* meaning *together* or *with*, and the Greek noun *harmos* meaning *joint*, *fastening*, *bolt*, or *peg*; thus, *synarmos* means *joined together*.

SYNARMOCRINUS BRACHIATUS

Lane, n. sp.

Pl. 112, figs. 14, 15

*Description.*—The crown is large, higher than wide, with an incomplete height of 77 mm., and maximum width at the level of IBrr<sub>1</sub>.

The dorsal cup is large, wider than high, and medium truncated bowl-shaped. The infrabasal circlet is partially exposed and is wide, star-shaped, subhorizontal or slightly downflaring with proximal portions covered by the columnals. The infrabasals are diamond-shaped.

All five basals are slightly wider than high and hexagonal in outline. The proximal part of each basal is curved abruptly inward forming the outer portion of flattened basal area of the cup and defining the basal plane. Distal parts of basals are upright, flattened, and constitute a major part of the side of the cup.

Radial plates are five in number, slightly less

than twice as long as high; each has a long basal suture and short interrarial suture on each side. The plates are essentially flat longitudinally, with slight transverse convexity confined largely to the lateral plate portions.

The two anal plates consist of a large quadrangular radianal and a small, highly convex anal-X. The radianal is in contact with the posterior basal, postero-right basal, right- and left-posterior radials, and the anal-X. Anal-X has lost contact with the posterior basal and is bounded, in a clockwise direction, by the right-posterior radial, radianal, and left-posterior radial.

All sutures are distinctly and sharply impressed. Ornamentation of radials, basals, and radianal consists of strong, irregular ridges and intervening steep-sided depressions. Each radial has a prominent elongate ridge along its upper edge, just outside the radial facet, that fades out laterally before reaching the lateral margins of the plate. This ridge merges at each end with other ridges that continue proximally down the side and into the center of the plate. A median ridge originates at the proximal tip of the radial, extends a short distance distally, and then divides into two lateral ridges that continue parallel and distal to the radial-basal sutures.

Basals have a small ridge next to each radial-basal suture that dies out at either end. At the distal tip of each basal is a median ridge that continues proximally and then bifurcates into two oblique ridges which are confluent with ridges originating at plate angle formed with adjacent radial and basal. In addition to the pronounced ridge pattern, the plates of the dorsal cup are covered with small, distinct granules 0.10 to 0.16 mm. in diameter and 0.32 to 0.38 mm. apart from center to center. Along edges of basals the granules tend to be aligned in rows parallel to sutures, which imparts a lined appearance to the plate edges. Ornamentation of infrabasals is unknown.

There are ten uniserial arms, two arms arising from the axillary first primibrachial of each ray. The arms are joined laterally in their proximal portions and were probably immovable in their lower parts. IAX<sub>1</sub> are large, almost three times wider than high, and occupy the full width of the radials. The plates are low, pentagonal in outline, and just above the radials each has a distinctly depressed, elongate area that distally curves outward abruptly. Along the median line to the primibrach the plate continues upward as a gently convex surface to the distal tip, but along each lateral margin the convex central part has the form of a ridge, the plate becoming depressed distally next to the suture with IIBr<sub>1</sub>.

The first secundibrachs are larger than any succeeding brachials and are swollen transversely. IIBr<sub>2</sub> and higher brachials are three to four times wider than high and are distinctly wedge-shaped, with alternating low and high ends. The wide edge of each brachial projects into a corresponding notch at the edge of adjacent arm formed by the narrow end of a brachial on that arm. Consequently proximal portions of the arms are united laterally to each other by a zig-zag suture that is quite prominent up through the more proximal 13 to 16 secundibrachs. This pattern gradually becomes less distinct distally as the higher secundibrachs exhibit progressively more quadrangular external faces. Surfaces of all brachials are distinctly granulose in appearance. The facets between succeeding brachials have radial grooves and give the outer edges of upper and lower surfaces of each brachial a finely denticulate appearance. Long, narrow pinnules are apparently on all IIBr, and have an average width of about 0.6 mm.

The type specimen reveals only the proximal part of the column, which is poorly preserved. The column is round, has a width of 8 mm., and individual columnals are about 1.5 mm. high.

The species name *brachiatus* is from the Latin word meaning *with arms* or *with branches*.

*Measurements.*—The following measurements for the holotype are recorded in mm.

Height of crown	77
Height of dorsal cup	22.5
Width of dorsal cup (maximum)	39.2
Width of dorsal cup (minimum)	29.9
Width, IBB circlet	12 (approximately)
Width, postero-left B	20.0
Height, postero-left B	16.8
Width, left posterior R	20.2
Height, left posterior R	13.0
Width, IAX <sub>1</sub>	18.5
Height, IAX <sub>1</sub>	6.8
Width, IIBr <sub>1</sub>	10.0
Height, IIBr <sub>1</sub>	3.4
Width, IIBr <sub>3</sub>	9.1
Height, IIBr <sub>3</sub> (maximum)	2.9
Height, IIBr <sub>3</sub> (minimum)	1.4
Width, IIBr <sub>30</sub>	8.8
Height, IIBr <sub>30</sub>	1.6
Length, LPR-RA suture	5.1
Length, RA-Anal-X suture	3.0
Length, Anal-X-RPR suture	1.9
Length, RA-PB suture	11.1 (approximately)
Length, interrarial suture	4.9
Length, radial-basal suture	11.4
Length, interbasal suture	12.0 (approximately)
Length, basal-infrabasal suture	4 (approximately)

*Material.*—The holotype (UCLA No. 34978) is an almost complete crown lacking distal portions of the free arms. In addition, several portions of

arms still in relative position have been collected, one of which displays the distal tips of the arms (Paratype, UCLA No. 34979). One internal mold of a dorsal cup is assigned tentatively to the genus.

*Occurrence.*—The species has been collected only from a locality in the Bird Spring Formation 2.5 miles southwest of Indian Springs Ranch, Indian Springs, Nevada. The locality can be reached by following a pole-line road west from the ranch about 0.8 mile to an unimproved road (old Cold Creek road) southwest about 2 miles. The crinoid was found in a brown-weathering fossiliferous siliceous platy limestone which is below a prominent cliff-forming limestone ledge that contains *Fusulinella* Möller at the base. The associated fauna includes large sponge spicules, *Delocrinus* Miller & Gurley, and numerous genera of brachiopods and bryozoans.

Genus PARULOCRINUS Moore & Plummer, 1940

*Type species.*—*Ulocrinus blairi* Miller & Gurley, 1893, p. 57, pl. 5, figs. 16–18. Original designation, Moore & Plummer, 1940, p. 361.

*Diagnosis.*—Dorsal cup approximately twice as wide as high ( $0.40 < H/W < 0.60$ ), two anal plates, subhorizontal or concave IB cirlet, 10 biserial arms branching on IBrr.

*Remarks.*—The genus *Parulocrinus* Moore & Plummer was proposed originally to encompass species that differ from *Ulocrinus* Miller & Gurley in having a “generally broad and flat base of the cup, with infrabasals (IBB) not visible or only barely perceptible in side view of the cup” (Moore & Plummer, 1940). The holotype of the type species consists of a dorsal cup without preserved arms, although the authors of the genus mentioned that each of two crowns referred to *Parulocrinus* has 10 arms composed of biserially arranged segments.

Strimple (1949, p. 9 (327)) indicated dissatisfaction with *Parulocrinus* and stated that species known only from dorsal cups should be assigned to *Ethelocrinus* Kirk. The latter genus has small, downflaring IBB; a prominent basal concavity; and more than 10 arms. Later, he (Strimple, 1961, p. 68) suggested that *Parulocrinus* be suppressed and that the type species be allocated to *Ulocrinus*. Reasons given for this change are that the exact horizon and location of the type specimen is not known; only the dorsal cup is preserved; and that topotype material will never be found and thus the arm structure of the type species will remain unknown. Strimple contended that *Parulocrinus blairi* is close to typical *Ulocrinus* and should, therefore, be included in that genus.

The type species is known to have come from “the Upper Coal Measures, near the line of Kansas and Missouri, southwest of Sedalia” (Miller & Gurley, 1894, p. 58), and Moore & Plummer (1940, expl. Pl. 19, fig. 5) stated that the specimen is from beds of “the Missouri series near McClellan Springs, Cass County, Missouri.” The location and geologic position of the specimen is not completely unknown, and the possibility that topotypic material with arms attached may eventually be found cannot be dismissed. Although the arms are missing on the type, crowns referred to *Parulocrinus* do have 10 biserial arms attached to dorsal cups that are essentially like that of the holotype of the type species. This situation is not uncommon among many type specimens of Paleozoic crinoids and should not in itself cause suppression of a genus. Exactly the same circumstance applies to the holotype of *Ulocrinus buttsi* Miller & Gurley, the type species of *Ulocrinus*, which was founded on a single dorsal cup from near Kansas City, Missouri. The “exact” locality and geographic occurrence of that species is equally vague, and yet Strimple accepts this genus as well founded. Knowledge of the arm structure of *Ulocrinus* is based on specimens from Oklahoma that certainly cannot be considered topotypic. Strimple’s (1961, p. 68) view that *Parulocrinus blairi* (Miller & Gurley) “is not far removed from typical *Ulocrinus*, indeed it is so close that assignment to the genus is natural” is probably in error for the reasons given below.

The principal difference in the dorsal cup separating *Ulocrinus* and *Parulocrinus*, as stated by the original authors of the latter genus, is the position of the infrabasal cirlet (Moore & Plummer, 1940, p. 361). In *Ulocrinus buttsi* this cirlet is strongly upflaring, and the infrabasals are clearly visible in side view. This plate arrangement results in the cup having a relatively high form ratio (height of dorsal cup/width of dorsal cup). The flattened or slightly concave IBB of *Parulocrinus* causes the dorsal cup of that genus to be relatively low compared to the width and to have a smaller form ratio. Among the species originally considered to constitute *Parulocrinus* by Moore & Plummer, the form ratios of some are as follows:

<i>Ulocrinus blairi</i> Miller & Gurley	H/W = 0.56
<i>Parulocrinus beedei</i> Moore & Plummer	H/W = 0.48
<i>P. marquisi</i> Moore & Plummer	H/W = c. 0.51
<i>P. compactus</i> Moore & Plummer	H/W = 0.50
<i>P. pustulosus</i> Moore & Plummer	H/W = 0.43

Species that have been assigned to *Ulocrinus* by Strimple (1961, p. 75) include the following for which the form ratio was determined.

<i>Ulocrinus buttsi</i> Miller & Gurley	H/W = 1.09
<i>U. kansasensis</i> Miller & Gurley	H/W = 0.65
<i>U. americanus</i> Weller	H/W = 0.64
<i>U. convexus</i> Strimple	H/W = 0.77
<i>U. caverna</i> Strimple	H/W = 0.62
<i>U. sangomenensis</i> Meek & Worthen	H/W = 0.74
<i>U. elongatus</i> Strimple	H/W = 0.88

In the former group of species the IBB cannot be seen, or are only barely discernible, in side view; and in the last cited list of species, these plates are clearly visible from the side. The relative proportions of the dorsal cup are quite different in the groups as can be seen readily by comparison of the form ratios given above. For these reasons, *Ulocrinus blairi* is judged not to be allied closely to *U. buttsi* Miller & Gurley or other species commonly assigned to *Ulocrinus*, and Strimple's suppression of *Parulocrinus* is not accepted.

Strimple suppressed *Parulocrinus* in his discussion of a new genus erected by him called *Metacromyocrinus* with *M. holdenvillensis* Strimple, 1961, type species. He assigned to the new genus four species, and the only formal diagnosis of the genus is given under his discussion of the Family Cromyocrinidae (*op cit.*, p. 65) where *Metacromyocrinus* is characterized as having "two anal plates, subhorizontal infrabasals, ten biserial arms." This brief diagnosis and Strimple's further discussion (p. 68-73) do not make clear in what way his new genus substantially differs from that offered by Moore & Plummer (1940, p. 361) for their antecedent genus, *Parulocrinus*. The four species listed under *Metacromyocrinus* have dorsal cups with form ratios of 0.58, 0.51, 0.47, and 0.49, well within the range of variation of species assigned to *Parulocrinus* by Moore & Plummer. All four species are more or less ornamented, but the type species of *Parulocrinus* has smooth plates. Degree of ornament alone is doubtfully sufficient for establishment of a new genus, especially because Moore & Plummer include species in *Parulocrinus* (i.e., *P. pustulosus*) that are distinctly ornamented. For these reasons *Metacromyocrinus* is here considered a junior subjective synonym of *Parulocrinus*.

PARULOCRINUS VETULUS Lane, n. sp.  
Pl. 112, figs. 11-13

*Description.*—Crown medium sized, higher than wide. Dorsal cup a basally impressed low bowl; all plates smooth and unornamented. Infrabasal cirlet small, downflaring, consisting of five equal diamond-shaped plates confined to basal depression and largely covered by the proximal columnal. Basals large, higher than wide, spear-shaped, only slightly convex trans-

versely, the upper two-thirds of plates visible in side view of cup, proximal portions strongly convex and forming outer edges of the basal depression. Interbasal sutures longer than basal-radial sutures. Radials almost twice as wide as high, gently convex transversely but only slightly convex or flattened longitudinally; without a projecting shelf in front of the radial facets. IBrr<sub>1</sub> axillary, with a broad lower surface occupying full width of radials below, and two long upper facets meeting at a sharp distal apex; plates are 2.5 times wider than high, flattened longitudinally and smooth. Outer ligament area long and narrow, extending almost full width of radials; inner ligament area not observed. Two anal plates, radial large, quadrangular, situated obliquely in the posterior interray and bounded in a clockwise direction by anal-X RPostR, Post RB and posterior B. Anal-X subquadrangular, resting on truncated surface of the posterior basal. The left and right sides are subparallel and in contact with the LPostR and radial respectively. A short suture exists between anal-X and RPostR. The flat upper surface of anal-X presumably bore a single distal plate. IIBrr<sub>1-3</sub> uniserial; the first IIBr large and quadrangular. IIBrr<sub>2</sub> smaller, wedge-shaped; IIBrr<sub>3-5</sub> progressively more wedge-shaped, failing to extend completely across the arm. All succeeding brachials biserially arranged, the most completely preserved arm showing 25 brachials without any evidence of further bifurcation. All brachials gently rounded on outer surfaces and having flat, sharply demarcated sides. Isolated ossicles of pinnules observed in matrix enclosing the arms. Three round proximal columnals 3 mm. wide, 1 mm. high, and having circular lumen, are preserved in the basal depression.

*Remarks.*—Other species assigned to *Parulocrinus* have a larger form ratio, generally larger, lower dorsal cup, and less distinct basal impression. Occurrence of *P. vetulus* n. sp. in the upper part of the *Rhipidomella nevadensis* (Meek) Zone serves as evidence for an Early Pennsylvanian age for the upper part of this zone. *Parulocrinus* has been recorded from beds as old as the Morrowan Epoch but not in older rocks.

Proximal portions of the dorsal cup are badly crushed inward, causing the basal concavity to appear much deeper than it was originally; a circular fracture cuts across the proximal parts of all five basals. Only eight arms can be observed; those of the anterior ray not being seen. Each of the other four rays clearly has two biserial arms and presumably the anterior ray had a similar arm arrangement. Although the dorsal cup plates are weathered rather badly, the

outer surface of the left-posterior radial is well preserved and is smooth.

The species name *vetulus* is the diminutive of the Latin adjective *vetus*, meaning *somewhat old*.

*Measurements*.—The following measurements of the holotype are in mm. Width of dorsal cup, 19; height of dorsal cup, 7; form ratio (H/W), 0.37; width RPostR, 9.2; height RPostR, 5.5; width RAntR, 11.2; height RAntR, 6.1; width IAx, 11; height IAx, 4.2; preserved height of crown, 31.

*Material*.—The holotype (UCLA No. 34980) is the only specimen.

*Occurrence*.—The holotype was collected on the north side of Arrow Canyon, approximately the center of W $\frac{1}{2}$  Sec. 12, T. 14 S., R. 64 E., Arrow Canyon Quadrangle, Clark Co., Nevada. The specimen came from near the top of brown-weathering bioclastic limestone, shale, and sandstone, which are below gray ledge-forming limestones that form a prominent cliff on both sides of the canyon; *Rhipidomella nevadensis* ranges up into the lower part of the gray, cliff-forming limestones. *Parulocrinus vetulus* is associated with numerous brachiopods and bryozoans, *Archimedes* Hall, and *Pentremites* Say.

Family AMPELOCRINIDAE Kirk, 1962

Genus POLUSOCRINUS Strimple, 1961

*Type species*.—*Polusocrinus avanti* Strimple, 1951, p. 24, original designation.

*Diagnosis*.—Ampelocrinids with IBB visible in side view; one anal plate; arms uniserial, IBrr<sub>2</sub> axillary, IIBrr<sub>2</sub> axillary.

*Remarks*.—The thin radial facets, that slope distinctly inward constitute the prime diagnostic character of the ampelocrinids. *Polusocrinus* is like *Aesiocrinus* Miller & Gurley except the latter genus has a relatively smaller IB cirlet that is flat or slightly concave and has a persistently lower dorsal cup. Species assigned to *Aesiocrinus* have a dorsal cup form ratio (H/W) ranging from 0.34 to 0.37 (Moore & Plummer, 1940), but described species of *Polusocrinus* have form ratios of 0.49 to 0.71, with an average value of 0.59.

*Polusocrinus* has a previously known range of uppermost Desmoinesian and Missourian; consequently descriptions of the new species below constitute an extension of the range downward into the Atokan or Morrowan of the lower part of the Pennsylvanian.

POLUSOCRINUS CALYCULOIDES Lane, n. sp.

Pl. 112, figs. 1–3

*Description*.—Dorsal cup low, bowl-shaped, almost twice as wide as high; base slightly flattened, sides evenly convex, becoming straight

on the posterior and lateral sides, but remaining gently convex on the anterior. All plates smooth and unornamented. Infrabasal cirlet relatively large, star-shaped, IBB gently convex longitudinally and transversely, with distal extremities clearly visible in side view; proximal ends sharply recessed around small, pentalobate stem impression. Basals large, the most conspicuous elements in side view of the cup, approximately equal in length and height, gently convex, hexagonal except for posterior basal which is heptagonal. Radials almost twice as wide as high, slightly convex longitudinally, with a narrow shelf developed in front of the outer ligament area, which is narrow and extends full width of radial. Ligament pit short, distinct. Anal-X large, quadrangular, resting on PostB and bounded by LPostR and RPostR. Lower seven-eighths of plate in the dorsal cup; upper surface beveled for contact with two succeeding anal plates that are not preserved. Arms not preserved.

The species name *calyculoides* is from the diminutive of the Latin noun *calyx*, meaning *cup*.

*Measurements*.—The following measurements of the holotype are in mm. Width of dorsal cup (Ant-Post), 18; width of dorsal cup (perpendicular to Ant-Post axis), 20.5; height of dorsal cup, 12; width of IB cirlet, 12; height of IB cirlet, 2.1; height of basal, 10.4; width of basal, 10.7; height of radial, 6.7; width of radial, 9.5; height of anal, 4.6; width of anal, 5.6; length of interrarial suture, 3.1; length of interbasal suture, 5.3.

*Material*.—The only specimen and holotype (UCLA No. 34981) is from the Callville Formation at Frenchman Mountain, east of Las Vegas, Nevada. The specimen is from the center of Sec. 24, T. 20 S., R. 62 E., Henderson Quadrangle, 60 feet above the base of the Callville Formation and 120 feet below *Chaetetes* Fischer, from a thin shale parting between massive beds of *Osagia*-bearing limestone.

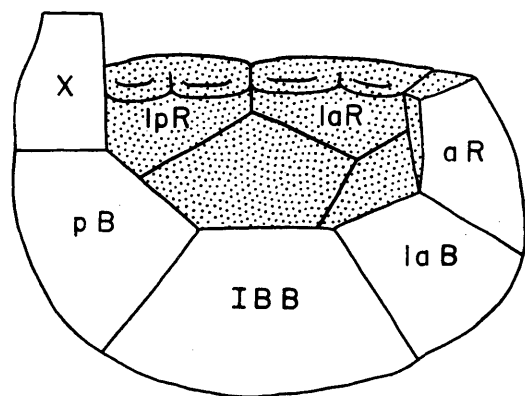
POLUSOCRINUS PACHYPLAX Lane, n. sp.

Pl. 112, figs. 4–10; text-fig. 1

*Description*.—Dorsal cup medium sized, globe-shaped; base gently convex, sides evenly convex to summit of radials. Plates smooth, without ornamentation. Infrabasals five, spear-shaped, evenly convex longitudinally, the distal one-half visible in side view. IBB exceptionally thick and massive, especially in larger specimens. Small IBB cirlets have proximal tips of IBB sharply upturned around a distinct lumen. Larger cirlets have only a faint depression surrounding an indistinct and perhaps closed lumen.

Basals large massive plates, evenly convex





TEXT-FIG. 1.—Median cross section of the dorsal cup of *Polusocrinus pachyplax* Lane, n. sp., showing the exceptionally thick basal and infrabasal plates. The section is drawn medially through the anterior radial (aR) and the posterior interradius, showing the left half of the cup, the shaded area representing parts beyond the plane of the section.

longitudinally and transversely, hexagonal except for PostB which is heptagonal. Radials relatively small, convex longitudinally, with an indistinct, narrow shelf in front of the radial facets. Facets narrow, less than maximum thickness of the RR, outer facet short, subhorizontal, with deep ligament pit; inner facet narrow, extending full width of R and inclined slightly toward the interior of the cup. Lateral lobes, intermuscular furrow and lateral muscle areas indistinct and poorly developed; faint intermuscular notch with widely spreading straight sides discernible on well preserved specimens.

One anal plate in posterior interray, resting on PostB and in contact laterally with LPost and RPost RR. Anal plate relatively large, quadrangular, and having two small facets on the distal side for reception of two tube plates. Arms uniserial, 10 in number, branching isotomously on IBrr<sub>2</sub>. IBrr<sub>1</sub> short with sides abruptly tapering distally; proximal surface wide, faceted, and equal in width to RR, and distal surface smooth, semicircular, and externally convex, especially near the distal border. IBrr<sub>2</sub> low, axillary, lower surface smooth and semicircular, prominently notched internally, upper surface with two sloping articular surfaces. Succeeding brachials narrow, rounded, uniserial, with prominent internal ambulacral notch.

Stem pentagonal, lumen circular, individual columnals alternating narrow and wide, each with a thin median ridge around the circumference.

*Remarks.*—The above description is based on a large number of silicified isolated crown plates that have been released from limestone matrix by acid solution. Tabulation of number of each

kind of ossicle is given below. A single specimen, selected as holotype, consists of associated IB circlet and four BB. In addition six complete IB circlets were recovered. The fact that all individual ossicles of each kind (basals, radials, etc.) are alike is judged to mean that they all belong to a single species and reconstruction of parts of the cup by matching radials, basals, and infrabasal circlets leads to the conclusion the species belongs to *Polusocrinus*. The most distinctive character of the new species, and basis for the name, is the massive infrabasals and basals, relative to the small, thinner radials. Although a total of almost 100 pieces belonging to the dorsal cup were collected, only three small stem fragments were found in the insoluble residues. The small size of the stem relative to the cup and the fact that the lumen piercing the IBB becomes less distinct and may be completely closed in larger IB circlets suggest that this species may have become elutherozoic in later stages. The exceptionally thick lower circlet plate may then have served effectively as a weight to keep the individual upright, but free, on the bottom.

The species name *pachyplax* is a combination of the Greek adjective *pachys*, meaning *thick* and the Greek noun *plax*, meaning *plate*.

*Material.*—The most complete specimen, an associated IB circlet and four BB, is selected holotype (UCLA No. 34982). An infrabasal circlet (UCLA No. 34983), two basal (34984, 34985), two radials (34986, 24987) and an anal plate (34988) that served to provide reconstruction of the dorsal cup (Pl. 112, figs. 4,8,9) are selected paratypes. Tabulation of number of different kinds of ossicles obtained in etching is as follows: IBB, 9; IB circlets, 6; BB, 43; RR, 23; anals, 3; IBrr<sub>1</sub>, 6; IAXx<sub>1</sub>, 2; IIBrr, 75+; stem, 3.

*Occurrence.*—The crinoid bed is 100 feet above the base of the Callville Formation, in the middle of the second prominent limestone ledge above the base, along the crest of the ridge north of the Flintkote quarry at Sloan, Nevada. The Callville-Monte Cristo contact is exposed in road cuts along the quarry road at the crest of the ridge. The crinoid bed occurs 230 feet below *Chaetetes* Fischer and Middle Pennsylvanian fusulinids and 20 feet above a brachiopod faunule characterized by *Schizophoria texana* Girty.

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