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Infulaster (Echinodermata: Echinoidea) from the Turonian of the Northern Calcareous Alps.

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KEYWORDS

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Abstract

The holasteroid echinoid *Infulaster excentricus* (WOODWARD, 1833) is recorded from the Ultrahelvetic Zone of the Northern Calcareous Alps for the first time. This record extends the range of this Middle to Late Turonian index fossil to the Tethys Realm, from which it was not known before. These echinoid specimens are also the first macrofossils from Turonian sediments of the Gschliefgraben section, which were formerly only recorded by micropalaeontological data.

Specimens from Austria are highly similar to *I. excentricus* from the British Chalk, but show minor differences in size and ambulacral pore development. Plastron plating is compared with previously un-described data on specimens in the BMNH collection revealing higher intraspecific variability than previously observed.

Infulaster excentricus (WOODWARD, 1833) ein holasteroider Seeigel wird erstmals aus dem Ultrahelvetikum der Nördlichen Kalkalpen beschrieben. Dies ist gleichzeitig der erste Nachweis von *I. excentricus* aus dem tethyalen Raum, aus dem diese Leitform für das Mittel- und Ober-Turonium bislang noch unbekannt war. Die hier beschriebenen Echiniden sind die ersten Makrofossilbelege aus dem Turoniums des Gschliefgraben, welches bislang nur durch mikropaläontologische Daten nachweisbar war.

Die österreichischen Exemplare von *I. excentricus* stimmen weitgehend mit den Stücken aus dem britischen Chalk überein. Geringfügige Differenzen betreffen die Größe und die Entwicklung der Ambulakralporen. Der Plastron-Aufbau wurde mit dem von unpublizierten Stücken aus der BMNH-Sammlung verglichen. Es zeigte sich, dass dieses Merkmal eine stärkere intraspezifische Variation aufweist als bislang beobachtet.

1. Introduction

Spatangoid and holasteroid echinoids - often called heart urchins - are common fossils in marine deposits, especially in shales and sandstones from the Cretaceous onwards. Their infaunal mode of life and adaptation to burrowing in mobile sediments accounts for their comparatively good fossil record (KIER, 1977). Despite being benthic animals, their common and widespread occurrence and evolutionary success has led to their employment as biostratigraphic markers, particularly for the Late Cretaceous (e.g. the *Micraster* zones in the Chalk of southern England and northern Germany).

The present paper reports on a new record of a holasteroid echinoid from the Northern Calcareous Alps recovered from the Gschliefgraben section. There, strata ranging from the Early Cretaceous to the Eocene crop out (PREY, 1983). Recent research has mainly focussed on Upper Campanian ammonites (KENNEDY and SUMMESBERGER, 1999), inoceramids (TRÖGER et al., 1999) and echinoderms (JAGT, 1999; KROH and JAGT, 2004). New material recently collected by private collectors and donated to the NHMW is described here. Apart from a record of indeterminable ammonites belonging to the Texanitinae (KENNEDY and SUMMESBERGER, 1999) the new specimens represent the first macrofossils collected from Pre-Campanian strata of the Gschliefgraben section.

2. Study area

The study area is located on the northern border of the Northern Calcareous Alps in the vicinity of Gmunden, Upper Austria (Fig. 1). The Gschliefgraben is a tectonic window exposing ultrahelvetic rocks which are mostly covered (overthrust) by the Flysch Nappe in the Northern Calcareous Alps. The sedimentary sequence includes Albian (Lower Cretaceous) to Eocene (Palaeogene) strata (PREY, 1983). It consists mainly of marls and marly limestones in the Cretaceous part and glauconitic sandstones and nummulitic limestones in the Palaeogene. Macrofossils are commonly restricted to certain levels, occurring predominantly in Upper Campanian and Eocene strata (Table 1; see also KROH and JAGT, 2004: Fig. 2). Bed-by-bed collection is impossible due to the unstable slopes of the Gschliefgraben mudflow (see PREY, 1983: 97). A synthetic section based on estimated thicknesses as well as on previously published stratigraphic data (PREY, 1983; KENNEDY and SUMMESBERGER, 1984) is given by KROH and JAGT (2004: Fig. 2).

From a palaeogeographic point of view, the ultrahelvetic strata exposed at Gschliefgraben were deposited at the southern slope of the European continental plate and belong to the Tethys Realm. The echinoderm faunas documented so far (Table 1) contain representatives of the North Temperate

realm (shallow water taxa), as well as Tethyan elements (bathyal taxa; KROH and JAGT, 2004: 568).

ABBREVIATIONS

NHMW - Naturhistorisches Museum Wien, Austria
BMNH - Natural History Museum, London, UK
TL - Test length

3. Systematic palaeontology

All specimens described in this study are housed in the collection of the Natural History Museum Vienna. For an explanation of the symbols in front of the dates in the synonymy list see MATTHEWS (1973). Text in angular brackets are comments by the author.

Class Echinoidea LESKE, 1778
Order Holasteroida DURHAM and MELVILLE, 1957
Suborder Cardiasterina POMEL, 1883
Family Cardiasteridae LAMBERT, 1917
Genus *Infulaster* DESOR, 1858
Infulaster excentricus (WOODWARD, 1833)

* *1833 Spatangus excentricus*. ROSE (MS). WOODWARD: 37; pl. 1, fig. 5.
1850 *Cardiaster excentricus*, WOODWARD. - FORBES: 443.
1852 *Cardiaster* […] *"Spatangus" excentricus*. - FORBES: 1-3; pl. 10, figs. 1-18.
1854 *Cardiaster excentricus*, ROSE, sp. - MORRIS: 73.
\# 1855 *Cardiaster Hagenowi*, D'ORB., 1853 - D'ORBIGNY: 143-144; pl. 832, figs. 1-5.
1858 *Infulaster Brochardi* HAGENOW. - DESOR: 348.
1858 *Infulaster excentricus* FORBES. - DESOR: 348.
1858 *Infulaster Hagenowi* BROCH. [SIC!] - DESOR: pl. 39, figs. 1-5.
? 1875 *Infulaster Krausei* QUENSTEDT: 614; pl. 86, fig. 14 [fide Nietsch (1921)]
1876 *Infulaster excentricus* FORB. - SCHLÜTER: 475
1878 *Infulaster excentricus* FORB. sp. - BEHRENS: 244-246; pl. 11, figs. 2a-c.
1881 *Infulaster excentricus* ROSE. - WRIGHT: 305-307; pl. 70, figs. 1a-k.
1921 *Infulaster excentricus* ROSE. - NIETSCH: 14-15; pl. 2, figs. 12a-d.
1921 *Infulaster Hagenowi* D'ORB. - NIETSCH: 15; pl. 2, figs. 10, 11, 14a-c.
\# 1921 *Infulaster Wöhrmanni* NIETSCH: 15-16; pl. 2, figs. 9, 13a-c.
pt 1949 *Infulaster excentricus* (WOODWARD, ex ROSE MS.). - WRIGHT and WRIGHT: 456-460; figs. 2a-b, 3-6 [not fig. 1 = Infulaster praecursor SMITH and WRIGHT, 2003].
1950 *Infulaster excentricus* FORBES. - MORTENSEN: 97.
1950 *Infulaster Hagenowi* (D'ORBIGNY). - MORTENSEN: 96; figs. 95, 96 [from DESOR 1858], 97b [from NIETSCH, 1921].
1950 *Infulaster Wöhrmanni* NIETSCH. - MORTENSEN: 96; fig. 97a (from NIETSCH, 1921)
1959 *Infulaster excentricus* FORBES, 1852. - MOSKVIN and POSLAVSKAYA: 271; pl. 17, figs. 4a-r.

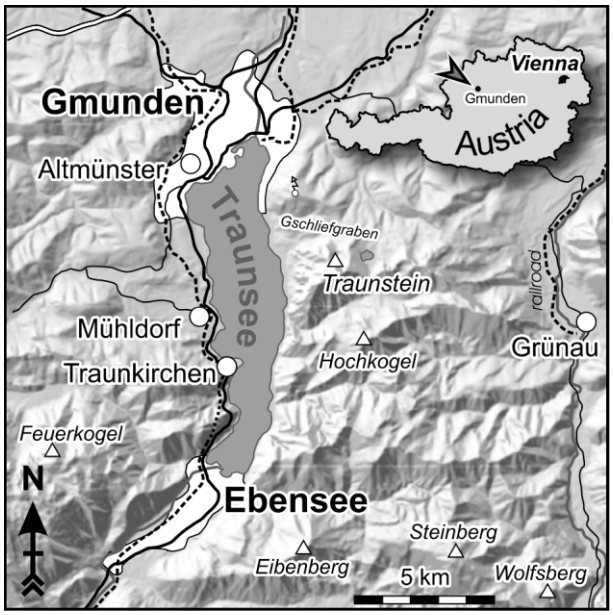

Figure 1: Position of the study area superimposed on a digital height model. Inset shows the location of the region within Austria. Thick dark lines: major roads; thin dark lines: minor roads; stippled lines: railroads; grey lines: rivers; white circles and white areas: villages and urban areas; triangles: mountains (from KROH and JAGT 2004: Fig. 1).

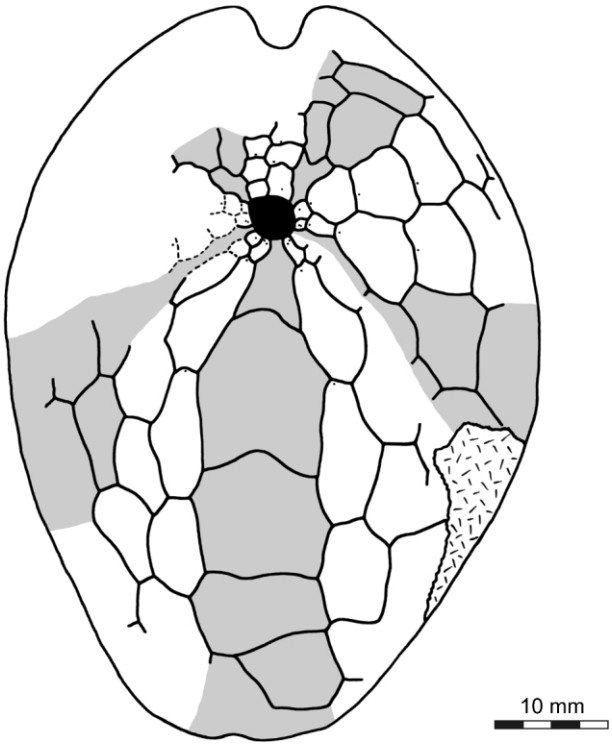

Figure 2: Camera lucida drawing of the oral plating in specimen NHMW 2005z0259/0019 of *Infulaster excentricus* (WOODWARD, 1833). Interambulacra are shaded, poorly visible sutures omitted or stippled.

(?) 1959 *Infulaster hagenowi* D'ORBIGNY, 1853. - MOSKVIN and POSLAVSKAYA: 272; pl. 17, figs. 5а-в.

? 1964 *Infulaster excentricus* (FORBES). - POSLAVSKAYA and SOLOVJIEV: 180; fig. 213д [plastronal plating indicates that this might be *I. praecursor* SMITH and WRIGHT, 2003].
1964 *Infulaster hagenowi* (D'ORBIGNY). - POSLAVSKAYA and SOLOVJIEV: 179, 180; fig. 214д; pl. 34, figs. 2а-в.
1966 *Infulaster excentricus* (WOODWARD). - WAGNER and DURHAM: U530; figs. 417(4a-c)
1971 *Infulaster excentricus* (WOODWARD 1833) und *I. hagenowi* (D'ORB. 1855). - ERNST and SCHULZ: 136; figs. 2 (W2, W18, H1, WL1)
1974 *Infulaster excentricus* (FORBES, 1852) - SAVCHINSKAYA: 325-326; pl. 108, figs. 4-7
1982 *Infulaster excentricus* (WOODWARD, 1833). - GALE and SMITH: 12-14; text-fig. 2(1).

? 1984 *Infulaster excentricus* (WOODWARD, 1833) - MĄCZYŃSKA: 455-456; pl. 206, figs. 2a-e

? 1989 *Infulaster excentricus* (WOODWARD, 1833) - MĄCZYŃSKA: 312-313; pl. 207, figs. 2a-e

? 1997 *Infulaster* sp. (= ? *Infulaster excentricus* (WOODWARD, 1833)) - TUR: 200; figs. 62a-b.
2003 *Infulaster excentricus* (WOODWARD, 1833). - SMITH and WRIGHT: 515-519; text-figs. 211, 212; pl. 165, figs. 1-19; pl. 166, figs. 5-8.

Fig. 2, Figs. 3A-F

Material: 2 specimens from the Gschliefgraben, near Gmunden, Upper Austria (NHMW 2005z0259/0018, 2005z0259/0019).

Measurements: Specimen NHMW 2005z0259/0019:
Test length: 68.6 mm
Test width: 53.0 mm
Test height: 43.9 mm
Posterior height: ~ 25 mm (deformed)
Distance apex-anterior margin: ~13 mm (deformed)
Apical angle: ~ 105° (deformed)

Description: The specimens are large, cordiform, antero-poste-

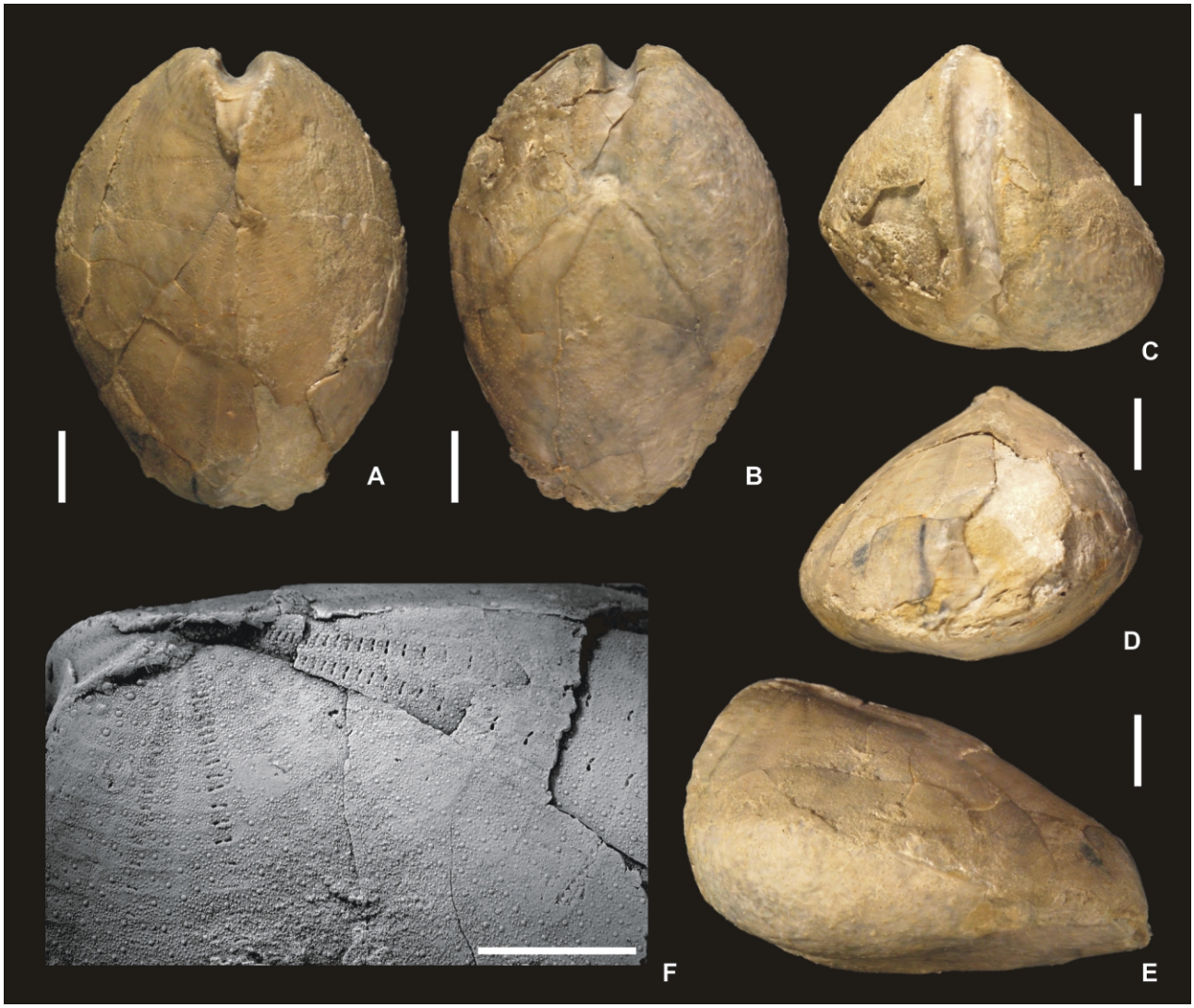

Figure 3: *Infulaster excentricus* (WOODWARD, 1833). A-F: NHMW 2005z0259/0019. - Gschliefgraben, near Gmunden, Austria (A: aboral view, B: oral view, C: anterior view, D: posterior view, E: left lateral view, F: oblique aboral view of adapical ambulacra IV and V coated with ammonium chloride). Scale bars equal 10 mm.

riorly elongated with a moderately deep, narrow frontal notch. In profile they are distinctly wedge-shaped, with strongly anteriorly displaced apex and the aboral side sloping towards the posterior end. The anterior end is high and rounded, the posterior end low and vertically truncated. The oral side is inflated and appears distinctly convex in side view.

The apical disc is situated immediately posterior of the apex and belongs to the elongate type, characteristic for holasteroids. Genital plate boundaries cannot be observed due to the poor preservation of the apical region in both specimens.

Ambulacrum III is relatively narrow and forms a well defined frontal groove between the apex and the peristome. The other ambulacra are slightly wider than the interambulacra at the ambitus and are flush with the interambulacra. Aborally ambulacra I, II, IV, and V are nonpetaloid and bear small elongate isopores. The pores lie parallel to the horizontal sutures and are located centrally along the adoral sutures on the ambulacral plates. Adapically the pores are closely spaced. Ambitally they are more widely spaced due to the increasing plate height towards the ambitus. The pores of the anterior columns in ambulacra II and IV are noticeably narrower than those of the posterior columns. Orally the ambulacral pores are minute unipores. In the ambulacrum III the pores are minute, oblique, partitioned isopores, the obliqueness increasing adorally, the pores being nearly vertically arranged close to the peristome.

Interambulacrum 5 forms a moderately high keel aborally, between the apex and the periproct. Likewise, interambulacral columns 2b and 3a form sharp keels (carinae) on both sides of the frontal groove. Adorally the interambulacra 1 and 4 are

Species	Age	Reference
Crinoidea		
Austinocrinus rothpletzi STOLLEY, 1892	Late Santonian - Late Campanian	JAGT (1999)
Echinoidea		
Cidaroida		
Cidaroida indet.	-	PREY (1983)
Rhabdocidaridae ? indet.	-	JAGT (1999)
Hemicidaroida		
"*Diplopodea* sp." [sic!, probably *Diplopodia*]	?	MICHELIN (in VON HAUER 1858)
Echinoeoida		
Conoclypeus anachoreta AGASSIZ, 1839	Eocene	PREY (1983)
Pyrina carinata ?	?	MICHELIN (in VON HAUER 1858)
Holasteroida		
Cardiaster gr. *cordiformis/granulosus*	Late Campanian - Maastrichtian	JAGT (1999)
Echinocorys sp.	-	PREY (1983)°, JAGT (1999)
E. ancileformis MOSKVIN and SHIMANSKAYA,1981	Late Paleocene	KROH and JAGT (2004)
E. ex gr. *fonticola* ARNAUD, 1897	Early - ? Late Campanian	KROH and JAGT (2004)
E. gr. *conica* (AGASSIZ, 1847) ?	Early Campanian - Early Maastrichtian	JAGT (1999)
E. gr. *subglobosa* (GOLDFUSS, 1829)	Early Campanian - Late Maastrichtian	JAGT (1999)
Ganbirretia? sp.	-	KROH and JAGT (2004)
Lampadocorys? *estermanni* KROH and JAGT, 2004	Middle - Late Campanian (CC18-CC23)*	KROH and JAGT (2004)
Lampadocorys? sp. nov. 1	? Campanian	KROH and JAGT (2004)
Lampadocorys? sp. nov. 2	Late Campanian (CC22c)*	KROH and JAGT (2004)
Pseudoffaster caucasicus (DRU, 1884)	Early Campanian - Maastrichtian	JAGT (1999)
Rispolia cf. *subtrigonata* (CATULLO, 1827)	Coniacian-Campanian	KROH and JAGT (2004)
Seunaster cf. *heberti* (SEUNES, 1889)	Maastrichtian	KROH and JAGT (2004)
Spatangoida		
Coraster beneharnicus SEUNES, 1888	Danian**	KROH and JAGT (2004)
Micraster aturicus HÉBERT in SEUNES, 1891	Early Campanian - Maastrichtian	JAGT (1999), KROH and JAGT (2004)
Linthia insignis (MERIAN, 1853)	Eocene	PREY (1983)
M. corcolumbarium DESOR, 1858	Early - Late Campanian	KROH and JAGT (2004)
M. stolleyi (LAMBERT in DE GROSSOUVRE, 1901)	Late Campanian	KROH and JAGT (2004)
M. gr. *schroederi/glyphus*	Early - Late Campanian	JAGT (1999)
Prenaster alpinus DESOR, 1853	Early - Mid Eocene	PREY (1983)
Pseudogibbaster? sp.°°	-	KROH and JAGT (2004)

* age of specimens controlled by calcareous nannoplankton analysis (WAGREICH in KROH and JAGT 2004)
** calcareous nannoplankton sample from the matrix were inconclusive (WAGREICH in KROH and JAGT 2004)
° as "*Ananchytes ovata*" by PREY (1983)
°° as "*Micraster gibbus* ?" by MICHELIN (in VON HAUER 1858)

TABLE 1: Echinoderms reported from the Gschliefgraben section and their stratigraphic ranges.

very narrow and blade-like, being constricted by the adjacent ambulacra (Fig. 2). The plastron is meridosternous; with a triangular labral plate followed by three uniserially arrange sternal plates (Fig. 2). The plastron is slightly raised along the midline, forming a weak keel.

The tuberculation is generally rather sparse, with few small and widely spaced primary tubercles interspersed with granules. On the aboral side, the surface appears smooth to the naked eye, except for a few enlarged tubercles in adapical interambulacra 2 and 3. On the oral side, primary tubercles are considerably larger than on the aboral side, but similarly widely spaced. The plastron is the only part of the test which is more densely tuberculate, the tubercles being arranged in loose columns radiating from the central elevations of the sternal plates. The periplastronal plates largely lack primary tubercles.

The peristome is small (4.5 mm length, 3.8 mm width) and irregularly circular. It is situated anteriorly (~ 25 % TL away from the anterior margin) and faces obliquely into the frontal groove formed by ambulacrum III.

The periproct is located high on the vertically truncated posterior end and seems to have been vertically elongated. It is not well preserved in either specimen.

Ambitally there are some traces of a marginal fasciole (in interambulacral 2, 3, 4 and ambulacral columns IVa, b and Va), which crosses ambulacrum III just below the ambitus. The fasciole corresponds to the parafasciole type of NÉRAUDEAU et al (1998).

Remarks: The present specimen falls well within the morphological variation of contemporary *Infulaster excentricus*-populations from the British Chalk and North European Schreibkreide (namely specimens from Swaffham (Norfolk), Boswell Farm (Lincolnshire), and Wolin (Poland)). Minor differences observed in the Austrian specimens comprise their comparatively large size and larger pores in the aboral ambulacra, the later possibly being a result of the former. Another (supposed) difference concerns the structure of the plastron: Published descriptions of *Infulaster excentricus* invoke the impression that variation of plastron architecture in this species is low. SMITH and WRIGHT (2003: 516) state that "Plastron plating rather uniform […] triangular labral plate followed by two somewhat asymmetrical plates arranged uniserially. […] Rarely, there may be three single plates following the labral plate", but comment that it is "...not certain that this specimen [the one with three plates] is correctly identified... " (SMITH and WRIGHT, 2003: 519).

New data from the BMNH collection show that plastron architecture is much more variable than formerly thought (data courtesy of A.B. SMITH, BMNH): Though the presence of two uniserial plates following the labrum (first plate not stretching across entire width of plastron is 5.b.3) appears to be the most common state (occurring in numerous specimens from Norfolk and Lincolnshire; BMNH E44188, EE6802, E33903, E40114, E33899, E33904, E44201), three uniserial plates (first biserial plate is 5.a.3) are also common (e.g. in specimens from Kent, Norfolk and Lincolnshire; BMNH E33898, E33901, E76832, E40112). Four uniserial plates (first biserial plate is 5.b.4) were observed in a specimen of doubtful age from Yorkshire (BMNH EE6799). The plastron structure in the present specimen thus does not differ from that observed in British populations.

Apart from the type species (*I. excentricus*), few other species of *Infulaster* have been described. Most (e.g. *I. borchardi* DESOR, 1858, *I. hagenowi* DESOR, 1858) are regarded as synonyms of *I. excentricus* (SCHLÜTER, 1876; BEHRENS, 1878; SMITH and WRIGHT, 2003). According to SMITH and

Broinsonia enormis (SHUMENKO, 1968) MANIVIT, 1971
Calculites ovalis (STRADNER, 1963) PRINS and SISSINGH, 1977
Chiastozygus litterarius (GORKA, 1957) MANIVIT, 1971
Eiffellithus eximius (STOVER, 1966) PERCH-NIELSEN, 1968
Eiffellithus turriseiffelii (DEFLANDRE and FERT, 1954) REINHARDT, 1965
Eprolithus floralis (STRADNER, 1962) STOVER, 1966
Gartnerago obliquum (STRADNER, 1963) NOEL, 1970
Glaukolithus sp.
Lithastrinus septenarius FORCHHEIMER, 1972
Lithraphidites carniolensis DEFLANDRE, 1963
Lucianorhabdus maleformis REINHARDT, 1966
Nannoconus sp.
Prediscosphaera cretacea (ARKHANGELSKY, 1912) GARTNER, 1968
Quadrum gartneri PRINS and PERCH-NIELSEN in MANIVIT et al., 1977
Rhagodiscus angustus (STRADNER, 1963) REINHARDT, 1971
Stradneria crenulata (BRAMLETTE and MARTINI, 1964) NOEL, 1970
Tranolithus orionatus (REINHARDT, 1966) PERCH-NIELSEN, 1968
Watznaueria barnesae (BLACK, 1959) PERCH-NIELSEN, 1968

Interpretation (by MICHAEL WAGREICH):
Though generally poorly preserved, the nannoflora can be attributed to zone CC12 = Middle/Late Turonian (above FO of *Eiffellithus eximius* and *Lucianorhabdus maleformis*; below FO of *Marthasterites furcatus*) following PERCH-NIELSEN (1985). According to the scheme of BURNETT (1998) the sample belongs to zone UC9 = Middle/Late Turonian – Early Coniacian (above FO of *Lithastrinus septenarius* below FO of *Micula staurophora*).

Table 2: Nannoplankton from a sample from the matrix of Infulaster excentricus, specimen NHMW 2005z0259/0019.

WRIGHT (2003: 518) *Infulaster woehrmanni* NIETSCH, 1921 is also synonymous to *I. excentricus*, having been established upon a small specimen that is identical to juveniles from British populations. *Infulaster praecursor* SMITH and WRIGHT, 2003 is the only other well known, valid species of *Infulaster*, differing from I. excentricus both in shape (lower profile, larger apical angle) and structure (with only a single uniserial plate following the labrum). Data on *Infulaster tuberculatus* VALETTE, 1913 is still patchy, but the species is maintained as valid by SMITH and WRIGHT (2003: 520) based on its younger age, smaller size and its differing corona shape (lesser antero-posteriorly elongation).

Occurrence: Middle - Late Turonian (WRIGHT and WRIGHT, 1949; ERNST and SCHULZ, 1971; GALE and SMITH, 1982; SMITH and WRIGHT, 2003). Probably also early Coniacian (a single specimen from the *M. cortestudinarium* zone at Dover; GALE and SMITH, 1982; SMITH and WRIGHT, 2003) and the Early Coniacian of Russia (MOSKVIN and POSLAVSKAYA, 1959).

England: Boswell Farm, Lincolnshire (SMITH and WRIGHT, 2003), Dover, Kent (FORBES, 1850, 1852; MORRIS, 1854; WRIGHT and WRIGHT, 1949; GALE and SMITH, 1982), Lincolnshire (WRIGHT and WRIGHT, 1949; GALE and SMITH, 1982), Swaffham, Norfolk (FORBES, 1850, 1852; WRIGHT and WRIGHT, 1949; SMITH and WRIGHT, 2003), West Norfolk (WOODWARD, 1833; MORRIS, 1854; DESOR, 1858; GALE and SMITH, 1982), Yorkshire (WRIGHT and WRIGHT, 1949; GALE and SMITH, 1982); Kiplingcotes, Yorkshire (SMITH and WRIGHT, 2003).

France: Douvres (DESOR 1858).

Germany: ? Halberstadt (QUENSTEDT, 1875), Lengerich, Lüneburg, Örlinghausen/Osning, Salzgitter-Salder, and Paderborn (ERNST and SCHULZ, 1971).

Poland: ? Miechów Trough (MĄCZYŃSKA, 1984, 1989), Stettin, Island Wolin (DESOR, 1858; SCHLÜTER, 1876; BEHRENS, 1878; NIETSCH, 1921; ERNST and SCHULZ, 1971).

Ukraine: Kopet Dag (MOSKVIN and POSLAVSKAYA, 1959; POSLAVSKAYA and SOLOVJIEV, 1964), Crimea (POSLAVSKAYA and SOLOVJIEV, 1964; SAVCHINSKAYA, 1974; ? TUR, 1997), Caucasia (POSLAVSKAYA and SOLOVJIEV, 1964).

4. Discussion

The unstable outcrop situation of the Gschliefgraben (see PREY, 1983: 97) precludes bed-by-bed collecting in most instances. The two specimens discussed here were picked from scree and donated to the NHMW by the private collector FERDINAND ESTERMANN (Gmunden). Thus, the stratigraphic provenance of the specimens is unclear. From a lithological point of view, the adhering matrix is very similar to the grey Upper Campanian marls and marly limestones that yielded nearly all of the (Cretaceous) macro-fossils recovered from the Gschliefgraben so far (FRAAYE and SUMMESBERGER, 1999; JAGT, 1999; KENNEDY and SUMMESBERGER, 1999; TRÖGER, et al. 1999; WAGREICH, 1999; KROH and JAGT, 2004; SUMMESBERGER and KENNEDY, 2004). A Mid/Late Turonian to Early Coniacian age, however, resulted from calcareous nannofossils investigation of the matrix of specimen NHMW 2005z0259/0019 conducted by MICHAEL WAGREICH (Table 2). This fits well with the stratigraphy implied by the echinoid species *Infulaster excentricus* itself, which occurs from the Late Turonian to Early Coniacian of the Chalk (SMITH and WRIGHT, 2003 and references therein). Samples taken from the second specimen (NHMW 2005z0259/0018) did not yield age-indicative nannofossils (due to poor preservation).

The present specimens represent the first macrofossils recovered from the Turonian of the Gschliefgraben section. The Turonian was previously recorded by foraminiferal evidence only (PREY, 1983). They furthermore extend the range of this index species that was previously reported from the Boreal Area only to the Tethys Realm.

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References

Behrens, G., 1878. Ueber die Kreideablagerungen auf der Insel Wollin. Zeitschrift der Deutschen Geologischen Gesellschaft, 30, 229-267.

Burnett, J.A., 1998. Upper Cretaceous (with contributions from Gallagher, L.T. and Hampton, M.J.). In: P.R. Bown (Editor), Calcareous Nannofossil Biostratigraphy. Kluwer Academic Publishers, Dordrecht, pp. 132–199.

Desor, E., 1855-1858. Synopsis des échinides fossiles. Reinwald, Paris, Ixviii+490 pp.

Durham, J.W. and Melville, R.V., 1957. A classification of echinoids. Journal of Paleontology, 31/1, 242-272.

Ernst, G. and Schulz, M.-G., 1971. Die Entwicklungsgeschichte der hochspezialisierten Echiniden-Reihe *Infulaster - Hagenowia* in der borealen Oberkreide. Paläontologische Zeitschrift, 45/3-4, 120-143.

Forbes, E., 1850. On *Cardiaster*, a new genus of Cretaceous Echinidæ, allied to Holaster. The Annals and Magazine of Natural History, 2nd Series, 6, 442-444.

Forbes, E., 1852. Figures and descriptions illustrative of British organic remains. Memoires of the Gological Survey of the United Kingdom, Dec. IV.

Fraaye, R.H.B. and Summesberger, H., 1999. New crustacean records from the Late Campanian of Austria. Beiträge zur Paläontologie, 24, 1-6.

Gale, A.S. and Smith, A.B., 1982. The palaeobiology of the Cretaceous irregular echinoids *Infulaster* and *Hagenowia*. Palaeontology, 25/1, 11-42.

Hauer, F.R.v., 1858. Ueber die Eocengebilde im Erzherzogthume Oesterreich und in Salzburg. Jahrbuch der kaiserlich-königlichen Geologischen Reichsanstalt, 9, 103-137.

Jagt, J.W.M., 1999. Late Campanian echinoids and crinoids from the Gschliefgraben (Ultrahelvetic, Austria). Beiträge zur Paläontologie, 24, 7-22.

Kennedy, W.J. and Summesberger, H., 1999. New Late Campanian Ammonites from the Gschliefgraben near Gmunden (Ultrahelvetic, Austria). Beiträge zur Paläontologie, 24, 23-39.

Kier, P.M., 1977. The poor fossil record of the regular echinoids. Paleobiology, 3, 168-174.

Kroh, A. and Jagt, J.W.M., 2004. Additional records of Late Cretaceous and Early Palaeogene echinoids from the Gschliefgraben (Ultrahelvetic, Upper Austria). Acta Geologica Polonica, 54/4, 551-571.

Lambert, J., 1917. Note sur quelques Holasteridae. Bulletin de la Société des Sciences Historiques et Naturelles de l'Yonne, 70/2, 191-223.

Leske, N.G., 1778. Jacobi Theodori Klein naturalis dispositio echinodermatum . . ., edita et descriptionibus novisque inventis et synonomis auctorem aucta. Addimenta ad I. T. Klein naturalem dispositionem Echinodermatum. G. E. Beer, Leipzig, XXII+278 pp.

Mączyńska, S., 1984. Typ Echinodermata. In: L. Malinowska (ed.), Budowa geologiczna Polski, tom III; Atlas skamienialosci przewodnich i charakterystycznych czesc 2c; Mesozoik, Kreda. Wydwanictwa Geologiczne, Warszawa, pp. 425-461.

Mączyńska, S., 1989. Type Echinodermata. In: L. Malinowska (ed.), Geology of Poland. Volume III. Atlas of Guide and Characteristic Fossils Part 2c Mesozoic, Cretaceous. Wydwanictwa Geologiczne, Warszawa, pp. 300-315.

Matthews, S.C., 1973. Notes on open nomenclature and on synonymy lists. Palaeontology, 16/4 , 713-719.

Morris, J., 1854. A Catalogue of British Fossils: comprising the genera and species hitherto described; with references to their geological distributions and to the localities in which they have been found. Second Edition. John Morris, London, i-vii , 372 pp.

Mortensen, T., 1950. A Monograph of the Echinoidea. V, 1. Spatangoida I. Protosternata, Meridosternata, Amphisternata I. Palæopneustidæ, Palæostomatidæ, Aëropsidæ, Toxasteridæ, Micrasteridæ, Hemiasteridæ. C. A. Reitzel, Copenhagen, 432 pp.

Moskvin, M.M. and Poslavskaya, N.A., 1959. Echinodermata. In: M.M. Moskvin (ed.), [Atlas of the Upper Cretaceous Fauna of the northern Caucasus and Crimea]. Gas Industry of the USSR, Moskva, pp. 237-304.

Néraudeau, D., David, B. and Madon, C., 1998. Tuberculation in spatangoid fascioles: Delineating plausible homologies. Lethaia, 31, 323-334.

Nietsch, H., 1921. Die irregulären Echiniden der pommerschen Kreide. Abhandlungen aus dem Geologisch Palaeontologischen Institut der Universität Greifswald, 2, 1-47 .

d'Orbigny, A., 1853-1855. Terrains Crétacés. Tome Sixième, contenant les Échinodermes. Paléontologie Française. Description zoologique et géologique de tous les Animaux Mollusques et Rayonnés fossiles de la France, comprenant leur application a la reconnaissance des couches., 6, Victor Masson, Paris, 596 pp.

Perch-Nielsen, K., 1985. Mesozoic calcareous nannofossils. In: H.M. Bolli, J.B. Saunders and K. Perch-Nielsen (Editors), Plankton Stratigraphy., Cambridge University Press, Cambridge, pp. 329-426.

Pomel, A., 1883. Classification méthodique et Genera des Échinides vivante et fossiles. Thèses présentées a la Faculté des Sciences de Paris pour obtenir le Grade de Docteur ès Sciences Naturelles, 503, Aldolphe Jourdan, Alger, 131 pp.

Poslavskaya, N.A. and Solovjev, A.N., 1964. [Class Echinoidea. Sea Urchins. Systematic Part (Order Spatangoida)]. In: Y.A. Orlov and R.F. Gekker (eds.), [Principles of paleontology. Handbook for Palaeontologists and Geologists of the SSSR - Echinodermata, Hemichordata, Pogonophora, Chaetognatha]. Nedra Press, Moscow, pp. 174-189.

Prey, S., 1983. Das Ultrahelvetikum-Fenster des Gschliefgrabens südöstlich von Gmunden (Oberösterreich). Jahrbuch der Geologischen Bundesanstalt, 126/1, 95-127.

Quenstedt, F.A., 1875. Petrefactenkunde Deutschlands. I. Abtheilung, 3. Band. Echinodermen (Echiniden). Fues's Verlag (R. Reisland), Leipzig, viii+720 pp.

Savchinskaya, O.V., 1974. Tip Echinodermata. In: G.Y. Krymgoltz (ed.), [Atlas of Upper Cretaceous Fauna of the Don Basin]. Nedra, Moscow, pp. 303-333.

Schlüter, C., 1876. Verbreitung der Cephalopoden in der oberen Kreide Norddeutschlands. Zeitschrift der Deutschen Geologischen Gesellschaft, 28, 457-518.

Smith, A.B. and Wright, C.W., 2003. British Cretaceous echinoids. Part 7, Atelostomata, 1. Holasteroida. Monographs of the Palaeontographical Society, 156 (619), 440-568.

Summesberger, H. and Kennedy, W.J., 2004. More Ammonites (Puzosiinae, Pachydiscidae, Placenticeratidae, Nostoceratidae, Diplomoceratidae) from the Campanian (Late Cretaceous) of the Gschliefgraben (Ultrahelvetic Nappe; Austria). Annalen des Naturhistorischen Museums in Wien, 106A, 167-211.

Tröger, K.-A., Summesberger, H. and Skoumal, P., 1999. Inoceramidae from the Campanian (Upper Cretaceous) of the Gschliefgraben (Ultrahelvetic; Austria). Beiträge zur Paläontologie, 24, 41-61.

Tur, N.A., 1997. [Echinoidea]. In: V.V. Arkadiev and T.N. Bogdanova (eds.), [Atlas of the Cretaceous fossils of south-western Crimea]. St. Petersbourg State University, St. Petersbourg, pp. 186-206.

Valette, A., 1913. Description de quelques échinides nouveaux de la Craie. 2e supplément. Bulletin de la Société des Sciences Historiques et Naturelles de l'Yonne, 67, 3-48.

Wagner, C.D. and Durham, J.W., 1966. Holasteroids. In: R.C. Moore (ed.), Treatise on Invertebrate Paleontology, U. Echinodermata. 3 (2). GSA & Univ. of Kansas Press , Boulder, CO & Lawrence, KS, pp. U523-U543.

Wagreich, M., 1999. Calcareous nannofossil assemblages from the Gschliefgraben near Gmunden (Ultrahelvetic, Austria). Beiträge zur Paläontologie, 24, 63-67.

Woodward, S., 1833. An Outline of the Geology of Norfolk. John Stacy, Norwich, 54 pp.

Wright, C.W. and Wright, E.V., 1949. The Cretaceous echinoid genera *Infulaster* Desor and *Hagenowia* Duncan. The Annals and Magazine of Natural History, 12th Series, 2, 454-474.

Wright, T., 1881. Monograph on the British fossil Echinodermata from the Cretaceous Formations. Vol. 1, part 9, on the Echinocoridæ. Monographs of the Palaeontographical Society, 24, 301-324.

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