

INADUNATE CRINOIDS FROM THE PENNSYLVANIAN
OF BRAZIL

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INADUNATE CRINOIDS FROM THE PENNSYLVANIAN OF BRAZIL

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ABSTRACT—Two new species of cladoid inadunate crinoids are described from the Itaituba Series (Middle Pennsylvanian) of Santana, State of Pará, Brazil. *Dicromyocrinus mendesi*, n. sp., shows relationship to a species from the Russian Moscovian, and *Plaxocrinus? brasiliensis*, n. sp., has affinities with pirasocrinids from the United States. One specimen of *D. mendesi* exhibits an unusual divided right-anterior basal plate that superficially resembles the posterior basal and radianal plate of the posterior interray. *Dicromyocrinus tapajosi* Strimple and *Erisocrinus loczyi* Katzer from the same beds are discussed.

THE two new species described below are the third and fourth species of inadunate crinoids described from the late Paleozoic of Brazil. The other species are *Erisocrinus loczyi* Katzer from Miritituba and Mangal, State of Pará; and *Dicromyocrinus tapajosi* Strimple from Itaituba, both of which are discussed, and the latter refigured, herein. The Itaituba Series, from which the crinoids were collected, is Middle Pennsylvanian in age, and is correlative with the Desmoinesian Series of the United States and the Moscovian of Russia, as determined by the presence of *Fusulinella* (Petri, 1952) and typical brachiopods (Dresser, 1954; Mendes, 1956, 1959). *Dicromyocrinus mendesi*, n. sp., shows surprisingly close relationship to *D. geminatus*, originally described from the Moscovian of Russia almost a century ago. The new pirasocrinid questionably referred to *Plaxocrinus* shows closest relationship to abundant lower and middle Pennsylvanian crinoids described from the United States. This is the first record of the Pirasocrinidae outside the United States.

The specimens were collected by J. C. Mendes, Department of Geology, University of São Paulo, Brazil, and were presented to the author for description. All four specimens are silicified and colored a dark brown on weathered plate surfaces. They occur in a soft limy matrix and they were easily prepared. The four individuals have been more or less crushed and none of the crowns is complete. The crinoids are from the Itaituba Series at Santana on the Rio Tapajos, State of Pará, Brazil. The locality is shown by Mendes (1956, text-fig. 1, p. 30).

Abbreviations for crinoid morphology and orientation are taken from Moore, Lalicker & Fischer (1952) and descriptive terms applied to dorsal cup shape and definitions of appropriate measurements are in accord with Moore & Plummer (1940). All specimen numbers refer to the University of California, Los Angeles, inver-

tebrate paleontology catalogue. The writer wishes to express his sincere appreciation to Dr. Mendes for making the specimens available for study and to Kenneth E. Caster, University of Cincinnati, for reading the manuscript.

Family CROMYOCRINIDAE Jaekel, 1918

Genus DICROMYOCRINUS Jaekel, 1918

Dicromyocrinus JAEKEL, 1918, p. 66; MOORE & PLUMMER, 1940, p. 351,364,365; MOORE & LAUDON, 1943, p. 104 (as *nomen nudum*); WRIGHT, 1952, p. 111; BASSLER & MOODEY, 1943, p. 377 (as junior synonym of *Cromyocrinus* Trautschold, 1867); STRIMPLE, 1960, p. 75; —, 1961, p. 66. *Mooreocrinus* WRIGHT & STRIMPLE, 1945, p. 221.

Type species: *Cromyocrinus ornatus* Trautschold, 1879. Subsequent designation, Moore & Plummer, 1940, p. 364-365.

Diagnosis.—Infrabasals subhorizontal, cup medium, truncate, globe shaped, without basal depression; anal plates three; arms 10, uniserial, with axillary IBrr₁.

Discussion.—Much confusion has existed concerning the validity of this genus, largely brought about by Jaekel's incorrect designation of a type species. The nomenclatorial history of the genus has been summarized recently by Strimple (1961). At one time or another Strimple has assigned four species from the Mississippian or Pennsylvanian of the United States to *Dicromyocrinus* or its junior synonym *Mooreocrinus*. At present all American species are allocated to genera other than *Dicromyocrinus* (Strimple, 1961, p. 66-67), and the genus is known certainly only from Russia and Brazil.

DICROMYOCRINUS MENDESI Lane, n. sp.

Pl. 57, figs. 1.2,6-10

Description.—The crown is higher than wide. The dorsal cup is medium, truncate, globe shaped, about twice as wide as high; all plates are smooth, convex, unornamented, and with

distinct sutures. The infrabasal cirlet is large, flat, subhorizontal, pentagonal in outline, and much wider than the stem impression. The IBB are flat or very gently convex, four sided and bear a small, circular, radially grooved stem impression on their median tips. The basals are large, smooth, pentagonal plates, both longitudinally and transversely convex, flattened proximally, turning up and becoming more convex near their distal borders. The radial plates are large, wider than high, gently rounded transversely, more strongly convex longitudinally, and the upper edges of the outer surfaces bordering the facets are flattened and gently inclined outward. The radial facets are large, subhorizontal, as wide as the radials, with long, narrow outer ligament areas that slope gently outward. The outer ligament furrow is deepest next to the outer marginal ridge; the ligament pit is deep, long and narrow; the transverse ridge is denticulate on both sides. The inner ligament area was not observed. The radianal is large, quadrangular, strongly convex longitudinally and gently convex transversely. Anal-X is small, gently convex, higher than wide, in contact with the radianal, posterior basal, and left-posterior radial. Another anal plate can be observed above and to the right of anal-X in two of the three specimens. This third anal plate has a narrow suture with the radianal, is long and narrow, and both it and the anal-X separate the left-posterior and right-posterior radials and extend above the radial cirlet.

There are two arms to each ray, branching on IBrr₁, which are axillary, large, wider than high, transversely convex, and restricted in width just above the radials; distal facets of IBrr₁ for articulation with secundibrachs have distinct outer ligament areas and deep ligament pits, the two facets on each IBr being separated by a high, straight ridge bearing a median groove along its distal edge. Secundibrachs large, wedge shaped, outer surfaces convex, sides flattened and IIBrr of adjacent arms in lateral contact. Sutures between IIBrr alternately sloping to right and left. There is a gradual decrease in size of IIBrr distally. Ten secundibrachs can be counted on the most completely preserved arm. The anal sac is unknown.

Discussion.—As mentioned above *Dicromyocrinus* is known certainly only from the Russian Moscovian and the Brazilian Pennsylvanian. A species from the Lower Carboniferous of Scotland (Wright, 1952) described as *D. geminatus*, is probably not conspecific with that species and may not be properly included in the genus.

Dicromyocrinus tapajosi Strimble, described

from Itaituba, Brazil, differs from *D. mendesi*, n. sp., in the former's larger size, ornamentation, presence of a median node on each radial, and lack of contact between Anal-X and the posterior basal.

Dicromyocrinus mendesi is quite unlike the type species of the genus, which has conspicuously ornamented cup plates and brachials, but is very similar in size, shape and ornamentation to *D. geminatus*. The two species differ in that *D. mendesi* has relatively higher IAxx that become narrower distally and the IIBrr are relatively higher, narrower plates. The dorsal cup of the new species is flatter, less rounded proximally; the radials are relatively wider and more strongly convex longitudinally. These differences are all of slight degree and in general aspect the two species are remarkably similar.

In the smallest of the three specimens (UCLA No. 32322) there is a remarkable example of division of the right-anterior basal into two plates (Pl. 57, fig. 2). This plate has seemingly grown as two distinct plates that are similar in size and arrangement to the posterior basal and radianal plates on the posterior side of the cup. The upper plate of the split RAB is quadrangular, and is situated above and to the left of the lower part of the basal, which is restricted along its upper left border. The anterior and right-anterior radials meet above the upper plate along a suture that is distinctly shorter than that between other radials of the cup.

When this specimen was first examined the posterior side of the cup was buried in matrix. The unusual arrangement of plates on the anterior side was noted and initially judged to represent a peculiar posterior interradius. No example could be found in the literature of an inadunate crinoid with the LPR and RPR meeting above a large radianal. This enigma was not resolved until the true posterior side was freed from the matrix, and this serves to point up the close similarity of the anterior plates of this specimen to the radianal and posterior basal of normal crinoids. Similar occurrences of extra plates in the dorsal cup of inadunate crinoids have been described by Moore & Plummer (1938) in *Morrowcrinus fosteri*, and by Strimble (1957, 1961) in *Phanocrinus*, *Laudonocrinus*, *Ataxiacrinus* and *Stellarocrinus*.

Material.—Three specimens of the species were available for study. UCLA No. 32321 is designated holotype, and Nos. 32320 and 32322 paratypes. The specimens are deposited in the Invertebrate Paleontology Collection, Department of Geology, University of California at Los Angeles.

DICROMYOCRINUS TAPAJOSI Strimple

Pl. 57, figs. 3-5

Dicromyocrinus tapajosi STRIMPLE, 1960, p. 75, figs. 1-3.

Remarks.—The holotype of this species (Univ. Cincinnati Mus. No. 26362) and only known specimen has been obtained on loan and carefully compared with the new species described above. Two additions to Strimple's description of the species can be made. The dorsal cup plates preserve a delicate shagreen ornamentation that is lacking in all three specimens of *D. mendesi*, n. sp., and each radial plate bears a distinct median node on the outer part of the distal, subhorizontal shelf external to the radial facet. As a consequence, when viewed from the side, the distal edge of each radial consists of two gently concave halves separated by the central node. This is clearly discernible in the figured illustration of the holotype (Pl. 57, fig. 4).

Family PIRASOCRINIDAE

Moore & Laudon, 1943

Genus PLAXOCRINUS Moore & Plummer, 1938

Type species: *Hydreionocrinus crassidiscus* Miller & Gurley, 1894.

Diagnosis.—Dorsal cup low, saucer shaped, with shallow basal depression; three anal plates; IB_{rr1} axillary and prominently spinose; arms uniserial, branching isotomously on the fourth or fifth IB_{rr}.

Discussion.—*Plaxocrinus* and closely related genera have been recently discussed and partially emended by Strimple (1961). He confines *Perimestocrinus* to species that lack spinose brachials, *Stenopecrinus* to forms that have all axillaries spinose, but in which the IA_{xx} spines are confined to the distal part of each plate, and *Plaxocrinus* to specimens having nonspinose IA_{xx} and spinose IA_{xx} in which the entire plate is involved in the spinose development. The species described below has spinose IA_{xx} exactly comparable to those ascribed to *Plaxocrinus*, but also has spinose IA_{xx}. Because the dorsal cup of *Plaxocrinus? brasiliensis*, n. sp., is badly crushed and the infrabasal circling is missing, the new species is referred to *Plaxocrinus* with reservation. Firm generic assignment must await procurement of more nearly complete specimens.

PLAXOCRINUS? BRASILENSIS Lane, n. sp.

Pl. 57, figs. 11,12

Description.—The dorsal cup is low, bowl shaped, and the plates are smooth except for a low, broad central node on each radial. The

sutures are not impressed. The infrabasal circling was not observed. The basals are small, pentagonal, smooth plates, moderately convex longitudinally and only slightly convex transversely. The radials are large, wider than high, gently convex both transversely and longitudinally, and have a broad central node on each plate that increases the apparent convexity. Outer surfaces of radials at the distal lateral corners of each plate extend inward past the outer ligament area of the facet and the outermost end of the facet lateral ridges. The radial facets are less than full width of the radials, the outer ligament area being distinctly narrower than the radial and subhorizontal, sloping only gently outward. The central ligament pit of the facet is deep, narrow and elongate, and the transverse ridges are high and narrow, relatively short, and meet the transverse ridges at each end at a point that projects outward beyond the subjacent plate surface. The inner ligament area is divided into two concave parts by a prominent intermuscular furrow and each half of the inner area slopes gently outward. The lateral ridges are prominent and bounded externally by a distinct adsutural platform and slope. Although the radials are displaced and not in contact laterally, interradsial notches clearly are present between adjoining radial plates at the summit of the cup. There are three plates in the gently concave posterior interradsial, the radianal, anal-X and right tube plate. Both the anal-X and right tube plate project above the level of the RR and a fourth anal plate is preserved distal to and between these two plates. The arms are uniserial, branching isotomously at least twice. The IB_{rr1} are large, axillary plates, narrower than the radials and each bears a long, slender, pointed, distally directed spine. The secundibrachs are quadrangular, gently convex transversely, and have flat sides. Several dissociated IA_{xx} are preserved that bear long, narrow, central, laterally directed spines. In the left-anterior ray branching can be observed on IB_{rr5} and there are three small quadrangular IB_{rr} above the secundaxil. A number of small dissociated quadrangular stellate plates are preserved among the brachials. These are undoubtedly part of the anal sac, which was probably porous. The stem is unknown.

Discussion.—The only specimen of this species is crushed, the plates are partly dissociated, and the infrabasal circling is missing. Consequently the shape of the dorsal cup is in doubt and a definite generic assignment cannot be made. It cannot be ascertained whether there was a basal depression, but because the RR and BB are only gently convex longitudinally, the basal depres-

sion, if it existed, could have involved only the IBB. The infrabasal-basal suture is relatively short on two well preserved basals and the infrabasal cirlet presumably was not very wide. The crinoid clearly belongs to the Pirasocrinidae, and is tentatively assigned to *Plaxocrinus* because of the strongly spinose IAX₁.

Material.—One specimen (UCLA No. 32323) was available for study and is the designated holotype of the species.

Measurements.—The following measurements (in mm.) were made on the specimen: Height of radial plate, 4.0; width of radial plate, 6.0; length of interradsial suture, 2.7; length of radial-basal suture, 2.6; height of basal plate, 2.7; width of basal plate, 3.3; length of interbasal suture, 1.2; length of infrabasal-basal suture, 2.0; height of IBr₁, 10.2.

Family ERISOCRINIDAE S. A. Miller, 1889
Genus ERISOCRINUS Meek & Worthen, 1865
ERISOCRINUS LOCZYI Katzer

Erisocrinus loczyi KATZER, 1903, p. 263, pl. 4, figs. 9a,b.

Discussion.—Because *Erisocrinus loczyi* is the only other Pennsylvanian crinoid that has been described from Brazil, its relationship to the above described new species is important. Katzer's description of the species is brief, but taken with his illustration it is clear that the species he described belongs to *Erisocrinus* even though this genus has been much more strictly interpreted since Katzer's reference to it. The cup of *E. loczyi* is of medium height, has a pentagonal outline in dorsal view, the infrabasals are not visible in side view, and there are no visible anal plates in the dorsal cup. The species differs from North American erisocrinids in having a globe-shaped, rather than a truncate, cone-shaped cup outline in side view. Katzer's illustrations include a dorsal and lateral view of the cup, and it is impossible from his figures to determine whether or not a small anal plate is present within the inner margins of the right and left posterior radials. *Erisocrinus* occurs in Desmoinesian through Wolfcampian rocks in the United States.

ADDENDUM

The four specimens described above and listed as in the UCLA invertebrate paleontology collections will be deposited in the collections of the Department of Geology and Paleontology, University of São Paulo, São Paulo, Brazil, and numbered as follows: 7-980 (=UCLA 32320), 7-981 (=UCLA 32321), 7-982 (=UCLA 32322) and 7-983 (=UCLA 32323).

TABLE 1—MEASUREMENTS OF *Dicromyocrinus mendesi* LANE, N. SP. (in mm.)

Measurements*	Specimens		
	32320	32321	32322
H	11.2	10.0	9.2
W	c. 21.	22.1	18.5
H/W	c. 0.52	0.45	0.49
HA	—	10.4	8.5
HB	7.0	7.4	5.9
HR	6.5	7.0	5.3
WBB	—	19.3	—
WB	9.1	9.7	8.2
WR	11.2	10.0	7.6
WIBB	—	7.4	—
WS	—	2.8	—
Wsp	—	18.2	—

* Abbreviations and definitions of measurements are in accord with Moore & Plummer (1940).

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EXPLANATION OF PLATE 57

All figures $\times 1$ unless otherwise indicated.

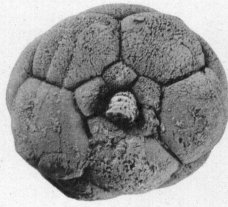
- FIGS. 1,2,6-10—*Dicromyocrinus mendesi* Lane, n. sp. 1,2,9, Posterior, anterior-oblique and anterior views, respectively, of paratype, UCLA No. 32322; 2 shows the split right-anterior basal on this specimen with the arms removed; 6,7,8, basal, postero-right and posterior views, respectively, of holotype, UCLA No. 32321; 10, right-posterior view of paratype, UCLA No. 32320.
- 3-5—*Dicromyocrinus tapajosi* Strimple. Basal, anterior and posterior views, respectively, of holotype, Univ. Cincinnati Mus. No. 26362.
- 11,12—*Plaxocrinus? brasiliensis* Lane, n.sp. Posterior and anterior views of crushed crown, holotype, UCLA No. 32323, $\times 2$.



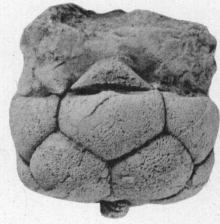
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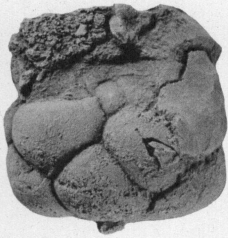
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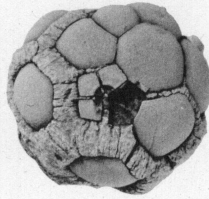
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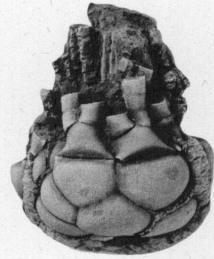
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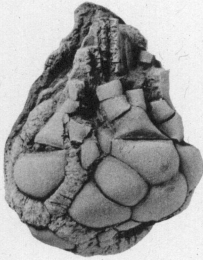
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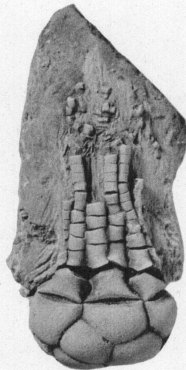
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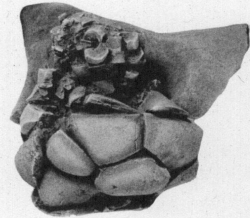
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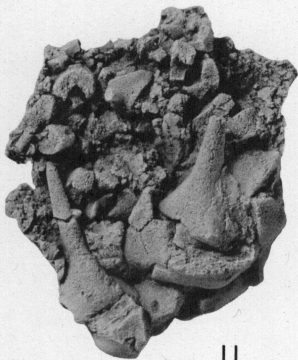
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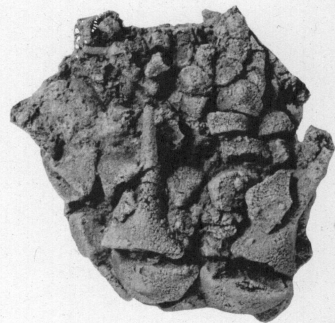
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10



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12