

A new echinoderm faunule from the Lower Jurassic (Pliensbachian) of southern Sweden

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In Sweden, Jurassic echinoderms are extremely rare. This present study documents an Early Jurassic echinoderm assemblage collected from a temporary exposure near Helsingborg in Skåne, southern Sweden, which includes a previously undescribed species of isocrinid crinoid, *Isocrinus ranae* sp. nov., and an acrosaleniid echinoid. The Swedish specimens demonstrate that even limited echino-derm material from small exposures can be assigned to a high systematic level and provide data of considerable significance to the evolution of the group as a whole.

Keywords: crinoids, echinoids, taphonomy, palaeoecology, Lower Jurassic, Skåne, Sweden.

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Echinoderms are uncommon in the Jurassic of the Nordic countries, owing to the areas of outcrop largely being restricted to southern Sweden and the island of Bornholm (Denmark). As a result, very few Jurassic crinoids have been formally described from Scandinavia, with Simms (1989) only mentioning one *nomen dubium* from this area. Moberg (1888) first mentioned the existence of up to four species of ‘*Pentacrinus*’ in the ‘Lias’ of southeastern Skåne, exposed at Kurremölla, including the new species *P. patulus* Moberg, 1888.

Simms (1989) regarded *P. patulus* as *nomen dubium* and the specimens referable to the genera *Balanocrinus* and/or *Isocrinus*. The other three taxa in Moberg (1888) are *P. cf. basaltiformis*, (now included in *Isocrinus*; Simms 1989), *P. cf. subteroides* (now referred to the genus *Balanocrinus*; Simms 1989) and *P. sp.* The deposits in this area have yielded a few ammonites indicating Sinemurian and/or early Pliensbachian age (Moberg 1888; Reyment 1959). In a monograph on the Early Jurassic of north-west Skåne, Troedsson (1951) recorded both the above-mentioned taxa found by Moberg (1888) in the southern part of Skåne and also discovered *P. scalaris* and *P. basaltiformis* in a temporary section through the Sinemurian and parts of the

Pliensbachian. Here, we re-examine these early occurrences of Early Jurassic crinoids from Sweden and describe new material collected from a temporary outcrop exposing Pliensbachian strata. This study attempts to demonstrate that these occurrences, however localised and poorly preserved, are significant in the documentation of the Early Jurassic normal marine echinoderm fauna more commonly associated with England, France and Germany (Jäger 1985a & b Simms 1989, Jäger 1990, 1991). We shall not only attempt to identify the disarticulated remains, but will also try to judge their palaeoecological and palaeoenvironmental significance, despite their geographical disparity to other regions under investigation.

Geology and stratigraphy

In Sweden, Upper Triassic and Jurassic strata occur exclusively in the southernmost province of Skåne (Fig. 1), and the largest continuous area is situated in the northwestern part of the province. Smaller areas of Jurassic surface bedrock are also located in central Skåne and the Vomb Trough in southern Skåne. The

most complete Lower Jurassic succession can be found in the northwesterly area overlying mainly deltaic and floodplain deposits of the Hettangian Höganäs Formation, are marine sandstones, siltstones and clays deposited through much of the remaining Early Jurassic. These sediments are included in the Rya Formation,

and range in age from the Sinemurian to the Aalenian (e.g. Norling *et al.* 1993). Large portions of this marine succession are richly fossiliferous, including both ammonites and foraminifera, and the stratigraphy is well established (Reyment 1959; Norling 1972). Sinemurian sedimentation started with the deposition of coarse-

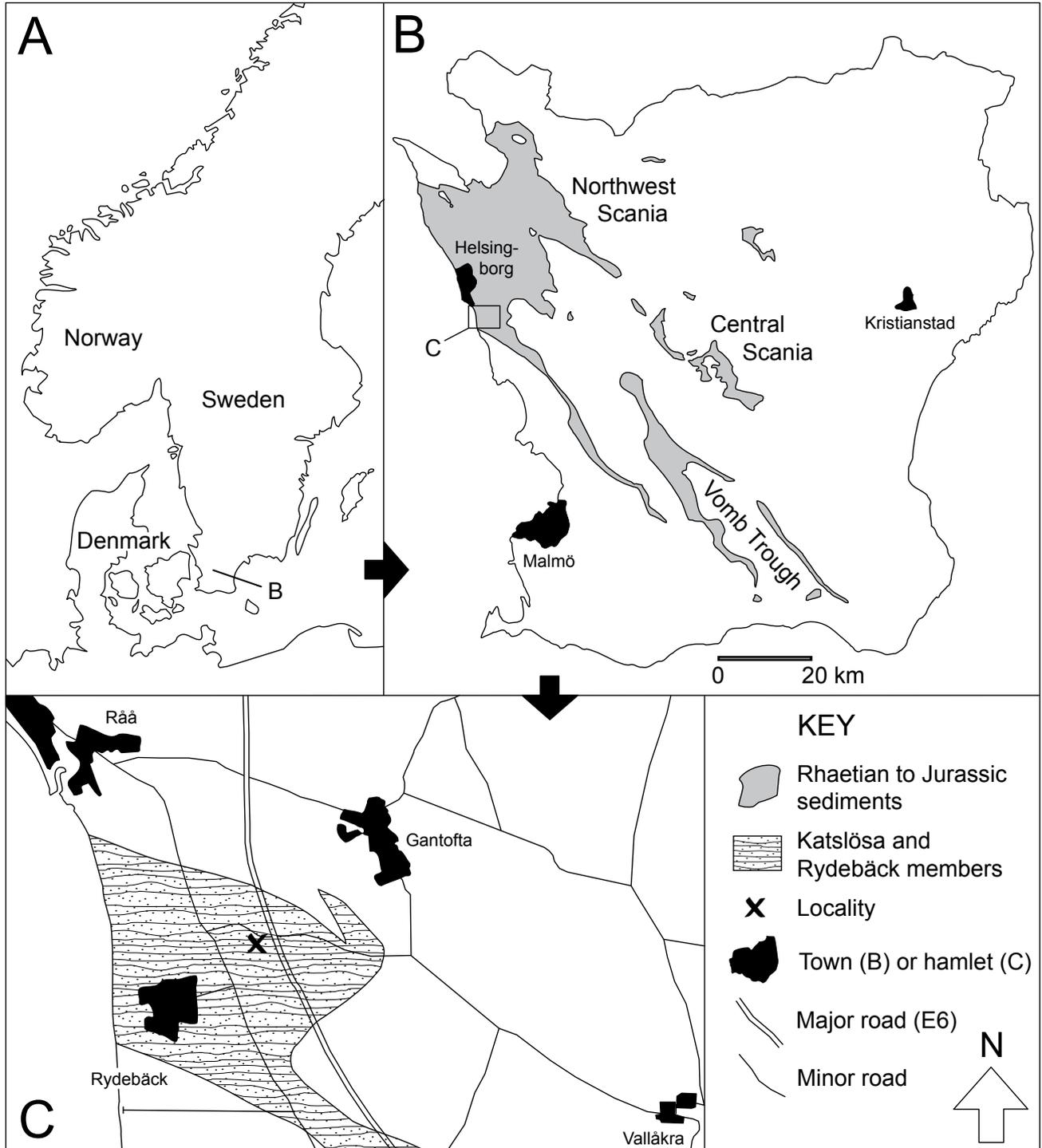


Fig. 1. A, the location of Skåne in Scandinavia. B, the extension of Rhaetian and Jurassic sediments in the province (based on map Ba 43 from the Geological Survey of Sweden). C, Katslösa and Rydebäck members as surface bedrock in the enlarged area (based on map Af 149 from the Geological Survey of Sweden) and the locality at the X. Modified from Rees (2000).

grained sandstones and siltstones, and these are followed by clays and marls that were laid down throughout the rest of the Sinemurian and Pliensbachian, with the exception of a short interval of terrestrial deposits in the Pankarp Member (Norling 1972; Norling *et al.* 1993). Strata of the Katslösa Member and Lower Jurassic portion the Rydebäck Member were deposited in a quiet environment below wave base (Norling *et al.* 1993). Crinoid columnals have previously been recorded by Troedsson (1951) from the Katslösa Member (see above).

The samples which yielded the echinoderm material described herein were collected from a temporary exposure accessible during the construction of a railway bridge over the road between the hamlets of Råå, Rydebäck and Gantofta (55°58'32"N, 12°47'36"E). The strata exposed included dark grey, poorly lithified silts and clays with patches of shell debris. Bioturbation was observed to be extensive within these sediments, and no other sedimentary structures were recorded. In addition to echinoderm remains, the samples yielded frequent belemnite rostra, bivalves, ostracods, foraminifera and fish remains, including shark teeth (Rees 2000). Ammonites were rare and fragmentary in the section sampled, but the rich foraminiferal fauna show strata to belong to the *Margaritatus* and *Spinatum* Zones in the late Pliensbachian (British Charmouthian or Domerian (see Simms 1989)), although some of the species recorded do suggest the slightly older *Davoei* Zone (E. Norling, pers. comm. 2000). It is thus likely that the samples collected encompass more than one ammonite zone.

Systematic palaeontology

The material described and figured is deposited in the Natural History Museum (Naturhistoriska riksmuseet) in Stockholm and numbered RM PZ X.

Class Crinoidea Miller, 1821
 Subclass Articulata von Zittel, 1879
 Order Isocrinida Sieverts-Doreck, 1952
 Family Isocrinidae Gislén, 1925

Genus *Isocrinus* Agassiz, 1836;
 [Syn. *Chladocrinus* Agassiz, 1836, see Simms 1989]

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

Diagnosis. After Simms (1989), a robust isocrinid. Stem pentalobate to pentagonal. Noditaxes of moderate length. Cirral scars of moderate size, directed out-

wards and slightly upwards. Symplectial areoles elliptical to slightly pyriform. Adradial crenulae of adjacent areolae generally separate and at slight angle to each other except near lumen. Cryptosymplectial articularia 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 articularia often projected.

Isocrinus ranae sp. nov.
 Figs 2. A-J

Holotype. The columnal Fig.2B (RM PZ 31445a) and pluri-columnals Fig.2D (RM PZ 31445b) are the named holotypes Fig.2A (RM PZ 31446a), Fig.2C (RM PZ 31446b), Fig.2E (RM PZ 31446c), Fig.2F (RM PZ 31446d) are named as paratypes.

Etymology. After Rán, the sea goddess in Norse mythology, who is the keeper of the drowned and the consort of Ægir, the ruler of the sea.

Type locality. Temporary exposure at a railway underpass between the hamlets of Råå, Rydebäck, and Gantofta (55°58'32"N, 12°47'36"E).

Type horizon and Bio-Zone. Temporary exposure, Pliensbachian, most likely *Margaritatus* or *Spinatum* zones (no ammonites found at the sampling area).

Material. Collection of disarticulated material from sieved mudstones, the residues include 58 pluricolumnals (RM PZ 31447a), eight columnals (RM PZ 31447b) and 10 brachials (IIBr) (RM PZ 31448). The specimen is described from columnals and using the classification defined by Simms (1989).

Diagnosis. 4-6 columnals per noditaxis. Columnal latera smooth, especially the interradii, some carinate tuberculation on the strongly developed radial epifacets. Interradii sharp to stellate and pentalobate, with low columnals. Adradial crenulations diminish in size towards the lumen. Crenulations are wide.

Description. Distal internodals are stellate (Fig. 2A-B) to pentalobate (Fig. 2C). The maximum internodal diameter is 6 mm and the smallest specimen has a diameter of 4 mm. No nodals are preserved. Nodal spacing is unclear, distal noditaxes with between five and seven columnals per noditaxis (Fig. 2D-F). Internodal height is low compared with internodal diameter. The latera of the columnals available are slightly inflated between the margins (Fig. 2D), but are otherwise unornamented. A small epifacet is developed in

the radius with some tubercles developed on the epifacet (Fig. 2D & F). The tubercles on the epifacet are not continuous around each internodal. All internodals have symplectial articulations (Fig. 2A-C). The

arrangement of crenulae on these is typical of the genus. No dorsal cup, cirri, or pinnules are found in the residue and the brachials are abraded but can not be assigned to genus.

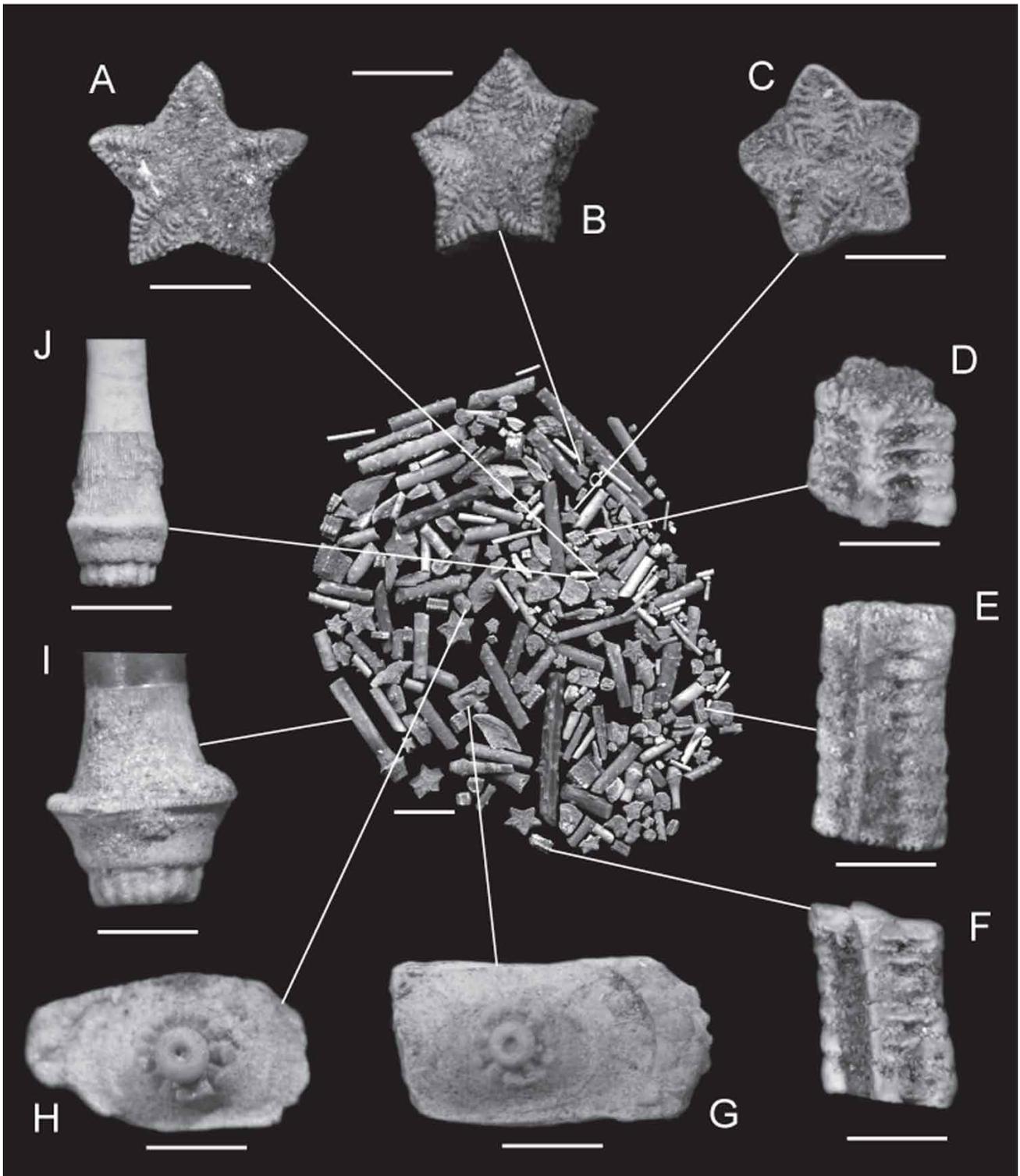


Fig. 2. Residue of the picked echinoderm material (centre, scale bar 10 mm). Specimens of *Isocrinus ranae* sp. nov. (A-C columnals (RM PZ 31447a), D-F pluricolumnals (RM PZ 31447b) and of ?Acrosaleniidae indet. Interambulacral G-H (RM PZ 31449a-b)- primary radioles (with bases) I-J (RM PZ 31450a-b) Scale bars 2 mm.

Remarks. It is quite possible that Moberg (1888) assigned the different conspecific columnals to separate species, as there are at least four species in his monograph, of which two can now be regarded as *nomina dubia*. There is a high morphological variation in crinoid columnals not recognised at that time, and members of the same species can have different shapes or even small variations in the crenulation pattern. The descriptions in Moberg (1888) are not very informative and it has not been possible to study his specimens during this investigation. Troedsson (1951) also clearly identified four species and hinted at two other morphotypes that share many of the diagnostic characters of *I. ranae*, such as smooth columnal latera, carinate tuberculation on the radial epifacets and low columnals. Troedsson (1951) recorded an unfigured specimen of *Pentacrinus scalaris* (now *Hispidocrinus scalaris*; Simms 1989), and illustrated specimens of *P. basaltiformis*, *P. cf. basaltiformis* and *P. cf. subteroides* (the latter is transferred to *Balanocrinus*; Simms 1989) at Katslösa. As these specimens were not studied first hand, it is difficult to confirm these designations. On examination of the plates in Troedsson (1951), we believe that *Balanocrinus subteroides* is correctly identified but we found no evidence of this species in our recently collected samples. It is common, however, for associated facies in the Lower and Middle Jurassic to have representatives of at least two genera of crinoids (Hunter & Zonneveld 2008). In addition, we believe that Troedsson (1951) provided few conclusive characters to provide a clear distinction between the 'pentagonal' *P. basaltiformis* and the more rounded *P. cf. basaltiformis* (now *Isocrinus basaltiformis*; see Simms 1989) which together are very likely to constitute the new species, *Isocrinus ranae*.

In comparison with other *Isocrinidae* from England and continental Europe, *Isocrinus ranae* is similar to the pre-Toarcian *Isocrinus psilonoti* (Quenstedt, 1858) in lacking ornament on columnal latera but the number of columnals per noditaxis is significantly lower. The new species differs from *Isocrinus tuberculatus* (Miller, 1821) in that it does not have tuberculate columnal latera and that the interradial are more rounded and tubercles less spinose in *I. tuberculatus* than in *Isocrinus ranae*. The number of columnals per noditaxis in *Isocrinus ranae* is only slightly lower than in *Isocrinus robustus* (Wright, 1858) and *I. basaltiformis* (Miller, 1821). *Isocrinus ranae* most closely resembles *I. robustus* in having tuberculate columnal latera with distinct epifacets but these epifacets are much more weakly developed in the *Isocrinus ranae* and are not continuous over the interradial (Fig. 2D). Both *I. ranae* and *I. basaltiformis* have sharp, commonly carinate interradial, with the absence of a continuous epifacet over the interradial, but *I. ranae* does not have spinose

columnal latera (Fig. 2E). Consequently, *I. ranae* closely resembles both *I. basaltiformis* and *I. robustus*, with which it is roughly contemporaneous. Simms (1989) states that "the sharpness of the interradial and the relatively tall columnals are typical features of immature *Isocrinus*, and immature columnals of *I. robustus* are frequently difficult to distinguish from those of *I. basaltiformis*". The very low and flat columnals of *I. ranae*, however, clearly belong to an adult stage distinct from *I. basaltiformis* (Fig. 2F). *Isocrinus ranae* also displays many in common characters with the early Toarcian *I. rollieri* (de Loriol, 1886), particularly the shorter noditaxes and the general lack of tuberculation on columnal latera. It is distinct from *I. nudus* (Quenstedt, 1876), also from the Lower Toarcian, as it does not have inflation of columnal radial around the position of the radial pores.

Superorder Echinacea Claus, 1876
Order Salenioda Delage & Hérouard, 1903
Family ?Acrosaleniididae Gregory, 1900

Diagnosis. Primary spines relatively stout and fusiform, with cortex. Upper parts spinose, prominent crenulated tuberculation (Smith A. B. The Echinoid Directory 2009).

Genus and species indet.

Fig. Interambulacral plates 2G-H (RM PZ 31449a-b)-primary radioles (with bases) 2I-J (RM PZ 31450a-b)

Material. 10 interambulacral plates (RM PZ 31451), 12 primary radioles (with bases) (RM PZ 31452), 53 primary radioles (RM PZ 31453). The plates are poorly preserved. Eight test plates preserving mamelons but lacking ambulacra, and 53 primary spines.

Description.

This specimen is described only from the preserved interambulacra and primary radioles.

Interambulacra plate boundaries are difficult to determine, as they are slightly abraded but rectangular (Fig. 2G). Some large granules are preserved on each plate. Scrobular circles are separated by a prominent groove (Fig. 2G). The primary tubercles are perforated, and have 10-14 crenulations (Fig. 2G-H). no smaller tubercles are preserved. The primary tubercles are convex, rising from a sub-rounded flattened basal terrace (Fig. 2G). The mamelons have slightly undercut necks. The primary spines are long and spinose (7cm) flattened or circular in cross-section, the distal part of the spine is flattened and ornamented by rows of thorns. The proximal surface has longitudinal lines towards the base (Fig. 2I). The spine tapers proximally into a short neck and ends in a slightly ex-

panded base with small longitudinal grooves around the sides (Fig. 2I).

Remarks. The tentative designation to the acrosaleniids is based on characters from the base of the spines and interambulacral test fragments, but with no ambulacral or apical plates preserved, designation beyond family level is not possible at this stage. Members of the Acrosaleniidae can be distinguished from other echinoids by having a single primary tubercle to each interambulacral plate; will all tubercles perforate and crenulate (Fig. 2G-H). Primary spines relatively stout and fusiform, with a cortex (Fig. 2I-J). Although the upper part of each spine is spinose or 'cidaroid' like, most members of the Cidaridae do not have strong crenulations on the tubercles.

Discussion

Moberg (1888) and Troedsson (1951) identified at least four species of crinoids within the Lower Jurassic (Sinemurian-Pliensbachian) of southern Sweden, along with several echinoid fragments, which even now are difficult to assign confidently. The poor preservation of the echinoid fragments means that we feel that we can not discuss their significance any further. In response to more recent developments in crinoid taxonomy, we have found that these can be revised to be at least two species, *Balanocrinus subteroides* and the new species *Isocrinus ranae*, and possibly a third taxon, *Hispidocrinus scalaris*, but we have no conclusive evidence of the last named taxon. This makes the Lower Jurassic crinoid fauna of Sweden comparable with that of the Lower Jurassic of England (see Simms 1989).

It is clear that despite the geographic separation, the Early Jurassic crinoids and echinoids described herein have clear taxonomic affinities with contemporary representatives of the British faunas. The preservation of the echinoids means that it is difficult to resolve the details of their significance. Nevertheless, this is an isolated occurrence and thus any interpretation must be approached with caution. Hunter & Zonneveld (2008) developed a classification of Jurassic crinoids, and although they used Middle Jurassic groups, it has some relevance to this study. The residues described herein for both the echinoids, and the crinoids belong to taphofacies 2 (Hunter 2006; Hunter & Zonneveld 2008); that is para-autochthonous articulated columnals, unabraded, and exposed to minimum transport.

Simms (1989) noted that many of the Early Jurassic crinoids he described could be either intermediate forms or evolved through neoteny, such as in *I.*

basaltiformis. Although *I. ranae* shares many characters with *I. basaltiformis* and could have originated by neoteny from a theoretical ancestor, it is difficult to quantify this due to lack of data. It is clear, however, that *I. ranae* shares many characters that were considered intermediate between two Early Jurassic species described by Simms (1989), which are found associated with the same muddy substrate. For instance, the late Sinemurian *I. tuberculatus* with its weak tubercles and radial epifacets is thought to be intermediate between *I. psilonoti* (Hettangian) and *I. robustus* (Pliensbachian), as the latter has distinctive tuberculation and radial epifacets, while *I. psilonoti* is largely smooth and devoid of such characters. However, *I. ranae*, which is Pliensbachian in age, shares many characters with *I. tuberculatus*, despite being contemporaneous with *I. robustus*. Thus, the new species could prompt a reanalysis of the species concept among the Lower Jurassic *Isocrinus*. Despite the apparent separation from the basin where most of these described groups occur, this species could indeed be related to the same evolutionary lineage identified by Simms (1989).

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