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Notes on silicified screwstones (Lower Carboniferous, Mississippian) from River Maas gravels in the Netherlands

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Abstract

Crinoid pluricolumnals and natural moulds are amongst the least loved of fossils, yet may provide important information on crinoid form. Herein, we document two crinoid columnal taxa in open nomenclature based on moulds, namely platycrinitid gen. et sp. indet. and *Pentagonocyclicus*? (col.) sp. Platycrinitids can rarely be classified to below family level from columnals alone; they presumably evolved neotenously from juveniles with synarthrial articulations. *Pentagonocyclicus*? (col.) sp. is recognised by 'lumping' together pluricolumnals of unimportantly differing morphologies, the sum of which might be found in the xenomorphic column of a single species. The pluricolumnal is robust, homoeomorphic to heteromorphic, N2221222; column circular or rounded pentagonal in section; columnals low; articulation radial symplectial; no areola; lumen rounded pentagonal; broad spatium and narrow axial canal.

Key words: pluricolumnals, preservation, spatium, platycrinitids, *Pentagonocyclicus*

1. Introduction

Neither crinoid columnals and pluricolumnals, nor natural moulds, would number amongst the most popular of palaeontological objects in collector and researcher circles. Yet moulds of pluricolumnals may reveal details of crinoid morphology that are not apparent in specimens preserved in original calcite (see, for example, Fearnhead and Donovan, 2007). Herein, we present additional observations of crinoids in silicified, erratic screwstone preservation from Pleistocene river gravels (see Donovan et al., 2016).

The name screwstones refers to silificied or chertified limestones with mouldic crinoid pluricolumnals preserved. Although rarely mentioned in modern dictionaries of geology, Humble (1860, p. 396) quaintly defined a 'screw stone' as, "The name of a fossil resembling, at first sight, a screw; if, however, the marks be carefully examined they will be found to be circular, and not spiral." They are a feature of, particularly, certain Mississippian (Lower Carboniferous) successions in northern Europe (see, for example, Donovan, 2006; Bouman and Donovan, 2015; Donovan et al., 2016).

Such crinoid-rich screwstones occur as erratic cobbles and boulders in gravels of the rivers Maas and Rhine in the south-east and central Netherlands (Van der Lijn, 1974; Bosch, 1992; Blankers and Nelissen, 2013; see also Donovan et al., 2016, 2020, 2021). Crinoid material of this kind is dominated by columnals and pluricolumnals, either in the form of external moulds or recrystallised ossicles. Of course, these are also the most common elements in *in-situ* limestones and mudrocks of Mississippian age; crinoid crowns and thecae are rare everywhere (except locally).

2. Locality and horizon

The present material was collected by PM during weekly visits in 2023 and 2024 to a site just south of Grubbenvorst (municipalities of Horst aan de Maas and Venlo) in the province of Limburg, the Netherlands (Fig. 1). Here, the floodplains ('uiterwaarden' in Dutch) on the left bank of the River Maas (Meuse) are widened and deepened in order to function as a buffer in times of excess riverine water to prevent flooding. At the same time, they act as a supply of sand and gravel for the construction industry. Large cobbles and boulders, some up to a metre in size, are dumped on the site. These include brownish, light beige to grey and splintery, screwstone-like lithologies (compare with Donovan et al., 2016, fig. 2).

Gravels laid down during the Pleistocene by precursors of the present-day rivers Maas and Rhine in the south-east Netherlands contain a range of fossiliferous Palaeozoic rock types, particularly limestones and quartzitic sandstones. These originated from both the Ardennes Massif of eastern Belgium (and farther south), and in the Eifel and Hunsrück mountains in Germany. Van der Lijn (1974) and Bosch (1992) recorded that fluvially transported rocks in the Dutch province of Limburg had originated from areas in northern France, and the southern (Namur-Dinant Basin) and northern Ardennes Massif (Liège Basin) in Belgium. Amongst the more typical rock types is 'ftaniet/silexiet' or 'schroevensteen' (= screwstone) (see Van der Lijn, 1974; Bosch, 1992). Although it is difficult, if not impossible, to determine the age of these erratics in more detail, they may be considered related to chert-bearing units of Tournaisian and Visean (= Mississippian) age in the Belgian Ardennes as outlined by Poty et al. (2002).

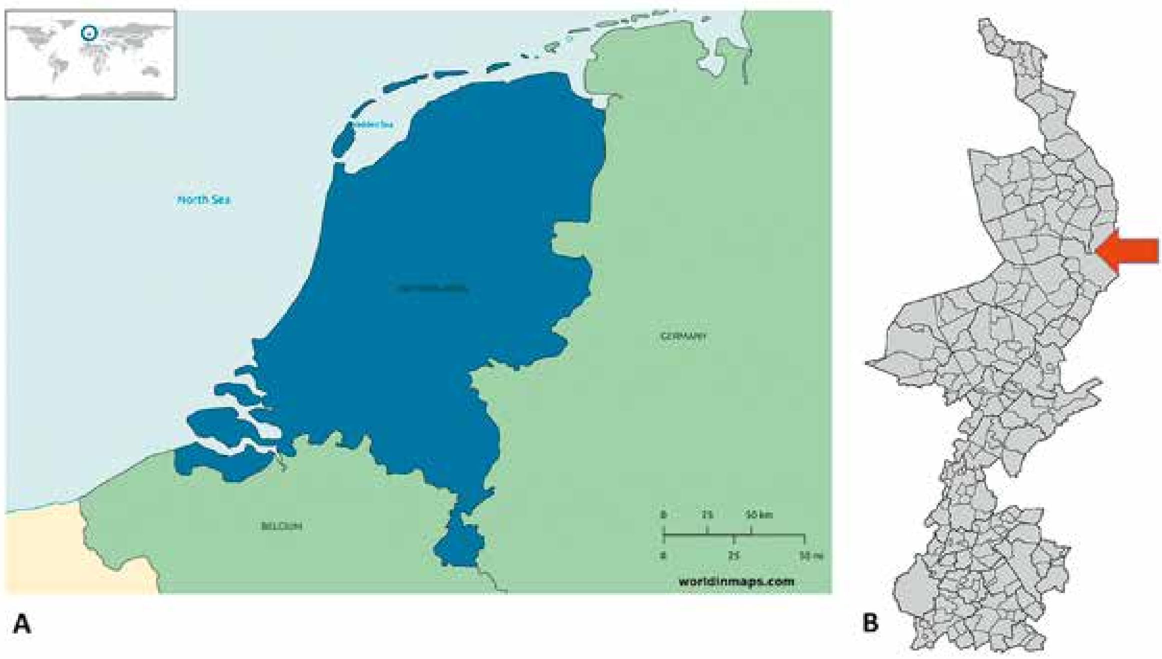

Fig. 1. Locality map, showing the position of the Netherlands in north-west Europe (**A**) and the province of Limburg, with municipalities (**B**), the arrow marking the approximate position of temporary excavations in the floodplains of the River Maas, near Grubbenvorst.

3. Material and methods

Photography was by a Canon G11 digital camera. Specimens were unwhitened. Our philosophy of open nomenclature follows Bengtson (1988). The terminology of the crinoid endoskeleton follows Webster (1974), Ubaghs (1978), Fearnhead (2008) and Ausich and Donovan (2023). All specimens described herein are contained in the collections of the Natuurhistorisch Museum Maastricht, the Netherlands, with the prefix NHMM.

Fig. 2. Platycrinitid gen. et sp. indet. (NHMM 2025 001); external mould of an elliptical articular facet. Note the mouldic debris of indeterminate crinoid ossicles in this image, and Figs. 4 and 5A. Scale in millimetres.

4. Systematic palaeontology

Class Crinoidea J. S. Miller, 1821
Class Camerata Wachsmuth and Springer, 1885
Order Monobathrida Moore and Laudon, 1943
Superfamily Platycrinitoidea Austin and Austin, 1842
Family Platycrinitidae Austin and Austin, 1842

Platycrinitid gen. et sp. indet.
(Fig. 2)

Material: A single specimen, an external mould without counterpart, NHMM 2025 001 (leg. P. Markies).

Locality and horizon: Temporary excavations in the floodplains of the River Maas, south of Grubbenvorst and directly north of the A67 motorway (Eindhoven-Duisburg) bridge across that river (Fig. 1). Collected from erratic cobbles and boulders of screwstone type, dated as Early Carboniferous (Mississippian) (see above).

Description: Elliptical columnal, preserved as external mould of articular facet without counterpart (Fig. 2). Long axis 5.5+ mm. Lumen central, small and pentagonal(?). Articular ridge incomplete, corresponding to long axis of articular facet, with fanned crenulae at distal extremities (compare with Donovan, 1997, pl. 11). Articular facet otherwise unsculptured, gently concave. Latera planar with small tubercles. Columnal height low.

Remarks: Of all major groups of Late Palaeozoic crinoids, the Platycrinitidae are the most easily identified to family as common disarticulated ossicles. Their columnals are elliptical with a synarthrial ridge corresponding to the long axis (Moore and Jeffords, 1968, pp. 41–46, pls. 3–5; Broadhead and Strimple, 1977; Donovan, 1997; Donovan and Lewis, 1999; Ausich and Kammer, 2009; Schoor et al., 2020). Identification to genus or species is dependent on more complete specimens.

Incerti ordinis

Genus *Pentagonocyclicus* (col.) Yeltysheva and Schevtshenko, 1960

Type species: *Pentagonocyclicus haldaranensis* Yeltysheva and Schevtshenko, 1960, p. 122, pl. 2, figs 9, 10, by monotypy (Jeffords, 1978, p. T934).

Diagnosis: Holomeric, circular columnals with a central, pentagonal or weakly pentastellate or pentalobate lumen; areola pentagonal to circular in outline where present; articulation symplectial, with crenulae arrayed radially (slightly modified after Donovan, 1995, p. 143).

Pentagonocyclicus? (col.) sp.

(Figs. 3–5)

Material: Three silicified screwstone clasts rich in crinoid debris, preserving specimens NHMM 2025 002–2025 006 (leg. P. Markies).

Locality and horizon: Temporary excavations in the floodplains of the River Maas, south of Grubbenvorst and directly north of the A67 motorway (Eindhoven-Duisburg) bridge across that river (Fig. 1). Collected from erratic cobbles and boulders of screwstone type, dated as Early Carboniferous (Mississippian) (see above).

Description, NHMM 2025 002, 003: Three broad moulds of pluricolumnals of circular section (two illustrated; Fig. 3A, B). NHMM 2025 002 (Fig. 3A) measures *c*. 21.0 mm in length, with a broad infilled spatium (Moore et al., 1968, fig. 4). The spatium is regular in form, suggesting that the column may have been homoeomorphic. Radial articulation symplectial, crenulae unbranched, lumen broad and pentagonal with rounded angles, no areola. Columnals low, latera planar.

NHMM 2025 003 (Fig. 3B) is a very incomplete pluricolumnal exposing the articular facet. Spatium narrower than in NHMM 2025 002 (Fig. 3A); lumen moderately broad and weakly pentagonal(?). No areola, articulation radial symplectial and consisting of numerous fine crenulae. Latera planar, column may be homoeomorphic. Columnal outline rounded pentagonal.

NHMM 2025 003bis (not figured) is similar to NHMM 2025 002, but with numerous small tubercles at mid-height of columnals. Possibly heteromorphic, N1, but nodals and priminternodals of similar heights.

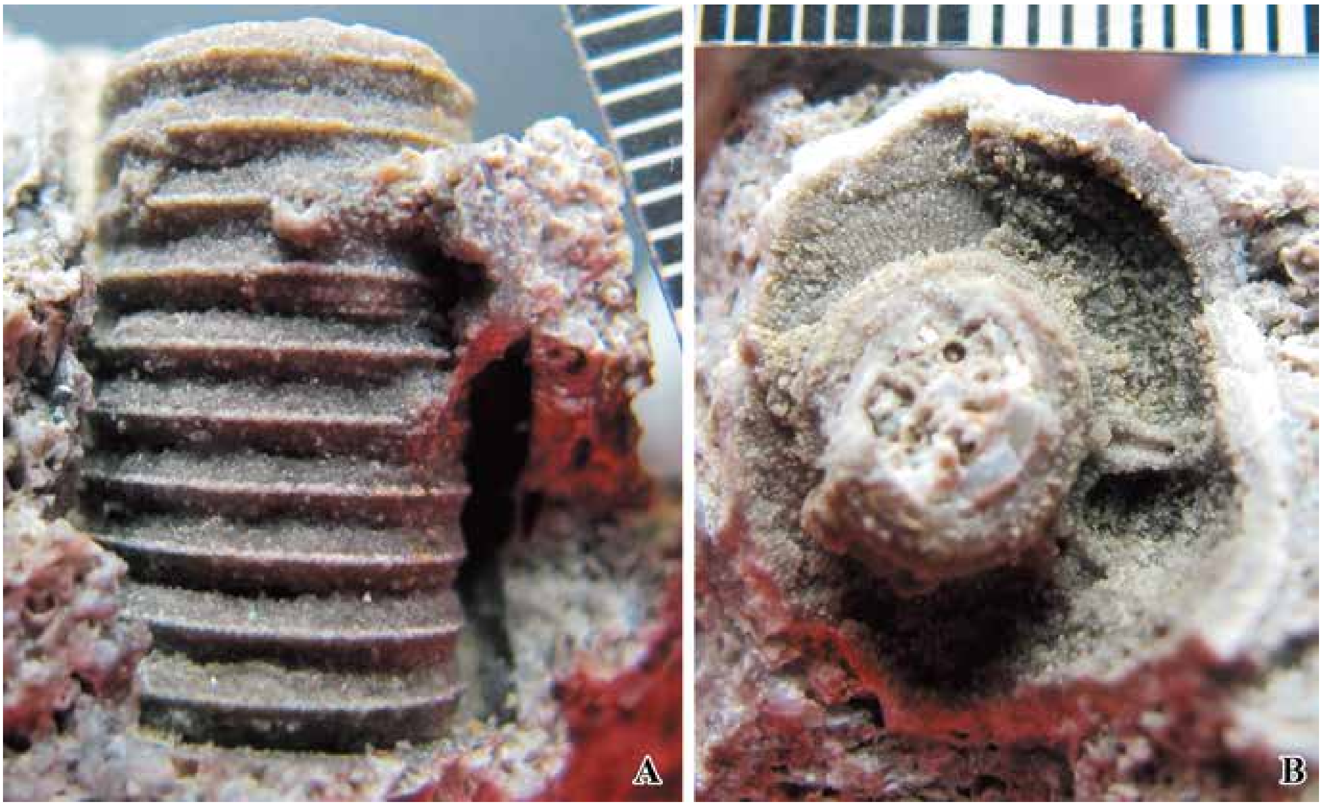

Fig. 3. _Pentagonocyclicus_? (col.) sp. (**A**) NHMM 2025 002, heteromorphic pluricolumnal, with a broad, central spatium. (**B**) NHMM 2025 003, articular facet; note rounded pentagonal outline and fine, radial crenularium. Specimens uncoated. Scales in millimetres.

Fig. 4. ***Pentagonocyclicus*? (col.) sp.**, NHMM 2025 004, slender pluricolumnal with broad spatium. Specimens uncoated. Scales in millimetres.

Description, NHMM 2025 004: A slender, heteromorphic pluricolumnal (Fig. 4), N1, of unknown section with a broad, circular spatium. Articulation symplectial. Lumen narrow, central (towards bottom of Fig. 4). Latera planar.

Description, NHMM 2025 005, 2025 006: Two large pluricolumnals figured. NHMM 2025 005 (Fig. 5A) has a broad spatium that suggests a heteromorphic column, perhaps N2221222, at least in part, nodals much higher than internodals. Column circular or rounded pentagonal in section. Articulation radial symplectial, lumen rounded pentagonal. Latera of N and 1IN gently convex, otherwise planar.

NHMM 2025 006 (Fig. 5B), illustrated in facetal view. Articulation radial symplectial. Latus planar.

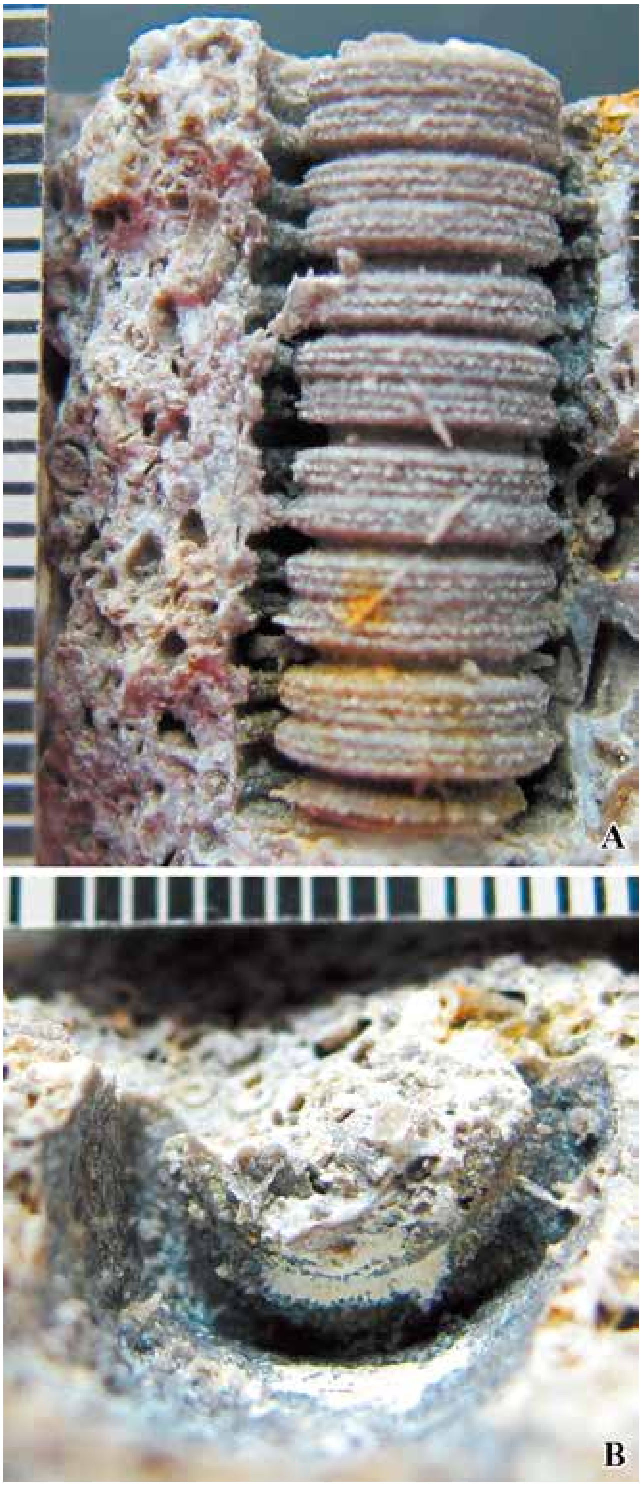

Fig. 5. ***Pentagonocyclicus*? (col.) sp.** (**A**) NHMM 2025 005, heteromorphic pluricolumnal. (**B**) NHMM 2025 006, incomplete articular facet. Specimens uncoated. Scales in millimetres.

Remarks: Large pluricolumnals are rare in the present clasts. The similarities apparent in the specimens discussed herein suggests they may be conspecific, albeit derived from slightly different parts of the pluricolumnal. However, because of differences in preservation, this is not completely certain. The specimens are 'lumped' together here and listed in open nomenclature, but described separately to emphasise both similarities and differences. These specimens likely represent either a cladid or a camerate crinoid.

With the exception of the platycrinitid (see above) these are the only large crinoid specimens in these clasts. They all preserve evidence of a spatium, a "Localized widening of columnal axial canal opposite interarticular sutures" (sensu Ausich and Donovan, 2023, p. 19; see also Moore et al., 1968, p. 30), although there are differences of preservational style. With one exception (NHMM 2025 005; Fig. 5A), they are either homoeomorphic or weakly heteromorphic, N1, with slight differences in columnal height. All of these pluricolumnals, including NHMM 2025 005, are likely components of the stem of a single species of crinoid with a xenomorphic column. Lumping them together herein as one morphospecies is seen as a judicious, indeed expected interpretation. Homeomorphic pluricolumnals are likely to be more distal, from the mesistele or dististele of the stem.

5. Discussion

Platycrinitids can rarely be classified to below family level on the basis of columnals alone. They were presumably evolved neotenously from a juvenile with synarthrial articulations (Simms, 1989, 1999). Such columnals are a locally common element of many Late Palaeozoic assemblages. The features of and variation within are well known within few platycrinitid columns.

Different modes of preservation of the crinoid stem incite contrasting questions. Mouldic preservation provokes the question as to what has been lost? But retention of the skeletal calcite must lead to the speculation that features are concealed that cannot be revealed without expensive or destructive techniques. *Pentagonocyclicus*? (col.) sp. is recognised by 'lumping' together pluricolumnals of slightly differing geometries; taken together, such a range of forms might be found in the xenomorphic column of just one species. It demonstrates what internal structures may be revealed by mouldic preservation of a complex pluricolumnal. Of note is the complexity of such pluricolumnals that is provided by the separation of the axial canal from its associated spatium. Specimens NHMM 2025 002–2025 006 expose this intricacy. The infill of the narrow axial canal is seen (such as towards the bottom of Fig. 4) in contrast to the width of the spatium which might otherwise be mistaken for a broad axial canal (such as Fig. 3A).

What is the function of the spatium? It is a geometry of the axial canal unknown from extant crinoids (Donovan, 2016); that of a stalked articulate crinoid is invariably narrow and central, containing few soft tissues. Donovan (1989) argued that the crinoid column was functionally ill adapted to being flexed by muscles. Crinoid columnals with a broad, circular axial canal invariably have a symplectial articulation, which would not have favoured muscular flexure (Donovan, 1988, 1989). The most probable 'filling' of the spatium in *Pentagonocyclicus*? (col.) sp. was that the perihaemal space of the axial canal was expanded and filled with perihaemal fluid. This would support a narrow axial canal with a similar group of soft tissues to that found in extant crinoids.

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