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The Genus *Temnocidaris* (Echinoidea, Cidaroida) in the Upper Cretaceous and Lower Tertiary of the Maastricht area (Belgium and The Netherlands)

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Abstract

In the chalk-deposits of Limburg (Belgium and the Netherlands) the genus *Temnocidaris* is represented by two species, *T. baylei* and *T. danica*. The former is confined to the Maastrichtian, the latter to the Danian. *Temnocidaris* is biostratigraphically useful in the Limburg chalk, even when only small coronal fragments or isolated plates are available.
Key-words: Echinoids – Cretaceous – Palaeocene – Belgium – Netherlands.

Résumé

Dans les dépots craieux du Limbourg (Belgique et Pays-Bas) le genre *Temnocidaris* est représenté par deux espèces, *T. baylei* et *T. danica*. La première est confinée dans le Maastrichtien, la seconde ne se trouve qu'au Danien. *Temnocidaris* est utile pour la biostratigraphie dans les craies du Limbourg, même quand on n'a retrouvé que des petits fragments de la corona ou que des plaques isolées.
Mots-clefs: Echinides – Crétacé – Paléocène – Belgique – Pays-Bas.

Introduction

Formerly, all chalk and tuffaceous chalk, outcropping in the Maastricht-area, was considered to be of Upper Cretaceous age and lumped into the Maastrichtian stage. In old museumcollections, no distinction is made between material from the uppermost part of this carbonaceous succession, the Geulhem Chalk, and from the underlying members of the Maastricht Formation. This is very unfortunate, since it became clear that, in spite of striking lithological similarities, both deposits are faunistically very dissimilar. It is now generally accepted that the Geulhem Chalk is of Danian age (Palaeocene) (FELDER, 1975).

In the second half of the 20th century, valuable collections have been made in the Geulhem Chalk, mainly at two localities: the Curfs Quarry at Geulhem (The Netherlands) and the cutting of the King Albert Canal at Vroenhoven (Belgium). Numerous echinoids were collected at both localities, elucidating the faunistical characteristics of the Geulhem Chalk and its differences with the Maastricht Chalk. Salenioid echinoids from both strata were discussed in previous papers (GEYS, 1979, 1982). The present paper deals with the Cidaroid genus *Temnocidaris* (sensu GEYS, 1987).

Two species of *Temnocidaris* have been recognised in the Maastricht-area. Both are represented by fragments and coronal plates, fairly large numbers of which are present in the collections of the Royal Belgian Institute for Natural Sciences in Brussels (KBIN) and of the Natural History Museum in Maastricht (NHMM). The latter museum also houses a superbly conserved complete corona, with some radioles attached, from the Maastricht Chalk at Bemelen (prov. Limburg, the Netherlands).

The identification of isolated coronal plates of cidaroid echinoids is rarely possible. For most genera, these fossils are virtually without any taxonomic value. Yet, coronal plates of *Temnocidaris* can easily be recognised as such, owing to the presence of small pits on their surface, for the globiferous pedicellaria. Even the distinction of species is fairly easy. *T. baylei* COTTEAU, 1863 is not rare in the Maastricht Chalk (Upper Cretaceous); *T. danica* (DESOR, 1855) seems to be restricted to the Geulhem Chalk (Danian).

The generic name *Temnocidaris* has been given a much wider meaning by SMITH & WRIGHT (1989), who included *Stereocidaris* as a subgenus. Yet, *Temnocidaris*, as defined by GEYS (1987) coincides with *Temnocidaris* (*Temnocidaris*) sensu SMITH & WRIGHT (1989), including five known species (four fossil and one recent). The fossil species are confined to the Maastrichtian and the Danian.

Systematic palaeontology

Class Echinoidea LESKE, 1778
Order Cidaroida CLAUS, 1880
Family Cidaridae GRAY, 1825
Subfamily Stereocidarinae LAMBERT, 1900
Genus *Temnocidaris* COTTEAU, 1863

Type species: *Temnocidaris magnifica* COTTEAU, 1863; by original designation.

Temnocidaris baylei COTTEAU, 1863
Pl. 1, figs. 1-8; Pl. 2, figs. 1-3

*.1863 *Temnocidaris Baylei*, COTTEAU, p. 359, pl. 1087, fig. 1-7, pl. 1087bis, fig 1-6.
.1875 *Temnocidaris Baylei*, QUENSTEDT, p. 174, pl. 68, fig. 2.
.1910 *Temnocidaris Baylei*, LAMBERT & THIERY, p. 156.
.1928 *Temnocidaris danica*, KRENCKEL, p. 23, pl. 2, fig. 4-5.
v.1965 *Temnocidaris danica*, MEIJER, p. 23 (pro parte).
.1972 *Temnocidaris baylei*, NESTLER, p. 186-189, pl. 6, fig. 1-9.
.1973 *Temnocidaris baylei*, NESTLER, p. 986-987, pl. 1, fig. 15-16.
.1973 *Temnocidaris baylei*, KUTCHER, p. 108-109, frontcover.
.1975 *Temnocidaris baylei*, NESTLER, p. 85-86, fig. 133.
.1982 *Temnocidaris baylei*, SALAH, p. 210-212, pl. 3, fig. 1-3.
?* 1861 *Cidaris rimatus*, QUENSTEDT, p. 52.
? 1874 *Cidaris rimatus*, QUENSTEDT, p. 173; pl. 68, fig. 1.

Locus typicus: Royan, Charente-Maritime, France.

Stratum typicum: Lower Maastrichtian.

Occurrence outside the Maastricht-area
France: Maastrichtian in the depts. Dordogne, Charente, Charente-Maritime and Manche (COTTEAU, 1863).
German Democratic Republic: Lower Maastrichtian of the Isle of Rügen (NESTLER, 1972).
Federal Republic of Germany: Upper Maastrichtian at Hemmoor, Niedersachsen (SALAH, 1982).
Belgium: Upper Maastrichtian at Ciply, prov. Hainaut (COTTEAU, 1893).

SPECIMENS STUDIED
Maastricht Formation at St. Pietersberg, near Maastricht (prov. Limburg, The Netherlands): 3 fragments (KBIN IST-10474, IST-10475, IST-10476); 9 fragments (NHMM 001791 MM-915, MM-918, MM-7374).
Maastricht Formation at Maastricht (prov. Limburg, The Netherlands): 3 fragments (NHMM 001791).
Maastricht Formation at Valkenburg (prov. Limburg, The Netherlands): 24 fragments (KBIN).
Maastricht Formation at Bemelen (prov. Limburg, The Netherlands): 1 fragment (NHMM MM-975); 1 corona (NHMM 1982153).
Maastricht Formation at Geulhem (prov. Limburg, The Netherlands): 11 fragments (NHMM MM-103).
Maastricht Formation at Vroenhoven (prov. Limburg, Belgium): 1 fragment (KBIN); 2 fragments (NHMM MM-920).
Maastricht Formation in the cut of the Albert Canal (prov. Limburg and/or Liège, Belgium): 21 fragments (NHMM MM-911).
Maastricht Formation (1st Bryozoa-bed, Meerssen Member) in the cut of the Albert Canal, NW of Kanne (prov. Liège, Belgium): 1 fragment (J. Jagt collection 2282).
Maastricht Formation at Eben-Emael (prov. Liège, Belgium): 5 fragments (NHMM MM-053, MM-912, MM-924).

FIGURED SPECIMENS IN THE KBIN-COLLECTIONS
IST 10474, figured herein, Pl. 1, Fig. 7.
IST 10475, figured herein, Pl. 2, Fig. 1-3.
IST 10476, figured herein, Pl. 1, Fig. 8.

DESCRIPTION OF THE CORONAL FRAGMENTS
Interambulacral primary tubercles are perforate, non crenulate. The diameter of the scrobicules is 4 times as large as the mamelons. The bosses are smooth and conical: the mamelon and the central part of the bosses are higher than the rims of the scrobicular rings. The scrobicules are moderately sunken. Their distal borders are steep, but not overhanging. Scobicular rings are complete and consist of 15 small tubercles. The rings of adjacent plates touch each other adorally and adapically, but scrobicules are not confluent. Adradial extrascrobicular surfaces are narrow and covered by a fine, dense granulation, without obvious regular arrangement. Interradial extrascrobicular surfaces are wider and also covered by a very dense, fine granulation (6 or 7 granules/mm^2). All adradial and interradial granules have almost the same size. Interradially, they are arranged in subhorizontal rows, separated by very fine furrows, which sometimes bifurcate. Interradially, small coronal depressions are numerous.

DESCRIPTION OF SPECIMEN NHMM 1982153

D = 60 mm	
h = 47 mm	h/D = 0,78
ds = 24 mm	ds/D = 0,40
dp = 23 mm	dp/D = 0,58

The peristome is circular and not sunken. Gill slits are absent. The periproct is subpentagonal.
Ambulacra are sinuous and wide, with depressed poriferous zones. Pores are not conjugate, but neural grooves are present. The pore-pairs are slightly oblique. A small granule is present on the interporous partition. Interporiferous areas are densly granulated. The adradial granules are arranged in a single vertical series. These are larger than the perradial granules: there is only one on each ambulacral plate. Perradial granules are smaller and not arranged in vertical series. Their distribution is irregular. They cover a zone, about 5 granular diameters wide. Each ambulacral series consists of about 130 platelets. At the ambitus, there are 22 ambulacral platelets for each interambulacral plate. Perradial coronal depressions were not observed.
Interambulacral plates are 7 or 8 in a series. Primary tubercles are perforate, non crenulate. Small coronal depressions are numerous on the interradial extrascrobi-

cular surfaces. The specimen under discussion lacks an areole on one of its ambital interambulacral plates.
Primary radioles are lost. Some scrobicular radioles have been preserved in connection with the test. They show short, spatuliform, finely striated shafts. A few ambulacral radioles are also present. These are very slender and show a very fine, longitudinal striation.

DISCUSSION

Differences between *Temnocidaris magnifica* COTTEAU, 1863 ("Senonian"; Aurignac, France) and *T. baylei* COTTEAU, 1863 are minor and subtle. The latter species is smaller and less flattened; its ambulacra are more sinuous and narrower; perradial coronal depressions are less numerous and arranged in a single vertical series. In some specimens they are absent. Ambulacral tubercles are 6 to 7 on a plate in *T. baylei*, more numerous in *T. magnifica*. *T. baylei* and *T. magnifica* are much more easily distinguished from *T. danica* and from *T. schlueteri*. These differences are discussed in the next paragraph.
According to SALAH (1982), *T. baylei* is confined to the Upper Maastrichtian. In the Maastrichtian type-area, the species has indeed never been found in strata underlying the Maastricht Formation (e.g. the Gulpen Formation), thus confirming SALAH's statement. Nevertheless, in other regions *T. baylei* has been recorded from the Lower Maastrichtian: Rügen (G.D.R.), the Charentes (France). Hence, the stratigraphical distribution of the species seems to be wider than presumed by SALAH covering the Maastrichtian from bottom to top.
All *Temnocidaris*-specimens and coronal fragment from the Maastricht area, present in the collections of the "Natuurhistorisch Museum in Maastricht" (NHMM) have been labeled "*Temnocidaris danica*" by MEIJER. Yet, specimens collected in the Maastricht Formation clearly belong to *T. baylei* and have thus been misidentified. The NHMM-material has been used subsequently by MEIJER (1965), to establish faunal lists and stratigraphical range tables for Maastrichtian and Danian echinoids in the Maastricht area. We can only conclude that *T. danica* has been erroneously reported from the Maastricht Formation.
QUENSTEDT (1861) described a reworked flint cast from Satow, in what is now the Rostock Bezirk of the German Democratic Republic, which he calls *Cidaris rimatus*. The original stratigraphical position of the specimen is unknown. QUENSTEDT (1875) redescribes the same specimen and mentions the presence of coronal depressions; his figure however does not show these. Also in the north of the G.D.R. (Rügen), KRENCKEL (1928) discovered more flint casts, which he considers to be similar to QUENSTEDT's specimen, but which he identifies as *Temnocidaris danica*. Disregarding small differences, which he ascribes to observational inaccuracies by QUENSTEDT, KRENCKEL considers *C. rimatus* a junior synonym of *T. danica*.
More and better preserved specimens from the Lower Maastrichtian at Rügen, were described by NESTLER (1972, 1973, 1975) and KUTSCHER (1973), who identified them correctly as *Temnocidaris baylei*. KRENCKEL's Rügener specimens were found on beaches, below the chalk-cliffs and thus very probably also belong to the Lower Maastrichtian. According to NESTLER (1972), the name *T. danica* sensu KRENCKEL is a misidentification of *T. baylei*. I agree: KRENCKEL's figure clearly shows the fine miliary granulation of the latter species.
Regarding *C. rimatus* QUENSTEDT 1861 however, I share the doubts of NESTLER (1972), concerning its synonymy with *T. baylei* (or *T. danica* sensu KRENCKEL). The true nature of *Cidaris rimatus* still remains a mystery.

Temnocidaris danica (DESOR, 1855)
Pl. 2, figs. 4-6

*.1855 *Cidaris Danica*, DESOR, p. 15
.1865 *Temnocidaris Danica*, COTTEAU, p. 362-364, pl. 1087, fig. 7-8.
1874 *Temnocidaris danica*, COTTEAU, p. 642.
.1882 *Temnocidaris danica*, SCHLÜTER, p. 125-130, fig. 17, fig. 1-2.
1897 *Temnocidaris danica*, LAMBERT, p. 145-146.
.1910 *Temnocidaris danica*, LAMBERT & THIERY, p. 156.
.1928 *Temnocidaris danica*, MORTENSEN, p. 285.
.1928 *Temnocidaris danica*, RAVN, p. 26-28, pl. 3, fig. 1-6.
v.1965 *Temnocidaris danica*, MEIJER, p. 23 (pro parte).
1982 *Temnocidaris danica*, SALAH, p. 213-215.

Locus typicus: Faxe, Sjaelland, Denmark.

Stratum typicum: Faxe Limestone, Danian, Paleocene.

Occurrences outside the Maastricht-area
Denmark: Danian at Faxe, Sjaelland (DESOR 1855; RAVN, 1928).
Belgium: Danian at Ciply, prov. Hainaut (COTTEAU, 1874).

SPECIMENS STUDIED

Houthem Formation, Guelhem Member at Geulhem (prov. Limburg, The Netherlands): 54 fragments (NHMM MM-104, MM-106, MM-896, MM-1007, MM-1183, MM-unnumbered).
Houthem Formation, Geulhem Member at Vroenhoven (prov. Limburg, Belgium): 30 fragments (NHMM MM-909, MM-917, MM-1184).

FIGURED SPECIMENS IN THE KBIN-COLLECTIONS

None.

DECRIPTION

Interambulacral plates are rectangular to pentagonal, with perforate, non crenulate primary tubercles. The diameter of the scrobicules is 2.5 to 3 times larger than the mamelon's. The bosses are smooth and conical. They do not protrude over the rim of the scrobicular rings. The

scrobicules are moderately sunken. Their distal borders are steep, but not overhanging. Scrobicular rings are complete and consist of 15 or 16 small tubercles. The rings of adjacent plates often touch each other. On the adoral side of the test, they may even share some tubercles. But scrobicules are never confluent. Extrascrobicular surfaces are narrow adradially, but moderately wide interradially. They are completely covered by a very dense, coarse granulation. The size of all granules is about the same. Adradially their arrangement is chaotic; interradially, they are arranged in subhorizontal rows, which are sometimes separated by rectilinear furrows. I counted 3 to 4 granules/mm^2. Small coronal depressions are numerous on interradial miliary surfaces. Sutural pits are also common.

Ambulacra consist of a large number of primary plates, each of them showing a pore-pair and three granules (at the ambitus). Also at the ambitus, 16 ambulacral platelets share an adradial suture with one interambulacral plate. The ambulacral granules are arranged in horizontal rows of three and in regular vertical series. The pore-paires are almost horizontal and show a small granule on the interporous partition.

DISCUSSION

Temnocidaris danica is easily distinguished from *T. baylei*, by its much coarser miliary granulation. Other differences are the larger size of the interambulacral mamelons, the deeper scrobicules, the regular vertical arrangement of ambulacral tubercles, the presence of only one horizontal series of granules on each ambulacral plate, etc., in *T. danica*. Differences between *T. danica* and *T. magnifica* are analogous. Differences between *T. danica* and *T. schlueteri* SALAH, 1982 (Maastrichtian, Hannover-area, Germany) are much more subtle. The most obvious differences between these closely related species are to be sought in the shape of the radioles. Radioles of *T. schlueteri* show a very characteristic, broadened crown at the distal end (SALAH, 1982); according to RAVN (1928) no such crown is present in the radioles of *T. danica*, the distal ends of which are tapering. Unfortunately, no well preserved specimens, with radioles attached, are known from the Low Countries. Having few clearly diagnostic features, radioles of *T. danica* may contribute to the larger mass of unidentifiable cidaroid remains, present in the chalk deposits of Limburg. Nevertheless, well preserved coronal plates of *T. schlueteri* can be distinguished from these of *T. danica*, by the presence of very small interstitial granules between the scrobicular tubercles, in the former species. These interstitial granules are absent in *T.danica*.

Morphologically, *T. schlueteri* and *T. danica* are very similar: much more so than *T. baylei* and *T. danica*. I would therefore argue for a modification in the phylogeny of the genus *Temnocidaris*, proposed by SALAH (1982). In my opinion, *T. schlueteri* is a much more plausible ancestor for *T. danica*, than *T. baylei*.

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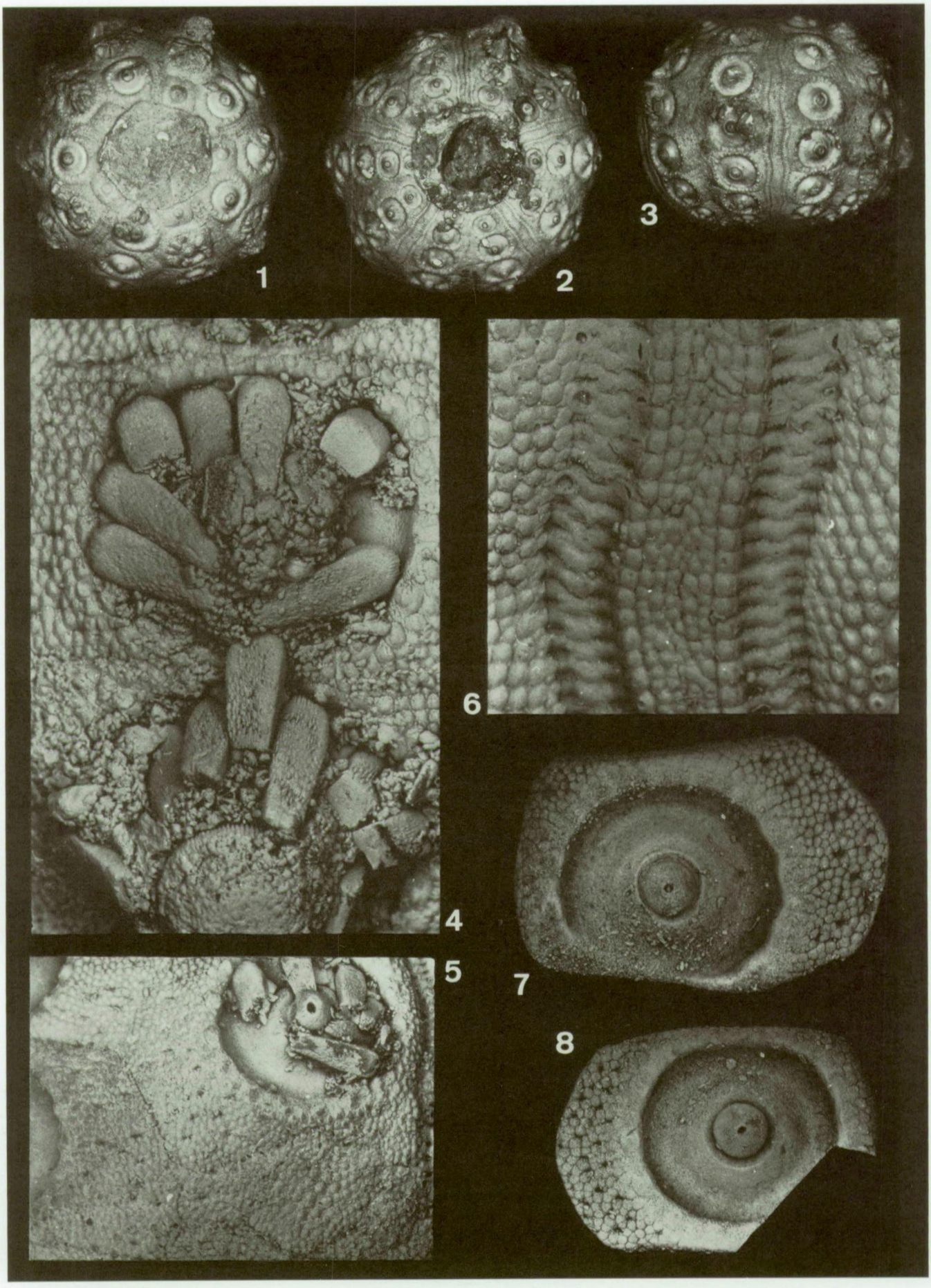
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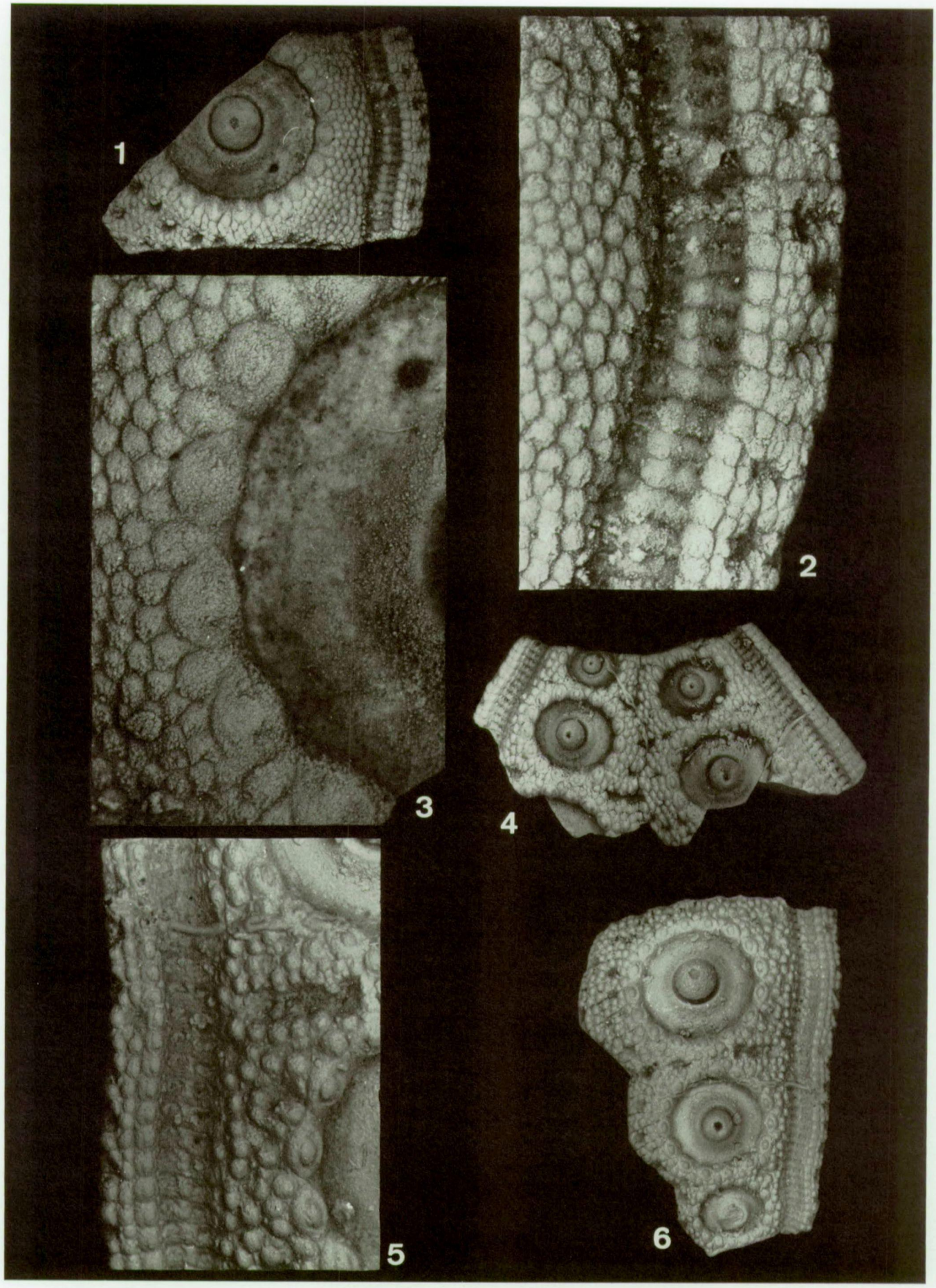
PLATE 1

1. *Temnocidaris baylei* COTTEAU, 1863; Maastricht Formation, Maastrichtian; Bemelen, prov. Limburg, the Netherlands; adapical view; NHMM 1982153; x 0,8.
2. Idem, same specimen; adoral view; x 0,8.
3. Idem, same specimen; lateral view; x 0.8.
4. Idem, same specimen; two of the scrobicules, showing scrobicular radioles; x 6.
5. Idem, same specimen; ambital part of an ambulacrum; x 8.
6. Idem, same specimen; interambulacral miliary surface, showing coronal depressions; X 8.
7. *Temnocidaris baylei* COTTEAU, 1863; Maastricht Formation, Maastrichtian; St. Pietersberg, prov. Limburg, the Netherlands; interambulacral plate; KBIN IST 10474; x 4.
8. Idem; KBIN IST 10476; x 4.

PLATE 2

1. *Temnocidaris baylei* COTTEAU, 1863; Maastricht Formation, Maastrichtian; St. Pietersberg, prov. Limburg, the Netherlands; coronal fragment; KBIN IST 10475; x 4.
2. Idem, same specimen; detail of ambulacrum; x 12.
3. Idem, same specimen; detail of scrobicular ring; x 12.
4. *Temnocidaris danica* (DESOR, 1855); Geulhem Member, Houthem Formation, Danian; Geulhem, prov. Limburg, the Netherlands; adoral coronal fragment; NHMM MM896a; x 3,6.
5. Idem; coronal fragment; NHMM MM896b; x 3,3.
6. Idem, same specimens; detail of ambulacrum and scrobicular ring; x 8,5.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