Archaeocidaris M'Coy (Echinoidea) from the Carboniferous of Egypt

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Key words — systematics, echinoids, *Archaeocidaris*, Carboniferous, Egypt.
Collections in museums usually have boxes of specimens which remain 'undiscovered' and yet which may be of importance or interest. The recent rediscovery of specimens of *Archaeocidaris* in the Nationaal Natuurhistorisch Museum, Leiden, from the Carboniferous of Egypt illustrates this point. These specimens were collected in 1938 by Dr. H.M.E. Schürmann (1891-1979), who had been a student of Professor J. Wanner (1878-1956), the noted expert on fossil echinoderms. The Egyptian *Archaeocidaris* plates include interambulacrals and radioles. These are closest to *Archaeocidaris rossica* (von Buch) from the Moscow area of Russia, although there are sufficient differences in radiole morphology to suggest that they are not necessarily conspecific.

Contents

Introduction

Museums contain many 'undiscovered' boxes of interesting specimens which are worthy of bringing to light, either in new public displays or in scientific publications. The reason for their being hidden away may simply be a lack of appropriate specialists on the museum staff. This in turn could mean that nobody outside the museum knows of the material, either. The specimens described herein fit this general category. They were 'found' in the collections of the Nationaal Natuurhistorisch Museum (NNM), Leiden, by S.K.D., who recognised them as being of some interest and importance to those interested in Palaeozoic echinoids. Although a collection of disarticulated plates, they are nevertheless identifiable with a reasonable degree of certainty; most collections of Palaeozoic echinoid plates are only recognisable as *Archaeocidaris* sp. (e.g., Lewis *et al*., 2003). An added point of interest was that they came from an exotic locality not famed for its Carboniferous echinoids, Egypt being better known for its post-Palaeozoic taxa (e.g., Carter & Hamza, 1994).

These specimens form part of the collection of Dr H.M.E. Schürmann (1891-1979), the distinguished petroleum geologist, whose scientific interests included the geology of Egypt and the petrology of Precambrian basement rocks (Dozy, 1979). As a doctoral

student in Bonn, he had studied under Professor Johannes Wanner (1878-1956), the notable echinoderm specialist (Moore, 1978; Winkler Prins, 2004). Schürmann's personal research collection is now in the NNM (Zwaan, 1994).

The terminology of the echinoid endoskeleton used herein follows Melville & Durham (1966), Durham & Wagner (1966), Lewis & Ensom (1982) and Smith (1984). Our philosophy of open nomenclature follows Bengston (1988). The sequential description of the specimens follows Lewis & Donovan (2005), organised to satisfy the format of this journal.

Systematic palaeontology

Class Echinoidea Leske, 1778
Family Archaeocidaridae M'Coy, 1844
Genus *Archaeocidaris* M'Coy, 1844

Type species — *Cidaris urii* Fleming, 1828, p. 478, by monotypy (Fell, 1966, p. U317); Mississippian, northern Europe.

Other species — [Not including taxa based mainly or solely on disarticulated radioles or left in open nomenclature, but see Jackson, 1912.] *A. aculeata* Shumard & Swallow, 1858 (Pennsylvanian to Permian(?); Kansas, Missouri, Texas); *A. agassizi* Hall, 1858 (Mississippian to Pennsylvanian; Iowa, Kansas); *A. aliquantula* Kier, 1958 (Mississippian Iowa); *A. barroisi* Mathieu, 1949 (Permian; Tunis); *A. biangulata* Shumard & Swallow, 1858 (Pennsylvanian; Missouri, Texas); *A. blairi* (Miller, 1891) (Mississippian; Montana); *A. clavata* von Eichwald, 1860 (Pennsylvanian; Russia); *A. cowleyi* Boos, 1929 (Lower Permian; Oklahoma, Kansas); *A. cratis* White, 1876 (Pennsylvanian; Utah, Nebraska, Colorado, Texas); *A. edgarensis* Worthen & Miller, 1883 (Pennsylvanian; Illinois, Iowa, Kansas); *A. fraxinensis* Maillieux, 1940 (Upper Devonian; Belgium); *A. gracilis* Newberry, 1861 (Carboniferous; Colorado); *A. halliana* (Geinitz, 1866) (Pennsylvanian; Colorado, Missouri, Nebraska); *A. immanis* Kier, 1958 (Pennsylvanian; Oklahoma, Texas); *A. keokuk* Hall, 1858 (Mississippian; Illinois, Missouri); *A. legrandensis* Miller & Gurley, 1889 (Mississippian; Indiana, Iowa, Kentucky, Missouri); *A. manhattanensis* Mathieu, 1949 (Permian; Texas); *A. megastyla* Shumard & Swallow, 1858 (Pennsylvanian; Kansas, Missouri); *A. meurevillensis* Dehée, 1927 (Mississippian (Lower Namurian); France, Belgium); *A. mosquensis* Ivanov *in* Yakovlev, 1939 (Pennsylvanian; former U.S.S.R.); *A. mucronata* Meek & Worthen, 1860 (Mississippian; Illinois, New Mexico); *A. nerei* (Münster, 1839) (Mississippian; Belgium, Spain); *A. newberryi* Hambach, 1884 (Mississippian; Missouri); *A. nikitini* Faas, 1939 (Pennsylvanian; Russia); *A. norwoodi* Hall, 1858 (Mississippian; Illinois, Missouri); *A. ourayensis* Girty, 1903 (Pennsylvanian; Colorado); *A. pizzulana* Gortani, 1905 (Pennsylvanian; Italy); *A. prisca* (Münster, 1839) (Carboniferous; Belgium); *A. propinqua* Jackson, 1929 (Mississippian; Belgium); *A. rossica rossica* (von Buch, 1842) (Mississippian; Russia); *A. rossica titovensis,* (Faas *in* Yakovlev, 1939) (Pennsylvanian; Russia); *A. setosa* Jackson, 1929 (Mississippian; Belgium); *A. shumardana* Hall, 1858 (Mississippian; Illinois, Missouri, Nevada(?)); *A. sixi* Barrois, 1882 (Pennsylvanian; Spain); *A. spinoclavata* Worthen & Miller, 1883 (Pennsylvanian; Illinois); *A. subwortheni* Faas *in* Yakovlev, 1939 (Pennsylvanian; former U.S.S.R.); *A. triplex* White,

1881 (Pennsylvanian; New Mexico, Colorado); *A. trudifer* White, 1874 (Pennsylvanian; Arizona, Colorado, Kansas, Utah); *A. werverkei* Tornquist, 1897 (Mississippian; Belgium, Germany); *A. whatleyensis* Lewis & Ensom, 1982 (Mississippian (Holkerian); Somerset, England); *A. wortheni* Hall, 1858 (Mississippian; St. Louis, Missouri).

Diagnosis — (Adapted from Fell, 1966, p. U317.) Test flexible, subspherical, probably depressed adorally and adapically. Ambulacral plates tending to form triads, with irregular enlargement of each successive third plate. Ambulacral pores uniserial. Interambulacral plates in four columns (at least ambitally). Interradial series imbricating more or less upon adradial series: adradial series imbricating more or less on ambulacral series. Primary tubercles perforate, noncrenulate. Primary spines smooth, striate or spinulose, or with lateral expansions, but without terminal clavate or discoid shaft; cortex reduced (or absent?), medulla (in some or all) hollow.

Range — Upper Devonian to Permian (Kier & Lawson, 1978, p. 5).

Archaeocidaris sp. cf. *A. rossica* (von Buch, 1842)

Pl. 1.

Material — Registration numbers, RGM 216076-216083. The specimens consist of 53 interambulacral plates plus various fragments, and over 100 portions of primary interambulacral radioles. The plates are mostly complete. The radioles are all broken, with a mixture of distal and proximal ends present. All the plates and tubercles have been weathered and polished, thereby removing most of the fine surface detail. There are no ambulacral plates or other plates of the test in the collection. Presumably there are several individuals present, as suggested by the variation in preservation and colour of the plates and radioles.

Locality and horizon — The label states that these specimens come from the Carboniferous of Wadi Araba, Red Sea Hills, Egypt. This is not the Wadi Araba which currently forms the border between Israel and Jordan since marine Carboniferous strata are rare or absent in this region (Monod & Weissbrod, 1996, pp. 446, 447). Rather, the locality is situated in the northeastern part of the Red Sea Hills, which extend along the southwest coast of the Gulf of Suez and, further south, the Red Sea (Zwaan, 1994, fig. 1; Legrand-Blain, 1985, fig. 16). Legrand-Blain (1985, p. 349) noted that "On the western shore of the Gulf of Suez, three formations of middle-late Carboniferous age are recorded." The Pennsylvanian Rod el Hamal Formation of the Wadi Araba area includes shales with sandstones and crinoidal-bryozoan limestones (Legrand-Blain, 1985, pp. 349, 350; Klitzsch, 1990, pp. 403, 404).

The material was collected in 1938 by H.M.E. Schürmann, bequeathed to the Rijksmuseum van Geologie en Mineralogie (RGM) and is now included in the collection of the Nationaal Natuurhistorisch Museum, Leiden, The Netherlands (NNM).

Description - Interambulacral plates (Pl. 1 figs. 1-5; Table 1). These are slightly higher than wide, and can be sorted conveniently into interradial column plates, which have straight margins, and adradial column plates, which have one margin curved and

Table 1. Measurements of interambulacral plates of *Archaeocidaris* sp. cf. *A. rossica* (von Buch) from the Mississippian of Egypt.

Dimensions in mm	Height	Length	Thickness over tubercle	Diameter of boss at parapet
Largest plate	15.6	14.3	4.0	4.8
Medium size plate	11.4	9.2	3.5	3.9
Smallest plate	7.5	7.0	2.1	2.1

indented for ambulacral plate abutment. Both kinds are slightly concave on the inner surface and may have one edge slightly extended into a rectangular shape. This is inferred to be adapical.

Scrobicular circles are complete and each plate has about 24 scrobicular tubercles. The scrobicule is about two and a half times the diameter of the boss. There is no basal terrace; the circular boss rises steeply, albeit not quite vertically, from the scrobicule, and has a parapet and a narrow platform. The parapet is just over twice the diameter of the mamelon and about five times the diameter of a scrobicular tubercle. The hemispherical mamelon has a straight neck and is perforate, with a foramen that is slightly elongated adorally-adapically.

There are secondary tubercles outside the scrobicular ring; at the widest part of the plate there are two rows, but elsewhere there may be one or none at all. The secondary tubercles are about half the diameter of the scrobicular tubercles.

Interradial plates — Interambulacral plates of the central interradial columns are irregularly hexagonal, with four longer and two shorter margins. There are grooved facets on adoral-adradial, adapical and adapical interradial margins, formed by the slight overhang of the scrobicular circles. These are shallow pits at either end of each groove. On opposite margins there are short, almost pointed, projecting flanges. These are present on the adapical adradial margin, and the adoral margin and adoral interradial margin, where the interradial flange is slightly larger than the adradial flange. These flanges fit into the shallow pits on adjacent plates and would act as hinges between the plates.

Adradial plates — Plates forming the two outer adradial columns of the interambulacra have one curved margin that was adjacent to the ambulacral plates and four other straight margins. Groove-like facets formed partly by the overhang of the scrobicular circles are present on the straight margins of the plate. The curved margin has a continuous facet with a shallow slope inwards on the underside of the plate. This facet has several short, shallow ridges and indentations at right angles to the margin of the plate, giving it a crinkled appearance and marking the position of the adjacent ambulacral plates which imbricated beneath it. Flanges are present on the adoral interradial, adoral, interradial and adapical interradial edges of the plate, beneath the margin formed by the scrobicular circles.

Description - Radioles (Pl. 1, figs. 6-8). The radioles are all weathered and incomplete, so the exact dimensions are unknown. By extrapolation from some of the radioles,

they may have reached 60 mm in length. There are two kinds, both solid: one has the typical shaft-neck-collar-milled ring-acetabulum form (form I); the other has a shaft-neck-acetabulum form (form II).

Typical form I radioles are long and slender, with many robust spinules on the shaft. These are arranged in approximately alternating rows along the length of the shaft, in a fairly even pattern. The neck is long and smooth, and widens into a broad collar with a narrow milled ring. The base is robust, short and concave. The acetabulum is circular and perforate. The largest milled ring is 5.45 mm in diameter and the acetabulum 2.7 mm in diameter (see Pl. 1, fig. fig. 6). The neck is 3.2 mm in diameter.

The form II radioles are long and slender, and have a similar sculpture of spinules. The neck is long and smooth, but, in contrast to form I radioles, it does not expand and widen into a broad collar. The acetabulum is perforate.

Discussion — The interambulacral plates from Egypt most closely resemble those of *Archaeocidaris rossica* (von Buch, 1842; Pl. 1, fig. 9 herein) from the Lower Carboniferous of Mjaschkova, near Moscow, Russia, as figured and described by Jackson (1912, pp. 263-265, pl. 10, fig. 10, pl. 11, pl. 12). Assuming that the radioles belong to the same taxon as the test plates, they are slightly more slender than those of *A. rossica* (Pl. 1, fig. 10) whose radioles are short and robust. However, weathering and erosion, and normal variation owing to size difference may be partly responsible for this.

The echinoids from Egypt and Mjaschkova both have solid radioles, unlike those of *Archaeocidaris whatleyensis* Lewis & Ensom, 1982, for example, which have hollow or spongy centres and show collapse features, especially towards the distal end of the shaft. This suggests the possibility of two distinct types of *Archaocidaris*, those with solid and those with hollow radioles. Post-Palaeozoic regular echinoids having hollow radioles include the families within the diadematoids. Pedinoids, curiously, have primary radioles that are solid and secondaries that are hollow. Further research is needed to determine if there is indeed a clear distinction within the archaeocidarids and, if so, whether both kinds should be grouped together.

The flanges of the plates show interesting variations in the structures that permit flexibility when compared with those of *A. whatleyensis*. Whereas *A. whatleyensis* has flanges which extend the length of the margins of the plates with slight expansion at the 'corners,' those of the Egyptian species has shorter spiky flanges present only at the 'corners' and not along the whole edge.

What cannot be determined, however, is the number of columns of plates present in each interambulacrum. For this, more complete portions of test are needed. Should the test prove to have more than four columns of plates per interambulacrum, the generic designation will have to be re-evaluated. However, unless this occurs we propose to retain *Archaeocidaris* as the designation.

If the interambulacral plates described herein are indeed those of *A. rossica,* this extends the palaeogeographical range of the taxon from northern Europe to northern Africa. If, however, and as is more likely, the taxon is a closely related species rather than *A. rossica sensu stricto*, more complete material, including ambulacral and jaw remains, is needed to confirm this surmise.

The genus *Jacksonaster* Lambert, 1936 (subjective junior synonym of *Proterocidaris,* according to Kier, 1966; see also Smith, 2004), also from Egypt, from the Upper Carboni-

ferous of Wadi Araba, has interambulacral plates which do not resemble those of the specimens of *Archaeocidaris* from Egypt. The tubercle is sub-central and not very well defined, and the interradial columns of plates have granular ornament.

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Plate 1

Figs. 1-8. *Archaeocidaris* sp. cf. *A. rossica* (von Buch, 1842), Carboniferous, Red Sea Hills, Egypt.

Fig. 1. RGM 216076. Composite assemblage of interambulacral plates, 'exploded' to show an approximation of the structure of part of an interambulacrum. This assemblage is composed of smaller plates and represents the test somewhere distal to the ambitus.

Fig. 2. RGM 216077. A second composite assemblage of interambulacral plates (compare with Pl. 1, fig. 1). This assemblage is composed of larger plates and represents the test near to the ambitus.

Fig. 3. Interambulacral plates, RGM 216078. (a) Interambulacral adradial plate showing the general surface view with the primary tubercle, scrobicular circle and secondary tubercles. Note the curved adradial edge on the left side of the figure. (b) Side view of an interambulacral adradial plate showing the profile. Note the curvature of the plate and the vertical sides of the tubercle boss. (c) Interambulacral plate seen from the inner surface to show the facets and flanges. Note the serrated edge of the right side of the figure showing where the ambulacral plates would abut.

Fig. 4. RGM 216079, a small interambulacral interradial plate to show the surface features.

Fig. 5. RGM 216080, a larger interambulacral interradial plate seen from the inner surface to show the facets and flanges important to the flexibility of the test.

Fig. 6. RGM 216081, a typical proximal end of a shaft-neck-collar-milled ring-acetabulum form of primary radiole (form I).

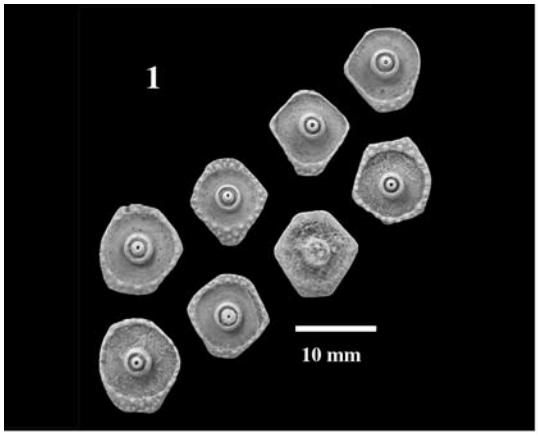
Fig. 7. RGM 216082, the proximal end of a shaft-neck-acetabulum form of primary radiole (form II).

Fig. 8. RGM 216083, the spinose part of a primary radiole.

Figs. 9, 10. *Archaeocidaris rossica* (von Buch, 1842) from the Lower Carboniferous (Mississippian) of Mjaschkova, near Moscow, Russia.

Fig. 9. The Natural History Museum, London (BMNH) E 9555, a collapsed test.

Fig. 10. BMNH E 1034, primary radiole.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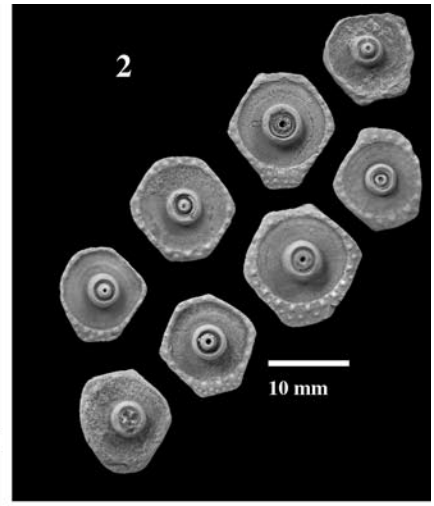
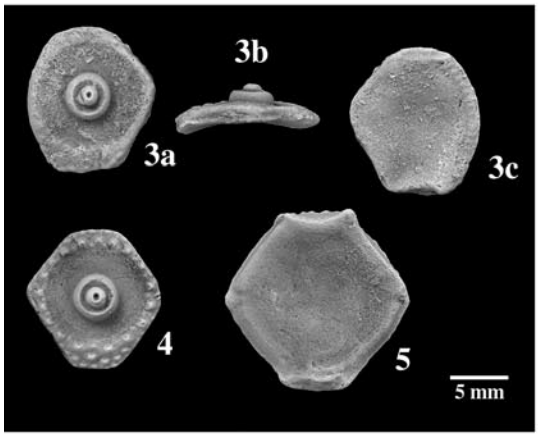
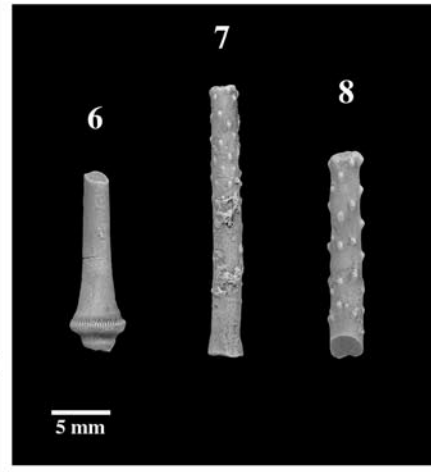
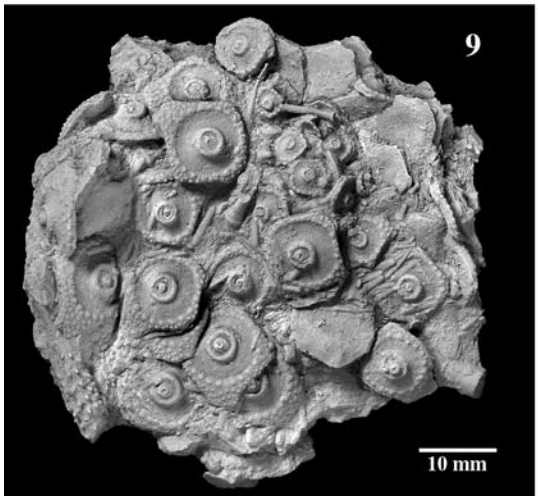
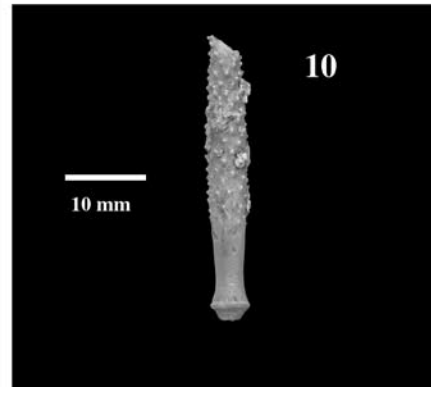

2
10 mm


3a
3b
3c
4
5
5 mm


6
7
8
5 mm


9
10 mm


10
10 mm