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Late Campanian echinoids and crinoids from the Gschliefgraben (Ultrahelvetic, Austria)

by

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Contents

Abstract

Eight species of echinoid and one crinoid are described from the Late Campanian of the Gschliefgraben near Gmunden (Upper Austria): rhabdocidarid(?) indet., *Pseudoffaster caucasicus* (DRU 1884), *Echinocorys* gr. *conica* (AGASSIZ 1847) ?, *Echinocorys* gr. *subglobosa* (GOLDFUSS 1829), *Echinocorys* sp., *Cardiaster* gr. *cordiformis/granulosus*, *Micraster* gr. *schroederi/glyphus*, *M. aturicus* HÉBERT *in* SEUNES 1891 and *Austinocrinus rothpletzi* (STOLLEY 1892). Other species represented in the collections studied are of Turonian/Coniacian and Maastrichtian/Early Palaeogene age; these will be described elsewhere.

Zusammenfassung

Aus dem Obercampan des Gschliefgrabens bei Gmunden (Oberösterreich) werden acht Echiniden-Arten und eine Crinoiden-Art beschrieben: rhabdocidarid(?) indet., *Pseudoffaster caucasicus* (DRU 1884), *Echinocorys* gr. *conica* (AGASSIZ 1847) ?, *Echinocorys* gr. *subglobosa* (GOLDFUSS 1829), *Echinocorys* sp., *Cardiaster* gr. *cordiformis/granulosus*, *Micraster* gr. *schroederi/glyphus*, *M. aturicus* HÉBERT *in* SEUNES 1891 and *Austinocrinus rothpletzi* (STOLLEY 1892). Sonstige Arten in den untersuchten Sammlungen sind aus dem Turon/Coniac und Maastricht/Unterpaläogen; diese werden gesondert beschrieben.

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Introduction

Echinoids and crinoids from the Gschliefgraben near Gmunden (Upper Austria), housed at the Naturhistorisches Museum Wien (NHMW; including the HÜTTER Collection) as well as contained in several private collections (ESTERMANN [EST] and SKOUMAL [SK] collections), have been studied. In view of the fact that there is no measurable section at the Gschliefgraben, and that all specimens were collected from an active mudflow, the material is rather poorly documented stratigraphically (for a synthetic section see KENNEDY & SUMMESBERGER 1984). A preliminary analysis suggests the age of these specimens to range from Turonian/Coniacian to Early Palaeogene. Species which have been shown to be of Late Campanian age elsewhere in Europe are here singled out for discussion and illustration. However, the ranges of some of these are known elsewhere to extend into the Maastrichtian, and this may apply to the Gschliefgraben as well.

Preservation varies considerably; most specimens have been crushed by sediment compaction but retain many details of test ornament, others are heavily abraded and fragmentary and appear almost smooth. Specimens from indurated strata have generally been mechanically prepared by the collectors and lack all surface ornament; still others are preserved as internal moulds (e.g. Pl. 3, figs. 1–3, 6).

Specimens not discussed in the present paper will be described elsewhere; these include:

1 – 'more primitive' (judging from labral/plastronal and petal structure) micrasterids of Turonian/Coniacian (and ?Santonian) age, comparable to material referred by previous authors to the *praecursor/cortestudinarium* group (ERNST et al. 1996; WIESE 1997; KÜCHLER 1998) or the *decipiens/normanniae* group (DAVID & FOURAY 1984; FOURAY 1985; FOURAY & POMEROL 1985) from elsewhere in Europe. Most authors (e.g. ERNST & SCHULZ 1974; STOKES 1977; DRUMMOND 1985, 1988; KÜCHLER & ERNST 1989; ROSE & CROSS 1993) are in agreement over the morphological plasticity of representatives of this genus, and its tendency to develop local forms (ecomorphs) during the

Turonian/Coniacian in western Europe. Similar phylogenetic patterns have recently been recorded for the Turonian/Coniacian of Kazakhstan (MARCINOWSKI et al. 1996).

2 – typically 'Tethyan' holasteroids such as the stegasterid *Stegaster* POMEL 1883 (at least two species, EST 140 and EST 151), which has been recorded from the Maastrichtian of the French Pyrenees, Navarra and Alicante (Spain), Tunisia, Turkey, Bulgaria, Georgia, Kopet Dagh, the Crimea and the northern Caucasus, and the corasterid *Coraster vilanovae* COTTEAU 1886 (e.g. EST 141–147, EST 160, EST 169, EST 194), which is known to date from the Maastrichtian-Danian of Alicante and Navarra (Spain), the French and Spanish Pyrenees, Bulgaria, Turkey, Georgia, Dagestan and the northern Caucasus.

3 – a single specimen each of an echinolampadid (EST 82), apparently close to *Neocatopygus arnaudi* (COTTEAU 1891) from the Late Palaeocene of southern France, Algeria and western Senegal, and a schizasterid (EST 81; ?*Linthia* DESOR 1853), both preserved in a rather coarse-grained, glauconitic matrix type.

4 – a single specimen (NHMW 1998z/98/35) of a large-sized ?holasteroid, which appears to be closely related to, if not conspecific with, the poorly known Eocene genus *Titanaster* SZÖRÉNYI 1929.

Late Cretaceous and Early Palaeogene echinoids have only rarely been considered in the palaeontological literature in Austria, notable exceptions being LAMBERT (1907) and KÜHN (1925). From Schattau, the latter author described two new species of '*Epiaster*' of ?Maastrichtian age (*E. variabilis* and *E. trauthi*) and a single new species of *Micraster* (*M. gappi*). In view of the co-occurrence of the last-named taxon with *Micraster decipiens* (BAYLE 1878), KÜHN considered it to be of Coniacian age. These three 'species' have virtually been neglected in subsequent papers (e.g. KIER & LAWSON 1978); on the basis of recently collected material in the NHMW and SKOUMAL collections they will be revised shortly. This material also includes a small hemiasterid.

Late Cretaceous crinoids appear to be extremely rare in Austria. From the Early Maastrichtian of the Schweinbachgraben east of Gams (Styria), KRISTAN-TOLLMANN (1987) recorded various species of isocrinid and bourgueticrinid. Of these, *Austinocrinus erckerti* (DAMES 1885) is the most important, stratigraphically speaking, being confined to strata of Early Maastrichtian age in southern Germany (BÖHM 1891), Spain (RASMUSSEN 1961) and in the Crimea, Caucasus, Turkmenia and central Asia (KLIKUSHIN 1973, 1975, 1982, 1983, 1992). The present record (see below) of another species of the same genus, *A. rothpletzi*, is thus of considerable interest.

Systematic palaeontology

Order Cidaroida CLAUS 1880
Family Rhabdocidaridae LAMBERT 1900 ?

rhabdocidarid (?) indet.
(Pl. 1, Fig. 11)

Material: A single primary spine (NHMW 1998z/98/2).

Discussion Cidarid spines are notoriously difficult to assign to genera and species. In being more or less cylindrical, long and ornamented with thin striae and well-spaced large thorns in irregular rows, the present material appears to be close to rhabdocidarids. However, test plates are needed to confirm such an assignment (see SMITH & WRIGHT 1989; SMITH 1995). There are but few records of Late Cretaceous rhabdocidarids; the present material may also be of Maastrichtian (or ?Early Palaeogene) age.

Order Holasteroida DURHAM & MELVILLE 1957
Family Stegasteridae LAMBERT 1917
Genus ***Pseudoffaster*** LAMBERT *in* LAMBERT & THIÉRY 1924

Type species *Offaster caucasicus* DRU 1884, by original designation.

Pseudoffaster caucasicus (DRU 1884)
(Pl. 1, Figs. 12–15)

1884 *Offaster caucasicus* DRU: 514, pl. 26, figs. 5–10.
1997 *Pseudoffaster caucasicus* (Dru, 1884); JEFFERY: 698, pl. 8, figs. 4–7; text-fig. 14c–e.
in press *Pseudoffaster caucasicus* (Dru, 1884); SMITH & JEFFERY, fig. 160 (with additional synonymy).

Specimen	length	width	height
SK unreg.	21.6	20.5	16.6

Table 1. Measurements (in mm) of *Pseudoffaster caucasicus* from the Late Campanian of the Gschliefgraben near Gmunden.

Material A single specimen, SK unregistered.

Discussion: This specimen is comparatively well preserved, being only slightly laterally compressed. It preserves sufficient details of tuberculation and plating to allow it to be assigned to *P. caucasicus* beyond doubt. JEFFERY (1997) and SMITH & JEFFERY (in press) showed *Pseudoffaster renngarteni* SCHMIDT 1938 and *P. schmidti* POSLOVSKAYA & MOSKVIN 1959 to be junior synonyms of the present species. The former had been recorded exclusively from strata of Maastrichtian age, the latter also from the Campanian of the former Soviet Union.

The present specimen may also be of Maastrichtian age, and is here referred to the Late Campanian with a query.

Present records of *P. caucasicus* include the Maastrichtian of the northern Caucasus and Kazakhstan, Kopet Dagh, Georgia and northern Spain.

Family Echinocoridae LAMBERT 1917
Genus ***Echinocorys*** LESKE 1778

Type species *Echinocorytes scutatus* LESKE 1778, by monotypy.

Remarks: Rather than lumping all 'species' into a single taxon, *E. scutata* (LESKE 1778), as advocated by a number of authors, treatment as morphotypes or groups of is preferred here, since various groups are definitely of stratigraphical value.

Echinocorys gr. ***conica*** (AGASSIZ 1847) ?
(Pl. 1, Figs. 9, 10)

compare:

1847 *Ananchytes conica* AGASSIZ: 136.
1903 *Echinocorys conicus*, Agassiz (*Ananchytes*), 1847; LAMBERT: 66, pl. 4, figs. 1, 2; pl. 5, fig. 6.
1935 *Echinocorys lamberti* SMISER: 32, pl. 2, figs. 3, 4; text–fig. 14.
1935 *Echinocorys conicus* Agassiz (*Ananchytes*); SMISER: 33, text–fig. 15.
1972 *Echinocorys conica* (Agassiz); ERNST: pl. 7, fig. 1.

Material A single specimen, SK unregistered.

Discussion: The present specimen appears to be a comparatively large representative of a group of 'species'

specimen	length	width	height
SK unreg.	63.8	54.2	50.1

Table 2. Measurements (in mm) of *Echinocorys* gr. *conica* (?) from the Late Campanian of the Gschliefgraben near Gmunden.

that is best known from the late Early Campanian and early Late Campanian (*conica/papillosa* to *conica/mucronata* zones *sensu germanico*; see e.g. ERNST 1972, 1975; ERNST et al. 1979, 1997).

However, there is also a certain resemblance to some tests usually assigned to the *pyramidata* group (non *pyramidalis* SMISER 1935, lapsus). This group comprises tests which are typically almost symmetrically conical and which characterise the Late (latest) Campanian and Early (earliest) Maastrichtian in NW Europe.

NIEBUHR et al. (1997: 220, pl. 4, figs. 7, 8) recorded '*E. pyramidalis*' from the middle *stobaei/basiplana* to the highest levels of the Ahlten Opoka (= upper *bipunctatum/roemeri* Zone = upper *langei* Zone), but this appears to be a distinct form.

Echinocorys gr. ***subglobosa*** (GOLDFUSS 1829)
(Pl. 3, Figs. 5–7)

1829 *Ananchytes striatus* (specimen) *subglobosum* GOLDFUSS: 146, pl. 44, fig. 3.
1903 *Echinocorys subglobosus*, Goldfuss, 1826; LAMBERT: 62, pl. 2, figs. 7, 8.
1935 *Echinocorys subglobosus* Goldfuss (*Ananchytes*); SMISER: 15, text-fig. 3.
1999 *Echinocorys* gr. *subglobosa* (Goldfuss 1829); SUMMESBERGER et al.: pl. 11, fig. 5.

Material EST 73, EST 123, EST 125, EST 126, EST 130, EST 131, EST 139, EST 162, EST 163, EST 171, EST 180, EST 188, NHMW 1997/2076/17 and 1998z/98/6–8).

Discussion This group is well represented in the collections studied, with most specimens comparing well with material known from the early Late Campanian (*conica/mucronata* and *basiplana/spiniger* zones) of northeast Belgium (Liège) and from the *stobaei/basiplana* (= *basiplana/spiniger*) Zone of NW Germany. ERNST (1975) and ERNST et al. (1997) showed the *subglobosa* group to range from the lower *papillosa* Zone (Early Campanian) into the *vulgaris/basiplana* (= *roemeri*) Zone, with a distinct maximum in the *stobaei/basiplana* Zone (Late Campanian).

A few specimens (e.g. EST 129, EST 177) appear to be closer to the '*E. pyramidalis*' of German authors (e.g. ERNST 1975; NIEBUHR et al. 1997), which in sections in the Hannover area characterises the *minor/polyplocum* and *bipunctatum/roemeri* zones. KÜHN's (1925:180) record of '*Echinocorys ovatus* LESKE var. *pyramidatus* (PORTLOCK)' may refer to this type. Typical *pyramidata* (sensu PORTLOCK 1843: 355) morphologies are not represented in the collections studied.

Still others (e.g. EST 124) are reminiscent of what LAMBERT (1903) and SMISER (1935) referred to as *E. conoidea* (GOLDFUSS 1829), which these authors recorded also from the Late Campanian. However, I prefer to interpret this form on the basis of the type material in the collections of the Rheinische Friedrich-Wilhelms-Universität Bonn. Test specimen 343a in the Goldfuss Collection clearly shows this to be from the Late Maastrichtian Lixhe 1 Member (Gulpen Formation) of the Haccourt-Lixhe area (Liège, NE Belgium).

Echinocorys sp.
(Pl. 3, Fig. 4)

Material EST 122, EST 128 and NHMW 1998z/98/9–10); EST 133 may also belong here.

Discussion: Specimens grouped under this heading are characterised by conspicuous test plating (well-developed sutures and more or less convex plates) and a curious test shape. The apical system is positioned in the posterior half of the test, which appears 'pushed over backwards' That this is not a preservational matter, i.e. a function of deformation by sediment compaction, is clearly seen in the specimen illustrated in Pl. 3, fig. 4. At the ambitus, test plates are splayed out, but only slightly so. The remainder of the test is undamaged. Specimens vary in total test length between 69.0 and 88 mm.

In view of the fact that nothing comparable has been found in the literature, this form cannot be assigned to species, nor to stratigraphical level. Its inclusion here

is based solely on similarity of adhering sediment to that of certain specimens of *E.* gr. *subglobosa*.
The ESTERMANN Collection includes two specimens (EST 135, EST 141) of very large size (length c. 101 and 133 mm, respectively) and with thick tests, but unfortunately these are poorly preserved and cannot be identified to species or group. Comparable sizes normally are only encountered in *E.* gr. *belgica* LAMBERT 1898, which appears to be typical of the Early Maastrichtian.

Family Cardiasteridae LAMBERT 1917
Genus ***Cardiaster*** FORBES 1850

Type species: *Spatangus granulosus* GOLDFUSS 1829, by original designation.

Cardiaster gr. ***cordiformis/granulosus***
(Pl. 3, Figs. 1–3)

1829 *Spatangus granulosus* GOLDFUSS: 148, pl. 45, fig. 3.
1833 *Spatangus cordiformis* WOODWARD: 50.
1972 *Cardiaster* aff. *granulosus* (Goldfuss); ERNST: 117, fig. 20.
1997 *Cardiaster cordiformis* (Woodward, 1833); NIEBUHR et al.: 220, pl. 5, fig. 1.

Material A single specimen, EST 195a, in internal mould preservation.
Discussion Although lacking test material, the present specimen is fairly well preserved. However, details of plastron plating cannot be made out.

specimen	length	width	height
EST 195a	50.0	52.0	26.2

Table 3. Measurements (in mm) of *Cardiaster* gr. *cordiformis/granulosus* from the Late Campanian of the Gschliefgraben near Gmunden.

Cardiaster cordiformis, which appears to be the (late) Late Campanian precursor of *C. granulosus*, a widely distributed species of Maastrichtian age, differs from the latter only in plastronal structure. On the basis of what may be seen of the structure in the present specimen, this appears to be closer to *C. granulosus* than to *C. cordiformis*. In the Hannover area, the latter species first appears in the middle *minor/polyplocum* Zone, and is fairly common in the *bipunctatum/roemeri* Zone (NIEBUHR et al. 1997). In Norfolk (SE England) it is known from coeval strata (Beeston Chalk and lower Paramoudra Chalk; see WOOD 1988).

Order Spatangoida CLAUS 1876
Suborder Micrasterina FISCHER [in:] MOORE 1966
Family Micrasteridae LAMBERT 1920
Genus ***Micraster*** AGASSIZ 1836

Type species *Spatangus Cor Anguinum* var. a *Anglicum* LESKE 1778, by subsequent designation of POMEL (1883:42).

Micraster gr. ***schroederi/glyphus***
(Pl. 2, Figs. 1–3, 7, 8)

1869 *Micraster glyphus* SCHLÜTER: 235, pl. 1, fig. 2.
1892 *Micraster schroederi* STOLLEY: 259, pl. 8, fig. 5; pl. 9, fig. 1.
1970 *Micraster (Micraster) glyphus* Schlüter, 1869; ERNST: pl. 17, fig. 4.
1972 *Micraster* m.f. *schroederi/glyphus*; ERNST, pl. 5, fig. 3.
1975 *Micraster glyphus* Schlüter 1869; STOKES: 70, fig. 291 (with additional synonymy).
1975 *Micraster schroederi* Stolley 1891; STOKES: 78, pl. 9, figs. 5–7; pl. 10, figs. 1, 2; text-fig. 30c (with additional synonymy).
1999 *Micraster glyphus* SCHLÜTER 1869; SUMMESBERGER et al.: pl. 12, figs. 1, 3, 5.

Material: NHMW 1998z/98/3 and 1998z/98/5; EST 76 and NHMW 1998z/98/4,11–33 may also belong here.
Discussion This group comprises all 'depressed' micrasterids with well-developed subanal fasciole occurring in the Early and early Late Campanian (see STOKES 1976). *Micraster schroederi* appears to be the precursor of *M. glyphus*, and 'typical' specimens of these two taxa are easily distinguished. However, populations normally contain many intermediates, which is why these are here referred to as a group (see JAGT 1999b).
A few comparatively small (? subadult; test length between 34.4 and 46.3 mm) specimens from the Gschliefgraben belong here. On details of petal and plastronal/labral structure these are easily spotted amongst the many micrasterids in the collections studied. Most of these, however, appear to be of the 'more primitive' morphologies (see above).
A single specimen (Pl. 2, figs. 4–6) may either belong here or with *M. aturicus*. The shape of labrum (Pl. 3, fig. 4) would favour an assignment to the latter.
There is also a good match between the specimen illustrated in Pl. 2, figs. 1–3 and STOKES's (1975: pl. 3, figs. 6–8) figure of the neotype of *Micraster corcolumbarium* DESOR 1858, which according to STOKES is confined to the Late Campanian of the Pyrenean Province (SW France, Spain). HANCOCK et al. (1993) recorded this species from unit H at Tercis (Dax, France). Of note is that STOKES (1975: 47) pointed out that, 'Un grand échantillon de cette espèce (= *M. corcolumbarium*) (Coll. LAMBERT) peut à peine être distingué d'un petit *M. glyphus* et donc nous supposons que *M. corcolumbarium* est un descendant néoténique de *M. glyphus*.'

Micraster aturicus HÉBERT [in:] SEUNES 1891
(Pl. 1, Figs. 16–18; Pl. 2, Figs. 9–14)

1891 *Micraster aturicus* Hébert, 1880, [in:] SEUNES: 30, pl. 4, fig. 1, pl. 5, fig. 1.
1975 *Micraster aturicus* Hébert ([in:] SEUNES) 1891; STOKES: 61, pl. 1, figs. 1–3.

in press *Micraster aturicus* SEUNES, 1891; SMITH & JEFFERY: fig. 171.

Material EST 120, EST 152, SK 75 and SK unreg. EST 117 may also belong here.

specimen	length	width	height
EST 120	55.6	51.2	40.9
EST 152	c. 60.0	57.3	40.4
SK 75	c. 57.5	54.4	26.0*
SK unreg.	49.1	49.4	35.0

Table 4. Measurements (in mm) of *Micraster* gr. *aturicus* from the Late Campanian of the Gschliefgraben near Gmunden. *distorted

Discussion The present species was first recorded by SEUNES (1891) from the *polyplocum* Zone (assise à *Heteroceras polyplocum*) of Tercis, Angoumé and Heugas (Landes, France). Specimens from the Gschliefgraben correspond closely with material illustrated by SEUNES (1891) and STOKES (1975). The latter author considered this species to be confined to his 'Province Pyrénéenne', and noted that it first appears during the latest Early Campanian (where intermediates to *M. antiquus* COTTEAU 1887 occur), but that 'la grande forme typique' was restricted to the Late Campanian. He went on (p. 47) to note that at Tercis, '... le grand *M. aturicus* typique ne semble se trouver que dans les calcaires marneux gris-vert-bleuté du Campanien supérieur.' In addition to French localities, cited as localities Montesquiu (Arce, Spain).
SMITH & JEFFERY (in press) remarked that *M. aturicus* differed from *M. schroederi* only in having a concave lateral profile of the anterior part of the test, and recorded it from the Campanian of the French Pyrenees and the Maastrichtian of Alicante (Spain) and Georgia.

Order Crinoidea MILLER 1821
Family Isocrinidae GISLÉN 1924
Genus ***Austinocrinus*** DE LORIOL 1889

Type species *Austinocrinus komaroffi* DE LORIOL 1889, by monotypy (= *Pentacrinus erckerti* DAMES 1885).

Austinocrinus rothpletzi STOLLEY 1892
(Pl. 1, Figs. 1–8)

1892 *Austinocrinus rothpletzi* STOLLEY: 252, pl. 10, figs. 7–10, 14.
1961 *Austinocrinus rothpletzi* Stolley, 1892; RASMUSSEN: 38, pl. 2, figs. 1–9 (with additional synonymy).
1975 *Austinocrinus turkmenicus* KLIKUSHIN: 98.
1992 *Austinocrinus rothpletzi* Stolley, 1892; KLIKUSHIN: 120, text-fig. 123, pl. 15, figs. 1–10.

Material NHMW 1998z/0034/0015 (HÜTTER Colln); some thirty (pluri)columnals and ten cirrals.
Discussion State of preservation as well as columnal diameter vary: between 5.3 and 15.5 mm. The sample contains a series of ten pluricolumnals (consisting of between 2 and 5 columnals each), whose diameter varies between 8.7 and 8.9 mm. These may all be from the same individual. The same goes for some smaller internodals with diameters between 5.3 and 5.7 mm. A single pluricolumnal preserves two proximal cirrals. Details of articular facets also vary considerably; many specimens appear water worn, with petals excavated. The best preserved specimens (Pl. 1, figs. 1, 3–5, 8) illustrate the variation in articular facet structure. Columnal latera are smooth (Pl. 1, figs. 1, 7).
Discussion Of the various Campanian-Maastrichtian species of this genus described in the literature (SIEVERTS-DORECK 1953; KLIKUSHIN 1973, 1975, 1982, 1992; JAGT 1999a), the present specimens have most features in common with *A. rothpletzi*, which ranges from the Late Santonian to the Late Campanian. However, the exact stratigraphic ranges of the various taxa are still rather poorly known, which may in part be explained by the range of variation seen in columnal articular facets and lateral surfaces. Intermediates between *A. rothpletzi* and *A. bicoronatus* have been recorded from the late Late Campanian/Early Maastrichtian of Norfolk, England (WOOD 1988). That author (p. 68) referred to 'early forms of *Austinocrinus bicoronatus*' from the so-called *Austinocrinus* Bed in the '*mucronata* Zone' Beeston Chalk at Caistor St Edmunds (Norfolk), and from the top of the Beeston Chalk and (possibly) the lower part of the Paramoudra Chalk of the St James Pit in the same area. He also noted (p. 72) that, 'The *Austinocrinus* are probably transitional between *A. rothpletzi* Stolley and the later *A. bicoronatus*.' JOHANSEN & SURLYK (1990) showed the 'Beeston Chalk Member' to be roughly equivalent to the NW German *polyplocum* and *langei* zones (sensu SCHULZ 1985) and the 'Paramoudra Chalk Member' to correspond to the *grimmensis/granulosus* Zone and possibly earliest Maastrichtian *lanceolata* Zone. CHRISTENSEN (1995), on the basis of coleoid cephalopods, showed the Beeston Chalk Member and the lower part of the Paramoudra Chalk Member to correlate with the *polyplocum* and lower *langei* zones, while the remainder of that member was equated with the upper *langei* and *grimmensis* zones.
Specimens (JAGT Colln) similar to the ones from the Gschliefgraben are also known from the *vulgaris/stolleyi* Zone of the Teutonia I quarry (Hannover area; see ERNST et al. 1997; NIEBUHR et al. 1997).
In a brief survey of previous crinoid records from Austria, KRISTAN-TOLLMANN (1987) noted that SIEVERTS-DORECK (1953: 115) mentioned an '*Austinocr.* sp., Flysch der Ostalpen ?' Unfortunately, of this record no geographic and stratigraphic data were supplied, so that it cannot be determined which species was involved.

Chronostratigraphy	Biostratigraphy NW Germany	Inoceramid assemblage zones	IZ
EARLY MAASTRICHTIAN	*Lanceolata* Zone		
LATE CAMPANIAN	*Grimmensis/Granulosus* Zone		
	Langei Zone		
	Polyplocum Zone	*Cat. haldemensis* Zone	*33*
	Vulgaris Zone	Unnamed Zone	
	Basiplana/Spiniger Zone	*Cat. vorhelmensis* Z. - *Inoc. agdjakendsis* Z.	*32*
	Conica/Mucronata Zone	*Cat. beckumensis* Zone	*31*
EARLY CAMPANIAN	*Gracilis/Mucronata* Zone	*Sph. sarumensis* Zone - *Cat. dariensis* Zone	*30*
	Conica/Gracilis Zone		
	Papillosa Zone		
	Senonensis Zone		
	Pilula/Senonensis Zone	*Sphe. patootensiformis* Zone	*29*
	Pilula Zone		
	Lingua/Quadrata Zone		
	Granulataquadrata Zone		
LATE SANTONIAN	*Marsupites/Granulata* Zone		

Range of Echinoids and Crinoids

Biostratigraphical range of the Gschliefgraben on the NW German biostratigraphical zonal scheme including the Subhercynian Cretaceous and the Münsterland Basin according to Christensen (1988, 1997), Ernst (1964, 1970 b, 1972, 1974), Kauffman et al. (1993), Petrascheck (1906), Riedel (1931), Schulz & Schmid (1983), Schulz (1979), Ulbrich (1971) and unpublished data.

Sphe - *Sphenoceramus*
Sph. - *Sphaeroceramus*
Cat. - *Cataceramus*

Inoceramid zones after Walaszczyk (1997), IZ Inoceramid zones after Tröger (1989), Tröger et al. (this volume).

Table 5. Stratigraphic range of echinoids and crinoids from the Campanian of the Gschliefgraben.

Conclusions

Despite the fact that the collections studied were made from an active mudflow and thus lack accurate stratigraphic data, sufficient data have been gathered to confirm the Late Campanian age of a certain portion of this material. Moreover, the Gschliefgraben fauna is shown to contain elements both of the Tethyan and North Temperate realms. In this respect, it recalls Early Maastrichtian faunas from southern Germany (SCHULZ 1983). The occurrence of *Micraster aturicus* and possibly of *M. corcolumbarium* (tentatively referred to *M.* gr. *schroederi/glyphus* above) allows a correlation with the French/Spanish Pyrenees, and the Tercis section in particular (see ODIN 1996). *Pseudoffaster caucasicus*, which however may be Maastrichtian in age, is another typically Tethyan representative. *Austinocrinus rothpletzi* links both realms, and the holasteroid echinoids amongst the Gschliefgraben assemblages appear to substantiate the early to late Late Campanian age assignment.

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Plate 1

Figs. 1–8: *Austinocrinus rothpletzi* STOLLEY; 1998z/0034/0015; (pluri)columnals (internodals as well as nodal and cirrals; articular facets and lateral aspects, all x 2.

Figs. 9, 10: *Echinocorys* gr. *conica* (AGASSIZ) ?; SK unregistered, x 1.

Fig. 11: Rhabdocidarid(?) indet., primary spine (three fragments of same specimen); NHMW 1998z/98/2, x 2.

Figs. 12–15: *Pseudoffaster caucasicus* (DRU); SK unregistered, x 2.

Figs. 16–18: *Micraster aturicus* HÉBERT *in* SEUNES; 16, 17 are SK unregistered; 18 is SK 75; x 1.

All specimens are from the Late Campanian of the Gschliefgraben near Gmunden.

PLATE 1

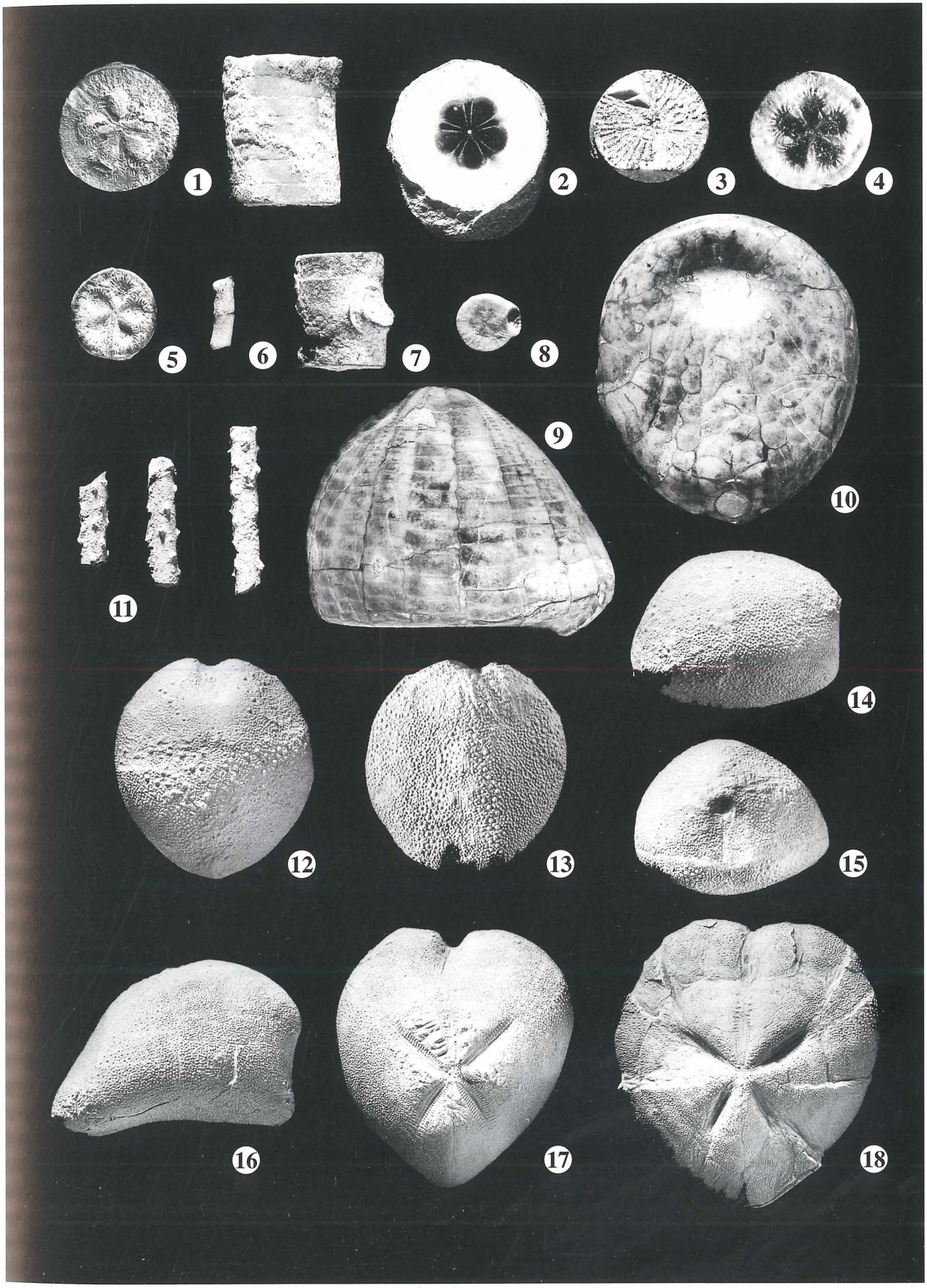

Plate 2

Figs. 1–3, 7, 8: *Micraster* gr. *schroederi/glyphus*; 1–3 are NHMW 1998z/98/3; 7, 8 are NHMW 1998z/98/5.

Figs. 4–6: *Micraster* sp.; NHMW 1998z/98/4.

Figs. 9–14: *Micraster aturicus* HÉBERT *in* SEUNES; 9, 10 are EST 152; 11–14 are EST 120.

All specimens are from the Late Campanian of the Gschliefgraben near Gmunden.
All are x 1, except 12–14 which are x 0.85.

PLATE 2

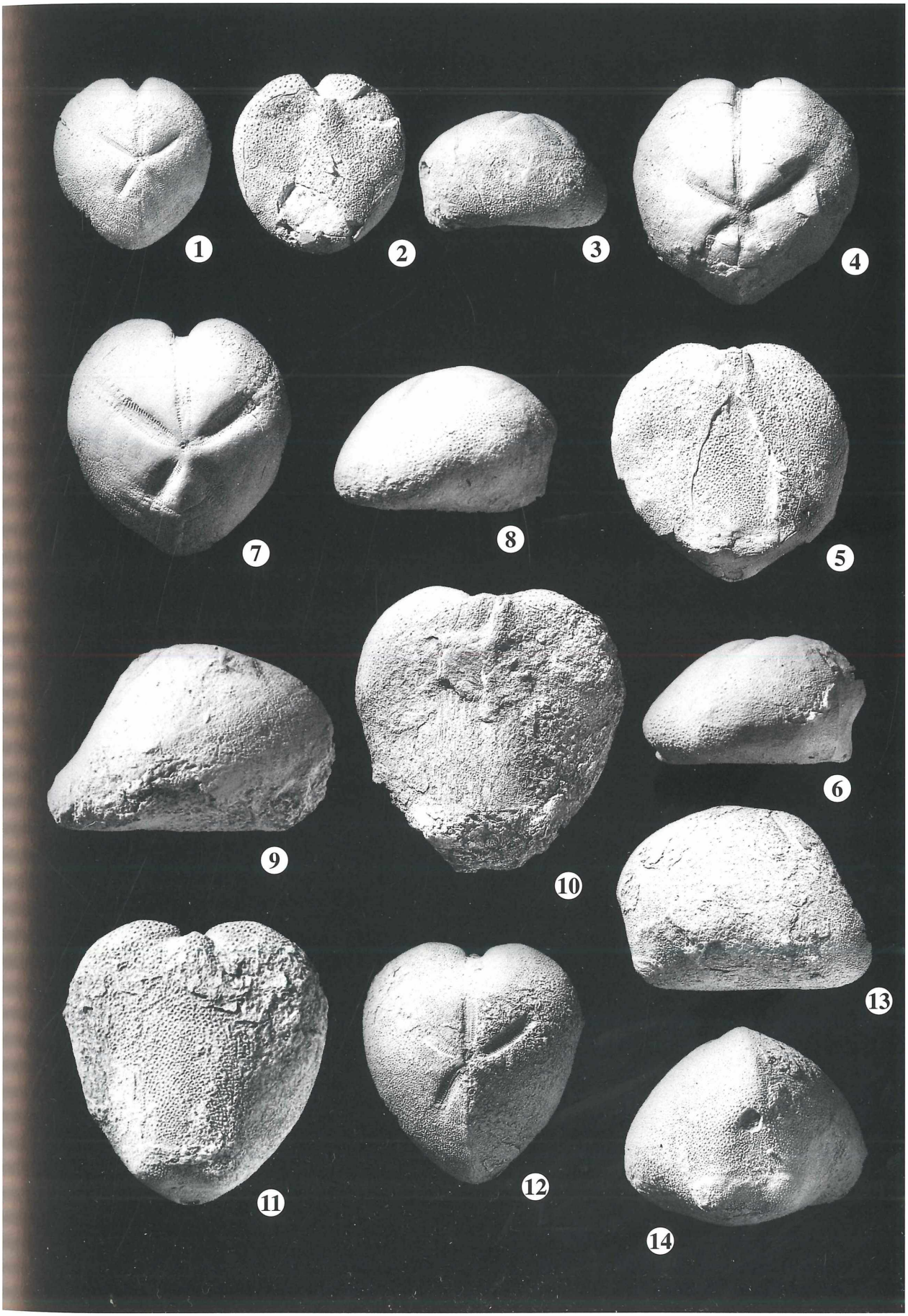

Plate 3

Figs. 1–3: *Cardiaster* gr. *cordiformis/granulosus*; EST 195a.

Fig. 4: *Echinocorys* sp.; EST 128.

Figs. 5–7: *Echinocorys* gr. *subglobosa* (GOLDFUSS); 5 is NHMW 1998z/98/6; 6 is EST 180; 7 is NHMW 1998z/98/7.

All specimens are from the Late Campanian of the Gschliefgraben near Gmunden; all are x 1.

PLATE 3