New Cladid Crinoid (Phylum Echinodermata) from the Middle Devonian Delaware Limestone, Franklin County, Ohio[1]

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Abstract. A new species of *Goniocrinus*, *G. saettii*, is described from the Delaware Limestone of Franklin County, OH. This is the first crinoid described from the Delaware Limestone and the first cladid crinoid described from Devonian limestones of Ohio. This new occurrence suggests that additional new echinoderm specimens may be found in Devonian limestones of Ohio with a directed search for strata conducive to complete echinoderm preservation, that is, rapidly deposited, fine-grained facies.

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INTRODUCTION

The Lower Devonian Columbus and Delaware limestones record the last middle Paleozoic carbonate platform deposition prior to transgression of the siliciclastic wedge from the Acadian Orogeny. These are relatively thick, shallow-water carbonates throughout the northern two-thirds of the central portion of the state and are relatively thick in the northern half of the state. They contain a diverse and abundant fauna dominated by brachiopods, corals, stromatoporoids, bryozoans, trilobites, and echinoderms. Despite considerable study of this fauna relatively few echinoderm species are known. Only two blastoid species and six crinoid species have been described from the Columbus Limestone of central Ohio (Table 1), and no identified echinoderms have been described previously from the Delaware Limestone. Thus, discovery of a new crinoid from the Delaware Limestone is especially noteworthy. Furthermore, this new crinoid belongs to the subclass Cladida, whereas previously described crinoids include only members of the subclass Camerata.

The majority of the older collections of the Columbus Limestone fauna was from insoluble residues of silicified specimens from *terra rossas*, rather than from material collected *in situ* with documented stratigraphic and sedimentologic context. Faunas preserved and collected in this manner, here and elsewhere (for example, the Salem Limestone of southern Indiana [Beede 1906]), are commonly dominated by camerate crinoids and blastoids. This tendency may be controlled by either the ecology of the facies that supported organisms, which as fossils were susceptible to this type of preservation, crinoid taphonomy, or both. Among crinoids, camerates have a much more robust calyx than cladids (Meyer and others 1989; Ausich and Sevastopulo 1994), which makes them more resistant to the taphonomic process of disarticulation and more likely to be preserved. Blastoids commonly are taphonomically similar to camerate crinoids (Meyer and others 1989; Ausich 2001).

This new Delaware Limestone crinoid occurrence suggests that the previous lack of cladid crinoids from the Columbus and Delaware limestones may be largely taphonomic in nature. Either due to the turbulence of the depositional environment or the sedimentation rate of these limestones, cladids were normally disarticulated prior to burial. However, this new material was buried by fine-grained, presumably storm-deposited sediments. A targeted search for echinoderms in a similar stratigraphic context should yield more well-preserved echinoderms and new taxa that required rapid burial for preservation.

Table 1

Blastoid and crinoid fauna of the Columbus Limestone.

BLASTOIDEA
Elaecrinus verneulianus (Troost)
Heteroschisma pyramidatus (Shumard)
CRINOIDEA
Dolatocrinus lacus Lyon
Dolatocrinus liratus (Hall)
Dolatocrinus major Wachsmuth and Springer
Megistocrinus depressus (Hall)
Megistocrinus rugosus Lyon and Casseday
Megistocrinus spinosulus Lyon

LOCATION AND STRATIGRAPHY OF NEW MATERIAL

This new crinoid was collected from float from a rubble pile immediately southeast of the intersection of Dublin Road and Scioto Darby Creek Road in Columbus, OH, which is immediately adjacent to the Marble Cliff Quarry operated by Martin Marietta Aggregates. The rock slab that contains the crinoids is a medium- to light-brown, poorly laminated, argillaceous wackestone to carbonate mudstone with a lenticular white chert bed and iron staining. The crinoids occur along a bedding surface. This lithology is very similar to Zone J and the upper part of Zone I of the Delaware Limestone in the upper part of the section at the Marble Cliff Quarry. Stauffer (1909) had a measured section from the Marble Cliff Quarry that corresponds to the section along the northern edge of the quarry, immediately south of Scioto Darby Creek Road. Thus, it is reasonable to interpret that this new

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material is from the Delaware Limestone and probably from either Zone J or the upper part of Zone I. Correlation of the Delaware Limestone globally is somewhat problematic. It is separated from the Columbus Limestone beneath by a significant unconformity and is now correlated to the Oatka Creek Formation of the Marcellus Subgroup of New York. Accordingly, this new crinoid material should be regarded as upper Eifelian in age (Sparling 1999; Baird and others 1999).

SYSTEMATIC PALEONTOLOGY

Discussion – Suprageneric classification of the Crinoidea follow Moore and Teichert (1978) with the modifications of Ausich (1998a,b). The genus *Goniocrinus* is placed within the Order Dendrocrinina, as listed in Moore and Teichert (1978), with acknowledgment that revisions to the suprageneric classification of the cladids is much in need. Terminology follows Ubaghs (1978).

Class CRINOIDEA Miller, 1821
Subclass CLADIDA Moore and Laudon, 1943
Order DENDROCRININA Bather, 1899
Superfamily MASTIGOCRINACEA Jaekel, 1918
Family MASTIGOCRINIDAE Jaekel, 1918
Genus GONIOCRINUS Miller and Gurley, 1890
GONIOCRINUS SAETTII new species

Diagnosis

Goniocrinus with a medium cone-shaped aboral cup; stellate ridges on aboral cup plates; low infrabasals; deep, peneplenary radial facets; two, high primibrachials; high secundibrachials; much expansion along the distal margin of brachials; ramulate arms with admedial ramule every second brachial; and a recurved anal sac with multiple vertical ridges formed by plate sculpturing; column pentagonal; cirri in middle part of column.

Description

Crown small, conical. Aboral cup probably medium cone shaped, width to height ratio approximately 1.5, plates convex, prominent stellate ridges connecting to like ridges on adjoining plates (Figs. 1C, 2A).

Infrabasals presumably five and equal in size; infrabasal circlet low, approximately 18% of aboral cup height; infrabasal concavity absent. Basals five, hexagonal, smaller than radials, approximately 1.25 times higher than wide, with prominent Y-shaped ridge connecting to infrabasal circlet below and adjoining radial plates above (Fig. 2A); CD basal smaller than other radials, wider than high; basal circlet approximately 37% of aboral cup height. Radials five, pentagonal in all rays, slightly wider than high; six dominant ridges, one below radial facet and one each to adjoining radials and basals; radial circlet approximately 45% of aboral cup height. Radial facets peneplenary, broadly horseshoe shaped, slightly declivate, deep, project abaxially, occupy approximately 65% of distal radial plate width (Fig. 1C); radial facet topography not known.

At least three anal plates in cup; radianal very small, quadrangular (rectangular to trapezoidal), below and to right of anal X; anal X heptagonal, higher than wide, somewhat smaller than radials, with stellate ridges to adjacent plates; one large sac plate immediately above anal X that is partially in aboral cup (Fig. 2B). Tegmen not known. Anal sac approximately 5.0 times higher than aboral cup but not as high as arms, recurved nearly along entire height (Figs. 1C, 2A); composed of plates arranged in alternate vertical columns, where one column has large, stellate, sculptured plates that together form a vertical (then recurved) ridge along the center of this column of plates and the adjacent column of plates has smaller, less prominently stellate plates, anal opening position unknown.

Arms branch once isotomously for a total of ten arms. Second primibrachial axillary; first primibrachial approximately 1.3 times higher than proximal width and primaxil 2.0 times higher than proximal width; distal margin of primibrachials expanded to at least 2.0 times the mid-brachial width (Fig. 1B). Secundibrachials slightly cuneate uniserial, same approximate dimensions and same distal expansion as on primibrachials, aborally rounded. Side branches from ten arms variable; principally long, wide ramules borne on approximately every other secundibrachial, dominantly but not exclusively borne on abmedial side of secundibrachials. In some short arm lengths alternate brachials bear ramules to alternate sides, thus technically being pinnulate. However, the overall, most common pattern of all individuals is ramulate arms.

Column pentagonal, heteromorphic, outer surface of epifacet rounded to very rounded, smooth or slightly keeled; nodals may have vertical expansion at corners of columnals. Column composed of nodals priminternodals, secundinternodals, and tertinternodal; each cycle with decreasing height and width. Nodals either with or without cirri (Fig. 1A). Facet morphology of rounded epifacet (especially on nodals), crenularium, areola, and lumen; from outer edge of column corner, crenularium (38% of diameter), areola (50%), lumen (12%); crenularium with symplectial articulation; lumen pentalobate.

Etymology

The trivial name recognizes Chris Saetti, who discovered these new crinoids and donated them to the Orton Geological Museum.

Types

The holotype for *Goniocrinus saettii* n. sp. is OSU 54089a, and paratypes are OSU 54089b and OSU 54089c. Types are deposited in the Orton Geological Museum, Department of Geological Sciences, The Ohio State University (OSU).

Occurrence

Although *Goniocrinus saettii* n. sp. was collected as float from a rubble pile, it is undoubtedly from Zone J or the upper part of Zone I of the Delaware Limestone (upper Eifelian) of Franklin County, OH. These specimens were collected immediately southeast of the intersection of Dublin Road and Scioto Darby Creek Road in Columbus, OH, which is immediately adjacent to the Marble Cliff Quarry operated by American Aggregates (GPS: N 40° 00.784'; W 83° 06.557').

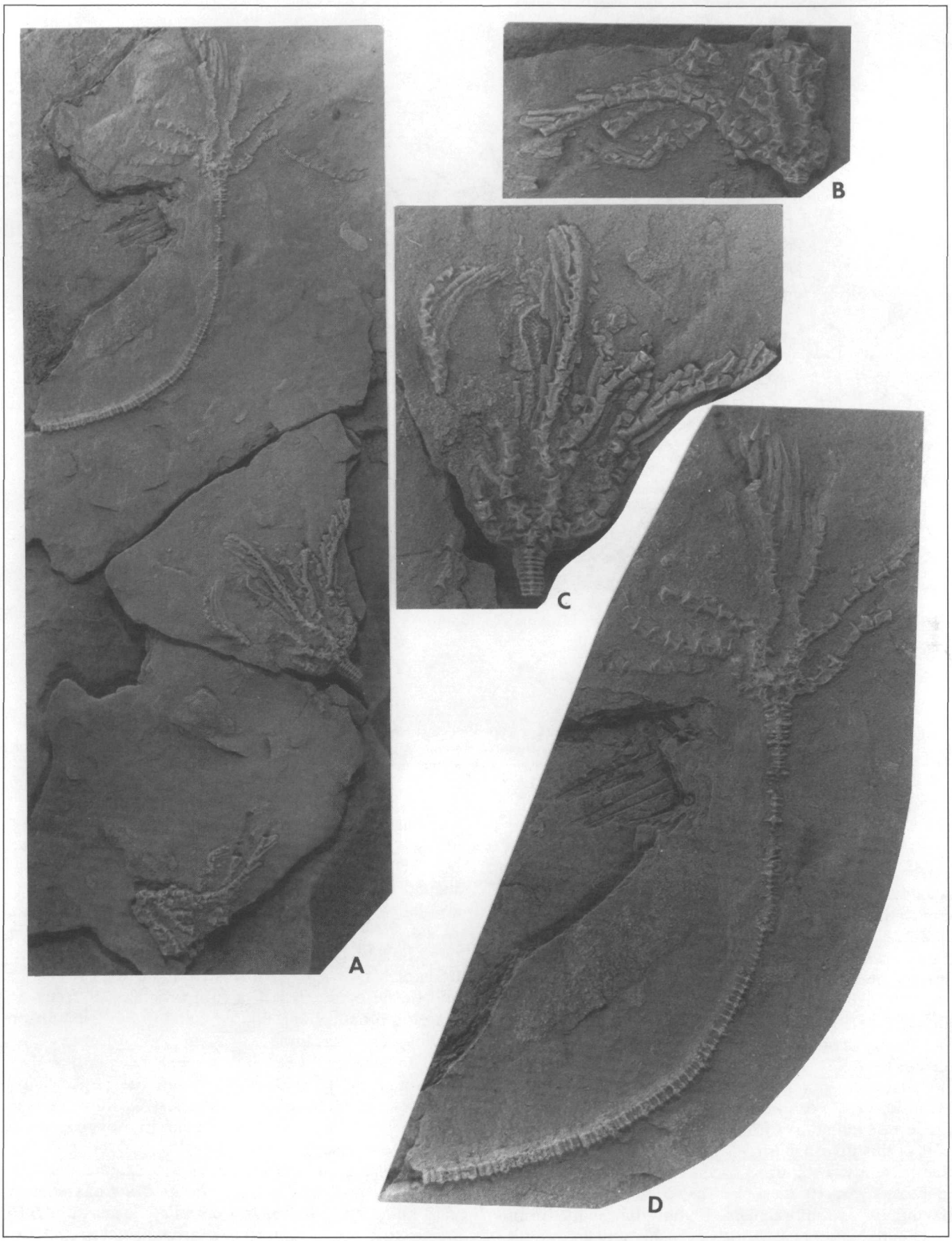

FIGURE 1. *Goniocrinus saettii* n. sp. A) Preserved positions of three specimens on one bedding plane, X 1.5, OSU 50489; B) small poorly preserved crown, note plate sculpturing on basal plates and brachials, X 3.0, OSU 50489c; C) well preserved crown, note recurved anal sac, X 3.0, OSU 50489a; D) poorly preserved crown with column attached, note column shape and shape of brachials, X 3.0, OSU 50489b.

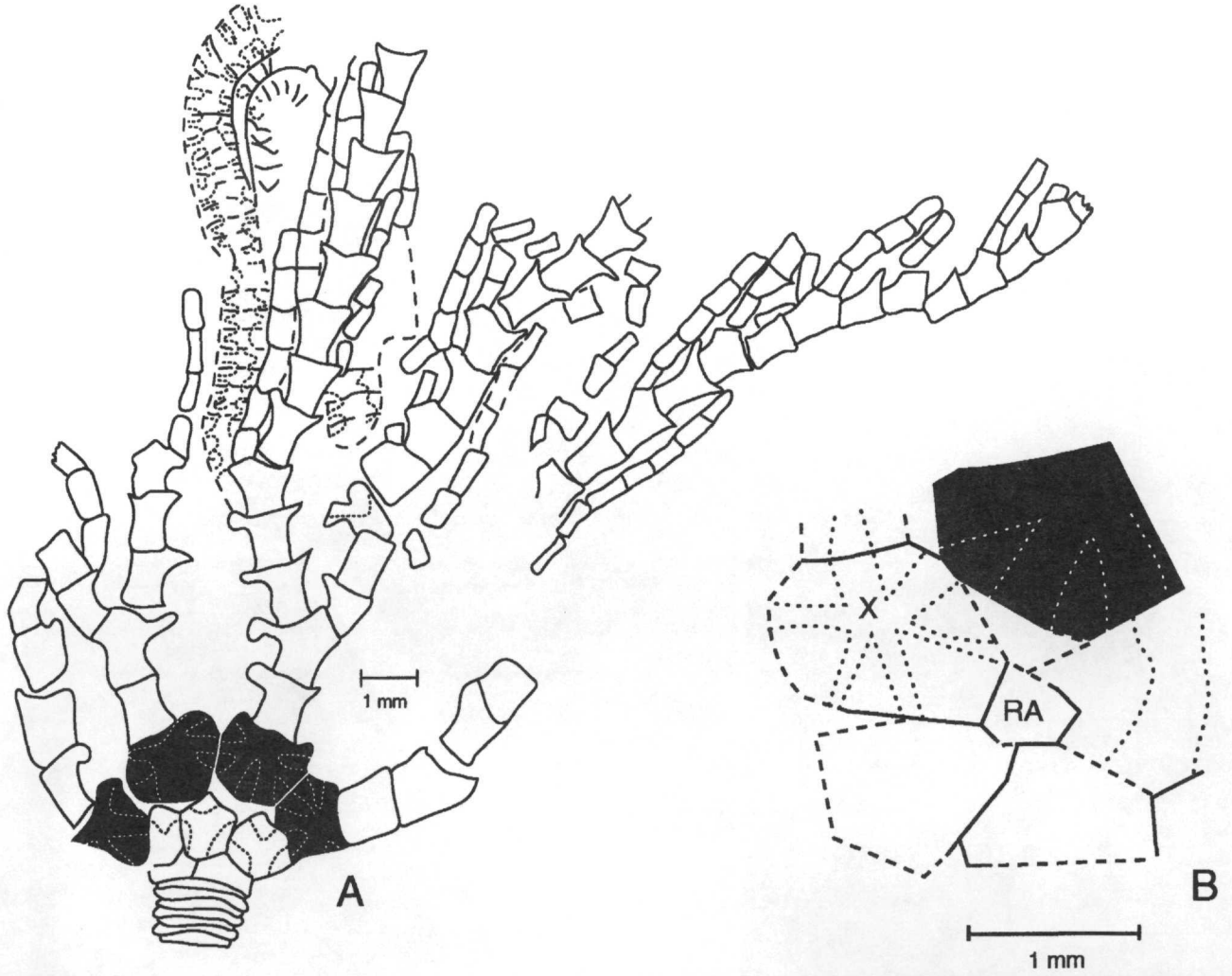

FIGURE 2. Camera lucida drawings of *Goniocrinus saettii* n. sp. A) OSU 50489a, note recurved anal sac and shape of brachials, compare to Fig. 2C; B) OSU 50489b, buried side of specimen in Fig. 2D, note very small radianal plate. Black pattern, radial plates; X = anal X plate, RA = radianal plate; dotted lines outline dominant plate sculpturing; dashed lines indicate uncertain plate boundaries.

DISCUSSION

Goniocrinus saettii n. sp. is known from three reasonably well-preserved specimens, but all three are at least somewhat crushed, so aboral cup dimensions and aboral cup shape can only be approximated.

The type species of *Goniocrinus*, *G. sculptilis* is from the Lower Mississippian Hampton Formation, and all species previously placed in this genus are also Lower Mississippian in age. However, it should be noted that McIntosh (1983) in his unpublished dissertation on Devonian cladid crinoids reassigned several Devonian species to *Goniocrinus* and named new Devonian species. Because the nomenclatoral changes proposed by McIntosh (1983) cannot be officially recognized and because re-evaluation of material from that study is not part of this investigation, *G. saettii* is compared only to the presently recognized species of *Goniocrinus* listed in Table 2. Among these species, *G. saettii* is unique by having two primibrachials, higher than wide primibrachials, higher than wide secundibrachials, ramules borne admedially only, and a recurved anal sac with multiple vertical ridges (Table 2). *G. saetti* is most similar to *G. harrisi* from the Edwardsville Formation at Crawfordsville, IN. In addition to the unique characters listed above for *G. saetti*, *G. saetti* can be distinguished from *G. harrisi* by possession of a medium cone-shaped aboral cup, ramules borne every second brachial, and lacking cirri in the proximal column. In contrast, *G. harrisi* has low cone-shaped aboral cup, four or more primibrachials, primibrachials as wide as high, secundibrachials wider than high, ramules heterotomous and borne every fourth or fifth brachial, and cirri in both the proximal and middle column. For comparison to all species, see Table 2.

McIntosh (2001) recently named several new Devonian cladid crinoids and revised the generic and familial assignment of many species. Of these revised concepts, *G. saettii* is most similar to *Nassoviocrinus* Jaekel. *Nassoviocrinus* and other Devonian crinoids that look similar to this new species are characterized by pinnulate arms. In contrast, *Goniocrinus* has species with ramulate or irregularly pinnulate arms, similar to *G. saetti*. Thus, despite the recurved anal sac, *Goniocrinus* is considered the proper generic assignment because of few primibrachials, arm branching, and brachial shapes. Assignment of *Goniocrinus* to the

TABLE 2

Species diagnoses table for Goniocrinus.

Species	Aboral Cup Shape	Aboral Cup Plate Sculpturing	Infrabasals	Radial Facets	Primi-brachial Number	Primi-brachial Shape	Secundi-brachial Shape	Distal Expansion of Brachials	Arm Branching	Anal Sac	Columnal Shape	Cirri
*G. sculptilis**	Medium Cone	Stellate ridges	High	Shallow	3	Wider than high	Wider than high	Yes, some	Ramulate or pinnulate, if ramulate every third brachial	Not recurved, one dominant anal ridge	Pentagonal to pentalobate	In proximal and middle column
G. angulatus	Medium Cone	Stellate ridges	High	Shallow	4	Wider than high	Wider than high	Yes, some	Ramulate, every third or fourth brachial	Unknown	Pentagonal	Position uncertain
G. harrisi	Low Cone	Stellate ridges	Low	Deep	4 or more	As wide as high	Wider than high	Yes, much	Ramulate, every fourth or fifth brachial	Unknown	Pentagonal	In proximal and middle column
G. maximus	Low Cone	Nodose	High	Deep	3 or 4	Wider than high	Wider than high	No	Ramulate, every second brachial	Not recurved, one dominant anal ridge	Pentagonal	In proximal column, middle column not known
G. saettii n.sp.	Medium Cone	Stellate ridges	Low	Deep	2	Higher than wide	Higher than wide	Yes, much	Ramulate, abmedial ramule every second brachial	Recurved, multiple vertical ridges	Pentagonal	In middle column

* Type species of genus.

Mastigocrinidae is called into question by McIntosh (1983), but it is beyond the scope of the present study to propose any revisions to family assignments among Devonian cladids.

These new crinoids occur on a single bedding plane encased in a fine-grained, very thin siliciclastic bed on a limestone slab. The fact that these crinoids are preserved with arms and a length of column attached indicates that they were buried rapidly with minimal transportation (see discussions and references in Ausich 2001). Although rapid burial can happen by several processes, apparently storm deposition is the most common bottom-smothering process that commonly leads to complete preservation of crinoids and other echinoderms (Meyer and others 1989; Ausich 2001).

Measurements

OSU 50489a**: crown height, 21.0; aboral cup height, 2.6; proximal aboral cup width, 2.0; distal aboral cup, 4.5*; anal sac height, 13.5; infrabasal plate height, 0.5; basal plate height, 1.4; basal plate width, 1.2; radial plate height, 1.4; radial plate width, 2.0. OSU 50489b: crown height, 18.5; aboral cup height, 2.8; stem length, 53. OSU 50489c: aboral cup height, 2.4; infrabasal plate height, 0.5; basal plate height, 1.8; radial plate height, 2.6; radial plate width, 1.5. (**Denotes holotype, *specimen crushed.)

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