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The discovery of *Isocrinus cf. robustus* from the Lias Group (Lower Jurassic) near Dunrobin Castle, Sutherland, Scotland

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Abstract

A single stem section (pluricolumnal) belonging to a post-Palaeozoic crinoid (sea lily) is reported from a small outcrop of Lower Jurassic Lias Group strata exposed in low cliff near Dunrobin Castle. This is the first Jurassic crinoid recorded from Eastern Scotland and the small fragment has enough diagnostic characters to be assigned to the species *Isocrinus cf. robustus*; a crinoid found commonly in the Lower Jurassic of England. The Scottish form collected has unusual morphology that is atypical of the genus.

Introduction

Within the grounds of Dunrobin Castle, Scotland (Fig. 1) is a small, but important, locality where one of the few fossiliferous outcrops of Jurassic strata in Eastern Scotland is exposed (Trewin, 2004; Hunter, 2006). It is here that an example of a Scottish post-Palaeozoic crinoid was collected. Crinoids are not uncommon in Scottish Jurassic strata. Several occurrences have been documented by Oak and Donovan (1984) and Simms (1989), and were reviewed and expanded more recently by Hunter and Clark (2009). This study details this latest discovery and demonstrates its significance, not only to the Scottish crinoid fauna, but also to the Early Jurassic 'Lias' echinoderm communities throughout Western Europe.

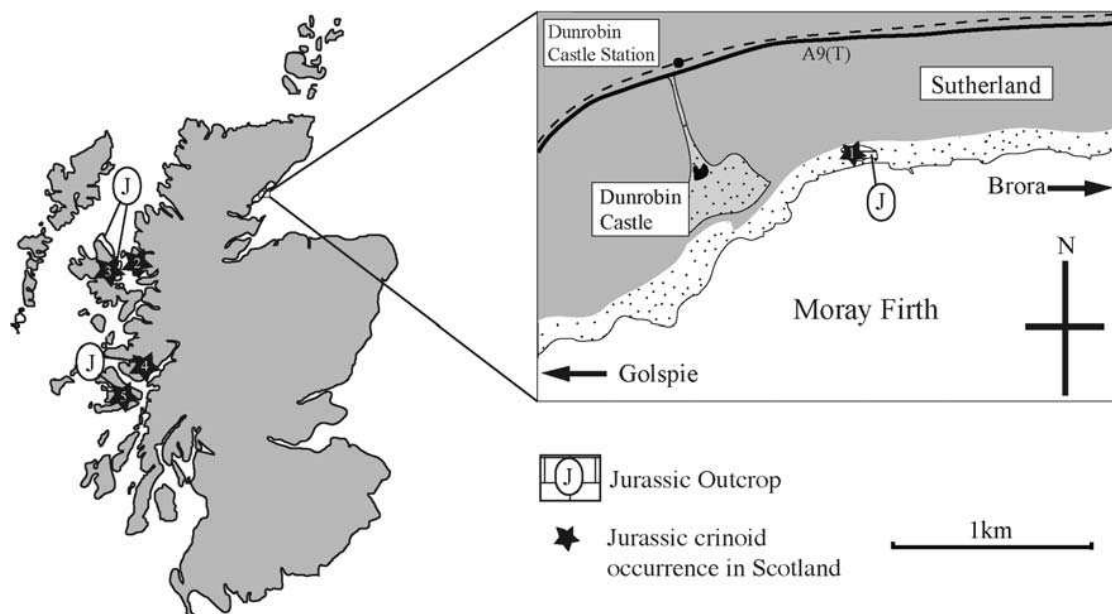


Fig. 1. Locality map of Scotland with inset showing the Dunrobin beach with the fossil locality (1) and other Jurassic crinoid localities in Scotland; (2) Applecross; (3) Isle of Skye and Raasay; (4) Loch Aline and (5) Isle of Mull (Hunter and Clark, 2009).

Geological setting

The Dunrobin Coast Section Site of Special Scientific Interest (SSSI) consists of an erosive edge or cliff with additional exposures on the shore platform. This is the only exposed onshore section in the Lower Jurassic rocks of the Moray Firth Basin on the western margin of the North Sea, the upper part of the succession can be correlated directly with the Pabba Shales of the Hebrides Basin (Trewin, 2004). The Lower Jurassic succession at Dunrobin crops out mainly in the intertidal zone, between ND 854 007 and ND 860 009, near Dunrobin Castle, Golspie, Sutherland. This outcrop area includes the most extensive onshore development of non-marine Lower Lias in Britain, showing an upward transition from freshwater to lagoonal and marine strata (Trewin, 2004). Exposures along about 0.9 km of shore show parts of a Hettangian to Pliensbachian succession at the margin of the Inner Moray Firth Basin and form part of greater Jurassic section of marginal marine sediments including the Brora Coal Member. However, these beds are largely devoid of echinoderms (Hunter, 2006).

The Dunrobin Bay Formation is divided into three members, in upward sequence, the non-marine Dunrobin Pier Conglomerate Member, the more marginal Dunrobin Castle Member and finally the predominantly marine Lady's Walk Shale (LWS) Member. The crinoid-bearing LWS has a thickness of at least 32 m (Trewin, 2004). Exposed reefs of harder rock include calcareous and muddy sandstones that are interbedded with soft shales containing calcareous concretions (Trewin, 2004). The lower part of the section has several coarsening-upward cycles capped by coarse-grained sandstone with scattered pebbles; the sand-rich tops of these cycles are bioturbated (including *Rhizocorallium*, *Siphonites* and *Chondrites*; Sellwood, 1972). The shelly fauna is otherwise generally sparse compared to classic British Lower Jurassic localities from central and southern England, but includes the bivalves with *Astarte*, *Myoconcha*, *Modiolus* and *Gryphaea* in the sandier units, and *Mactromya* within the mudstones (Sellwood, 1972). The crinoid bearing upper part of the succession consists of blue-grey shales, much less micaceous and with a much higher proportion of illite than the lower part of the member. Fossil preservation is poor but includes common *Pseudopecten*, *Pseudolimea* and *Cardinia*, together with *Gryphaea*, *Chlamys*, *Parainoceramus*, *Astarte*, *Grammatodon* and *Protocardia*. Ammonites occur only rarely in the LWS but include *Eoderoceras miles*, *Gleviceras guibalianum*, *Gleviceras* cf. *victoris*, *Paltechioceras* sp. cf. *favrei*, *P. rotldpletzi*, *Apoderoceras* cf. *sociale*, *Apoderoceras* aff. *aculeatum* and *Tragophylloceras*. Most of the section has been dated to Raricostatum Zone, Aplanatum Subzone (upper-most Sinemurian) (Trewin, 2004).

Systematic palaeontology

The described and figured material is deposited in the Hunterian Museum Glasgow GLAHM 131182-3. All specialist terms are annotated on Fig. 2. For more information on specialist terminology see Simms (1989).

Class Crinoidea Miller, 1821
Subclass Articulata von Zittel, 1879
Order Isocrinida Sieverts-Doreck, 1952
Family Isocrinidae Gislén, 1924
Genus *Isocrinus* Von Meyer in Agassiz, 1836
[Syn. *Chladocrinus* Agassiz, 1836, see Simms (1989)]

Type species: Isocrinus pendulus Agassiz, 1836 (see Simms, 1989)

Diagnosis: A robust isocrinid. Stem pentalobate to pentagonal. Noditaxes of moderate length. Cirral scars of moderate size, directed outwards and slightly upwards. Symplectial areolae elliptical to slightly pyriform. Adradial crenulae of adjacent areolae generally separate and at slight angle to each other except near lumen. Cryptosymplectial articula with first and second order crenulae. Radial pores in proximal columnals indistinct. Basals small, separate, projecting slightly to overhang top of stem. Arms stout. Brachitaxes short to moderate length. Fulcral ridge of muscular articula often projecting (after Simms, 1989).

Isocrinus robustus (Wright, 1858)

Holotype and type locality: Holotype. BMNH E1874, by original designation, a well-preserved crown with arms and a short length of attached stem, Railway cutting adjacent to Mickleton Tunnel, near Chipping Campden, Gloucestershire (Simms, 1989).

Occurrence and stratigraphic range: This species is most common in the Lower Jurassic (Upper Sinemurian–Upper Pliensbachian) exposures in Bristol and Gloucestershire, (although rare in Blockley Quarry, Gloucestershire). Other localities mentioned by Simms (1989) include Crich, near Blisworth, Upper Shuckburgh, Warwickshire ('Middle Lias'); Crosby Warren (Pecten Ironstone) near Scunthorpe; Staithes, North Yorkshire (uncommon); Carsaig Bay, Mull; and the Isle of Pabba, near the Isle of Skye.

Isocrinus cf. robustus

Material: The species is described from two stem fragments (pluricolumnals) collected from the Lower Jurassic Lias Group near Dunrobin Castle, Sutherland, Scotland (Fig. 2a–d) and are described using the classification system of Simms (1989).

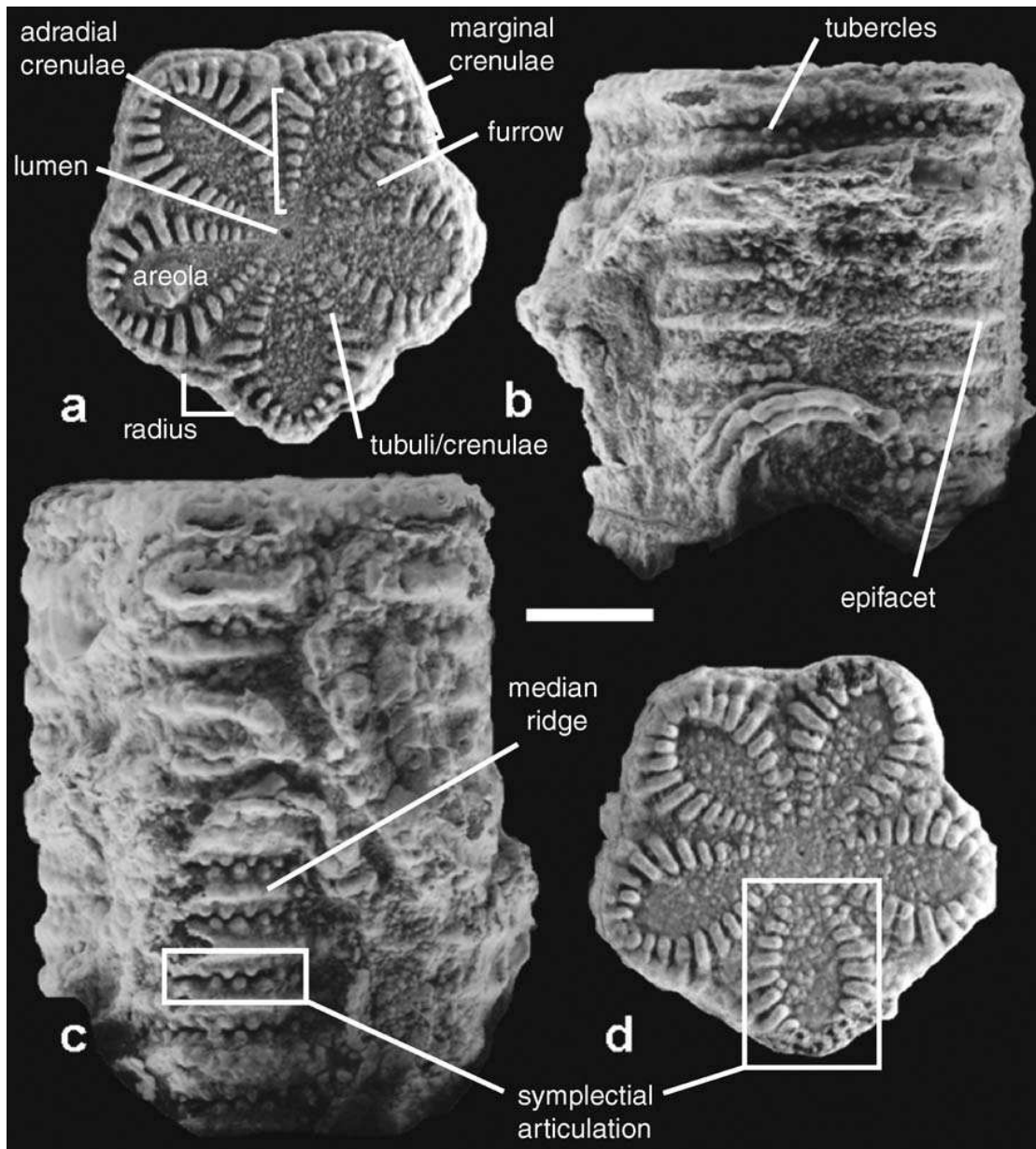


Fig. 2. Plate showing *Isocrinus* cf. *robustus* annotated with the main terminology. Example (1) a (articular face), b (side view) = GLAHM131182; (2) c (articular), d (side view) = GLAHM 131183 scale bar = 0.25 cm.

Description: The internodals are weakly stellate to weakly pentalobate. Distal internodals are subpentagonal to pentagonal. The internodal diameter is 8 mm and 9 mm. Between 5 and 11 columnals preserved in the columnals. Internodal height is low (28% of internodal diameter). Nodals and cirral scars are apparently not preserved. The latera are slightly inflated and ornamented with a sharp median epifacet and random tubercles on either side. Articulation between nodal and infranodal is apparently cryptosymplectial. Columnal articulations are symplectial. The marginal crenulae are lobate with wide areola and furrows developed between adjacent adradial crenulae. Adradial crenulae stop abruptly and do not continue to the lumen.

Remarks: *I. robustus* differs from *Isocrinus psilonoti* (Quenstedt, 1858) and *Isocrinus tuberculatus* (Miller, 1821) in having tuberculate columnal latera with distinct epifacets continuous over the interradii (Simms, 1989) as do the

specimens from Dunrobin. The columnals described here are clearly mature and they share few characters, if any, with *Isocrinus basaltiformis* in which the epifacet does not pass over the interradii. Simms (1989) suggested that there could be an intermediate morphology between *I. robustus* and its ancestor *I. tuberculatus* found in the Sinemurian. For example, increasingly shorter and more robust arms and a more heavily ornamented stem with shorter noditaxes as seen in *I. psilonoti* and *I. tuberculatus*. However, there is no evidence for these features in the example from Dunrobin. It does have an unusual morphology on the articular face with much more rounded adradial crenulae and lobate form along with a complete absence of marginal crenulae in the central area. Normally the marginal crenulae are angled towards the lumen in the genus *Isocrinus*. The arrangement of crenulae is thus atypical of the genus for this example (see Simms, 1989). This particular morphology is more consistent with the genus *Balanocrinus* and *Chariocrinus*, although there are clear furrows between the petals, showing that this is indeed *Isocrinus*. This might have significance to the origin of these groups as current thinking states that *Balanocrinus* evolved from *Isocrinus* by paedomorphic progenesis (Simms, 1988, 1989).

Discussion

The Lady's Walk Shale Member contains a varied shallow marine, shelly fauna with rare belemnites and ammonites. Trewin (2004) proposed that the shales and thin sandy beds represent changing water depths, with coarse sand, pebble beds and the varied size sorted nature of some shell beds possibly indicating winnowing in a near-shore setting. Furthermore the abundance of kaolinite in many of the shales has been considered to indicate near-shore conditions (Trewin, 2004). The Dunrobin coastal section represents a marginal facies considered unique in the Lower Jurassic of Great Britain, and the occurrence of *I. robustus* within this environment would suggest that isocrinid crinoids had already established themselves in the near shore environment by the Early Jurassic. The preservation of columnal sections or pluricolumnals which articulated, suggest minimal transport from the original setting (Hunter, 2006).

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Keywords:

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