Synarmocrinus Cobbani, A New Crinoid from the Minturn Formation (Middle Pennsylvanian) of Colorado[1]

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ABSTRACT

Synarmocrinus cobbani, new species, is reported from the Minturn Formation (Pennsylvanian, late Atokan), McCoy, Eagle County, Colorado. This is the second species of *Synarmocrinus* and the eighth cromyocrinid reported from the Minturn Formation. The holotype is a complete cup, which is medium globe-shaped, has a shallow basal concavity, and contains two anal plates. The primanal is large and quadrangular; the secundanal is narrow, extends above the cup, and makes a narrow contact with the CD basal. *S. cobbani* is distinguished from all other species of *Synarmocrinus* by the surface ornament, which consists of numerous, widely-spaced nodes, sometimes connected by ridges, and by other details of the cup shape and cup plates.

INTRODUCTION

We report a new species of cromyocrinid, *Synarmocrinus cobbani*, the holotype of which is a complete cup found by one of us (W. D. B.) in a marine siltstone bed in the Minturn Formation, near the town of McCoy, Eagle County, Colorado (Fig. 1). The crinoid fauna of the Minturn Formation (late Atokan to early Desmoinesian) has been the subject of previous studies (Strimple and Moore, 1973; Webster and Houck, 1998) and is the most diverse known from the Pennsylvanian of Colorado. In all, seven cromyocrinids, one protencrinid, two pirasocrinids, one erisocrinid, and one flexible crinoid were known from whole or partial cups prior to the present study. In addition, four taxa based on columnals are known from the Minturn Formation. Most of the Minturn crinoid species are endemic.

The record of Pennsylvanian crinoids elsewhere in Colorado is rather sparse. One cromyocrinid found at McCoy has also been found in the Belden Formation (late Atokan) near Dotsero, Eagle County (Webster and Houck, 1998). Two cromyocrinids and a flexible crinoid were reported from the Pinkerton Trail Limestone (late Atokan or early Desmoinesian) near Molas Lake in southwestern Colorado by Strimple and Miller (1971). Two erisocrinids, one cromyocrinid, and one pirasocrinid were reported from the Desmoinesian Madera Formation (Minturn Formation according to some authors), Huerfano Park by Tischler (1963) and Strimple, (1976).

STRATIGRAPHIC SETTING

The Pennsylvanian sediments in the vicinity of McCoy were originally named the McCoy Formation by Roth and Skinner (1930). Stevens (1958) recognized the equivalence of these beds with those in the vicinity of the town of Minturn, Colorado, approximately 45 km to the southeast, which were named the Minturn Formation by Tweto (1949). Stevens subdivided the Minturn Formation at McCoy into 19 numbered units, which include both marine and nonmarine rocks. Some of these units were further subdivided by Houck (1993, 1997) (e.g., units 3a, 3b, 3c). Houck correlated several of the marine units of the

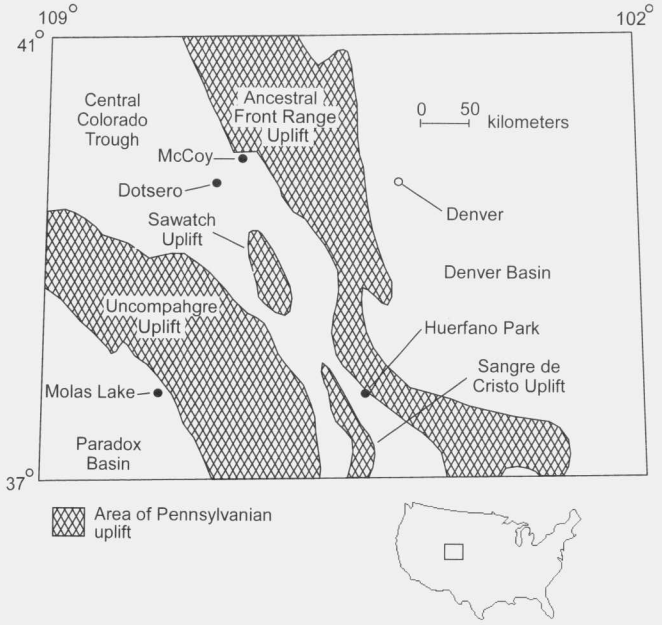

Figure 1. Middle Pennsylvanian paleogeographic map of Colorado, showing areas of uplift around the Central Colorado Trough. Crinoid localities are marked with solid dots. (After Mallory, 1972; Devoto, 1980; Webster and Houck, 1998.)

Minturn Formation at McCoy with the fusulinid biozones of Ross and Ross (1987). The cup was found within unit 3b of Houck (1993, 1997), which correlates with the biozone of *Fusulinella famula, Fusulinella iowensis,* and *Fusulinella iowensis leyi* (late Atokan).

The locality where the holotype of *Synarmocrinus cobbani* was found is in prominent cliffs north of the Colorado River and Eagle County Road 301, about 4 km west of the road's intersection with Colorado State Highway 131. Maroon and purple sandstones, conglomerates, shales, and limestones in the lower part of the cliffs comprise most of unit 3. They are overlaid by an erosional unconformity, which has removed unit 4. In the middle is unit 5, a prominent band of gray shale and tan sandstone. Above are maroon and purple rocks, which comprise units 6 through 9. The stratigraphic column shown in Figure 2 is based on section 87/16a of Houck (1993), which was measured approximately 70 m to the north of the locality at which the cup was found. It depicts the portion of unit 3 exposed in the outcrop, including the position at which the cup was found, in a marine siltstone immediately (within 1 meter) below a fossiliferous marine limestone bed. The limestone bed can be traced continuously from one locality to the other. The stratigraphy is essentially the same at these two localities.

During the Middle Pennsylvanian Period, McCoy was at the eastern margin of an intermontane basin, the Central

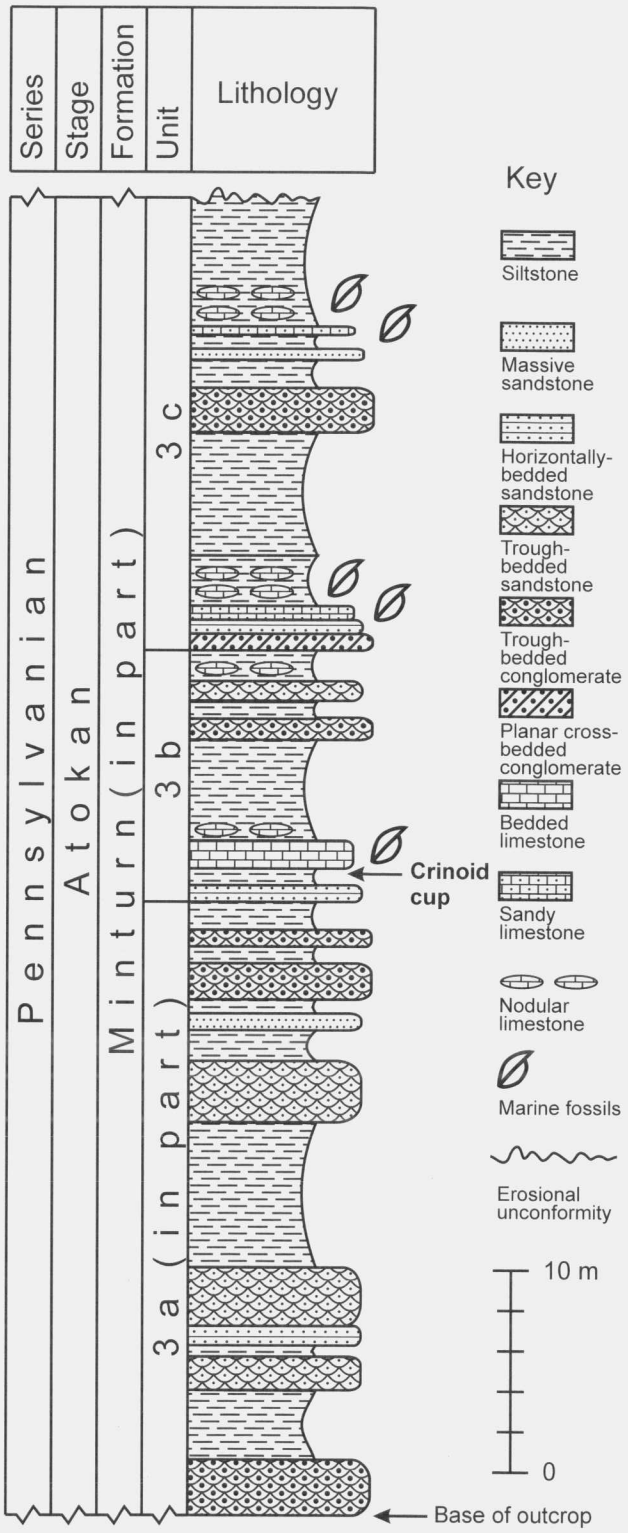

Figure 2. Partial stratigraphic section of the Minturn Formation showing the horizon, indicated by the arrow, at which the holotype of *Synarmocrinus cobbani* new species, DMNH 22970, was found. The diagram is based on measured section 87/16a of Houck (1993), which is about 70 m to the north of the holotype locality.

Colorado Trough (Fig. 1) (Mallory, 1972; DeVoto, 1980). This was a period of high tectonic activity, which resulted in a generally high rate of clastic influx to the shallow-marine environment in which the McCoy crinoids lived. The paleoecology and depositional environment of the crinoid-bearing beds has been discussed in detail by Webster and Houck (1998). They found the McCoy crinoids to have lived in two environments: 1) on the flanks of phylloid algal mounds or 2) in patches on abandoned delta lobes and splay deposits on the gently sloping substrate. The environment of the type locality for *Synarmocrinus cobbani* was of the second kind. More specifically, the crinoids were growing on washover fan deposits associated with a drowned barrier island (Houck, 1993, 1997). Erisocrinids, pirasocrinids, and particularly cromyocrinids dominate the McCoy crinoid fauna. The discovery here of another cromyocrinid reinforces this observation. These families of crinoids are interpreted to have had dense filtration fans and were found in relatively high-energy, nearshore environments having moderately high clastic influx in the stable-platform "Terrigenous Facies Belt" of the Midcontinent of North America. In contrast, crinoids with more open filtration fans were associated in the Midcontinent with farther offshore, lower-energy (i.e., clay-rich) environments with lower clastic influx. It seems likely that the level of clastic influx in the environment of the McCoy crinoids was similar to that of the nearshore environments in the Midcontinent and that this was an important controlling factor in determining the crinoid faunas. Webster and Houck (1998) also noted that the Minturn crinoid fauna is made up exclusively of relatively large forms and that the diversity is low compared to that of other Pennsylvanian faunas. Both low diversity and large size have been observed to be characteristic of nearshore, as opposed to offshore, Pennsylvanian crinoid faunas in the Midcontinent. Since the cup of *Synarmocrinus cobbani* is relatively large and the crinoid faunal diversity remains low, even with the addition of another species, none of the general observations of Webster and Houck (1998) are changed.

SYSTEMATIC PALEONTOLOGY

Class CRINOIDEA Miller, 1821
Subclass INADUNATA Waschsmuth and Springer, 1885
Family CROMYOCRINIDAE Bather, 1890
Genus SYNARMOCRINUS Lane, 1964

Type species. — *Synarmocrinus brachiatus* Lane 1964.

Other species. — *S. adornatus* Strimple and Watkins, 1969; *S. carrizoensis* Webster and Lane, 1970; *S. depressus* Washburn, 1968; *S. iatani* (Strimple, 1949); *S. molasensis* (Strimple and Miller, 1971); *S. papulosus* (Moore and Plummer, 1938).

Diagnosis. — Cup medium truncate bowl-shaped, widest at apices of basals with shallow basal concavity; infrabasals subhorizontal or slightly downflared; radial facets subhorizontal; cup plates with coarse nodes or ridges; sutures impressed; 2 anals; 10 uniserial arms; column round (Webster 1981).

Occurrence. — Pennsylvanian (Morrowan-Missourian); U.S.A.

Discussion. — The species list includes all those listed by Webster (1981) in his revision of the Cromyocrinidae, except for *S. fundundus* Strimple, 1966, and *S. oklahomensis* (Moore and Plummer, 1938). *S. fundundus* has been transferred to *Metacromyocrinus* (Strimple, 1975), and *S. oklahomensis* has been transferred to *Aglaocrinus* (Strimple, 1982). They are excluded from *Synarmocrinus* because they possess biserial arms.

SYNARMOCRINUS COBBANI new species

Figures 3.1-3.5
Synarmocrinus molasensis
Webster and Houck, 1998,
p. 1063, fig. 4.14.

Diagnosis. — Cup medium globe-shaped, with basal concavity. Two anals; primanal large, quadrangular; secundanal narrow, extending above cup, making narrow contact with CD basal. Ornament consisting of numerous, widely-spaced nodes, sometimes connected by ridges, but more often isolated.

Description. — Cup medium globe-shaped, 38 mm wide, 15 mm high, with basal concavity, sutures deeply incised. Width greatest at approximately two-thirds cup height. Five small infrabasals, subhorizontal, confined to basal concavity. Ratio of diameter of infrabasal circlet to diameter of cup 0.25. Five large basals, pentagonal, proximal ends forming sides of basal concavity, extending distally about halfway up lateral walls of cup, strongly convex longitudinally, moderately convex transversely, AB basal 19.5 mm wide and 13 mm long, CD basal narrower, 12.8 mm from vertex adjacent to BC basal and primanal to vertex adjacent to DE basal and D radial, 12.5 mm long. Five large radials, pentagonal, proximal ends not reaching basal plane, incurving distally, A radial 19 mm wide and 11 mm long. Primanal contacting C radial, BC and CD basals, secundanal. Secundanal contacting primanal, D radial, CD basal. Ornament consisting of numerous small nodes, sometimes connected by ridges. Separations between nodes usually greater than diameters of nodes.

Etymology. — Named after William A. Cobban of the U. S. Geological Survey, in honor of his contributions to invertebrate paleontology, particularly of the ammonites of the western interior of North America.

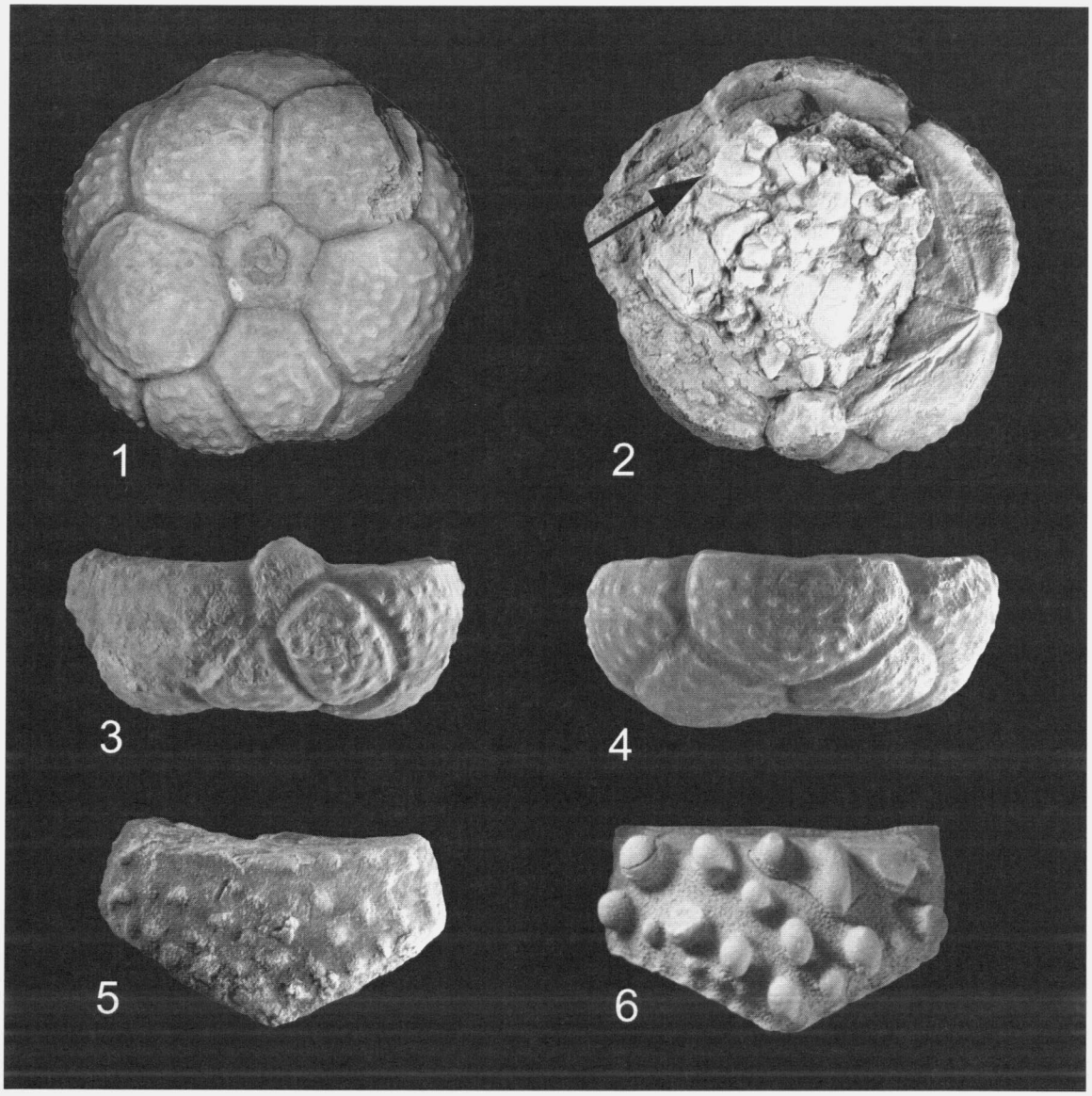

Figure 3. *1-5, Synarmocrinus cobbani* new species, *1-4,* Basal, oral, posterior, and B ray views, holotype, DMNH 22970, ×1.5; *5,* radial plate, DMNH 22971, ×2.5. *6, Synarmocrinus molasensis* (Strimple and Miller, 1971), radial plate, DMNH 22972, ×2.5. Damage to the EA basal of the holotype seen in basal view (1) was caused by a digging implement. Arrow in oral view of cup (2) indicates uniserial arm plate.

Material examined. — The holotype, a complete cup (DMNH 22970). Minturn Formation, unit 3b (late Atokan) Sec. 2, T2S, R84W, Eagle County, Colorado. Found by William Bateman. Isolated radial plate (DMNH 22971). Minturn Formation, unit 3b (late Atokan) Sec. 3, T2S, R84W, Eagle County, Colorado, near locality 86/8 of Houck (1993), approximately 700 m to the west of the locality at which the cup was found. Found by Wayne Itano. Isolated radial plate (DMNH 10311). Minturn Formation, unit 3a (late Atokan) Sec. 3, T2S, R83W, Eagle County, Colorado. Found by Karen Houck. All material deposited at the Denver Museum of Nature and Science (formerly known as the Denver Museum of Natural History), together with more detailed locality information.

Occurrence. — Minturn Formation, units 3a and 3b (late Atokan) McCoy, Eagle County, Colorado. Unit 3b, in which the cup (DMNH 22970) and the isolated plate (DMNH 22971) were found, has been dated to the fusulinid biozone of *Fusulinella famula, Fusulinella iowensis,* and *Fusulinella iowensis leyi* by Houck (1997).

Discussion. — Isolated cup plates with large nodes from the Minturn Formation were referred to *Synarmocrinus*

molasensis by Webster and Houck (1998). Figure 3.6 shows a radial plate (DMNH 22972) of this type, which we assign to *S. molasensis,* found by William Bateman at the same locality and horizon as the holotype of *S. cobbani* (DMNH 22970). Figure 3.5 shows for comparison a radial plate (DMNH 22971) which we assign to *S. cobbani. S. molasensis* is distinguished from *S. cobbani* by having fewer and larger nodes. The isolated radial plate (DMNH 10311) shown in Figure 4.14 of Webster and Houck (1998) and referred by them to *S. molasensis* should be assigned to *S. cobbani.* However, the other plates, Figures. 4.15-19 (DMNH 10312, 10313, 10316, 10317, 10318) were correctly assigned to *S. molasensis.* The possibility that more than one species was represented in this collection was noted by Webster and Houck (1998). The arms of *S. cobbani* are not known. However, a uniserial arm plate was found associated with the holotype (Fig. 3-2). If this is a true association, then the assignment to *Synarmocrinus* is nearly certain.

All other species of *Synarmocrinus* are distinguished from *S. cobbani* by one or more features. *S. adornatus* has ornament consisting of irregular nodes and ridges and has a wider infrabasal circlet. *S. carrizoensis* has ornament consisting of coarse, irregular nodes and short ridges and has upflaring infrabasals. *S. depressus* has coarse, irregular ornament and a wider infrabasal circlet. *S. iatani* has a cup with more erect sides and radial facets with narrower outer attachment areas. The plates are smoother than those of *S. cobbani*, but this may be the result of abrasion. *S. papulosus* has ornament consisting of closely spaced irregular nodes and short ridges, a wider infrabasal circlet, and a more globular cup. *S. brachiatus* has ornament consisting of strong, irregular ridges and a wider infrabasal circlet. In addition, the holotypes of *S. adornatus, S. carrizoensis, and S. brachiatus* differ from that of *S. cobbani* in having secundanals that do not contact the CD basal. However, the variability of the anal plates is not known and so may not be a reliable diagnostic feature. Since the arms of *S. cobbani* are not known with certainty to be uniserial, it is possible that reassignment to another genus will prove necessary if in the future it is found to have biserial arms. However, this should not change its status as a new species. Among crinoids having biserial arms, *S. cobbani* is closest to *Aglaocrinus oklahomensis* (Moore and Plummer, 1938) and *Metacromyocrinus fundundus* (Strimple, 1966). *A. oklahomensis* has coarser ornament and radial facets with narrower outer attachment areas. *M. fundundus* has more closely spaced nodes, a less pronounced basal concavity, and a more globular cup.

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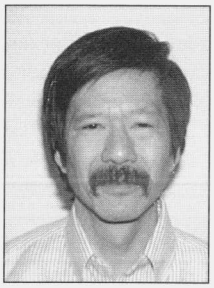

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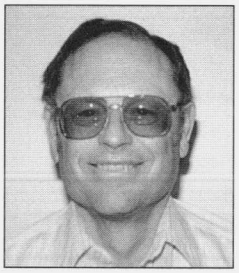

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