A NEW EOCRINOID FROM THE LOWER CAMBRIAN OF SPAIN

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ABSTRACT. An eocrinoid similar to *Gogia*, but having single or partitioned epispires with dome-shaped calcite cover, is described as *Gogia* (*Alanisicystis*) *andalusiae* subg. et sp. nov. It is from the Lower Cambrian (Marianian stage) of Alanis (Seville), Andalusia, Spain, and it is the second species of *Gogia* from the Lower Cambrian.

THE eocrinoids comprise a heterogeneous assemblage of primitive pelmatozoans, which probably contains the ancestors of all other cystoids s.l. or blastozoan echinoderms (see Smith 1984; Paul 1988). Yet the term 'eocrinoid' remains convenient to designate those Cambrian and Ordovician pelmatozoans which, at this time, cannot be referred to any of the currently accepted classes.

Only three genera and three species of eocrinoids (including lepidocystoids) are known from the Lower Cambrian, all of them from North America (Sprinkle 1973; Durham 1978). They are *Kinzercystis durhami* Sprinkle, *Lepidocystis wanneri* Foerste and *Gogia ojenai* Durham. In addition, isolated plates from the Lower Cambrian of California (Sprinkle 1973), England (Donovan and Paul 1982) and south-east Iran (Wolfart 1974) have been described as possible or probable eocrinoid remains.

Among the species just referred to, only one has been assigned to the genus *Gogia*: *G. ojenai* from the late Lower Cambrian Latham Shale of California (Durham 1978). A second, but somewhat older species, was discovered a few years ago by one of us (D.V.) in south-western Spain (Andalusia) near Alanis (Province of Seville). This new species, described below, is of special interest because of its epispires as well as being the oldest recorded representative of the genus.

The presence of echinoderm plates in the Lower Cambrian of Alanis has been previously reported by R. and E. Richter (1940) and G. Henningsmoen (1958). According to the latter, the plates resemble those of *Gogia prolifica* Walcott from the Mt Whyte Formation, lower Middle Cambrian, British Columbia, Canada.

LOCATION AND AGE

The fossils dealt with herein were collected near Alanis, about 75 km north-north-east of Seville, in the Sierra Morena Oriental, from an outcrop on a pathway going from Alanis station to Hornillo-Viejo farm, some twenty metres after the crossing of the Benalija River (the position of this outcrop is indicated (2) in fig. 1 of Gil Cid 1972).

The layer that yielded the echinoderm remains belongs to the upper part of the Marianian stage (Lower Cambrian; Sdzuy 1971), correlated with beds of Botomian age of the Siberian sequence (Sdzuy 1972). The trilobite fauna of Alanis, as revised by Gil Cid (1975), comprises the following species: *Saukianda andalusiae* R. and E. Richter, *Perrector perrectus* R. and E. Richter, *Eops eo* R. and E. Richter, *Strenueva sampelayoi* R. and E. Richter, *Strenueva melendezi* Gil Cid and *Alanisia guillermoi* R. and E. Richter.

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SYSTEMATIC PALAEONTOLOGY

'Class' Eocrinoidea Jaekel, 1918
Family Eocrinidae Jaekel, 1918
Genus GOGIA Walcott, 1917
Subgenus ALANISICYSTIS subg. nov.

Etymology. From Alanis (Seville), Spain, type locality.

Type species. *Gogia* (*Alanisicystis*) *andalusiae* sp. nov.

Diagnosis A subgenus of *Gogia*, characterized by single or partitioned epispires provided with external dome-like stereomic cover.

Discussion. *Alanisicystis* conforms with the diagnoses proposed by Sprinkle (1973) for the family Eocrinidae and the genus *Gogia*, except for the peculiar morphology of its epispires. While those of *Gogia* are single pore-like sutural openings surrounded by a prominent raised rim, those of *Alanisicystis* are commonly divided into two funnel-shaped hollows leading to a single or to paired internal pores and protected by an external dome-like stereomic cover or a pair of such covers.

Epithecal covering on epispires is known in several eocrinoids but none appears to be the same as that observed in *Alanisicystis*. In the type specimen of the Middle Cambrian *Acanthocystites briareus*, a thin lid – possibly on the plate interior (Sprinkle 1973) – with pores at opposite ends closes off the central part of each epispire (Ubaghs 1967), but other specimens assigned to this species by Fatka and Kordule (1984) do not show this feature (Fatka, personal communication). In the Lower Ordovician, *Rhopalocystis destombesi*, the existence of an external cover of minute plates over epispire pores has been reported (Ubaghs 1963). In other eocrinoids such as the Ordovician *Palaeocystites*, it is the plate epistereom itself that covers the epispires, which are therefore exposed only where the external plate surface has been eroded. But it is probably the calcitic cupolas protecting the humatipores of the diploporites *Holocystites s.s.* and *Pustulocystis* that the epispire covering of *Alanisicystis* most resembles, at least superficially.

Alanisicystis has an irregularly multiplated calyx and holdfast, more or less numerous epispires, spiralled brachioles (a feature found in some other species of *Gogia* but in no other echinoderms) attached separately or in groups to spout-like projections of modified calyx plates on the edge of the oral area, as well as an anal pyramid laterally located near the calyx summit. All these characters fit those of *Gogia*, indicating a close relationship with this genus. Still, with its peculiar and complex epispires, *Alanisicystis* stands apart from all known representatives of *Gogia*. It is unlikely that it could have evolved into one of them and probably represents an early offshoot from the main stock of *Gogia*. It is to mark at one and the same time its distinctiveness from, and its similarity to, *Gogia* that it is here considered as a subgenus of the latter.

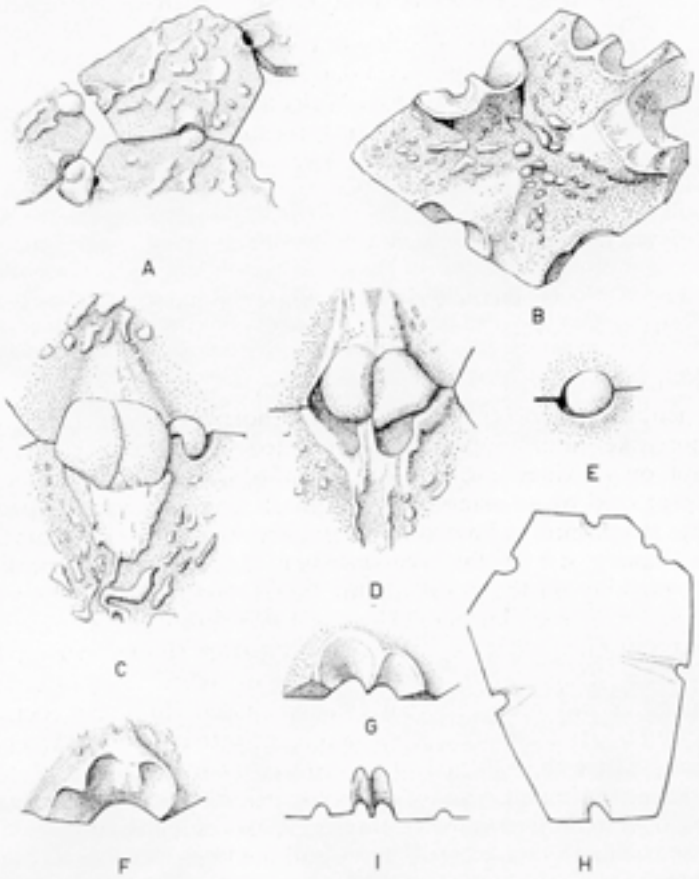
Gogia (*Alanisicystis*) *andalusiae* subg. et sp. nov.

Etymology. From Andalusia, a region of southern Spain, where this new species was discovered.

Holotype. Specimen VCE 24 (Pl. 1, fig. 7).

Diagnosis. A species of *Alanisicystis* with calyx probably globose; thecal plates relatively large and thick; showing pustulose and low ridged exterior ornament, epispires all over calyx or part of it, up to 12 per plate in large specimens; holdfast relatively short and distally inflated, composed of numerous small, unornamented plates; transition from calyx to holdfast abrupt; at least 6 or 7 brachioles, spiralled in right hand direction.

Material. Seven specimens (three with both part and counterpart) and isolated plates, all preserved as external moulds in a greenish shale and more or less distorted. Brachioles and holdfast still attached to the theca in three



TEXT-FIG. 1. Epispires of *Gogia* (*Alanisicystis*) *andalusiae* subg. et sp. nov., camera lucida drawings. A, VCE 11,*1*, thecal plates of a small specimen showing simple epispires (one cover missing). B-I, VCE 24; B, thecal plate with partitioned epispires, covers not preserved; C, paired covers and small simple (?incipient) epispire with cover on the right side; D, paired covers slightly displaced; E, small simple epispire with cover between two large plates; F and G, oblique view of epispires with partial and complete partition; H, smooth internal face of a plate, with slight markings associated with sutural openings (note the small size and feeble differentiation of these openings); I portion of internal edge of a plate, with simple and partitioned sutural openings. All figures approximately ×17·5.

specimens, suggesting rapid burial at or near place of life. The specimens are numbered VCE 11,*1–3*, 23, 24, 25 and 26; they will be deposited in the collection of the Faculty of Sciences of the University of Madrid, Spain.

Description. Differences worthy of note may be observed between the smaller and the larger specimens. They mainly concern the shape of the theca, the relative size, complexity and distribution of the epispires, the ornamentation of the calyx plates and the aspect of the anal pyramid. They suggest the possibility of the existence of more than one species. Nevertheless, as the available material is small and variously preserved, it is dealt with below as representing a single taxon.

The specimens show a great diversity in size and thecal shape – the latter partly at least as a result of rock deformation. The calyces of the two smallest specimens (together on one slab and having the same orientation) are approximately twice as wide as high: VCE 11,*1* (Pl. 1, fig. 1) is 6·6 mm wide and 3·9 mm high; VCE 11,*2* (Pl. 1, fig. 4) is 6·1 mm wide and 2·9 mm high. The largest calyx (VCE 24; Pl. 1, fig. 7) is higher (11·2 mm) than wide (9·5 mm), but it is distorted. Its strong convexity suggests, however, that, like the calyx of the two smallest specimens, it was initially globose.

The calyx plates are relatively thick (up to 0·3 mm in larger specimens), polygonal, tesselated and irregularity arranged (Pl. 1, figs. 1, 4, 5). Their number per side is 18–25, suggesting an average of 35–50 plates for the whole calyx. The larger ones are located in the lower and middle portions of the theca (Pl. 1, figs. 1, 4, 7). In the smaller specimens, the calyx plates are slightly to moderately convex; in the larger ones, they have a slightly domed centre, but a few of the smaller plates are flat or even concave. They are rather coarsely ornamented. Those of the smaller specimens have irregular pustules, which become fainter towards the plate edges (Pl. 1, figs. 2 and 5), while those of the largest individual have vermiculate pustules concentrated on the upraised central area and passing to the periphery into low ridges which extend to the plate margins or meet the thickened apical portion of the prominent rim of the epispires (Pl. 1, fig. 9). Unlike the outer surface, the inner side of the calyx plates is smooth, but for faint markings associated with the sutural pores (text-fig. 1H).

The epispires are the most distinctive feature of the species. In the two smaller individuals, they are nearly or entirely lacking from one side of the theca (Pl. 1, figs. 4 and 5), while present on most plates of the other side, ranging from none to five per plate (Pl. 1, fig. 2; text-fig. 1A); most of them are 'U' shaped, small (0·2 mm wide), simple, with a raised rim thickened at the apex and provided with a hemispherical cap-like stereomic cover (not always preserved; text-fig. 1A). In the largest available specimen (VCE 24), the epispires seem to occur over the entire calyx, up to 12 per plate. They appear externally as conspicuous funnel-shaped sutural hollows, more than twice as large as those of the smaller specimens. They are surrounded by a powerful rim, with generally a prominent buttress-like thickening at the apex (text-fig. 1B–D). Their floor is rounded and smooth or it may comprise several shallow depressions (text-fig. 1B), but more commonly it is divided into two similar hollows by an internal partition which may be partial or complete. In the former case the epispire has a single internal pore (text-fig. 1F), in the latter case it has two contiguous internal openings (text-fig. 1G, I).

As stated above, each epispire has a conical or rounded cap-like cover, or a pair of such covers when the epispire comprises two separate compartments (Pl. I, figs. 2, 7, 9; text-fig. 1C, D). These covers do not seem to be a mere continuation of the calyx plates, but rather distinct skeletal elements, apparently loosely connected to the calyx, for not infrequently they are displaced or altogether missing and, when missing, no trace of their attachment can be observed. They most certainly served to protect the presumed respiratory evaginations of the body wall that the epispires are said to have accommodated during life, but the question arises whether they could open and close, or whether they were permanently closed. In that case, gaseous exchange must have been effected through them, as it was through the calcified external surface of the tubercular humatipores of some diploporite cystoids (*Holocystites s.s.*, *Pustulocystis*), which structures they somewhat resemble.

The partitioning of the epispires suggest that the soft organs they contained could branch, as do the papulae of some Recent asteroids. As to the internal pores, they are small and simple compared to the extended and complex external openings, though they generally show faint markings along their edges (text-fig. 1H). The occasional presence of small simple (?incipient) epispires in the largest plates, is noteworthy, and suggests that new epispires could still be added at a relatively late stage of plate development (text-fig. 1C, E).

The transition from the calyx to the holdfast is abrupt. The best preserved holdfast (VCE 11,*2*) seems to be composed of a short (0·5 mm) and wide (1·6 mm) cylindrical proximal part, with about 10 plates across the width, and a distal expanded portion (2·9 mm largest diameter; Pl. 1, figs. 4 and 5). The holdfast is made of tiny unornamented, rounded plates (0·15–0·2 mm wide), slightly imbricating towards the distal end of the organ (Pl. 1, fig. 2).

The observed number of brachioles ranges from 5 (VCE 11,*1*) to 7 (VCE 24) None of these appendages is complete. The longest preserved one (VCE 24) is 27·5 mm, suggesting a brachiole:calyx length ratio equal or greater than to 2·5 to 3. The brachioles are spiralled in a clockwise direction: there are about 3 spirals in the longest observed brachiole; the spiralling in this, as in other brachioles of the same specimen, starts within

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EXPLANATION OF PLATE 1

Figs. 1–9. *Gogia* (*Alanisicystis*) *andalusiae* subg. et sp. nov. 1, 3 and 6, VCE 11,*1*, 1, calyx and part of brachioles of a small specimen, ×6; 3, anal pyramid (see text-fig. 3A), ×10; 6, proximal portion of two brachioles, ×10. 2, 4 and 5, VCE 11,*2*; 2, calyx and inflated distal portion of the holdfast (note presence of epispires on calyx plates) ×8; 4 and 5, counterpart of the same small specimen and detail of calyx plates and holdfast (note absence of epispires on this calyx face), ×6 and ×12. 7, 8 and 9, VCE 24, holotype; 7, calyx (somewhat distorted) and brachioles (note spiralling of brachioles in clockwise direction; the arrow indicates the anal pyramid), ×4; 8, portion of two brachioles (see text-fig. 2B), ×10; 9, detail of calyx plates, ×8.

All photographs are of latex casts whitened with ammonium chloride sublimate.

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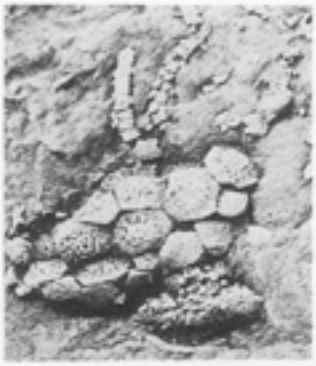

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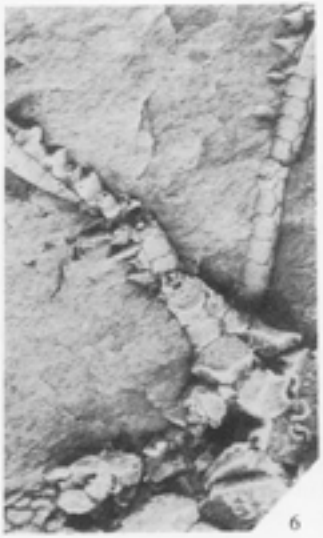

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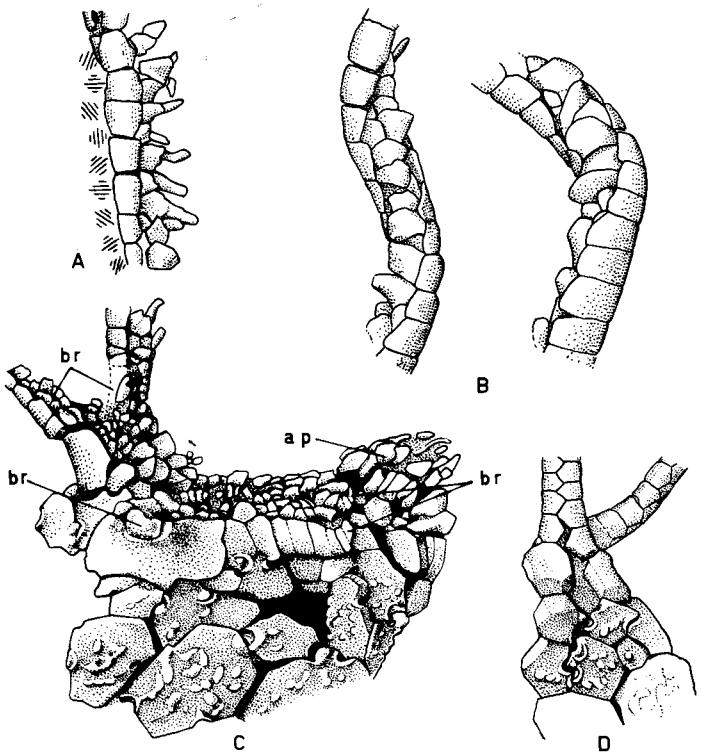
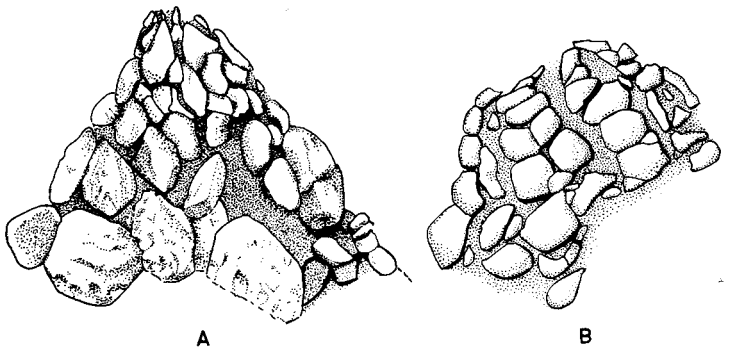


TEXT-FIG. 2. *Gogia* (*Alanisicystis*) *andalusiae* subg. et sp. nov., camera lucida drawings. A, VCE 11,*1*, portion of a brachiole, × 17·5. B, VCE 24, portion of two brachioles (see Pl. 1, fig. 8) × 17·5. C, VCE 11,*1*, calyx summit showing oral area, insertion and proximal portions of five brachioles (br) and anal pyramid (ap), × 12·5. D, reverse view of the pair of brachioles on the left side of the preceding figure, × 12·5.

2·3 mm of the calyx summit (Pl. 1, figs. 1, 6, 7). The brachioles taper very gradually. They are composed of unornamented brachiolar plates, about 15 on a side in 5 mm proximally and about 20 more distally (specimen VCE 24). Their ventral groove, as observed on the proximal portion of a brachiole, is wide and deep; it shows on its lateral walls an abrupt change of surface, possibly serving as the mounting area for cover plates. The latter are a little more numerous than the brachiolar plates, in a ratio of 7 or 8 to 5. There are apparently two sets of them, smaller ones alternating with larger ones (Pl. 1, figs. 6 and 8; text-fig. 2A, B). The latter, which slightly imbricate in distal direction, are as wide as the brachiolar groove, while the smaller ones cover only a part of it.

The brachioles are attached to unornamented spout-like calyx plates edging the relatively small oral area, either singly or in groups of 2 or 3 (Pl. 1, figs. 1 and 6; text-fig. 2C, D). Each brachiole is inserted on two thecal plates (text-fig. 2D), except possibly in the A ray (opposite the anus) where an apparently single large thecal plate bears only one attachment facet (text-fig. 2C). Neither the mouth nor the ambulacral grooves have been observed on the thecal summit, but the arrangement of brachioles around the oral area in specimen VCE 11,*1* – the only one to show this part of the calyx – suggests the existence of a single ambulacral groove in the A ray and of two lateral ones leading to a pair of brachioles on either side; such triradiate symmetry of the ambulacral system would certainly represent a very primitive condition.

The oral surface is paved with small (0·12–0·20 mm wide), unornamented irregular plates. On its very edge or slightly below it rises a relatively conspicuous anal pyramid. In the two smaller specimens (VCE 11,*1* and *2*), the anal pyramid appears as a pointed structure (2·3 mm wide at base, 1·7 mm high in specimen VCE 11,*1*) made of rows of elongated convex plates of decreasing size towards the summit and ending in needle-shaped platelets (Pl. 1, fig. 3; text-fig. 3A). In the largest specimen (holotype), it looks like a truncated cone (1·7 mm wide at base, 1·5 mm high) composed of rows (6–7 on the exposed face) of subquadrate, convex plates converging towards the apex (possibly missing; Pl. 1, fig. 7: text-fig. 3B).



TEXT-FIG. 3. *Gogia* (*Alanisicystis*) *andalusiae* subg. et sp. nov., camera lucida drawings, anal pyramid. A, VCE 11,*1*, (see Pl. 1, fig. 3), ×17·5. B, VCE 24 (see Pl. 1, fig. 7), ×17.

Comparison. Gogia (*Alanisicystis*) *andalusiae* shows the same general organization as all known species of *Gogia*. In addition, it shares: 1. spiralling of brachioles (though in opposite direction) with *G. ojenai*, *G. spiralis*, *G. granulosa* and *G. guntheri*; 2. relative shortness and distal expansion of holdfast with *G. ojenai* and *G. gondi*; 3. abrupt transition of calyx to holdfast with *G. spiralis* and *G. radiata*; 4. coarseness of calyx plate ornamentation with *G. ojenai*, *G. granulosa* and some Poleta plates figured by Sprinkle (1973, pl. 25, figs. 9 and 19). On the whole, it is *G. ojenai* of late Lower Cambrian (Durham 1978), that it most resembles, for it has in common with this species characters 1, 2 and 4 just mentioned. It differs from *G. ojenai* by its complex and covered epispires, less sharply ridged calyx plate ornamentation, less numerous and clockwise (instead of anticlockwise) spiralled brachioles, and abrupt rather than gradational transition from calyx to holdfast. While assuredly a primitive echinoderm, *G.* (*Alanisicystis*) *andalusiae* has surprisingly sophisticated respiratory structures, suggesting an early appearance of advanced features among the cystoid pelmatozoans.

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