A crinoid crown from the Wenlock (Silurian) of Coalbrookdale, Shropshire, England

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The specific diversity of fossil crinoids from the Much Wenlock Limestone Formation at Dudley, Worcestershire, and in Shropshire differ by an order of magnitude. The latter are relatively depauperate and include only about six nominal species. Over 165 years ago, a specimen from Coalbrookdale, Shropshire, was identified as *Cyathocrinites tuberculatus* Miller (= the taxocrinid flexible *Protaxocrinus tuberculatus* (Miller)). This specimen, although indifferently preserved, is distinct from other Silurian crinoids of the British Isles and is described herein as a monobathrid camerate, *Macrostylocrinus*? *jefferiesi* sp. nov. This species has a moderately large, conical dorsal cup with at least 20 arms, broad primibrachials, a granular surface sculpture and no ray ridges. It is close in morphology to a ten armed species from the Much Wenlock Limestone Formation of Dudley, *Macrostylocrinus anglicus* Jaekel, although different in sculpture.

Contents

Introduction

Echinoderms are well known from a number of horizons in the Silurian of the British Isles (Lewis *et al*., 2007; Donovan *et al*., 2008). Donovan *et al*. (2008) noted about 100 species of crinoids from this interval, of which 62 were known from the Much Wenlock Limestone Formation of the Dudley district, Worcestershire (Wenlock Series, Homerian Stage). Indeed, about half of the echinoderm species known from the British Silurian come from this site. In contrast, the Much Wenlock Limestone Formation of Wenlock Edge, Shropshire, about 40 km to the west and the type area of the Wenlock Series (Melchin *et al*., 2004, p. 191), has yielded only six nominal crinoid species (Donovan *et al*., 2008, table 1), although others remain undescribed in private collections (W. Fone, written comm., October 2007). The difference is at least partly due to taphonomic bias. Dudley is internationally renowned for its well preserved crinoids, whereas on Wenlock Edge they occur as common columnals, pluricolumnals and brachial ossicles, uncommon thecal plates and thecae, and only rare crowns and complete crinoids.

However, this apparent paucity was not reflected in a paper by Prestwich (1840, p. 490) in which he listed six species of crinoid from one small area of the Much Wenlock

Table 1. Crinoids listed by Prestwich (1840, p. 490) from the Much Wenlock Limestone Formation at Coalbrookdale, Shropshire, England, with their modern names (Webster, 2003). Key: * = occurrence on Wenlock Edge also recorded by Donovan *et al*. (2008, table 1).

Prestwich (1840)	**Modern name**
Actinocrinites moniliformis? Miller, 1821	indeterminate crinoid pluricolumnal
Actinocrinites? *expansus* Phillips, 1839	*Sagenocrinites expansus* (Phillips, 1839)
Cyathocrinites goniadactylus Phillips, 1839	*Gissocrinus goniodactylus* (Phillips, 1839)
Cyathocrinites tuberculatus Miller, 1821	*Macrostylocrinus*? *jefferiesi* sp. nov.
Cyathocrinites rugosus Miller, 1821	* *Crotalocrinites verucosus* (Schlotheim, 1820)
Marsupiocrinites caelatus Phillips, 1839	* *Marsupiocrinus* (*M.*) *coelatus* (Phillips, 1839)

Limestone Formation at Coalbrookdale, Shropshire (Table 1). Two of Prestwich's species were also noted from Wenlock Edge by Donovan *et al*. (2008), namely the cladid *Crotalocrinites verucosus* (Schlotheim, 1820) and the monobathrid *Marsupiocrinus coelatus* (Phillips, 1839). *Actinocrinites moniliformis* Miller, 1821 (pp. 115-116, pl. opposite p. 114, fig. 8) is an indeterminate crinoid pluricolumnal, poorly illustrated by an articular facet only (Miller's monograph was "much ... criticised for its artwork;" Knell, 2000, p. 102). The sagenocrinid flexible *Sagenocrinites expansus* (Phillips, 1839) is known from the Much Wenlock Limestone Formation at Dudley, but is not otherwise reported from Wenlock Edge. Similarly, the cladid *Gissocrinus goniodactylus* (Phillips, 1839), well known from Dudley, is only recorded from Shropshire by Prestwich. Examination of the collections of The Natural History Museum, London, failed to reveal Prestwich's specimens of *S. expansus* and *G. goniodactylus*, and we consider their occurrence in Shropshire unproven. However, disarticulated brachials of *Gissocrinus* species are known from this succession (Donovan, research in progress).

Prestwich's sixth species, listed as *Cyathocrinites tuberculatus* Miller, 1821, in 1840, is the subject of the present paper. This species is now included in the taxocrinid flexibles as *Protaxocrinus tuberculatus*, but Prestwich's specimen, now part of the collection of The Natural History Museum, London, is not a member of this species or genus.

Terminology of the crinoid endoskeleton follows Ubaghs (1978a) and Moore *et al*. (1978). Higher classification of crinoids follows Simms & Sevastopulo (1993) and Ausich (1998). Our philosophy of open nomenclature follows Bengtson (1988). The specimen discussed herein is deposited in the Department of Palaeontology, The Natural History Museum, London (BMNH).

Systematic palaeontology

Class Crinoidea J.S. Miller, 1821
Subclass Camerata Wachsmuth & Springer, 1885
Order Monobathrida Moore & Laudon, 1943
Superfamily Patelliocrinacea Angelin, 1878
Family Patelliocrinidae Angelin, 1878
Genus *Macrostylocrinus* Hall, 1852

Type species – *Macrostylocrinus ornatus* Hall, 1852, p. 203, by monotypy (Ubaghs, 1978b, p. T508).

Other species – Webster (2003) listed about 24 further nominal species of *Macrostylocrinus*, to which should be added *M.*? *jefferiesi* and various species in open nomenclature.

Diagnosis – (Mainly after Ubaghs, 1978b, p. T508; but see also Eckert, 1984, pp. 14, 16.) Monocyclic camerate, basals three or five. "Calyx conical to subglobose; fixed secundibrachs 1 or 2; interprimibrachs few, connected with tegmen, 1st one large; *CD* interray much wider than others; primanal followed by 3 to 5 plates in next range. Tegmen low, composed of small irregular pieces, with narrow ambulacral tracks and more or less distinct orals; anus marginal. Free arms generally 10, biserial and simple, recumbent and as many as 23 to 25 in a Devonian species. Column with small axial canal; whorls of cirri may be present."

Range – North America, Cincinnatian (Upper Ordovician) to Geddinian (Lower Devonian); northern Europe, Ashgill (Upper Ordovician) to Wenlock (Lower Silurian) (Webster, 2003). Commonest in the Silurian (Lane & Ausich, 1995, p. 1101).

Remarks – We concur with the statement of Witzke & Strimple (1981, p. 120) that "*Macrostylocrinus* ... exhibits a wide range of variation in calyx shape, degree of development of the interrays, and shape and size of the primibrachs in the included species ... [and thus] includes a diverse group of patelliocrinids [that require generic revision]." Over 25 years later, this revision is still required. Characters used to define species were listed by Lane & Ausich (1995, p. 1101).

***Macrostylocrinus*? *jefferiesi* sp. nov.**

Pls. 1, 2; Fig. 3.

1840 Cyathocrinites tuberculatus, *Miller*: Prestwich, p. 490 [table].

Etymology – In honour of Dr. Richard P.S. Jefferies, colleague, co-author and dedicated scholar.

Holotype – BMNH E6526, a crinoid crown with a broken base and lacking the more distal parts of the arms (Pls. 1, 2). The only specimen known.

Locality and horizon – The label states "Wenlock Limestone. Coalbrookdale." Silurian, Wenlock Series, Homerian Stage, *ludensis* Biozone (Cocks *et al*., 1992, fig. 3). Much Wenlock Limestone Formation. Shropshire, England.

Diagnosis – *Macrostylocrinus* with a moderately large dorsal cup, a granular surface sculpture, ray ridges absent, at least 20 arms branching at IBr_2 and $IIBr_2$, and broad primibrachials.

Description – Attachment structure and column not preserved. Crown moderately broad vase-shaped with a weakly tuberculate sculpture. Base of dorsal cup damaged, but preserves part of two basals and the (damaged) radial circlet (Fig. 3). Basals incompletely

seen, probably 5, quite high, but smaller than radials. Radials 5, large, heptagonal(?), forming a continuous circlet (Fig. 3). Ray ridges absent. Arms facets about half the width of radial plate. CD interray slightly wider than others. Contact between C and D radials notched, supporting primanal, which tapers distally and supports at least one more plate of anal series. Interbrachial plates not preserved. Arms robust, uniserial and apinnulate proximally (presumed fixed), branching isotomously at IBr_2 and $IIBr_2$, at least three tertibrachials, but incomplete; uniserial to that level. Primibrachials broad. Distal arms not preserved.

Remarks – Prestwich (1840) presumably had access to the original description and illustrations of *Cyathocrinites tuberculatus* Miller, 1821 (Fig. 1), and the later illustration and description by Phillips (1839) (Fig. 2). The latter illustration was much the better and bears a superficial resemblance with BMNH E6526 (compare Fig. 2 with Pl. 1, fig. A). Miller's species is now placed within the taxocrinid flexible genus *Protaxocrinus* Springer, 1906. However, in *Protaxocrinus* and related taxa, the radial circlet is interrupted in the posterior interray by the anal X and the elongate CD basal (Moore, 1978, p. T773, fig. 511.5). In contrast, the radial circlet of BMNH E6526 is not interrupted in the CD interray; rather, the anal plate rests in adjacent notches of the C and D radials. The apparent lack of distal coiling of the admittedly incomplete arms also suggests that it is not a flexible. Interbrachials are not preserved, but these could have been lost before final burial.

This specimen is dissimilar to all disparid and cladid crinoids from the British Silurian (Donovan *et al*., 2008). In particular, we note the observation by Simms (1993, p. 305) that "In cladids, the so-called anal X articulates, in most instances, with a single basal and lies within the radial circlet ... the anal series in many two-circlet taxa lies either above the upper circlet ... or articulates with one or two plates in the lower circlet." BMNH E6526 is thus only improbably a cladid, flexible or diplobathrid, because the anal series lies above the upper circlet. It should more correctly be interpreted as a monobathrid camerate, assuming that the interbrachial plates have been lost due to an accident of preservation or subsequently, due to over-zealous cleaning. Of the British Silurian monobathrids, the Coalbrookdale specimen is closest to *Macrostylocrinus* Hall.

Even tentative inclusion of this species in *Macrostylocrinus* is not done without some hesitation. The preservation of the Coalbrookdale specimen is somewhat incomplete. The missing base to the dorsal cup prevents confident determination that it is monocyclic. The base was obviously broken at the time of collection, but the remnants of the dorsal cup remain firmly attached. All interbrachial plates are lost, although the interradial areas show obvious signs of mechanical cleaning. Arms distal to $IIBr_2$ are poorly preserved, so it is impossible to confirm that they became biserial and pinnulate (see generic diagnosis, above). Thus, some diagnostic features of *Macrostylocrinus* cannot be recognised. In contrast to the diagnosis used herein, some authors consider that *Macrostylocrinus* is limited to species with ten arms (e.g., Springer, 1926, p. 25; Eckert, 1984, p. 16). Our qualified identification is made using all available morphological features while noting the similarity in gross morphology to *M. anglicus* from the Much Wenlock Limestone Formation at Dudley.

All other species of *Macrostylocrinus* from the Lower Palaeozoic of the British Isles have ten arms (or at least ten arms where incompletely known). Donovan *et al*. (2008) recognised three other species of *Macrostylocrinus* from the Silurian, *Macrostylocrinus*?

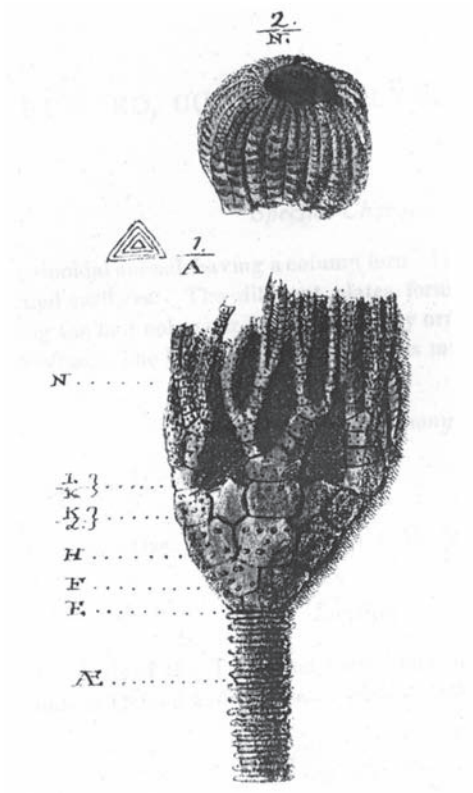

Fig. 1. *Cyathocrinites tuberculatus* Miller, 1821 (after Miller, 1821, pl. opposite p. 88). (Upper) Distal tips of arms incurved as commonly seen in flexible crinoids. (Lower) Crown and proxistele. Note dicyclic dorsal cup, broad arm facets on radials, granular sculpture, arms branching isotomously at IBr_2 and $IIBr_3$(?), and large interprimibrachial plate. Although Miller's system of classification of the crinoids was celebrated, the artwork was not (Knell, 2000, p. 102).

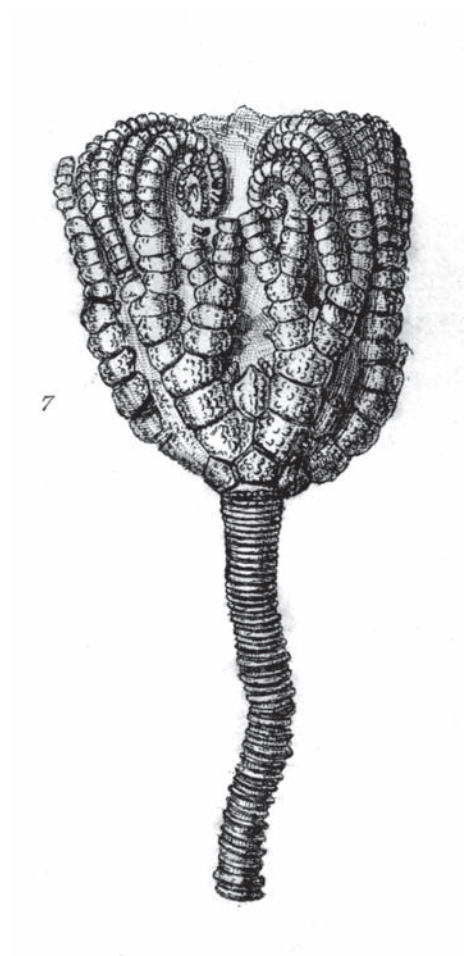

Fig. 2. *Cyathocrinites tuberculatus* Miller, 1821 (after Phillips, 1839, pl. 18, fig. 7), crown, proxistele and proximal part of dististele. Phillips figured a juvenile(?) in figure 6 of the same plate.

sp. of Donovan (1993) (Rhuddanian, southwest Wales), *M. silurocirrifer* Brower, 1975 (Telychian, Pentland Hills, Scotland) and *M. anglicus* Jaekel, 1918 (Homerian, Dudley, England). The crown of *M. anglicus*, also from the Much Wenlock Limestone Formation, has a sculpture of fine, densely packed, intermittent to continuous ridges, arrayed longitudinally on the arms, and radially and either concentrically or granularly on other plates of the crown (Donovan *et al*., 2008). Despite similarities of gross morphology, *M.*? *jefferiesi* has a coarser granulation without organisation into ridges. *Macrostylocrinus silurocirrifer* has a sculpture of small nodes or granules on the crown. *Macrostylocrinus*? sp. is only known from an internal mould; radial arm facets are broad. A single species is known from the Upper Ordovician (Rawtheyan) of southwest Scotland, *M.*

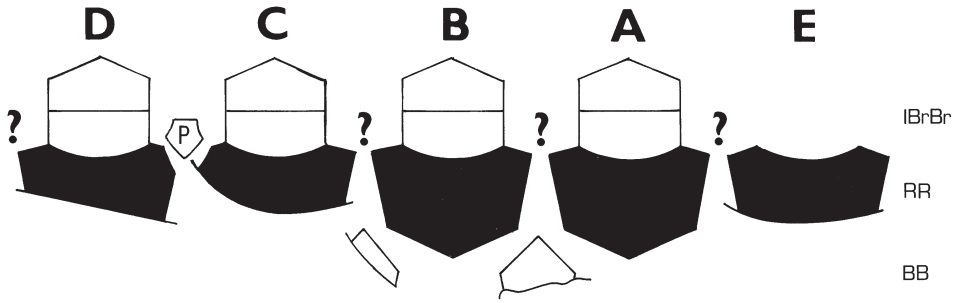

Fig. 3. *Macrostylocrinus*? *jefferiesi* sp. nov., schematic plating diagram of known morphology of the dorsal cup, primanal and proximal arms. Radials (RR) black, basals (BB) and primibrachials (IBrBr) white. Key: A, B, C, D, E = Carpenter rays (B centre for comparison with Pl. 1, fig. A); P = primanal; ? = inferred positions of interbrachials (not preserved). Only two, incomplete basals are preserved (AB and BC interrays), radials in C, D and E rays are damaged, and the E ray arm is not seen. Compare with Ramsbottom (1961, text-fig. 8).

cirrifer Ramsbottom, 1961; it has delicate axial ridges on the plates of the dorsal cup. The Coalbrookdale species does not closely resemble any North American species of *Macrostylocrinus*.

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References

Angelin, N.P. 1878. *Iconographia crinoideorum in Stratis Sueciae Siluricus fossilium*. Holmiae: iv+62 pp.

Ausich, W.I. 1998. Phylogeny of Arenig to Caradoc crinoids (Phylum Echinodermata) and suprageneric classification of the Crinoidea. *University of Kansas Paleontological Contributions* (new series), **9**: 36 pp.

Bengtson, P. 1988. Open nomenclature. *Palaeontology*, **31**: 223-227.

Brower, J.C. 1975. Silurian crinoids from the Pentland Hills, Scotland. *Palaeontology*, **18**: 631-656.

Cocks, L.R.M., Holland, C.H. & Rickards, R.B. 1992. A revised correlation of Silurian rocks in the British Isles. *Geological Society, London, Special Report*, **21**: 1-32.

Donovan, S.K. 1993. A Rhuddanian (Silurian, Lower Llandovery) pelmatozoan fauna from south-west Wales. *Geological Journal*, **28**: 1-19.

Donovan, S.K., Lewis, D.N., Crabb, P. & Widdison, R.E. 2008 (in press). A field guide to the Silurian Echinodermata of the British Isles: part 2 – Crinoidea, minor groups and discussion. *Proceedings of the Yorkshire Geological Society,* **57**.

Eckert, J.D. 1984. Early Llandovery crinoids and stelleroids from the Cataract Group (Lower Silurian) in southern Ontario, Canada. *Royal Ontario Museum Life Sciences Contributions*, **137**: iv+83 pp.

Hall, J. 1852. *Palaeontology of New York, volume 2, containing descriptions of the organic remains of the Lower Middle Division of the New-York System. Natural History of New York, Part 6*. D. Appleton, and Wiley & Putnam, Albany, New York: vii+362 pp.

Jaekel, O. 1918. Phylogenie und System der Pelmatozoen. *Paläeontologisches Zeitschrift*, **3** (1): 1-128.

Knell, S.J. 2000. *The Culture of English Geology, 1815-1851: A Science Revealed through its Collecting*. Ashgate, Aldershot: xviii+377 pp.

Lane, N.G. & Ausich, W.I. 1995. Interreef crinoid fauna from the Mississinewa Shale Member of the Wabash Formation (northern Indiana; Silurian; Echinodermata). *Journal of Paleontology*, **69**: 1090-1106.

Lewis, D.N., Donovan, S.K., Crabb, P. & Gladwell, D.J. 2007. A field guide to the Silurian Echinodermata of the British Isles: Part 1 – Eleutherozoa and Rhombifera. *Scripta Geologica*, **134**: 27-59.

Melchin, M.J., Cooper, R.A. & Sadler, P.M. 2004. The Silurian Period. *In*: Gradstein, F.M., Ogg, J.G. & Smith, A.G. (eds.), *A Geologic Time Scale 2004*: 188-201. Cambridge University Press, Cambridge.

Miller, J.S. 1821. *A Natural History of the Crinoidea or lily-shaped Animals, with observations on the genera* Asteria, Euryale, Comatula *and* Marsupites. Bryan & Co., Bristol: 150 pp.

Moore, R.C. 1978. Flexibilia. *In*: Moore, R.C. & Teichert, C. (eds), *Treatise on Invertebrate Paleontology, Part T, Echinodermata* **2** (2): T759-T812. Geological Society of America & University of Kansas Press, Boulder & Lawrence.

Moore, R.C. & Laudon, L.R. 1943. Evolution and classification of Paleozoic crinoids. *Geological Society of America, Special Paper*, **46**: 1-153.

Moore, R.C., with additions by Ubaghs, G., Rasmussen, H.W., Breimer, A. & Lane, N.G. 1978. Glossary of crinoid morphological terms. *In*: Moore, R.C. & Teichert, C. (eds.), *Treatise on Invertebrate Paleontology, Part T, Echinodermata* **2** (2): T229, T231, T233-T242. Geological Society of America & University of Kansas Press, Boulder & Lawrence.

Phillips, J. 1839. *In*: Murchison, R.I., *The Silurian System, part 2. Organic Remains*: 670-675. John Murray, London.

Prestwich, J. 1840. On the geology of Coalbrook Dale. *Transactions of the Geological Society, London* (series 2), **5**: 413-495.

Ramsbottom, W.H.C. 1961. The British Ordovician Crinoidea. *Monograph of the Palaeontographical Society*, **114** (492): 1-37.

Schlotheim, E.F. von. 1820. *Die Petrefactenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung einer Sammlung versteinerter und fossiler Überretse des Theirund Pflanzenreichs der Vorwelt erläutert*. Beckersche Buchhandlung, Gotha: 437 pp. [Not seen.]

Simms, M.J. 1993. Reinterpretation of thecal plate homology and phylogeny in the Class Crinoidea. *Lethaia*, **26**: 303-312.

Simms, M.J. & Sevastopulo, G.D. 1993. The origin of articulate crinoids. *Palaeontology*, **36**: 91-109.

Springer, F. 1906. Discovery of the disk of *Onychocrinus* and further remarks on the Crinoidea Flexibilia. *Journal of Geology*, **14**: 467-523.

Springer, F. 1926. American Silurian crinoids. *Smithsonian Institution Publications*, **2871**: iv+236 pp.

Ubaghs, G. 1978a. Skeletal morphology of fossil crinoids. *In*: Moore, R.C. & Teichert, C. (eds.), *Treatise on Invertebrate Paleontology, Part T, Echinodermata* **2** (1): T58-T216. Geological Society of America & University of Kansas Press, Boulder & Lawrence.

Ubaghs, G. 1978b. Camerata. *In*: Moore, R.C. & Teichert, C. (eds.), *Treatise on Invertebrate Paleontology. Part T, Echinodermata* **2** (2): T408-T519. Geological Society of America & University of Kansas Press, Boulder & Lawrence.

Wachsmuth, C. & Springer, F. 1885. Revision of the Palaeocrinoidea, part III, section 1. Discussion of the classification and relations of the brachiate crinoids, and conclusion of the generic descriptions. *Proceedings of the Academy of Natural Sciences of Philadelphia*: 223-264.

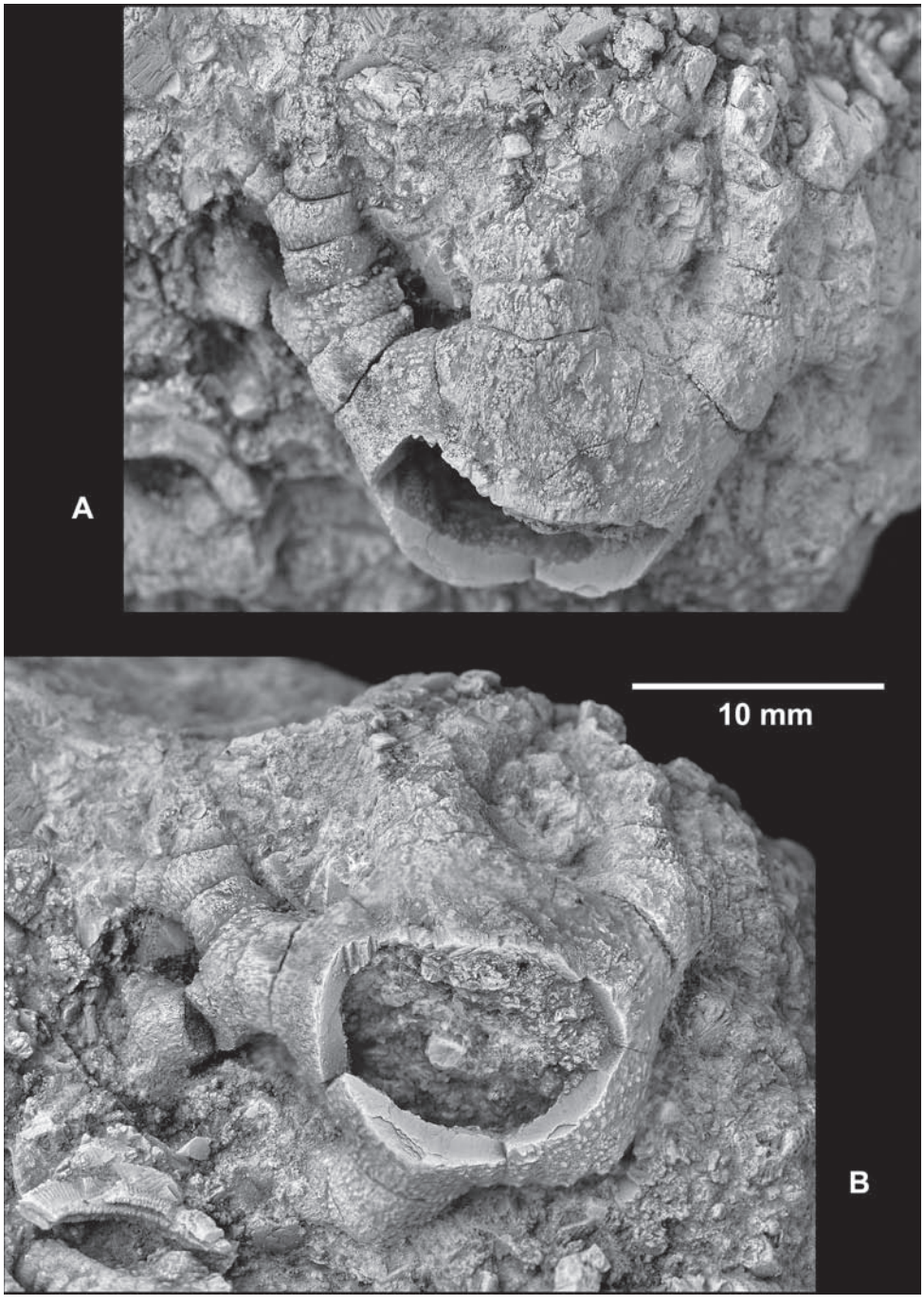
Webster, G.D. 2003. Bibliography and index of Paleozoic crinoids, coronates, and hemistreptocrinoids 1758-1999. *Geological Society of America Special Paper*, **363**. <http://crinoid.gsajournals.org/crinoidmod>.

Witzke, B.J. & Strimple, H.L. 1981. Early Silurian camerate crinoids of eastern Iowa. *Proceedings of the Iowa Academy of Sciences*, **88**: 101-137.

Plate 1

Figs. A, B. *Macrostylocrinus*? *jefferiesi* sp. nov., BMNH E6526, holotype. (A) Lateral view, B ray centre; note broken base and incomplete arms. (B) Basal view; the B ray, shown in the centre of (A), is upper centre in this view, with the anterior (A ray) top right and the posterior (CD interray) bottom left.

Specimen coated with ammonium chloride for photography.


A
10 mm
B

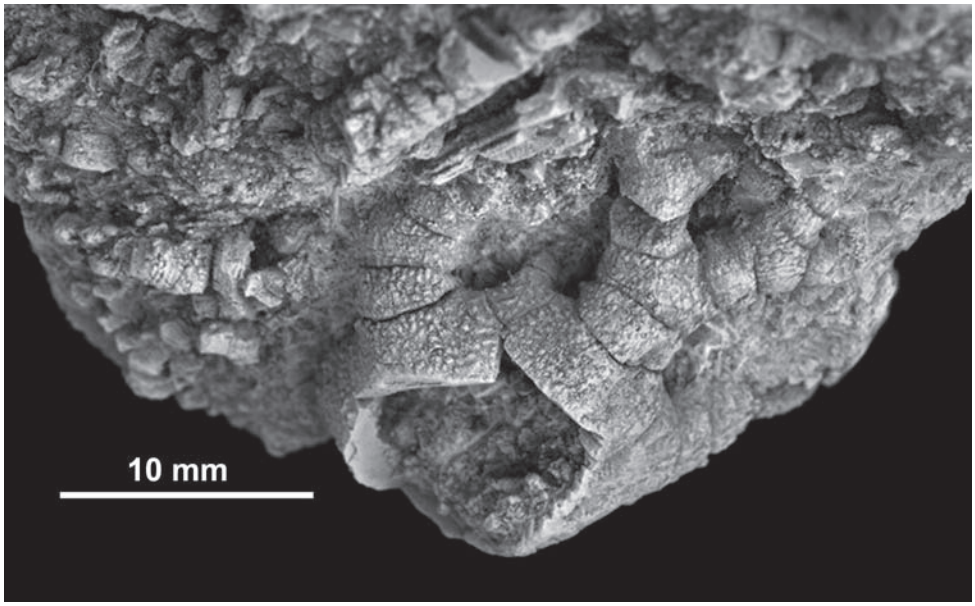


Plate 2

Macrostylocrinus? *jefferiesi* sp. nov., BMNH E6526, holotype. Lateral view, CD interray centre; note notches in C and D basals, supporting small primanal.

Specimen coated with ammonium chloride for photography.