

A monograph of the Polish Oxfordian echinoids: Part 2, Subclass Euechinoidea Bronn, 1860

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ABSTRACT:

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The non-cidaroid echinoids (subclass Euechinoidea Bronn, 1860) from the Oxfordian epicontinental sequence of Poland (Polish Jura, Holy Cross Mountains, Mid-Polish Anticlinorium) are assigned to the genera *Hemipedinia* Wright, 1855, *Hemicidaris* L. Agassiz, 1838, *Hemitiaris* Pomel, 1883, *Pseudocidaris* Étallon, 1859, *Stomechinus* Desor, 1856, *Eucosmus* L. Agassiz in Agassiz and Desor, 1846, *Glypticus* L. Agassiz, 1840, *Pleurodiadema* de Loriol, 1870, *Diplopodia* McCoy, 1848, *Trochotiara* Lambert, 1901, *Desorella* Cotteau, 1855, and *Heterocidaris* Cotteau, 1860, plus one acropeltid taxon, and one taxon left in open nomenclature.

Within the genus *Hemicidaris* L. Agassiz, 1838, the relationship between *Hemicidaris intermedia* (Fleming, 1828), *Hemicidaris crenularis* L. Agassiz, 1839 [*non* Lamarck, *nec* Goldfuss] and *Hemicidaris quenstedti* Mérian, 1855, all with confused taxonomy, is discussed.

Based on test structure, the genera *Polydiadema* Lambert, 1883, and *Trochotiara* Lambert, 1901, of the family Emiratiidae Ali, 1990, are proved to be separate; the common species *mamillana* of F.A. Roemer (1836) is a typical *Trochotiara*.

An attention is paid to the morphology of the tiny, juvenile specimens, common in *Eucosmus decoratus* L. Agassiz in L. Agassiz and Desor, 1846, and in *Pleurodiadema stutzi* (Moesch, 1867).

Key words: Euechinoidea; Taxonomy; *Hemicidaris*; *Trochotiara*; Juvenile echinoids; Upper Jurassic; Poland.

INTRODUCTION

In 2003 I published the first part of *A monograph of the Polish Oxfordian echinoids*, which embraced exclusively the cidaroids, the representatives of the subclass Cidaroida Claus, 1880, as recorded from the epicontinental Oxfordian of Poland. The present paper, being the second part of the Monograph, comprises all of the non-cidaroid forms of regular echinoids of the region.

This study is based primarily on newly acquired material. Of the old collections which survived the

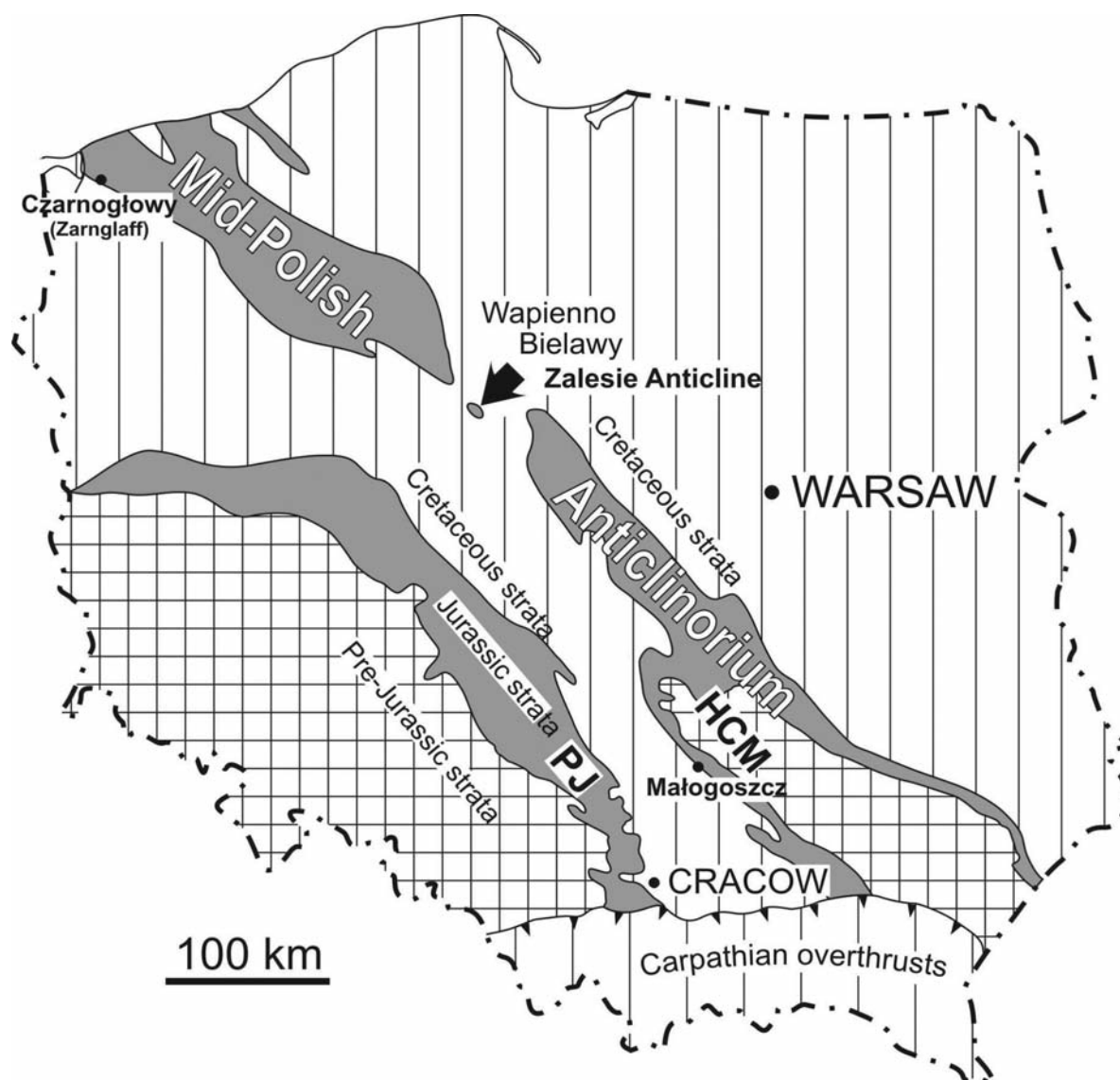
Second World War, and are included in this study, is that of Siemiradzki (1893). All echinoid reports appearing in the form of regional fossil lists (Lewiński 1912; Świdziński 1931; Samsonowicz 1934) are unverifiable. Illustrations of several non-cidaroids from the Oxfordian of Poland were provided by Roemer (1870) and Wiśniewska-Żelichowska (1971). Compared to the cidaroids, the non-cidaroid regular echinoids in the epicontinental Oxfordian sequences of Poland are extremely rare (Radwańska 2003a, p. 144), and any irregulars are almost totally absent. This also concerns the Oxfordian sequences of the Tethyan

(Carpathian) domain in Poland, from where there is only a single report (Wójcik 1913–14, pp. 458, 459 and 547) from exotic blocks of the Carpathian flysch at Kruhel Wielki.

The study presented herein started in the 1980s, and comprises new field collecting, existing museum material (The Geological Museum of the Polish Academy of Sciences, Cracow: Siemiradzki's Collection; Museum of the Geological Survey of Poland, Warsaw: Wiśniewska-Żelichowska's Collection), and some private collections, made generously accessible by their owners. All these data demonstrate that non-cidaroid regular echinoids are not as extremely rare as could have been expected from the published literature.

ECHINOID-BEARING SEQUENCES AND THEIR AGE

The general characteristics of the echinoid-bearing epicontinental Oxfordian sequences in Poland (Text-fig. 1) are presented in Part 1 of the Monograph (Radwańska 2003a, pp. 143–145). These data are supplemented herein by updated and/or new data on the Early Oxfordian sequences of the Polish Jura (Zalas, Ogrodzieniec, Wrzosowa) and of the Holy Cross Mountains (Gnieździska), as recently published by Głowniak (2012), and by the author's new echinoderm records (Radwańska 2004a, b; 2005; 2007; Radwańska and Radwański 2003, 2005).



Text-fig. 1. Geological map of Poland, without Cenozoic cover, to show the main regions of the Oxfordian localities yielding non-cidaroid echinoids (taken from Part 1 of 2003); PJ – Polish Jura Chain, HCM – Holy Cross Mountains, Wapienno and Bielawy quarries in the Zalesie anticline (the Couiavia region); also indicated are the localities Małogoszcz and Czarnogłowy (Zarnglaff), which yield Lower Kimmeridgian echinoids (see Radwańska 1999); adopted from Matyja and Wierzbowski (2000, fig. 1)

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Polish Jura

In the Polish Jura Chain, the Oxfordian is accessible both in natural exposures and in numerous quarries (Text-fig. 2). The echinoid-bearing strata of the region are mostly thin-bedded limestones with marly interbeds (Jasna Góra beds) of Early to Middle Oxfordian age (see Trammer 1982; cf. also Radwańska 2003a, p. 145). The largest and best accessible exposure is the Zalas Quarry, c. 20 km west of the city of Cracow (see Text-fig. 2), in the southern part of the Chain. In this quarry is exposed a Callovian to Middle Oxfordian sequence overlying the Variscan rhyodacite laccolith (see Radwańska 2005). Both Callovian and Oxfordian echinoids were briefly characterized, and all former records (of Siemiradzki 1893 and Wójcik 1910) were revised (Radwańska (2005).

At Zalas, the Oxfordian echinoids, in particular the cidaroids (see Radwańska 2003a, 2005), are associated with disarticulated elements of crinoids, starfish and ophiuroids. The echinoderm-bearing thin-bedded limestones, intercalated with marls, represent the Lower-basal Middle Oxfordian *Cardioceras tenuicostatum*

Subzone of the *Perisphinctes plicatilis* Zone (Matyja and Tarkowski 1981; see also Trammer 1982, fig. 3).

An age-equivalent sequence to the Zalas succession is exposed in the neighbouring quarry at Młynka and, farther to the north, in a disused quarry at Ogradzieniec (see Trammer 1982, fig. 3; cf. Radwańska 2003a, p. 146), from where a new eugeniocrinitid has recently been reported (Salamon 2006). The sequence in Niegowonice, near Ogradzieniec, represents the Middle Oxfordian *Gregoryceras transversarium* Zone (Siemiradzki 1893, pp. 142, 143; Trammer 1989, fig. 3). The sequence of the Wrzosowa Hill, now within the city of Częstochowa, and those of Kłobuck (Skrzeszów) and Włodowice, represent the Lower Oxfordian *Cardioceras cordatum* Zone (see Trammer 1982, fig. 3; cf. Radwańska 2003a, p. 145). The youngest Oxfordian strata, of the *Idoceras planula* Zone (see Wiśniewska-Żelichowska 1971), are represented at Rudniki.

Holy Cross Mountains

In this area, the Oxfordian is exposed along the Mesozoic margins surrounding the Palaeozoic structures in the centre (Text-fig. 3). Along the north-eastern margin, the Early Oxfordian biohermal limestones (see Gutowski 1998, fig. 3) are exposed near the town of Ostrowiec. The limestones are overlain by late Middle Oxfordian chalky, coralliferous limestones (Gutowski 1998), which are well exposed along the picturesque banks of the Kamienna River at Bałtów. Both units yield low-diversity echinoid assemblages, of which those from Bałtów are of special significance.

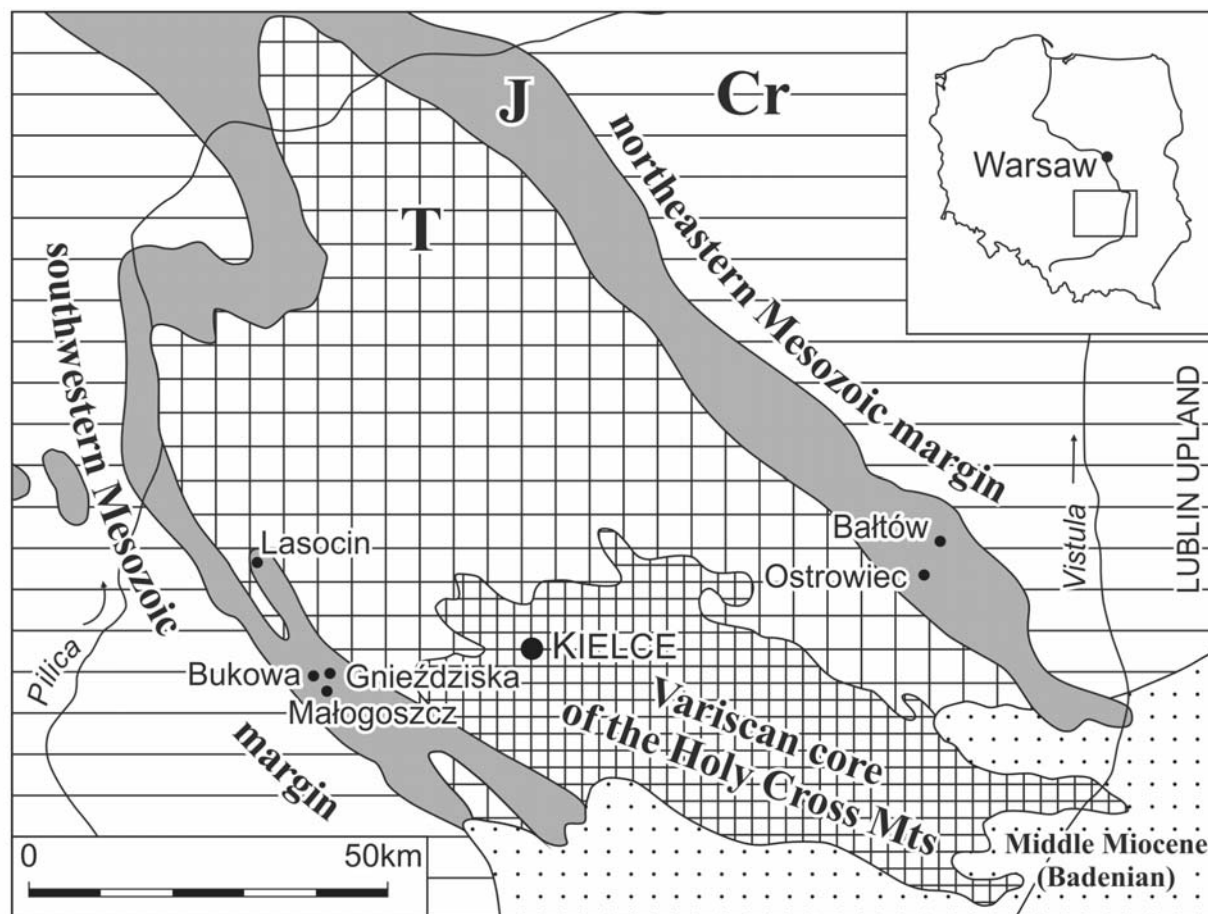
The chalky organodetrital grainstones of Bałtów yielded *Paracidaris florigemma* (Phillips, 1829), *Hemitiaris? meryaca* (Cotteau, 1850), and *Glypticus hieroglyphicus* (Goldfuss, 1829), an assemblage which is almost absent from other Oxfordian localities in Poland. A functional analysis of their tests and spines (Radwańska 2004a) showed that these echinoids occupied a shallow-marine (sub- to intertidal) habitat.

Along the south-western margin of the Holy Cross Mountains, the widely occurring Oxfordian strata yield echinoids in three localities that have not been reported previously (Gnieździska, Lasocin, Bukowa – Text-fig. 3).

In the Gnieździska Quarry, the echinoids are recorded in the middle part of the exposed Bathonian through Middle Oxfordian succession (Głowniak 2012). The echinoid-bearing strata are 3-m-thick marly limestone interbedded with marl (equivalent to the Jasna Góra Beds), of the Lower Oxfordian *Cardioceras cordatum* Zone (Głowniak 2012, fig. 3). A similar se-



Text-fig. 2. Location of the studied Oxfordian exposures yielding non-cidaroid echinoids in the Polish Jura; hatched is the outcrop zone of Upper Jurassic deposits (insert shows position in Poland, see Text-fig. 1); adopted from Radwańska (2003a, fig. 2)



Text-fig. 3. Location of the studied Oxfordian exposures bearing non-cidaroid echinoids along the Mesozoic margins of the Holy Cross Mountains (insert shows position in Poland, see Text-fig. 1): T – Triassic, J – Jurassic, C – Cretaceous; adopted from Radwańska (1999, fig. 2, and 2003a, fig. 3)

quence was formerly exposed in the now disused Lasocin Quarry.

The latest Oxfordian succession is exposed in the Bukowa Quarry (known for the very well preserved coral patches – see Roniewicz and Roniewicz 1971). The succession directly underlies the echinoid-bearing Early Kimmeridgian sequence, known from its occurrences in the Małogoszcz Quarry (see Radwańska 1999).

Wapienno/Bielawy

The Middle to Late Oxfordian Wapienno/Bielawy biohermal sequence is exposed in huge quarries within the Zalesie Anticline, in the Couiavia region of central Poland (see Text-fig. 1). The structure of the sponge-cyanobacterial bioherm and its peculiar faunal content has recently been presented for the Wapienno Quarry (Radwańska 2003a, Radwańska and Radwański 2003) and the Bielawy Quarry (Radwańska 2004b, 2007; Radwańska and Radwański 2005).

In the Wapienno Quarry, small-sized echinoids, particularly those of the genus *Eucosmus*, occur in bedded limestones of a proximal talus of the Wapienno/Bielawy bioherm (see Radwańska and Radwański 2003, fig. 2). The echinoderm-bearing part, represented predominantly by crinoid limestones (see also Ostrowski 2003), is assigned to the Upper Oxfordian *Epipeltoceras bimammatum* and/or *Idoceras planula* Zone (Matyja and Wierzbowski 2002; see also Radwańska and Radwański 2003, p. 304). The crinoid limestones are replete in places with isolated ossicles (?columnals) and longer fragments (?pluricolumnals) of the enigmatic genus *Cyclocrinus* d'Orbigny, 1850, classified recently as *Cyclocrinus couiavianus* Radwańska and Radwański, 2003, and interpreted as possibly the modified radicular cirrals of unrecognizable members of the bourgueticrinids (Radwańska and Radwański 2003; see also Hess 2008).

The echinoderm-bearing marls of the Bielawy Quarry, represent an upper part of the talus of the Wapi-

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enno/Bielawy bioherm (see Radwańska 2007, fig. 2), assigned (Matyja and Wierzbowski 2002) to the Upper Oxfordian *Idoceras planula* Zone (just beneath Unit I of Matyja and Wierzbowski 2002, p. 412 and figs 3, 4; see also Radwańska 2004b, p. 37; 2007, p. 163). Their fossil assemblage, apart from ubiquitous sponges and brachiopods (see Krawczyński 2005, 2008), is composed of diverse echinoderms, such as the free-living comatulid crinoids *Semiometra petiti* (see Radwańska 2007), the aberrant starfish *Sphaeraster* (see Radwańska 2003b), as well as the showy, large-sized echinoids *Rhabdocidaris* and *Plegiocidaris* (see Radwańska 2003a), some of which are adorned with cysts of exoparasitic copepods (see Radwańska and Radwański 2005).

SYSTEMATIC ACCOUNT

The taxonomy of the Euechinoidea used herein follows Smith (1984), Smith and Wright (1993, 1996), and Kroh and Smith (2010).

Repositories

Almost all of the specimens described here are housed in the Collection of the Stanisław Józef Thugutt Geological Museum of the Faculty of Geology, University of Warsaw.

The specimens from the Museum of the Geological Survey of Poland, Warsaw (Wiśniewska-Żelichowska Collection), are prefixed with IG.

Class Echinoidea Leske, 1778
 Subclass Euechinoidea Bronn, 1860
 Infraclass Acroechinoidea Smith, 1981
 Order Pedinoidea Mortensen, 1939
 Family Pedinidae Pomel, 1883
 Genus *Hemipedina* Wright, 1855

TYPE SPECIES: *Pedina etheridgei* Wright, 1854; SD Lambert (1900, p. 6).

DIAGNOSIS: Pedinidae genus with interambulacral plates relatively tall, with single series of primary tubercles, and non-confluent areoles throughout.

Hemipedina guerangeri Cotteau in Cotteau and Triger, 1858
 (Pl. 1, Figs 1a–1h)

pars 1858. *Hemipedina Guerangeri*, Cotteau, 1858; G. Cotteau and J. Triger, pp. 113–114, pl. 22 [non 21], figs 2–7.

1858. *Hemipedina Guerangeri*, Cot.; E. Desor, p. 440.

1871. *Hemipedina Guerangeri*, Cotteau; E. Desor and P. de Loriol, pp. 191–192, pl. 32, figs 5, 5a–5d.

1883. *Hemipedina Guerangeri*, Cotteau, 1858; G. Cotteau, pp. 504–507, pl. 397, figs 4–14.

2005. *Eosalenia miranda* Lambert, 1905; U. Radwańska, p. 71, pl. 2, fig. 3 and pl. 3, figs 1a–c.

MATERIAL: Seven tests from Zalas (MWGUW/ZI/56/246–252), two from Ogrodzieniec (MWGUW/ZI/56/254), one from Wrzosowa (MWGUW/ZI/56/255), and one from Gnieździska (EOx/256).

DIAGNOSIS: *Hemipedina* species with test extremely thin-walled, and with interambulacral plates bearing relatively small primary tubercles, surrounded by delicate, sparse scrobicular tubercles.

DESCRIPTION: Tests range from about 7 to 13 mm in diameter, and 3 to 6.5 mm in height. The test is thin-walled, low, hemispherical, flattened aborally (Pl. 1, Fig. 1a).

The ambulacra (Pl. 1, Figs 1c–e) are straight-sided and slightly taper aborally. The plating is trigeminate, with plate compounding in acrosaleniid style, with two elements united by a primary tubercle alternating with a single plate (Pl. 1, Figs 1d, 1e). Adapically, the primary tubercles reduce gradually in size (Pl. 1, Fig. 1c). The pore-pairs are P2-type isopores (as defined by Smith 1978), and show delicate crowding towards the peristome (Pl. 1, Figs 1e, 1f).

The interambulacra are broad, with 5 or 6 plates in a column. All plates are slightly wider than high and carry a small primary perforate and noncrenulate tubercle (Pl. 1, Figs 1g, 1h). Delicate, sparse scrobicular tubercles lie around the areole. The areoles are non-confluent throughout.

The apical disc (Pl. 1, Fig. 1b) is large, dicyclic, bound firmly to the corona, with its diameter being 58% of the test diameter. The plates of the apical disc are covered by very small and sparse tubercles.

The peristome is slightly smaller than the apical disc (its diameter being about 52% that of the test). Buccal notches are broad and very shallow (Pl. 1, Figs 1g, 1h).

The lantern and spines remain unknown.

REMARKS: The specimens studied correspond well to those described by Cotteau (1858) from the Upper Oxfordian of France (see Cotteau and Triger 1858, pl. 22 [not 21, as incorrectly stated by Cotteau], figs 2–7). Of

all the species included in this genus, the species *H. guerangeri* is characterized by relatively small interambulacral primary tubercles, and sparse scrobicular and other secondary tubercles, which gives the impression of a naked corona. Because of the inadequate state of preservation, the specimens from Zalas were formerly misidentified by the present author (Radwańska 2005) as *Eosalenia miranda* Lambert, 1905.

Infraclass Carinacea Kroh and Smith, 2010
 Family Hemicidaridae Wright, 1857
 Subfamily Hemicidarinae Wright, 1857
 Genus *Hemicidaris* L. Agassiz, 1838

TYPE SPECIES: *Cidarites crenularis* Lamarck, 1816; OD L. Agassiz (1838, p. 3).

DIAGNOSIS: Genus of Hemicidarinae with ambulacral tubercles at ambitus arranged biserially.

REMARKS: In spite of the common occurrence of these echinoids in Jurassic epicontinental areas of Europe, their taxonomy is still a subject of serious discussion (see Desor 1855; Lambert and Thiéry 1911, 1914; Mortensen 1935; Beurlen 1937; Fell and Pawson 1966; Smith and Wright 1993). The primary reason for the confusion seems to be in the early recognition of two Late Jurassic species with almost identical test morphology but with different spines, which are either (i) long, slender and stick-like, or (ii) relatively shorter, thicker, and typically club-shaped (see Hess, 1975, Radwańska 1999).

The first species has long been classified as *Hemicidaris intermedia* (Fleming, 1828), represented in the English Oxfordian by numerous specimens adorned with their spine canopy superbly preserved (Forbes 1850, Wright 1855; see Radwańska 1999, pp. 313–315).

The second species was established earlier by Lamarck (1816, p. 59) who, however, described a spineless test, from older illustrations [of Bourguet (1788) from the Swiss Jura (see Radwańska 1999, pp. 313–315)], and referred it to “*Cidarites crenularis*”. Some years later, Goldfuss (1829, p. 122 and pl. 40, figs 6a, b) illustrated such a spineless specimen, which Lambert and Thiéry (1911, p. 170) designated as the type species of the genus *Hemicidaris* L. Agassiz, 1838. They diagnosed its spines as identical with those of the Goldfuss (1829) specimen (!). Goldfuss (1829), however, clearly wrote (his page 122) that “*Die Stacheln sind nicht bekannt*”. This misunderstanding was followed and repeated, certainly in good faith, by subsequent authors (Lambert

and Thiéry 1925, p. 562; Mortensen 1935, p. 414). Consequently, *Cidarites crenularis* of Goldfuss (1829) is evidently a *nomen dubium*, as associated spines are unknown.

The first type species designation [neglected by Lambert and Thiéry, 1911] is that by L. Agassiz (1838, p. 3), who referred to “*Cidarites crenularis* Lamarck”. However, Agassiz himself (1840b, p. 44), and Agassiz and Desor (1847), Desor (1855), as well as Smith and Wright (1993, p. 203) refer to Agassiz [not Lamarck (1816), or Goldfuss (1829)] as the author of the species *crenularis*. This involves a taxonomic knot further on, because *Cidarites crenularis* of Lamarck (1816) is also a *nomen dubium*, as it lacks any associated spines. Its treatment as the type of the genus *Hemicidaris* still remains very arbitrary.

Not better is the situation with “*Hemicidaris crenularis* Ag.” illustrated by Agassiz (1840b, p. 44 and pl. 18, fig. 23) by a captivating specimen with an almost complete spine canopy from Besançon in France. This specimen, kept in the Naturhistorisches Museum in Vienna (see Radwańska, 1999, p. 315), is preserved in a limestone slab, unfortunately in upside-down position having, except for spines, only its oral side exposed. Although this makes the species recognition of its test impossible, its taxonomic validity and relationship to other *Hemicidaris* species have long been discussed in the literature (Quenstedt 1873; Lambert and Thiéry 1911, 1914; Beurlen 1937; Smith and Wright 1993; for details see below).

Subgenus *Sphaerotiaris* Lambert and Thiéry, 1914

TYPE SPECIES: *Hemicidaris quenstedti* Mérian in Desor, 1855; SD Lambert and Thiéry 1914, p. 274.

DIAGNOSIS: Subgenus of the genus *Hemicidaris* with primary spines clavate, slightly expanded distally to a blunt crown.

Hemicidaris (Sphaerotiaris) quenstedti Mérian in
 Desor, 1855
 (Pl. 2, Figs 1–7)

1855. *Hemicidaris Quenstedti* Mérian, nov. sp.; P. Mérian in E. Desor, p. 56.
 1858. *Cidarites scolopendra*; F.A. Quenstedt, pp. 734–735, pl. 89, fig. 32.
 1858. *Hemicidaris scolopendra* Quenst.; E. Desor, p. 440.
 1858. *Hemicidaris Quenstedti*, Mérian, Desor; A. Oppel, p. 711.

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1880. *Pseudocidaris Quenstedti* (Mérian in Desor), Cotteau 1880; G. Cotteau, pp. 17–21, pl. 264, figs 1–9.

MATERIAL: Two tests: one from Bielawy, Zalesie Anticline (MWGUW/ZI/56/243), one from Ostrowiec (MWGUW/ZI/56/245), five fragments of primary spines from Bielawy (MWGUW/ZI/56/259–263).

DIAGNOSIS: Species of *Hemicidaris* (*Sphaerotiaris*) with box-shaped test, tall interambulacral plates with relatively small primary tubercles, and clavate primary spines.

DESCRIPTION: Tests range in diameter from about 20 mm to 30 mm. Tests are circular in outline, box-shaped in profile, distinctly flattened adapically, with the ambitus lying at about one-third of the test height (Pl. 2, Figs 1a–c, 7).

The ambulacra are distinctly sinuous and narrow adapically, expand at the ambitus, and remain broad subambitally (Pl. 2, Fig. 1b). Adapically, the plate compounding is in the acrosaleniid arrangement, with two elements united by a primary, weakly crenulate and perforate, relatively small tubercle, alternating with a single plate covered by secondary tuberculation only. In the adapical part the primary tubercles are arranged in two rows (Pl. 2, Figs 1a and 7). At the ambitus there is an abrupt change in tuberculation (Pl. 2, Fig. 2b). In this region the primary tubercles become greatly expanded, to occupy much of the perradial width. These plates are multigeminate with four elements to each. Subambitally, the tubercles decrease in size and the plates become trigeminate, and this arrangement continues to the peristome. The pore-pairs are uniserial with P2-type isopores adapically, and form phyllodes with P3-type isopores towards the peristome (Pl. 2, Fig. 1d).

The interambulacra are broad with relatively few (five) plates in a column. The interambulacral plates are taller than wide above the ambitus (Pl. 2, Fig. 2c). Each plate has a relatively small central tubercle that is perforate and crenulate. The most adapical plate in each column has a distinctly smaller primary tubercle, but all adapical plates have fully formed tubercles (Pl. 2, Figs 1a and 7). The circular areoles are broad and non-confluent above the ambitus. Scrobicular tubercles form distinct circles around the primary tubercle. The secondary tubercles are small and very scanty (Pl. 2, Fig. 1c).

The apical disc is small, hemicyclic, bound strongly to the corona, and its diameter is 34% of that of the test. The plates of the apical disc are covered by small, densely spaced tubercles which form a distinct collar around the periproct (Pl. 2, Figs 1a and 7).

The peristome is large, its diameter being about 60% that of the test. Buccal notches are narrow and moderately deep (Pl. 2, Fig. 1d).

The lantern remains unknown.

Primary spines are long (much longer than the test), with a clavate shaft covered by longitudinal, delicate striae, and with a blunt crown (Pl. 2, Figs 2–6).

REMARKS: Mérian in Desor (1855, p. 56) briefly described, but did not illustrate *Hemicidaris quenstedti*. Quenstedt (1858) established a new species, *Cidarites scolopendra*, with good description and illustration. Cotteau (1880) synonymized both species, with the name *quenstedti* having priority, and referred the species to the genus *Pseudocidaris* Étallon, 1859. Although there are many similarities, particularly in the structure of the interambulacral columns, the Cotteau treatment is here rejected: the ambulacral columns of *quenstedti* are of *Hemicidaris* type. Quenstedt (1873, p. 258) created the genus *Tiaris* for *Hemicidaris* species with stout, clavate spines. Initially, Lambert and Thiéry (1911, p. 169) applied Quenstedt's genus and designated *H. quenstedti* Mérian in Desor, 1855 as its type; later, however, realising that the name *Tiaris* was pre-occupied, they renamed the genus as *Sphaerotiaris* (see Lambert and Thiéry 1914, p. 274). Beurlen (1937) pointed out that *H. crenularis* has spines identical to those of *H. quenstedti*, and that the two species are closely related, if not synonymous. Smith and Wright (1993, p. 203) accepted this treatment, and synonymized *H. quenstedti* with *H. crenularis* as then understood.

The tests of *H. quenstedti*, as compared with those of *H. intermedia* (see e.g. Radwańska 1999, pl. 19), have fewer plates in a column; the plates are slightly taller than wide and have circular, non-confluent areoles above the ambitus, and the adapical plates bear less distinct primary tubercles. These characters are rather of *Pseudocidaris* type, as stated already by Cotteau (1880), but the ambulacra remain in the *Hemicidaris* style and, consequently, the species in question is kept in the genus *Hemicidaris* L. Agassiz, 1838, more precisely in *Sphaerotiaris* Lambert and Thiéry, 1914, regarded herein as a subgenus of the former.

In the present author's opinion, a separate analysis is recommended to qualify the validity of almost all of the above-used taxonomic names, and their accordance with the ICZN requirements (!).

On the other hand, stratigraphical age would also have to be taken into account to clarify the relationships of particular *Hemicidaris* species. For example, of all the *Hemicidaris* species under discussion from the Oxfordian sequences of Europe, only one, *H. intermedia*

(Fleming, 1828), ranges in Poland up to the Early Kimmeridgian, when it was common in various very shallow water, predominantly oolitic facies (see Radwańska 1999, pp. 313–315).

Genus *Hemitiaris* Pomel, 1883

TYPE SPECIES: *Hemicidaris stramonium* (L. Agassiz, in L. Agassiz and Desor, 1847); SD Lambert and Thiéry (1911, p. 170).

DIAGNOSIS: Genus of Hemicidarinae with massive ambulacral tubercles at ambitus, arranged in a single alternate row.

Hemitiaris? *meryaca* (Cotteau, 1850)
(Pl. 2, Figs 8, 9)

1850. *Hemicidaris Meryaca*, Cot.; G. Cotteau, pp. 126–128, pl. 13, figs 10–12.
 1855. *Hemicidaris Meryaca* Cot., E. Desor, p. 52.
 1881. *Hemicidaris meryaca*, Cotteau, 1850; G. Cotteau, pp. 110–112, pl. 291, figs 1–6.
 1993. *Hemitiaris meryaca* (Cotteau); A.B. Smith and C.W. Wright, p. 203.
 2004a. *Hemicidaris meryaca* Cotteau, 1850; U. Radwańska, pp. 133–134, pl. 2, figs 3, 4.

MATERIAL: Two specimens from Bałtów (MWGUW/ZI/56/257–258).

DIAGNOSIS: Species of *Hemitiaris* with ambulacral primary tubercles above ambitus relatively robust, and continuous to apex.

DESCRIPTION: Tests range from 20 to 33 mm in diameter, and 13 to 20 mm in height. The thick-walled test is circular in outline and hemispherical in profile, with the ambitus at about mid-height of the test (Pl. 2, Figs 8, 9).

The ambulacra are slightly sinuous and distinctly narrow adapically; they expand at the ambitus and remain broad subambitally. Adapically, the compounding plate is of acrosaleniid style, with two elements united by a crenulate and perforate primary tubercle, alternating with a single plate covered by secondary tuberculation (Pl. 2, Figs 8a, 9a). The primary tubercles are relatively swollen and separated distinctly by secondary tubercles. In the adapical part, the primary tubercles are arranged in a single, zigzag row (Pl. 2, Figs 8a, 9a). In the larger individual there is a relatively abrupt change

in the tuberculation at the ambitus (Pl. 2, Fig. 9b); in the smaller specimen the change is more gradual (see Pl. 2, Fig. 8c). In this region, the primary tubercles become greatly expanded, to occupy much of the perradial width. These plates are multigeminate with five elements in each. Subambitally the tubercles decrease in size and the plates become trigeminate, and this arrangement continues to the peristome. Pore-pairs are uniserial, with P2-type isopores adapically, and with P3-type isopores forming phyllodes towards the peristome (Pl. 2, Fig. 8b).

The interambulacra are broad, with six relatively tall plates in a column. Each plate has a large perforate and crenulate central tubercle. These tubercles are intumescent, with a large mamelon seated on a large swollen boss (Pl. 2, Figs 8d, 9b). The most adapical plate in each column has a slightly smaller primary tubercle but all adapical plates have fully formed tubercles (Pl. 2, Figs 8a, 9a). The oval areoles are narrow and confluent throughout (Pl. 2, Figs 8d, 9b). Scrobicular tubercles are confined to the adradial and interradian margins of the plates, where they form a continuous scalloped line. There are seven scrobicular tubercles on either side of a primary tubercle at the ambitus. No secondary tubercles lie outside the scrobiculars, even in the larger individual.

The apical disc is small, dicyclic, bound strongly to the corona, with its diameter being 21% of the test diameter (Pl. 2, Figs 8a, 9a). The plates of the apical disc are covered by small, densely spaced tubercles.

The peristome is large, with its diameter being c. 60% of the test diameter. Buccal notches are narrow and moderately deep (Pl. 2, Fig. 8b).

Spines are unknown.

REMARKS: The specimens studied correspond well to *Hemicidaris meryaca* of Cotteau (1850) (= *H. meryaca* in Cotteau, 1881); they were referred previously to *H. meryaca* by the present author (see Radwańska 2004a, pl. 2, figs 3, 4).

The generic assignment of the species is still unresolved. Pomel (1883, p. 96) included *Hemicidaris meryaca* into his new genus *Hemitiaris*, of which the diagnostic feature was the array of primary tubercles at the ambitus. In contrast to the genus *Hemicidaris* L. Agassiz, 1838, in which the primary tubercles are arranged biserially, in *Hemitiaris* they are arranged in a single alternate row.

In the specimens studied, and particularly in the larger one (see Pl. 2, Fig. 9b), the arrangement of the primary tubercles at the ambitus is close, albeit not identical, to that regarded as diagnostic of the genus *Hemitiaris*. The other features of the material, such as

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the high position of the ambitus (at the mid-height of the test) involving a more spherical outline of the test; the sinusoid course of the ambulacra with the primary tubercles arranged in a single zigzag row at the adapical part; and finally the swollen ambulacral and interambulacral primary tubercles, are nearly identical to those of *Hemitiaris stramonium* L. Agassiz, in L. Agassiz and Desor, 1847, the type species of the genus. Consequently, the view of Pomel (1883), followed by Smith and Wright (1993), that *H. meryaca* should be placed in the genus *Hemitiaris*, is accepted herein, although with a question mark.

Hemitiaris? *meryaca* differs from *Hemitiaris stramonium* in its larger and more sparsely dispersed ambulacral primary tubercles above the ambitus, and in a less distinct zigzag arrangement of the primary tubercles at the ambitus.

Subfamily Pseudocidarinae Smith and Wright, 1993
 Genus *Pseudocidaris* Étallon, 1859

TYPE SPECIES: *Hemicidaris thurmanni* L. Agassiz, 1840, p. 52; SD by Étallon (1862, p. 333).

DIAGNOSIS: Genus of Pseudocidarinae with weakly crenulate and perforate ambital and adoral tubercles.

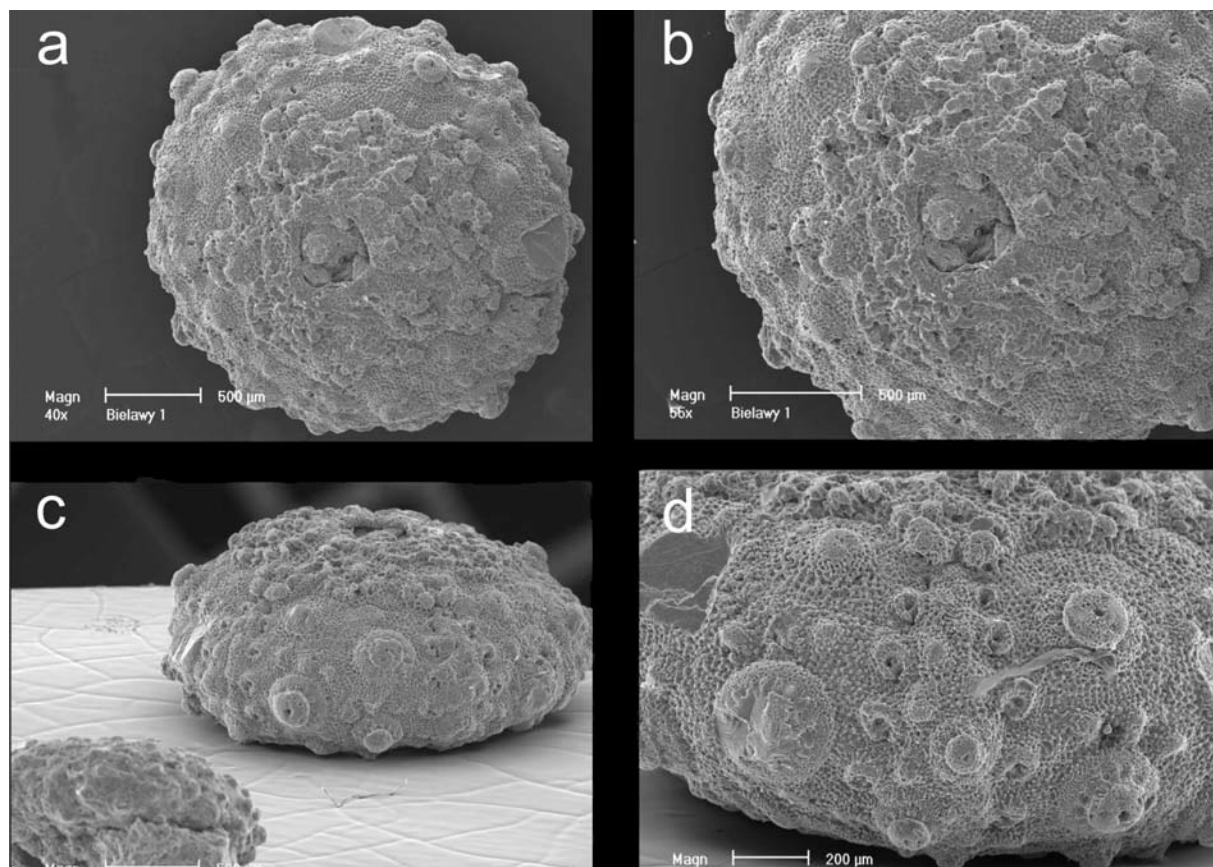
Pseudocidaris sp.
 (Text-fig. 4)

MATERIAL: One juvenile specimen from Bielawy, Zalesie Anticline (MWGUW/ZI/56/245).

DESCRIPTION OF THE JUVENILE SPECIMEN: Test is circular in outline, flat-hemispherical in profile, 2.3 mm in diameter (Text-fig. 4a, 2c).

The ambulacra are straight, expanding gradually from the apex to the ambitus. The ambulacral plating is simple above the ambitus, with P2-type isopores throughout, arranged sparsely. In the adapical part, the primary tubercles are arranged in two rows (Text-fig. 4d). At the ambitus there is an abrupt change in tuberculation. In this region the crenulate and perforate primary tubercles expand markedly to occupy much of the radial width (Text-fig. 4d).

The interambulacra are broad, with relatively few (three) plates in a column. The interambulacral plates



Text-fig. 4. *Pseudocidaris* sp.; a – Aboral view of the test, to show apical disc, b – Close-up view of the apical disc, c – Lateral view of the test, to show interambulacrum, d – Lateral view of the test, to show ambulacrum; Juvenile specimen from Bielawy, No. MWGUW/ZI/56/245

are taller than wide above the ambitus. Each plate has a large perforate and crenulate central tubercle (Text-fig. 4c–d). The areoles are broad and circular. The scrobicular tubercles form distinct circles around the primary tubercle. The secondary tuberculation is not yet developed.

The apical disc is large, hemicyclic, bound slightly asymmetrically to the corona and raised, forming a cap. Its diameter is 73% of that of the test (Text-fig. 4a). The ocular plates are heart-shaped in outline. The disc bears epistroma-like ornament (Text-fig. 4b).

REMARKS: Due to its simple ambulacral plating above the ambitus, crenulate and perforate ambital and adoral tubercles, and the character of the apical disc, this specimen is referred to the genus *Pseudocidaris* Étallon, 1859. The specific characters are uncertain.

Echinacea Claus, 1876

Order Stomopneustoida Kroh and Smith, 2010

Family Stomechinidae Pomel, 1883

Genus *Stomechinus* Desor, 1856

TYPE SPECIES: *Echinus bigranularis* Lamarck, 1816; SD Lambert and Thiéry 1911, p. 237.

DIAGNOSIS: Genus of Stomechinidae with single primary interambulacral tubercle per plate, or just secondary granulation on plates above ambitus; rather gradual change in tuberculation at ambitus; ambulacra trigeminate with pore-pairs in arcs of three, forming relatively wide band of offset pore-pairs which extends from apex to peristome.

Stomechinus perlatus (Desmarest, 1825)
(Pl. 3, Figs 1, 2)

1825. *Echinus perlatus*; A.C. Desmarest, p. 100.

1829. *Echinus lineatus* nobis; A. Goldfuss, p. 124, pl. 40, figs 11a, b.

1839. *Echinus perlatus* Desmar.; L. Agassiz, pp. 82–83, pl. 22, figs 13–15.

1839. *Echinus psammophorus* Ag.; L. Agassiz, p. 84, pl. 22, figs 1–3.

1839. *Echinus serialis* Ag.; L. Agassiz, pp. 85–86, pl. 22, figs 10–12.

1858. *Echinus lineatus*; F.A. Quenstedt, pp. 737–738, pl. 90, fig. 8.

1859. *Stomechinus lineatus*, Des, 1856; G. Cotteau and J. Triger, pp. 118–122, pl. 22, fig. 12.

1884. *Stomechinus perlatus* (Desmarests), Desor, 1857; G. Cotteau, pp. 734–745, pls 466–469.

1971. *Stomechinus perlatus* (Desmarests) Desor, 1857; M. Wiśniewska-Żelichowska, pp. 58–59, pl. 35, figs 1a, 1b, 2.

1971. *Stomechinus* cf. *semiplacenta* (Agassiz) Desor, 1857; M. Wiśniewska-Żelichowska, p. 59, pl. 35, fig. 3.

1975. *Stomechinus perlatus* (Desmarest); H. Hess, p. 100, text-fig. 39 and pl. 39, fig. 4.

non 2001. *Psephechinus perlatus* (Desmarests in Defrance, 1827); A. Vadet, N. Remy and E. Wille, pp. 31–34, pls 22–24.

MATERIAL: Three incomplete tests from Rudniki, Polish Jura Chain, southern Poland; IG: 1183 II 306, 1183 II 307, 1183 II 308.

DIAGNOSIS: *Stomechinus* species with delicate ornamentation, and well developed secondary tuberculation in interradial part of the interambulacral plates.

DESCRIPTION: The test is slightly subpentagonal in outline (Pl. 3, Fig. 1a), moderately high, hemispherical in profile, with a broad flattish base and with the ambitus located close to the base.

The ambulacra are straight, tapering sharply adapically (Pl. 3, Fig. 1a). The pore zones are relatively broad, slightly depressed with pore-pairs arranged in arcs of three (Pl. 3, Fig. 1b), located obliquely to the sutures; close to the peristome they form phyllodes. The pore zones are associated with small tubercles dispersed between the pore-pairs. Every second ambulacral plate bears an imperforate and non-crenulate primary tubercle above the ambitus (Pl. 3, Figs 1b, 2b). These plates are separated by plates which bear three or four, equally-sized, small tubercles. Adorally, a primary tubercle is developed on every ambulacral plate. Each primary tubercle is surrounded by densely spaced scrobicular tubercles. The primary tubercles are largest at the ambitus and just below; they decrease gradually in size both adapically and adorally. The perradial zone is narrow.

The interambulacra are more than twice as wide as the ambulacra at the ambitus (Pl. 3, Fig. 2a). Each interambulacral plate bears one small imperforate and non-crenulate primary tubercle placed in the middle of the plate (Pl. 3, Fig. 2b). There are two rows of secondary tubercles: one along the adradial, and one along the interradial suture. These tubercles are equal in size, with primary ones at the ambitus and towards the peristome. Aborally, the secondary tubercles decrease gently in size. The secondary tubercles are located slightly

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closer to the adapical suture than the primary ones. The primary and secondary tubercles are surrounded by densely spaced scrobicular tubercles, forming regular circles (Pl. 3, Figs 1b, 2b).

The interradial zone is narrow, slightly depressed and smooth adapically; the smooth area is relatively short (Pl. 3, Fig. 2a).

The small (about one-fifth of the test diameter) apical disc is dicyclic (Pl. 3, Fig. 2c), with ocular plates well separated from the periproct. The genital plates are broad and low with large gonopores situated at a distance of the outer sutures. The madreporite is distinctly larger than other genitals. All plates are covered by relatively large tubercles. The periproct is large, subquad-rangular in outline.

The peristome is large, about half the size of the test diameter.

REMARKS: *Stomechinus perlatus* (Desmarest, 1825) is quite common in the Oxfordian strata of Europe. In Poland, it first was recorded by Wiśniewska-Żelichowska (1971, pl. 35, figs 1, 2) as “*Stomechinus perlatus* (Desmarests)”. In the present author’s opinion, the specimen of *S. cf. semiplacenta* of Wiśniewska-Żelichowska (1971, pl. 35, fig. 3) also represents *S. perlatus*; it does not differ in its ornamentation from other specimens from this locality.

From *Stomechinus bigranularis* (Lamarck, 1816), the type species of the genus, *S. perlatus* differs in its more delicate ornamentation (less distinct primary tubercles of the ambulacral and interambulacral columns) and in more pronounced secondary tuberculation in the interradial zone.

Psephechinus perlatus (Desmarests in Defrance, 1827) of Vadet et al. (2001, pls 22, 23) is clearly something different. Their specimens differ from *S. perlatus* in the presence of primary tubercles, and in the relatively equal sizes of the primary and secondary tubercles on both the interambulacral and ambulacral columns. Their specimens also differ from typical representatives of the genus *Psephechinus* (compare – e.g. *Psephechinus michelini* (Cotteau in Cotteau and Triger 1857). In the present author’s opinion they should be referred to “*Echinus robinaldinus*”, and/or “*Stomechinus robineau*”, described by Cotteau (1853, 1884) from the French “Corallien”.

Stomechinus sp.
(Pl. 3, Fig. 3)

MATERIAL: Two incomplete tests from Ostrowiec (MWGUW/ZI/56/264–264a).

DESCRIPTION: The test is slightly subpentagonal in outline, moderately high, hemispherical in profile, with a broad flattish base and the ambitus located close to the base (Pl. 3, Figs 3a, b).

The ambulacra are straight and taper sharply adapically. The pore zones are relatively broad, slightly depressed with pore-pairs arranged in arcs of three (Pl. 3, Fig. 3a), located obliquely to the sutures; close to the peristome they form slightly expanded phyllodes. The pore zones are associated with small tubercles dispersed between the pore-pairs. Every second ambulacral plate bears an imperforate and non-crenulate primary tubercle above the ambitus (Pl. 3, Fig. 3a). These plates are separated by those which bear three or four, equally-sized small tubercles. Adorally, a primary tubercle is developed on every ambulacral plate. Each primary tubercle is surrounded by densely spaced scrobicular tubercles. The primary tubercles are largest at the ambitus and just below; they decrease gradually in size both adapically and adorally (Pl. 3, Figs 3a, b). The perradial zone is narrow.

The interambulacra are more than three times as wide as the ambulacra at the ambitus (Pl. 3, Fig. 3b). Each interambulacral plate bears one small imperforate and non-crenulate primary tubercle, located in the middle of the plate (Pl. 3, Figs 3b, c). The primary tubercles are surrounded by densely spaced scrobicular tubercles, forming regular circles (Pl. 3, Fig. 3c). There is one row of secondary tubercles along the adradial suture; these tubercles are equal in size to the primary ones at the ambitus and towards the peristome. Aborally, the secondary tubercles decrease gently in size. On each interambulacral plate, there are four or five secondary tubercles smaller than the primary one. These tubercles are located in the middle of the plate, where they form a characteristic horizontal row with the primary tubercles (Pl. 3, Fig. 3c). Below these tubercles (just above the adoral suture) there are five or six small tubercles arranged in a horizontal row (Pl. 3, Fig. 3c). At the interradial zone, the adapical part of the plates is naked.

The apical disc is not preserved.

REMARKS: The single primary interambulacral tubercle per plate, gradual change in tuberculation at the ambitus, trigeminate ambulacra with pore-pairs in arcs of three, and the formation of a relatively wide band of offset pore-pairs allow these specimens to be placed safely in the genus *Stomechinus* Desor, 1856. From *S. bigranularis*, the type species of the genus, and other *Stomechinus* species, they differ in the ornamentation of their interambulacral plates (with primary and secondary tubercles arranged horizontally), and in the

naked adapical part of their interambulacral plates aborally. The limited number of specimens and the imperfect state of their preservation does not allow for determination at species level.

Order Arbacioida Gregory, 1900

Genus *Eucosmus* L. Agassiz in L. Agassiz and Desor, 1846

TYPE SPECIES: *Eucosmus decoratus* (L. Agassiz in L. Agassiz and Desor, 1846, p. 52); OD.

DIAGNOSIS: Arbacioida genus with ambulacral plating simple from the ambitus adapically, trigeminate from the ambitus adorally; single series of small tubercles in each half ambulacrum, forming double, zigzag column of tubercles in each ambulacral zone.

Eucosmus decoratus L. Agassiz in L. Agassiz and Desor, 1846
(Pls 4–6)

1846. *Eucosmus decoratus* Agass.; L. Agassiz in L. Agassiz and E. Desor, p. 52, pl. 15, figs 12, 13, 13a.
 1856. *Magnosia decorata*; E. Desor, p. 116.
 1858. *Magnotia decorata* Agass.; T. Wright, p. 195.
 1858. *Echinus nodulosus*; F.A. Quenstedt, p. 649, pl. 80, figs 12–14.
 1871. *Magnosia decorata*, Desor (Agassiz); E. Desor and P. de Loriol, p. 210, pl. 34, figs 7–9.
 1883. *Magnosia decorata* (Agassiz), Desor, 1856; G. Cotteau, pp. 611–614, pl. 423, figs 1–11.
 1914. *E. decoratus* Agassiz; J. Lambert and P. Thiéry, p. 270.
 1975. *Magnosia decorata* (Agassiz); H. Hess, p. 102, pl. 39, fig. 10.
 1995. *Eucosmus decoratus* Agassiz, 1847; F. Nicolleau and A. Vadet, pp. 71–72, pl. 29, fig. 2A–2C.
 2005. *Magnosia decorata* (L. Agassiz in Desor, 1846); U. Radwańska, p. 68, pl. 2, figs 2a–2c and pl. 3, figs 2a–2c.

MATERIAL: 212 tests total; 43 adult tests: 29 from Zalas (MWGUW/ZI/56/265–266; MWGUW/ZI/56/277/box); 10 from Ogrodzieniec (MWGUW/ZI/56/275/box); 1 test from: Ćmielów near Ostrowiec (MWGUW/ZI/56/278); Wrzosowa (MWGUW/ZI/56/279); Młynka (MWGUW/ZI/56/276); 169 juvenile tests (1–3 mm \varnothing test): 140 from Zalas (MWGUW/ZI/56/270–272, MWGUW/ZI/56/273/box), 29 from Bielawy (MWGUW/ZI/56/267–269, MWGUW/ZI/56/274/box).

DIAGNOSIS: *Eucosmus* species with every third ambulacral plate carrying relatively large primary tubercle.

DESCRIPTION: The test is small, up to 10 mm in diameter, subglobular in profile, flattened adorally (Pl. 4, Figs 1a, b and Pl. 5, Figs 3a, b).

The ambulacra are straight, narrow with apparently simple plating from the ambitus adapically, with all elements reaching the perradius (Pl. 4, Figs 2a–c and Pl. 5, Fig. 3d) and trigeminate from the ambitus adorally (Pl. 4, Figs 2e, g). The pore pairs are small, uniserial, represented by the P2-type aborally (Pl. 4, Figs 2a–c), passing into the P2/P3-type, and forming short phyllodes, adorally (Pl. 4, Figs 2e, g). A single series of tubercles is developed in each half ambulacrum only (Pl. 4, Figs 2a, c; Pl. 5, Figs 2, 3b, 3d and Pl. 6, Figs 1a, 2a). Every third ambulacral plate carries a relatively large primary tubercle (Pl. 4, Figs 2c, e). The primary tubercles form a double, zig-zag column with no perradial space in each ambulacrum (Pl. 4, Figs 1b, 2a, 2c and Pl. 5, Figs 2, 3b, 3d).

The interambulacral plates are wider than tall with only one row of up to 8 equal-sized tubercles on each (Pl. 4, Fig. 2f). There are naked, slightly sunken areas in the central, aboral part of each interambulacrum (Pl. 4, Figs 2d, 2f and Pl. 5, Figs 1, 3a, 3c). The tubercles are imperforate and non-crenulate, without a platform (Pl. 4, Figs 2c, 2d, 2e and Pl. 5, Fig. 3c), and are slightly larger on the oral surface (Pl. 4, Figs 2e, 2g).

The apical disc is small, dicyclic and bound firmly to the corona (Pl. 4, Fig. 2b). The genital plates are wider than tall, with the gonopore shifted outwards; the ocular plates are small and pentagonal in outline. There is a ring of tubercles developed around the inner edge of the genital plates, encircling the periproct.

The peristome is very large (Pl. 4, Fig. 2f), more than half of the test diameter, subpentagonal with well defined buccal notches (Pl. 4, Fig. 2g).

DESCRIPTION OF JUVENILE SPECIMENS: The test is very small, ranging between 1.0 and 3.0 mm in diameter, distinctly flattened and more or less subconical in profile (Pl. 5, Figs 1, 2 and Pl. 6, Figs 1a, b), pentagonal in outline (Pl. 6, Fig. 2c). This subconical profile is accentuated by the distinctly exposed apical disc (Pl. 5, Fig. 1 and Pl. 6, Figs 2a, b).

The ambulacra are straight, with apparently simple plating throughout; phyllodes are not developed (Pl. 6, Fig. 3). A single series of equal-sized, relatively large tubercles is developed in each half ambulacrum (Pl. 5, Fig. 2 and Pl. 6, Figs 1a, 2a); the tubercles form a simple zig-zag row (Pl. 5, Fig. 2).

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The interambulacra are wide, with relatively distinct, naked and slightly sunken areas in the central aboral part (Pl. 5, Figs 1, 2 and Pl. 6, Figs 1b, 2b). The tubercles are relatively large (Pl. 6, Figs 1a–1c and 2a–2c), imperforate and non-crenulate, without a platform (Pl. 6, Fig 1a, b). The apical disc is small, dicyclic and bound firmly to the corona (Pl. 6, Fig. 2d). The genital plates are wider than tall; the gonopore is not opened. The ocular plates are small and pentagonal in outline.

The peristome is very large (Pl. 6, Fig. 3), more than half of the test diameter, circular or subpentagonal in outline with buccal notches not defined (Pl. 6, Fig. 3).

REMARKS: The specimens studied correspond well to *Eucosmus decoratus* described by L. Agassiz (1846) from the Upper Jurassic of Switzerland. *Eucosmus decoratus* is quite common in several localities in Poland, and in the Oxfordian of France, Switzerland, and Germany. It is the only *Eucosmus* species in Oxfordian deposits of Europe. Another species, *Eucosmus meslei* (Gauthier, 1875), is known from the Tithonian of Algeria.

The collected material comprises 212 specimens, the majority of which (169 specimens, 80% of the total) are juveniles. An ubiquity of the latter forms, as well as their good state of preservation, allow the ontogenetic development in this species to be recognised. In the juvenile stage (1–3 mm in test diameter), the test is distinctly flattened, conical in profile and pentagonal in outline. Later in ontogeny the test becomes loaf-shaped in profile and circular in outline. Above the ambitus, the ambulacral columns are composed of simple plates, adorned with one primary tubercle. In adult specimens these tubercles are arranged in vertical triads, with every third one being larger than the remaining two (Pl. 4, Fig. 2c). In young specimens only the larger tubercles develop, having been arranged in one zigzag column (Pl. 6, Fig. 2a); the others are very small or completely missing (Pl. 6, Fig. 1a). In the course of ontogeny smaller primary tubercles appear gradually, changing the structure of the ambulacral tuberculation where the primary tubercles finally form a double zigzag column.

Already in the early ontogenetic stages the apical disc is relatively small relative to the test diameter (ratio 36%), and such proportion is kept, without distinct changes, until the adult stage (ratio 26%).

The remarkable abundance of juvenile specimens in the collected material may be ascribed to various factors. A high juvenile mortality (observed also in other echinoids), on one hand, and a relatively high fossilization potential (thick-walled, robust test, including the apical disc), on the other, could possibly explain this

effect. Partly at least, the juvenile abundance seems to be an artefact caused by sieving an immense quantity of the weathered scree material.

Family Glypticidae Lambert and Thiéry, 1914

Genus *Glypticus* L. Agassiz, 1840

TYPE SPECIES: *Echinus hieroglyphicus* Goldfuss, 1829, p. 126, by monotypy.

DIAGNOSIS: Glypticidae genus with trigeminate ambulacral plates throughout, and with epistroma in form of irregular pustules, developed adaptically.

Glypticus hieroglyphicus (Goldfuss, 1829)
(Pls 7–8)

1829. *Echinus hieroglyphicus* nobis.; A. Goldfuss, p. 126, pl. 40, figs 17a, b.
1840. *Glypticus hieroglyphicus* Ag.; L. Agassiz, p. 13.
1839. *Glypticus hieroglyphicus* Ag.; L. Agassiz, pp. 96–97, pl. 23, figs 37–39.
1839. *Glypticus afinis* Ag.; L. Agassiz, p. 97, pl. 23, figs 40–42.
1847. *Glypticus hieroglyphicus* Agass.; L. Agassiz and E. Desor, p. 56.
1847. *Glypticus afinis* Agass.; L. Agassiz and E. Desor, p. 57.
1855. *Glypticus hieroglyphicus* Agass.; E. Desor, p. 95, pl. 16, figs 1–3.
1855. *Glypticus afinis* Agass.; E. Desor, p. 96.
1857. *Glypticus hieroglyphicus* Goldfuss; T. Wright, pp. 186–188, pl. 13, figs 3a–f.
1859. *Glypticus hieroglyphicus*, Ag. 1840; G. Cotteau and J. Triger, pp. 115–117, pl. 21, figs 19, 20.
1870. *Glypticus hieroglyphicus* Agass.; F. Roemer, p. 268, pl. 25, figs 22–24.
1883. *Glypticus hieroglyphicus* (Goldfuss) Agassiz, 1840; G. Cotteau, pp. 582–590, pls 416, 417.
1975. *Glypticus hieroglyphicus* (Goldfuss); H. Hess, p. 102, pl. 10, fig. 4.
1992. *Glypticus hieroglyphicus* (Goldfuss, 1826); A. Zbinden, pp. 176–178.
2001. *Glypticus hieroglyphicus* (Goldfuss, 1826); A. Vadet, N. Remy and E. Wille, pp. 50–52, pls 39–41.
2004a. *Glypticus hieroglyphicus* (Goldfuss, 1826); U. Radwańska, p. 133 and p. 136, pl. 2, figs 1, 2.

MATERIAL: Two tests: one juvenile from Bałtów (MWGUW/ZI/56/280–281) and one broken adult from Bukowa (MWGUW/ZI/56/282).

DIAGNOSIS: *Glypticus* species with well and irregularly developed epistroma.

DESCRIPTION: The test is thick-walled, low hemispherical, flattened adorally (Pl. 7, Figs 1a, b and Pl. 8, Figs 1c, d, 1f).

The ambulacra are straight, and the ambulacral plating is trigeminate, with the lowest element being the largest, the medium smaller, and the upper developed as a small demiplate. All compound plates bear a large imperforate and non-crenulate tubercle (Pl. 7, Fig. 1a and Pl. 8, Fig. 1g). The pore-pairs are uniserial aborally and represent the P2-type (Pl. 7, Fig. 1a and Pl. 8, Figs 1c, d, 1g); they change to the P3/P4-type beneath the ambitus, forming phyllodes.

The interambulacral plates are wider than tall, with a single large imperforate and non-crenulate primary tubercle on all ambital and oral plates (Pl. 7, Figs 1a, b, 1d and Pl. 8, Figs 1f, 1h). Above the ambitus, there is still a small tubercle, which is surrounded by a coarse epistromal ornamentation (Pl. 8, Figs 1b, c). In the juvenile specimen, the epistromal ornamentation is not so clear and restricted to the base of the tubercles (Pl. 8, Figs 1f, 1h).

The apical disc is moderately large, dicyclic, bound firmly to the corona (Pl. 7, Fig. 1c and Pl. 8, Figs 1a, b). The genital plates are pentagonal in outline with a subcentrally placed gonopore. The inner edge of the genital plates is raised and forms a lip around the small periproct (Pl. 7, Fig. 1c). The ocular plates are heart-shaped and slightly exert. The disc plates are ornamented by pustular tubercles and sutural depressions.

The peristome is large, circular and slightly sunken; the buccal notches are distinct and moderately sharp (Pl. 7, Fig. 1d).

The primary spines are absent in the specimens studied. [For well preserved spines *in situ*, see Vadet *et al.* 2001, pl. 41: and for isolated ones, Zbinden 1992, figs on her pages 177, 178].

REMARKS: The specimens studied correspond well to *Echinus hieroglyphicus* described by Goldfuss (1829) from the Oxfordian of Germany. The species seems to be uncommon in the Oxfordian strata of Poland and it has hitherto been only rarely described. Roemer (1870, p. 268 and pl. 25, figs 22–24) described some forms from the Polish Jura. The peculiarly shaped spines of this species were reported by Gallinek (1896, p. 404) from the Bielawy sequence. To this species should most probably be referred the material of Wójcik (1910), who reported on the occurrence of “*Glypticus sulcatus*” from several localities (including Zalas) of the Cracow Upland (see comment in Radwańska 2004a). In the Holy

Cross Mountains, the species was noted by Samsonowicz (1934, p. 33; see also Radwańska 2004a, p. 139).

Outside Poland, *G. hieroglyphicus* is known from the Oxfordian of western Europe, having been locally so common that the Liesberg Beds of the Middle Oxfordian in the Swiss Jura are distinguished as a separate “Glyptician” unit (see Hess 1975, pp. 27 and 102).

Based on functional analysis of tests and isolated spines of *E. hieroglyphicus* (see Zbinden 1989) it was possible to infer (Radwańska 2004) the phenotypic convergence of *Glypticus hieroglyphicus* (Goldfuss, 1829) with the extant species *Colobocentrotus atratus* (Linnaeus, 1758), adapted to the surf zone of Hawaii and other Indo-Pacific littorals (cf. Blake 1984, Schultz 2005; Radwańska 2003b, pl. 1, figs 18a, b).

Genus *Pleurodiadema* de Loriol, 1870

TYPE SPECIES: *Pleurodiadema stutzi* (Moesch, 1867); OD (de Loriol 1870, p. 196).

DIAGNOSIS: Genus of the Glypticidae with ambulacral plates simple adapically, and trigeminate beneath ambitus to peristome.

Pleurodiadema stutzi Desor in Desor and de Loriol, 1871
(Pls 9–12)

1867. *Hemipedina Stutzi*, Des.; C. Moesch, p. 137. [*nomen nudum*].

1871. *Pleurodiadema stutzi*, Desor; E. Desor and P. de Loriol, pp. 196–198, pl. 33, figs 1, 2.

1875. *Pleurodiadema Stutzi* (Desor), de Loriol, 1871; G. Cotteau, p. 186, pl. 26, figs 1, 2.

1884. *Pleurodiadema Stutzi* (Desor), de Loriol, 1871; G. Cotteau, pp. 552–555, pl. 409, figs 1–11, and pl. 410, figs 1–10.

1995. *Pleurodiadema stutzi* (de Loriol, 1871); P. Nicolleau and A. Vadet, pp. 77, 78, pl. 30, fig. 3.

2005. *Pleurodiadema gauthieri*, Cotteau, 1884; U. Radwańska, p. 68, pl. 2, figs 1a–c and pl. 3, figs 3a, b.

MATERIAL: 36 adult tests: 29 from Zalas (MWGUW/ZI/56/283–285, MWGUW/ZI/56/285a/box); 1 from Młynka (MWGUW/ZI/56/290); 4 from Wrzosowa (EOx/286, EOx/287, EOx/287a/box); 2 from Ogrodzieniec (EOx/288, EOx/289); 1 from Ćmielów (MWGUW/ZI/56/291). 124 juvenile tests from Zalas MWGUW/ZI/56/295–296, MWGUW/ZI/56/296a/box) and 3 from Wapienno (MWGUW/ZI/56/292–294).

DIAGNOSIS: *Pleurodiadema* species with primary ambulacral and interambulacral tubercles developed beneath the ambitus to peristome; aboral side of test covered by small, widely dispersed secondary tubercles.

DESCRIPTION: The test is relatively thin-walled, small (the largest specimen is 27 mm in diameter), subglobular in profile, flattened adorally (Pl. 9, Figs 1–5).

The ambulacra are straight, with apparently simple plating aborally (Pl. 9, Figs 1b, 2a, 4a); the plates are covered by a few small granules (Pl. 10, Figs 1a, 1b). Beneath the ambitus to the peristome the plates become rapidly trigeminate with one large tubercle covering all three elements (Pl. 10, Fig. 1d). The pore-pairs are small, oblique and arranged uniseriably throughout (Pl. 10, Figs 1a–c), but those located the most adorally form initial phyllodes (Pl. 10, Fig. 1d). The aboral, widely arranged isopores represent the P2-type (Pl. 10, Fig. 1f); adorally they pass into the P2/P3-type (Pl. 10, Fig. 1d).

The interambulacral plates are slightly wider than tall and bear one large primary tubercle with a large imperforate mamelon and a slightly crenulate platform (Pl. 10, Figs 1e, 1g, h). All plates are covered with small, widely dispersed, equal-sized secondary tubercles (Pl. 10, Fig. 1g). Beneath the ambitus (Pl. 10, Figs 1a), the adradial zone of the interambulacrum is covered by lateral grooves and aligned granules. In some specimens (Pl. 9, Fig. 4b and Pl. 10, Fig. 1a), primary tubercles are not developed on the most aboral plates.

The apical disc is large, dicyclic, and bound firmly to the corona; all plates are covered by pustular granules (Pl. 9, Fig. 5).

The peristome is slightly sunken, large, about half the size of the test diameter (Pl. 9, Figs 2b, 3); the buccal notches are shallow and surrounded by a distinct margin (Pl. 10, Fig. 1d).

DESCRIPTION OF JUVENILE SPECIMENS: The test is high, hemispherical in profile (Pl. 11, Figs 1b, 2a, b and Pl. 12, Figs 1b, c, 2b), attaining 1.0–5.0 mm in diameter.

The ambulacral primary tubercles are developed beneath the ambitus towards the peristome (Pl. 12, Fig. 1b). The pore-pairs are oblique and arranged uniseriably (Pl. 12, Fig. 1b).

The interambulacral primary tubercles are relatively large. They are located at the ambitus and on the aboral side of the test (Pl. 11, Figs 1b, 2a, b and Pl. 12, Figs 1a, 1c, 2b).

The apical disc is large (Pl. 11, Figs 2c, d); in very small specimens (with diameter c. 1 mm) it reaches almost the ambitus (Pl. 11, Fig. 1b and Pl. 12, Fig. 2b).

Borders between ocular and genital plates are visible (Pl. 11, Fig. 2d and Pl. 12, Figs 1d, 2a). The genital pores are not open. All plates are covered by epistomal pustules (Pl. 11, Figs 1, 2). The periproct is small, located centrally or subcentrally (Pl. 11, Figs 1a, 2c, d and Pl. 12, Fig. 1a).

The peristome is large, c. 80% of the test diameter, and circular in outline.

REMARKS: The specimens studied correspond well to *Pleurodiadema stutzi*, described and illustrated by Cotteau (1884). The specimens from the Oxfordian of Zalas, studied herein, were referred earlier (Radwańska 2005) to *Pleurodiadema gauthieri* Cotteau, 1884. The misinterpretation resulted from the much poorer state of preservation of the material then available; all specimens were slightly worn and their interambulacral primary tubercles on the most adapical plates were not preserved. The new specimens have interambulacral primary tubercles developed on the most adapical plates; comparison of these specimens with the syntype of *P. gauthieri*, clearly indicate that they represent *P. stutzi*.

From *P. gauthieri* Cotteau, 1884, *P. stutzi* differs in its more domed profile, the delicate and strongly dispersed secondary tubercles, and in the presence of one large primary tubercle on the interambulacral plates above the ambitus. From *P. nudum* Cotteau, 1875, known from the Kimmeridgian of Germany, *P. stutzi* differs in the presence of non-perforate primary tubercles below the ambitus (see Pl. 10, Fig. 1d), and interambulacral primary tubercles above the ambitus.

Pleurodiadema stutzi, together with *Eucosmus decoratus*, are the most commonly represented species in the collected material. Both species are also represented by a remarkable number of juveniles; in *P. stutzi* the juveniles constitute 78% of the material.

Order Arbacioida

Family Acropeltidae Lambert and Thiéry, 1914

genus and species indet.

(Pl. 13, Figs 1, 2)

MATERIAL: Eight juvenile specimens from Bielawy, Zalesie Anticline (MWGUW/ZI/56/296-297, MWGUW/ZI/56/296a/box).

DESCRIPTION: The test is small (less than 2 mm in diameter), low hemispherical in profile (Pl. 13, Figs 1c, d, 2b, c).

The ambulacra are straight, with a single non-crenulate and imperforate tubercle on each plate, arranged in one zigzag column in the smallest specimen (Pl. 13, Fig.

1c), or into two rows in the larger ones (Pl. 13, Figs 2c, d). Ambulacral plates are trigeminate throughout (Pl. 13, Fig. 2d) with two elements bearing the primary tubercle alternating with a small demiplate. Phyllodes are not developed.

The interambulacra are more than twice as wide as the ambulacra at the ambitus (Pl. 13, Figs 1c, 2b) and are dominated by non-crenulate and imperforate primary tubercles with a massive mamelon and no platform (Pl. 13, Figs 1d, 2b). The ambital plates bear two primary tubercles per plate (Pl. 13, Figs 1d, 2b). The primary tubercles are largest at the ambitus and decrease adapically and adorally. The secondary tuberculation is present around the primary tubercles at the ambitus.

The apical disc (Pl. 13, Figs 1a, b, 2a) is relatively small (about 43% of the test diameter), thickened and bound firmly to the corona. The plating is dicyclic, with ocular plates projecting beyond the genital plates (Pl. 13, Figs 1a, b, 2a). Single or double primary tubercles occupy the centre of genital plates. The gonopores are not open, even in the largest specimens studied.

The peristome is large, circular in outline.

REMARKS: All of the specimens studied clearly represent juveniles. The presence of imperforate and non-crenulate primary tubercles with a massive mamelon without a platform, and a characteristic apical disc adorned with tubercles, trigeminate ambulacral plates, and a lack of epistroma may indicate the family Acropeltidae Lambert and Thiéry, 1914. However, the presence of two interambulacral primary tubercles per column at the ambitus (Pl. 13, Figs 1d, 2b) is unknown in this family. This feature accentuates during ontogeny, and the largest specimen bears two interambulacral plates at the ambitus with two tubercles per column (compare Pl. 13, Fig. 1c with Pl. 13, Fig. 2b). Three or four tubercles per column are known in some representatives of the genus *Eucosmus* L. Agassiz and Desor, 1846. At a comparable size (1.5–2 mm in diameter), the juveniles of, e.g., *E. decoratus* (see Pl. 6, Figs 1, 2) studied herein have, however, a higher number of small interambulacral primary tubercles and simple ambulacral plating. Until adult specimens of this morphotype are found, the studied juveniles are left in open nomenclature in the family Acropeltidae.

Stem group Calycina

Order Phymosomatoida Mortensen, 1904

Subfamily Diplopodiinae Smith and Wright, 1993

Genus *Diplopodia* McCoy, 1848

TYPE SPECIES: *Diplopodia pentagona* McCoy, 1848, p. 412, by monotypy; Bajocian of England.

DIAGNOSIS: Genus of Diplopodiinae with interambulacral ambital plates bearing single distinct primary tubercle.

Diplopodia aequale (L. Agassiz, 1839)
(Pl. 14, Figs 1–4)

1839. *Diadema aequale* Ag.; L. Agassiz, p. 18, pl. 17, figs 36–38.

1847. *Diadema aequale* Agass.; L. Agassiz and E. Desor, p. 42.

1855. *Pseudodiadema aequale* Agass; E. Desor, p. 65.

1855. *Diplopodia bipunctata* Desor, nov.sp.; E. Desor, p. 77.

1856. *Pseudodiadema aequale* Agassiz; T. Wright, p. 140.

?1871. *Pseudodiadema bipunctatum*, Desor; E. Desor and P. de Loriol, pp. 169, 170, pl. 27, figs 3, 3a–3d.

1871. *Pseudodiadema aequale* (Agassiz), Desor; E. Desor and P. de Loriol, pp. 173, 174, pl. 29, figs 1, 1a–d.

1882. *Pseudodiadema bipunctatum*, Desor, 1856; G. Cotteau, pp. 292–295, pl. 339, figs 1–6 and pl. 340, figs 1–6.

1882. *Pseudodiadema aequale* (Agassiz), Desor, 1856.; G. Cotteau, pp. 295–299, pl. 341, figs 1–7 and pl. 342, figs 1–8.

1975. *Diplopodia aequalis* (Agassiz); H. Hess, p. 100, text-fig. 53 and pl. 38, fig. 3.

1989. *Diplopodia aequalis* Agassiz, 1840; A. Zbinden, p. 189, text-fig. 5.

2005. *Diplopodia aequale* (L. Agassiz, 1840); U. Radwańska, p. 65 and 71, pl. 2, figs 6a, b and 7a, b.

DIAGNOSIS: A *Diplopodia* with ambulacral pore-pairs less biserially arranged adapically.

MATERIAL: 26 tests in total; 8 from Wrzosowa (MWGUW/ZI/56/299–300, MWGUW/ZI/56/300a/box); 7 from Zalas (MWGUW/ZI/56/305/box), 3 from Ogrodzieniec (MWGUW/ZI/56/301, MWGUW/ZI/56/301a/box); 3 from Lasocin (MWGUW/ZI/56/306/box), 2 from Kłobuck (MWGUW/ZI/56/307/box), and single tests: from Gneździska (MWGUW/ZI/56/298), Rudniki (MWGUW/ZI/56/308), and Włodowice (MWGUW/ZI/56/309).

DESCRIPTION: The test is moderately large, subpentagonal in outline, flattened adapically and adorally (Pl. 14, Figs 1–4).

The ambulacra are straight, tapering sharply adapi-

cally, expanding at the ambitus (Pl. 14, Figs 1, 2a, 3b). They taper gradually towards the peristome (Pl. 14, Figs 2c, 4). Large pore-pairs are arranged uniserially (Pl. 14, Figs 3b, c), except towards the apex, where they become biserially offset (Pl. 14, Fig. 3a). A few pore-pairs develop into short phyllodes adorally (Pl. 14, Figs 2c, 4). Compound plates are trigeminate in the diadematoïd manner (all elements reach the perradius) becoming quadrigeminate adapically. The pore-pairs are relatively large and represent P2 isopores (Pl. 14, Figs 3b, c). Each of the compound plates bears a single large crenulate and perforate primary tubercle. The primary tubercles decrease gradually in size, both adapically and adorally, and have a large swollen boss and a moderately large mamelon (Pl. 14, Figs 1, 2a, 3b). The perradial zone is narrow. The secondary tuberculation is confined to the perradial zone and to adapical and adoral sutures (Pl. 14, Figs 1, 3b).

The interambulacral plates are slightly wider than tall. Interambulacra are more than twice as wide as ambulacra and more tapered both adapically and adorally (Pl. 14, Fig. 3c). Each interambulacral plate bears one crenulate and perforate primary tubercle (Pl. 14, Figs 2b, 3c). The primary tubercles have a large swollen boss and a moderately large mamelon. The largest primary tubercles, present at the ambitus, decrease gradually in size both adapically and adorally. Areoles are narrow and confluent to the ambitus; they become contiguous or non-confluent (in the largest specimens) adapically (Pl. 14, Figs 2b, 3c). The second row of small tubercles, less than half the diameter of the primary tubercles, is located on the adradial plate margin (Pl. 14, Figs 2b, 3c); these tubercles diminish in size adapically and are absent above the ambitus. The interradian zone is relatively broad and covered by the secondary tuberculation and granules at the adoral side. There is a single zigzag row of tubercles (Pl. 14, Figs 2b, 3c). This tuberculation declines gradually towards the apex and, consequently, a naked area appears on each interambulacrum adapically (Pl. 14, Fig. 3a).

The apical disc is subpentagonal in outline (Pl. 14, Fig. 3a), moderately large, about 50% of the test diameter. Apical plates are not preserved in any of the specimens studied.

The peristome is large (about half of the test diameter) and has deep buccal notches (Pl. 14, Figs 2c, 4).

REMARKS: *Diplopodia aequale* occurs in many exposures, but is never common. The preservation state of specimens is poor, and in many of them the apical part is completely eroded. When preserved, the ambulacra show a double row of pore-pairs on the most adapical plates.

The synonymy of *D. aequale* includes *D. bipunctata* of Desor (1855), which differs only in its better developed secondary tuberculation on the interambulacral plates. From *Diplopodia pentagona* McCoy, 1848, the type species of the genus, *D. aequale* differs in its distinctly shorter double row of ambulacral pore-pairs and in the presence of the secondary row of relatively larger tubercles in the adoral part of the test.

Family Emiratiidae Ali, 1990

Since their first description, the systematic positions of the two genera, *Polydiadema* [Lambert, 1888, p. 13, type species *P. davidsoni* (Wright, 1851); SD Lambert and Thiéry 1925, p. 565] and *Trochotiara* [Lambert, 1901, p. 236, type species *T. prisca* (Agassiz, 1840); OD Lambert 1901, p. 236], have been variously interpreted, the main problem being the various structures of their ambulacral plating. The genera were regarded either as separate, partly identical, or were fully synonymized. According to the present author, their distinctness is quite clear, and the genera *Polydiadema* and *Trochotiara* can be diagnosed as follows (see Beurlen 1937, p. 108):

Polydiadema, with polygeminate plating throughout, but quinquegeminate at ambitus and above;

Trochotiara, with trigeminate plating throughout, but one quadrigeminate plate at ambitus.

The representative of the family studied herein, the species *langi* of Desor (1856), displays trigeminate plating throughout (or, with one ambital plate quadrigeminate) and evidently belongs to the genus *Trochotiara*. To this genus also belongs “*Cidarites mamillanus* Nob.” of Roemer (1836, p. 26, pl. 2, fig. 1), albeit regarded by Lambert and Thiéry (1911, p. 189) and by the *Treatise* (Fell and Pawson 1966, p. 389) as the type of the genus *Polydiadema* Lambert, 1888.

The latter erroneous treatment has evidently resulted from an earlier misinterpretation of the species “*Diadema davidsonii* Wright, 1851” bearing polygeminate plates (see Wright 1855, p. 132, pl. 8, fig. 2d), which Wright himself (1855, p. 132), followed by Desor and de Loriol (1871), synonymized with the trigeminate “*Cidarites mamillanus*” of Roemer (1836). Unfortunately, the “*mamillanus*” specimens figured by Desor and de Loriol (1871, pl. 25, figs 2, 3) were determined erroneously and represent the species *davidsoni*, as already pointed out by Lambert and Thiéry (1925, p. 565), who had earlier (1911, pp. 181 and 189) regarded them as typical of the genus *Polydiadema*.

Genus *Trochotiara* Lambert, 1901

TYPE SPECIES: *Diadema priscum* Agassiz, 1840; *OD* Lambert (1901, p. 236).

DIAGNOSIS: Emiratiidae genus with uniserial pore-pairs above ambitus, ambulacral plating trigeminate throughout (with one ambital plate per column quadrigeminate), pore-pairs forming phyllodes.

Trochotiara langi (Desor, 1855)
(Pls 15–16)

1855. *Pseudodiadema Langi* Desor nov. sp.; E. Desor, p. 65.
 1871. *Pseudodidema areolatum* Desor; E. Desor and P. de Loriol, pp. 139–141, pl. 23, fig. 3.
 1871. *Pseudodiadema Langi* Desor; E. Desor and P. de Loriol, pp. 141, 142, pl. 24, fig. 2.
 1882. *Pseudodiadema Langi*, Desor, 1856; G. Cotteau, pp. 289–291, pl. 338, figs 6–14.
 1882. *Pseudodiadema Beaudouini*, Cotteau, 1882; G. Cotteau, pp. 287, 288, pl. 338, figs 1–5.
 1882. *Pseudodiadema areolatum* Desor; G. Cotteau, p. 417.
 1975. *Polydiadema langi* (Desor); H. Hess, p. 99, pl. 39, fig. 7.
 1989. *Polydiadema (Aplodiadema) langi* (Desor); A. Zbinden, pp. 189, 190, text-figs 6–8.
 2005. *Polydiadema langi* (Desor, 1856); U. Radwańska, p. 71, pl. 2, figs 4a–c.

DIAGNOSIS: *Trochotiara* species with large, swollen, primary tubercles occupying almost whole surface of ambulacral and interambulacral plates.

MATERIAL: 36 tests in total; 14 from Ogrodzieniec (MWGUW/ZI/56/310/box); 8 from Zalas (MWGUW/ZI/56/303, MWGUW/ZI/56/303a/box); 7 from Wrzosowa (MWGUW/ZI/56/302, MWGUW/ZI/56/304, MWGUW/ZI/56/304/box); 4 from Gnieździska (MWGUW/ZI/56/box); single tests from: Lasocin (MWGUW/ZI/56/312), Młynka, (MWGUW/ZI/56/313), and Kłobuck (MWGUW/ZI/56/314).

DESCRIPTION: The test is small, subpentagonal in outline, low, flattened adorally and adapically (Pl. 15, Figs 1a–d and Figs 2a–d). The collected material comprises both adult and juvenile forms. The adult forms range from 14 to 20 mm in diameter, the smallest one reaches 8 mm

The ambulacra are straight, tapered sharply adapically, expanded at the ambitus (Pl. 15, Figs 1c, 2a and

Pl. 16, Figs 1a, 1c); they taper gradually towards the peristome (Pl. 16, Fig. 1g). Large pore-pairs are arranged uniserially (Pl. 16, Figs 1a, 1c, d), except a few, crowded together close to the peristome and forming narrow phyllodes with P2/P3 isopores (Pl. 16, Figs 1g, h). Compound plates are trigeminate (Pl. 16, Fig. 1e) in the diadematooid manner (all elements reach the perradius). On the ambital plates, the pore-pairs are widely spaced, and represent P2 isopores (Pl. 16, Fig. 1c, 1e). Each compound plate bears a single large crenulate and perforate primary tubercle. Primary tubercles have a large swollen boss and a relatively large mamelon (Pl. 16, Figs 1c, 1e); these tubercles gradually decrease in size both adapically and adorally. The perradial zone is narrow and almost naked, and secondary tuberculation is confined to adapical and adoral sutures only (Pl. 16, Fig. 1c).

Interambulacral plates are slightly wider than tall; interambulacra are about 1.5 times wider than the ambulacra at the ambitus. Each interambulacral plate bears one crenulate and perforate primary tubercle (Pl. 16, Figs 1b, 1f). Primary tubercles have a large swollen boss and a relatively large mamelon (Pl. 16, Fig. 1f). The largest tubercles are present at the ambitus, and decrease gradually in size both adapically and adorally. Areoles are narrow and non-confluent throughout (Pl. 16, Fig. 1b). The secondary tuberculation is evenly distributed around the areole and confined to one circle (Pl. 16, Fig. 1f).

The apical disc is subpentagonal in outline (Pl. 15, Figs 1a, 2c), moderately large (about half of the test diameter). Apical plates are not preserved in the specimens studied.

The peristome is large (about 55% of the test diameter), with shallow, but clearly defined buccal notches (Pl. 15, Figs 1b, 2d).

REMARKS: The specimens studied correspond well to those described by Desor (1855) as “*Pseudodiadema Langi* nov. sp.” From *Trochotiara prisca* (Agassiz, 1839), the type species of the genus, *T. langi* differs in test ornamentation, having the primary tubercles distinctly swollen (bosses and mamelons) in both ambulacral and interambulacral columns.

Stem group Irregularia
 Microstomata *incertae sedis*
 Family Desorellidae Lambert, 1911
 Genus *Desorella* Cotteau, 1855

TYPE SPECIES: *Hybochlypus elatus* Desor in L. Agassiz and Desor, 1847; SD Cotteau (1873, p. 333).

ECHINOIDS FROM THE OXFORDIAN (JURASSIC) OF POLAND

Desorella sp.
(Pl. 7, Figs 2, 3)

MATERIAL: Three specimens from Niegowonice (MWGUW/ZI/56/318-/320), badly preserved with the apical part worn away.

DESCRIPTION: The test is relatively large, depressed, ovate in outline (Pl. 7, Figs 2, 3). The tuberculation on the aboral side is fine and uniform. The ambulacra are narrow, with simple plates and pore-pairs arranged uniserially; they do not form petals. The periproct is teardrop-shaped in outline, located ambitally in a shallow anal sulcus (Pl. 7, Figs 2, 3). The peristome is small, sunken, located obliquely to the long test axis, without buccal notches. Around the peristome the interambulacra are not swollen.

REMARKS: The specimens studied probably belong to *Desorella elata* (Desor in L. Agassiz and Desor, 1847), known from the Oxfordian of France. Their poor state of preservation prevents definite species identification.

Order Incertae sedis
Family Heterocidaridae Mortensen, 1934
Genus *Heterocidaris* Cotteau, 1860

TYPE SPECIES: *Heterocidaris trigeri* Cotteau, 1860; OD

DIAGNOSIS: Test large, circular in outline, wheel-shaped in profile; ambulacra straight with trigeminate

(or ? polyporous) plates; interambulacra broad, each plate with 2 to 6 large, equal in size primary tubercles, forming vertical series.

Heterocidaris dumortieri Cotteau, 1871
(Text-fig. 5)

1871. *Heterocidaris Dumortieri*; G. Cotteau in E. Dumortier, p. 79, pl.4, figs 26, 27.

1882. *Heterocidaris Dumortieri* Cotteau, 1871; G. Cotteau, p. 432, pl. 375, figs 4–6.

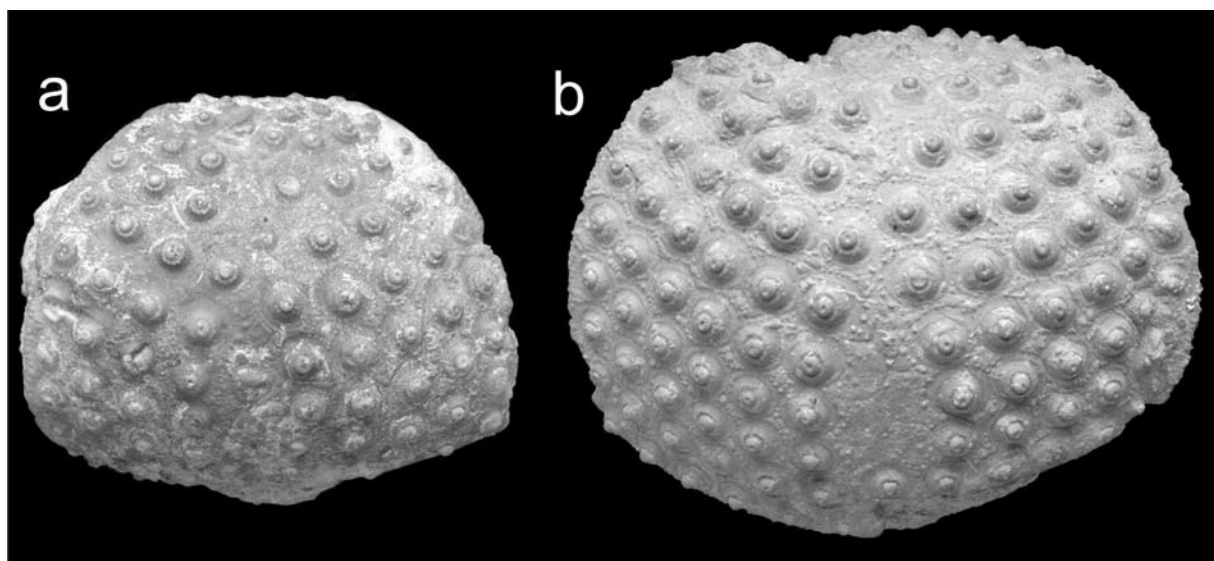
1885. *Heterocidaris Dumortieri* Cotteau, 1871; G. Cotteau, p. 871, pl. 509, figs 8, 9.

2005. *Heterocidaris dumortieri* Cotteau, 1871; U. Radwańska, p. 71, pl. 2, fig. 5.

MATERIAL: Ten interambulacral fragments from Zalas (MWGUW/ZI/56/315-317, EOx/317/box).

DIAGNOSIS: *Heterocidaris* species with interambulacra with 6 primary tubercles, forming vertical series at ambitus, and with naked area at interradian zone just above ambitus.

DESCRIPTION: The thin-walled tests range from about 70 to 100 mm in diameter, and 40 to 50 mm in height. They are circular in outline, wheel-shaped in profile, with the ambitus at about mid-height (Text-fig. 5). Ambulacra are not preserved in the specimens studied. Interambulacra are broad, with numerous plates in a column. All plates are distinctly wider than tall, with four to six, equal in size, perforate and crenulate primary tu-



Text-fig. 5. *Heterocidaris dumortieri* Cotteau, 1871; a – Lateral view of interambulacrum; × 1.5; Specimen from Zalas, No. MWGUW/ZI/56/315; b – Lateral view of interambulacrum; × 1.5; Specimen from Zalas, No. MWGUW/ZI/56/316

bercles, forming horizontal series (Text-fig. 5). In the largest individuals, a naked area appears in the interradial zone of the ambitus (Text-fig. 5). Delicate, sparse scrobicular tubercles surround each areole (Text-fig. 5). Areoles are non-confluent adapically, but contiguous ambitally and adorally. The secondary tuberculation is weakly developed on the adapical plates. The peristome is probably large, pentagonal in outline. The apical disc, lantern and spines are not preserved.

REMARKS: The specimens studied correspond well to those described by Cotteau (1871, 1882, 1885). From *H. trigeri* Cotteau, 1860 and *H. wickense* Wright, 1860, the species under discussion differs in its larger test diameter, in a larger number of primary tubercles arranged in horizontal rows, and in weakly developed secondary tuberculation (see Cotteau 1860, 1882, 1885).

Fell (1966) included the genus *Heterocidaris* and the monogeneric family Heterocidaridae in an uncertain order, because both their apical disc and lantern remain unknown. The Polish material discussed herein provides no new data relevant to the systematic position of these taxa.

FINAL REMARKS

The Oxfordian echinoids in Poland, when compared with those of Kimmeridgian age (see Radwańska 1999), are much less abundant and distinctly less diverse. This seems not to be the case in other European countries, such as France or Switzerland (see Agassiz 1839, 1840; Desor 1855; Cotteau 1880; Hess 1975) and Germany (see Goldfuss 1829; Opper 1856–1858; Quenstedt 1858), where the European Sponge Megafacies from the Swabian and Franconian Albs is identical to that of the Polish Alb (= Polish Jura Chain; cf. Trammer 1982, 1989; Matyja and Wierzbowski 1995). Consequently, the observed relationship in Poland may be at least partly the result of collecting bias. With the exception of the two large quarries that have existed for over a century (Zalas in the Cracow Upland, Bielawy/Wapienno in Couiavia), the other localities are much smaller (e.g., Trzebinia, Ogrodzieniec, Niegowonice in the Polish Jura; Bukowa (coralliferous part) and Lasocin in the Holy Cross Mountains). Moreover, collecting in a number of the source localities used herein took place over a relatively short time interval of a few to several years only, or even a shorter time in some cases.

As stated earlier (Radwańska 2003a, p. 147), the most favourable habitats for the cidaroid echinoids, and also for the non-cidaroids presented herein, were the

flanks of sponge bioherms or their talus (see Radwańska 2003b, 2007; also Ostrowski 2003).

The total number of Oxfordian echinoid species-level taxa recognised and reported by the author is 27 (see Table 1), comprising 13 cidaroids (reported by Radwańska 2003a), and 14 non-cidaroids (studied in this paper). This is based on both the author's own collection and various historical collections (Roemer 1870; Siemiradzki 1893; Wójcik 1910; Barczyk 1961; Wiśniewska-Żelichowska 1971).

The Zalas section, where the most diverse lithologies are represented, (see Matyja and Tarkowski 1981; Radwańska 2005; Głowniak 2012), has yielded as many as twelve taxa (some of which were studied separately; see Radwańska 2005). Of special note here is the species *Heterocidaris dumortieri* Cotteau, 1871, a rarity anywhere in Oxfordian strata of Europe (cf. Fell 1966).

At Bielawy/Wapienno, on the flanks of a huge, one hundred metres high biohermal complex, a number of specimens were found, with eight echinoid species recognised. The most spectacular are large *Rhabdocidaris nobilis* (Münster in Goldfuss, 1829), and *Plegiocidaris monilifera* (Goldfuss, 1829), the latter known from specimens infested by parasitic copepods producing skeletal cysts upon the echinoid test (see Radwańska and Radwański 2005, fig. 6/1–3).

It is noticeable that in both Zalas and Bielawy, i.e. in sections with complex facies architecture, juvenile specimens seem to occur abundantly. This is even more pronounced at Zalas, where the juveniles dominate over the adults in *Eucosmus decoratus* L. Agassiz in L. Agassiz and Desor, 1846 [140 juveniles vs. 29 adults], and in *Pleurodiadema stutzi* Desor in Desor and de Loriol, 1871 [124 juveniles vs. 29 adults]. At Bielawy, this is noted in the species *Eucosmus decoratus*, of which 29 juveniles were found without any adult individuals. Such an abundance of juveniles is, as yet, rarely noted in Jurassic echinoids; available reports are of Cretaceous or Tertiary species (see e.g., Kotchetoff *et al.* 1975). Interestingly, a similar case of the ubiquity of small-sized dwarfish forms and juveniles in the Polish Jura has already been noted by Matyja (1984) in some Oxfordian ammonites. This has been interpreted to result from the sheltering of only small-sized specimens in the sponge mazes in the bioherms (Matyja 1984, p. 480).

Of special note of regional importance are two additional localities, Bałtów in the Holy Cross Mountains, and Niegowonice in the Polish Jura, both of which yield echinoid species unknown from other sites in Poland (see Table 1).

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Bałtów in the Holy Cross Mountains, as noted in the introduction, is generally a coralliferous megafacies, with a true coral patch reef at the centre (see Roniewicz and Roniewicz 1971), surrounded by diverse organodetrital chalky facies. The latter have recently been studied in great detail and yield an assemblage of extremely diverse biota, ranging from red algae (Rhodophyta) with preserved pink-coloured thalli ('Beetroot Stones') to a wide spectrum of invertebrates. All of these biota were carefully revised and

summarized by Hara and Taylor (1996), who additionally described very well preserved bryozoans, some of them new to science. The echinoderms presented in a preliminary account (Radwańska 2004a) comprised three species: *Paracidaris florigemma* (Phillips, 1829), *Hemitiaris? meryaca* (Cotteau, 1850), and *Glypticus hieroglyphicus* (Goldfuss, 1829). As apparent from the bryozoan morphology, their colonies lived in a very shallow part of the photic zone, commonly encrusting various organic substrates (see Hara

Species	Bielawy/Wapienno	Bałtów	Ostrowiec	Niegowonice	Ogrodzieniec	Wrzosowa	Rudniki	Zalas
<i>Rhabdocidaris nobilis</i> (Münster in Goldfuss, 1829)	+						+	
<i>Rhabdocidaris maxima</i> (Münster in Goldfuss, 1829)	+							
<i>Polycidaris</i> sp. 1				+				
<i>Polycidaris</i> sp. 2								+
<i>Polycidaris? suevica</i> (Desor, 1855)					+			+
<i>Polycidaris? sp. 3</i>				+				
<i>Plegiocidaris crucifera</i> (L. Agassiz, 1839)			+					+
<i>Plegiocidaris monilifera</i> (Goldfuss, 1829)	+						+	
<i>Paracidaris blumenbachi</i> (Münster in Goldfuss, 1829)						+		+
<i>Paracidaris elegans</i> (Münster in Goldfuss, 1829)			+					+
<i>Paracidaris florigemma</i> (Phillips, 1829)		+						
<i>Paracidaris laeviscula</i> (L. Agassiz, 1839)					+			+
<i>Paracidaris propinqua</i> (Münster in Goldfuss, 1829)	+		+					
<i>Hemipedina guerangeri</i> Cotteau in Cotteau and Triger, 1858					+	+		+
<i>Hemicidaris quenstedti</i> Mérian in Desor, 1855	+		+					
<i>Hemitiaris? meryaca</i> (Cotteau, 1850)		+						
<i>Pseudocidaris</i> sp.	+							
<i>Stomechinus perlatus</i> (Desmarest, 1825)							+	
<i>Stomechinus</i> sp.			+					
<i>Eucosmus decoratus</i> L. Agassiz in L. Agassiz and Desor, 1846	+		+		+	+		+
<i>Glypticus hieroglyphicus</i> (Goldfuss, 1829)		+						
<i>Pleurodiadema stutzi</i> Desor in Desor and de Loriol, 1871	+				+	+		+
<i>Diplopodia aequale</i> (L. Agassiz, 1839)					+	+	+	+
<i>Trochotiara langi</i> (Desor, 1855)					+	+		+
<i>Desorella</i> sp.				+				
<i>Heterocidaris dumortieri</i> Cotteau, 1871								+

Table 1. Echinoid taxa recorded in the Oxfordian sequence of Poland (cidaroid taxa taken from Radwańska 2003a)

and Taylor 1996). These organodetrital facies are completely different from Oxfordian facies found elsewhere in Poland and presumably represent extremely shallow water environments that were not available for the freely swimming ammonites, which are notably missing here. Under such conditions, a former interpretation (Radwańska 2004a) of the functional convergence of *Paracidaris florigemma* with the present-day *Eucidaris tribuloides* (Lamarck, 1816) is well substantiated (cf. Hendler *et al.* 1995; Schultz 2005), as is the herein presented convergence of *Glypticus hieroglyphicus* with the extant *Colobocentrotus atratus* (Linnaeus, 1758).

At Niegowonice in the Polish Jura, the small disused quarry exposes an about 8–10 m high sequence of a sponge-cyanobacterial bioherm interfingering the layered platy limestones with thin marly interbeds (cf. Radwańska 2003a, p. 147). In the scree were recovered fragmentary cidaroid tests, classified (Radwańska 2003a) as “*Polycidaris* sp. 1” and “*Polycidaris* sp. 3”, both of which were not comparable with any other from the Oxfordian (and Kimmeridgian) sequence in Poland. In addition, there were three poorly preserved specimens of *Desorella* sp. (apical part lost, see Pl. 7, Figs 2, 3), the only irregular species in the Oxfordian sequence of Poland.

Of the remainder of the taxa listed (Table 1), it is noteworthy that all the localities in the Polish Jura with the marl-bearing facies (the Jasna Góra Beds of Wrzosowa, Ogrodzieniec, and part of the Zalas section) yield the same four non-cidaroid taxa: *Eucosmus decoratus* L. Agassiz in L. Agassiz and Desor, 1846, *Pleurodiadema stutzi* Desor in Desor and de Loriol, 1871, *Diplopodia aequale* (L. Agassiz, 1839), and *Trochotiara langi* (Desor, 1855).

The recognized echinoid faunas supplement the formerly known diversity of other invertebrates of the Oxfordian sequences in Poland, in particular the world-famous ammonites (see Bukowski 1887; Siemiradzki 1899; Matyja and Wierzbowski 1995, 2000, 2002; Głowniak 2012), all of which typify the Submediterranean Bioprovince ranging from the Early Oxfordian to the Early Kimmeridgian. The studied assemblage of Oxfordian echinoids in Poland becomes thus compatible to those of the Submediterranean Bioprovince, known for almost two centuries in other parts of Europe.

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PLATE 1

Hemipedina guerangeri Cotteau in Cotteau and Triger, 1858

1a – Lateral view of the test, to show ambulacrum, $\times 7$; **1b** – Close-up view of the apical disc; **1c** – Aboral view of the ambulacrum; **1d** – Close-up view of the ambital P2 isopores; **1e** – Close-up view of the adoral part of ambulacrum, to show delicate crowding of isopores; **1f** – Close-up view of fragment of the peristome, to show shallow buccal notches; **1g** – Close-up view of the interambulacrum; **1h** – Close-up view of the interambulacral plate, to show its ornamentation; Specimen from Zalas, No. MWGUW/ZI/56/246

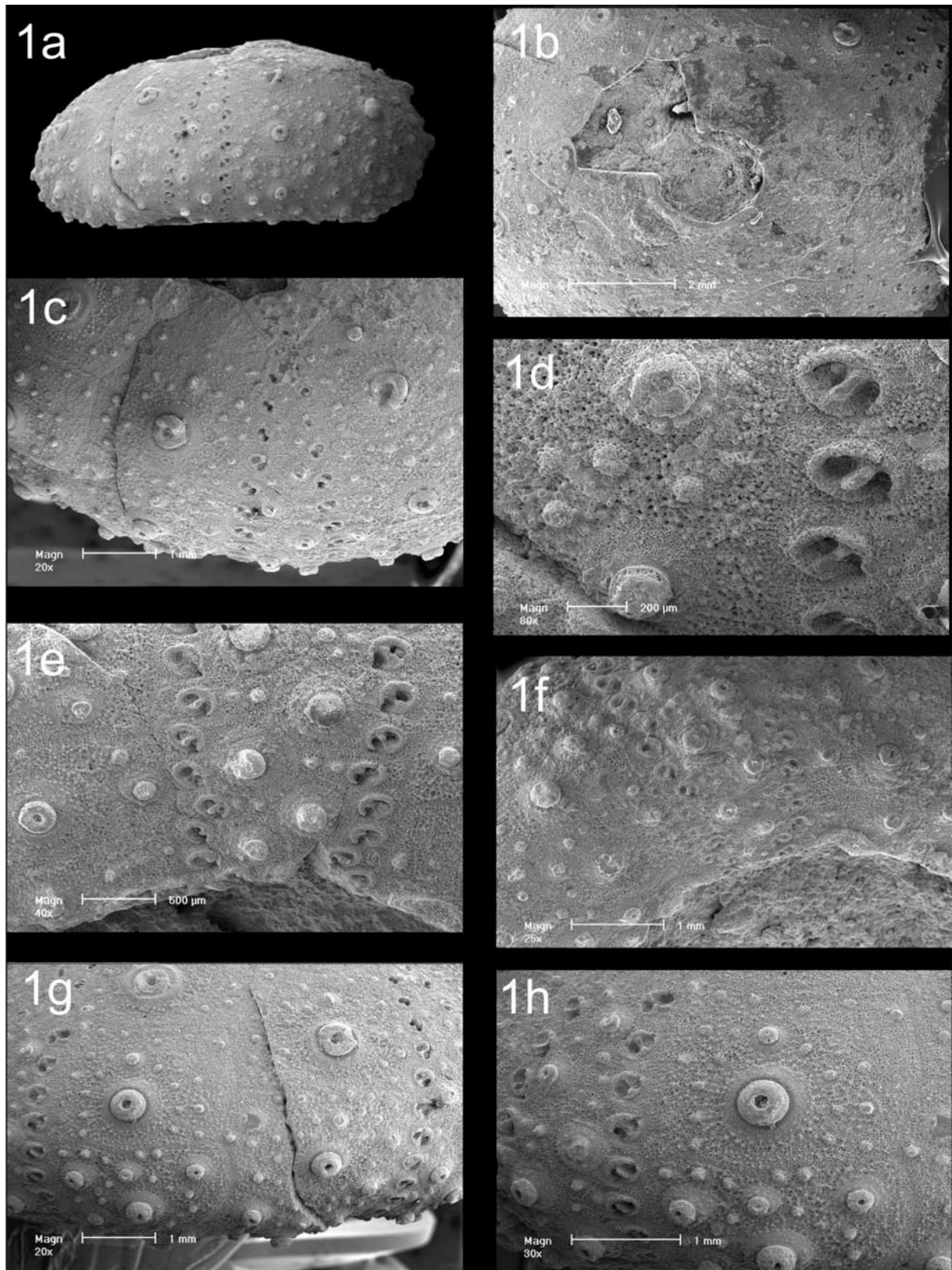


PLATE 2

1-7 – *Hemicidaris (Sphaerotiaris) quenstedti* (Cotteau, 1880); 1a – Aboral view of the test; 1b – Lateral view of the test, to show ambulacrum; 1c – Lateral view of the test, to show interambulacrum; 1d – Oral view of the test; × 2; Specimen from Bielawy, No. MWGUW/ZI/56/243; 2-6 – Primary spines; 2-5 – Lateral view, 6 – Top view; × 2; Specimens from Bielawy, No. MWGUW/ZI/56/259 successively to MWGUW/ZI/56/263; 7 – Aboral view of the test; × 2; Specimen from Ostrowiec, No. MWGUW/ZI/56/245

8-9 – *Hemitiaris? meryaca* (Cotteau, 1850); 8a – Aboral view of the test; 8b – Oral view of the test; 8c – Lateral view of the test, to show ambulacrum; 8d – Lateral view of the test, to show interambulacrum, × 2; Specimen from Bałtów, No. MWGUW/ZI/56/257; 9a – Aboral view of the test; 9b – Lateral view of the test, to show ambulacrum; × 2; Specimen from Bałtów, No. MWGUW/ZI/56/258

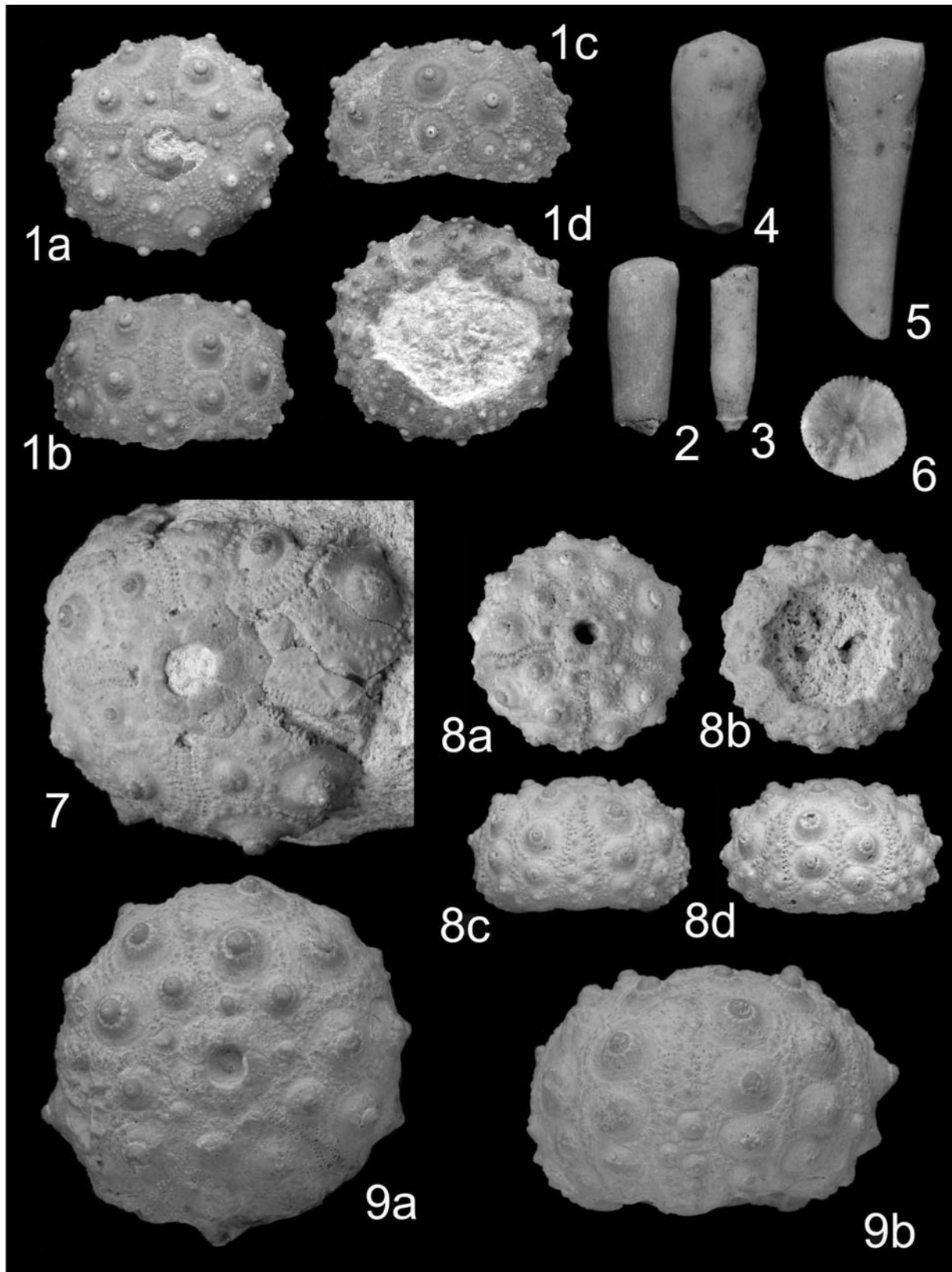


PLATE 3

1-2 – *Stomechinus perlatus* (Desmarest, 1825); 1a – Aboral view of the test; $\times 1.5$; 1b – Close-up view of the adapical part of ambulacrum; $\times 3$; Specimen from Rudniki, No. IG 1183. II. 307; 2a – Aboral view of the test; $\times 1.5$; 2b – Close-up view of the adapical part of interambulacrum; $\times 3$; 2c – Close-up view of the apical disc; Specimen from Rudniki, No. IG 1183. II. 306

3 – *Stomechinus* sp.; 3a – Lateral view of the test, to show ambulacrum; $\times 1.5$; 3b – Lateral view of the test, to show interambulacrum; $\times 1.5$; Specimen from Ostrowiec, No. MWGUW/ZI/56/264

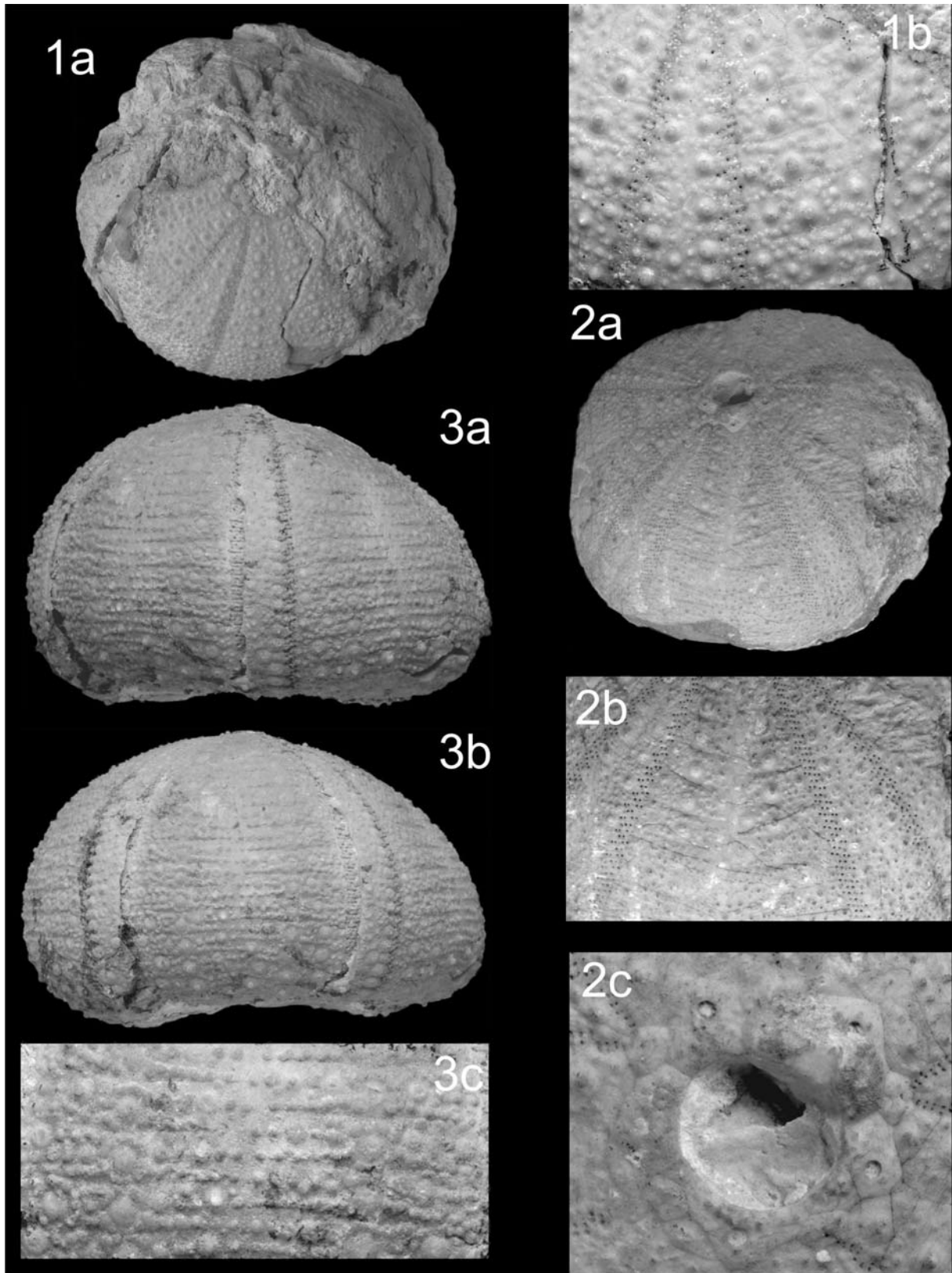


PLATE 4

Eucosmus decoratus L. Agassiz in L. Agassiz and Desor, 1846

1a – Aboral view of the test, × 4; **1b** – Lateral view of the test, to show ambulacrum; × 4; Specimen from Zalas, No. MWGUW/ZI/56/265; **2a** – Close-up view of the adapical part of ambulacrum; **2b** – Close-up view of the apical disc; **2c** – Close-up view of the ambital part of ambulacrum, **2d** – Close-up view of the adapical part of interambulacrum, to show the naked central area, **2e** – Close-up view of the more adoral part of ambulacrum; **2f** – Lateral view of the test, to show interambulacrum; **2g** – Close-up part of the peristome, to show short phyllodes and buccal notches; Specimen from Zalas, No. MWGUW/ZI/56/266

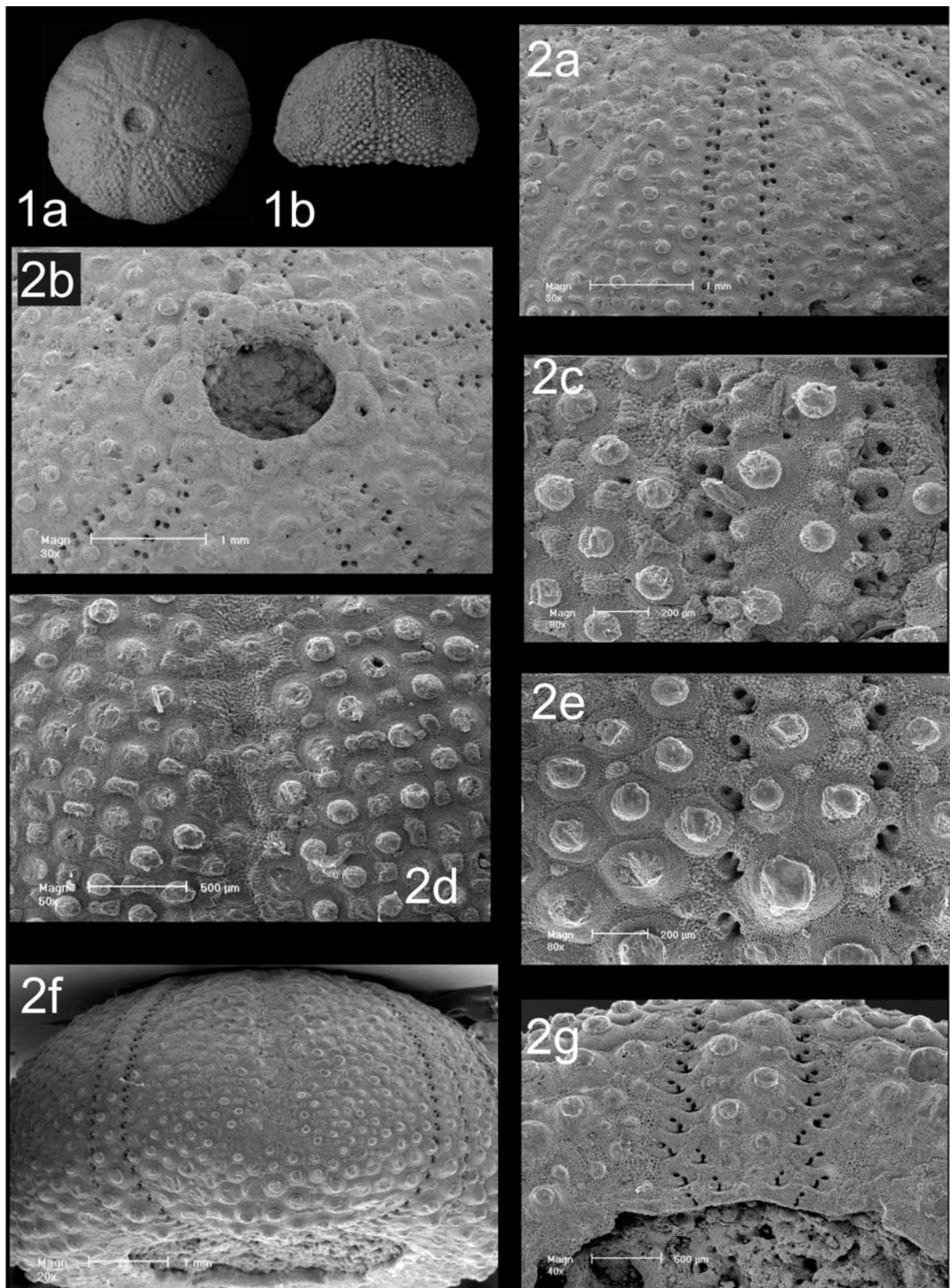


PLATE 5

Eucosmus decoratus L. Agassiz in L. Agassiz and Desor, 1846

1 – Lateral view of the test, to show interambulacrum, Juvenile specimen from Wapienno, No. MWGUW/ZI/56/267; **2** – Lateral view of the test, to show ambulacrum; Juvenile specimen from Wapienno, No. MWGUW/ZI/56/268; **3a** – Aboral view of the test, **3b** – Lateral view of the test, to show ambulacrum; **3c** – Close-up view of the interambulacrum, to show the naked central area; **3d** – Close-up view of the ambulacrum; Juvenile specimen from Wapienno, No. MWGUW/ZI/56/269

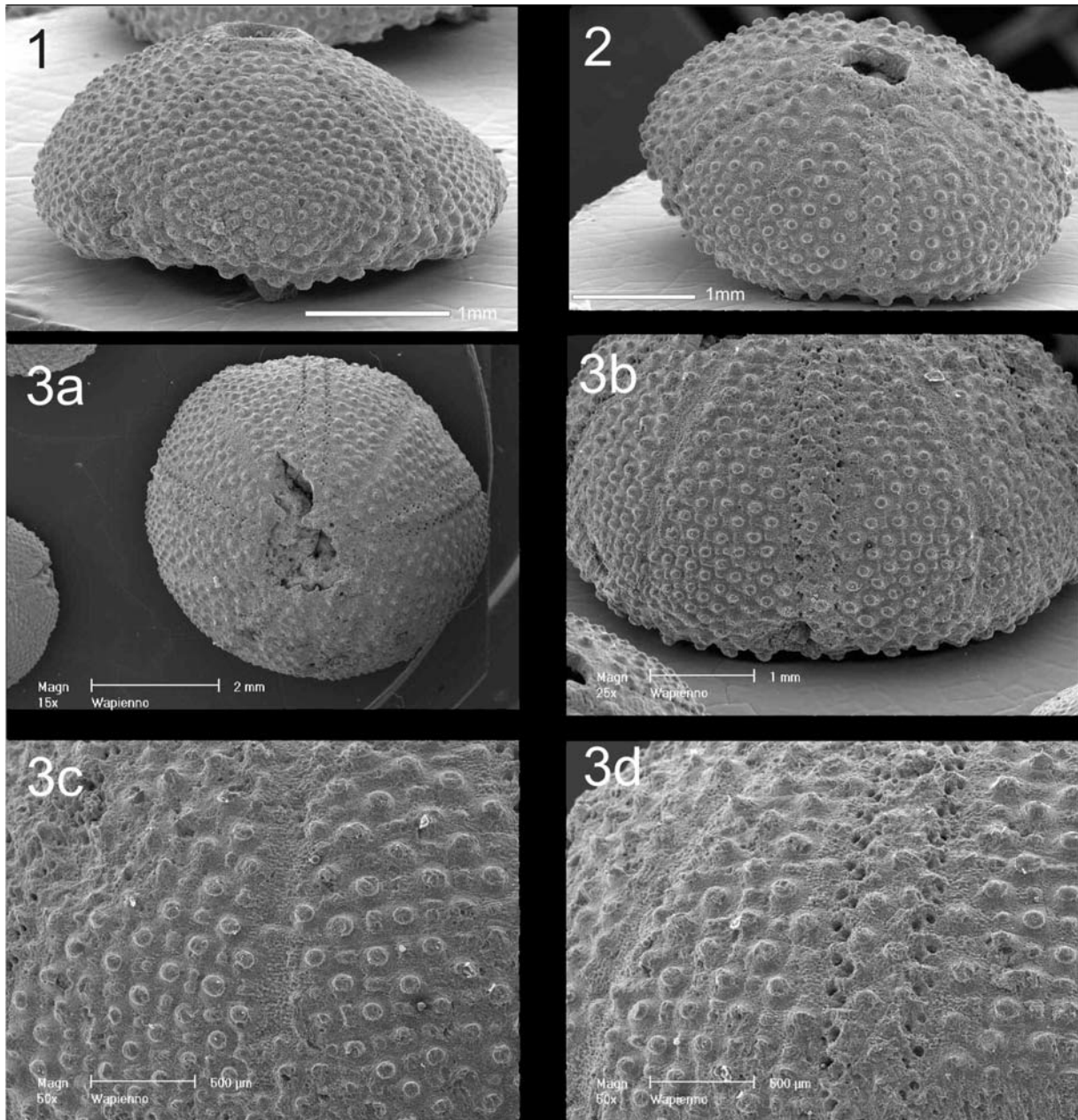


PLATE 6

Eucosmus decoratus L. Agassiz in L. Agassiz and Desor, 1846

1a – Lateral view of the test, to show ambulacrum; **1b** – Lateral view of the test, to show interambulacrum; **1c** – Aboral view of the test; Juvenile specimen from Zalas, No. MWGUW/ZI/56/270; **2a** – Lateral view of the test, to show ambulacrum; **2b** – Lateral view of the test, to show interambulacrum, **2c** – Aboral view of the test, **2d** – Close-up view of the apical disc; Juvenile specimen from Zalas, No. MWGUW/ZI/56/271; **3** – Oral view of the test; Juvenile specimen from Zalas, No. MWGUW/ZI/56/272

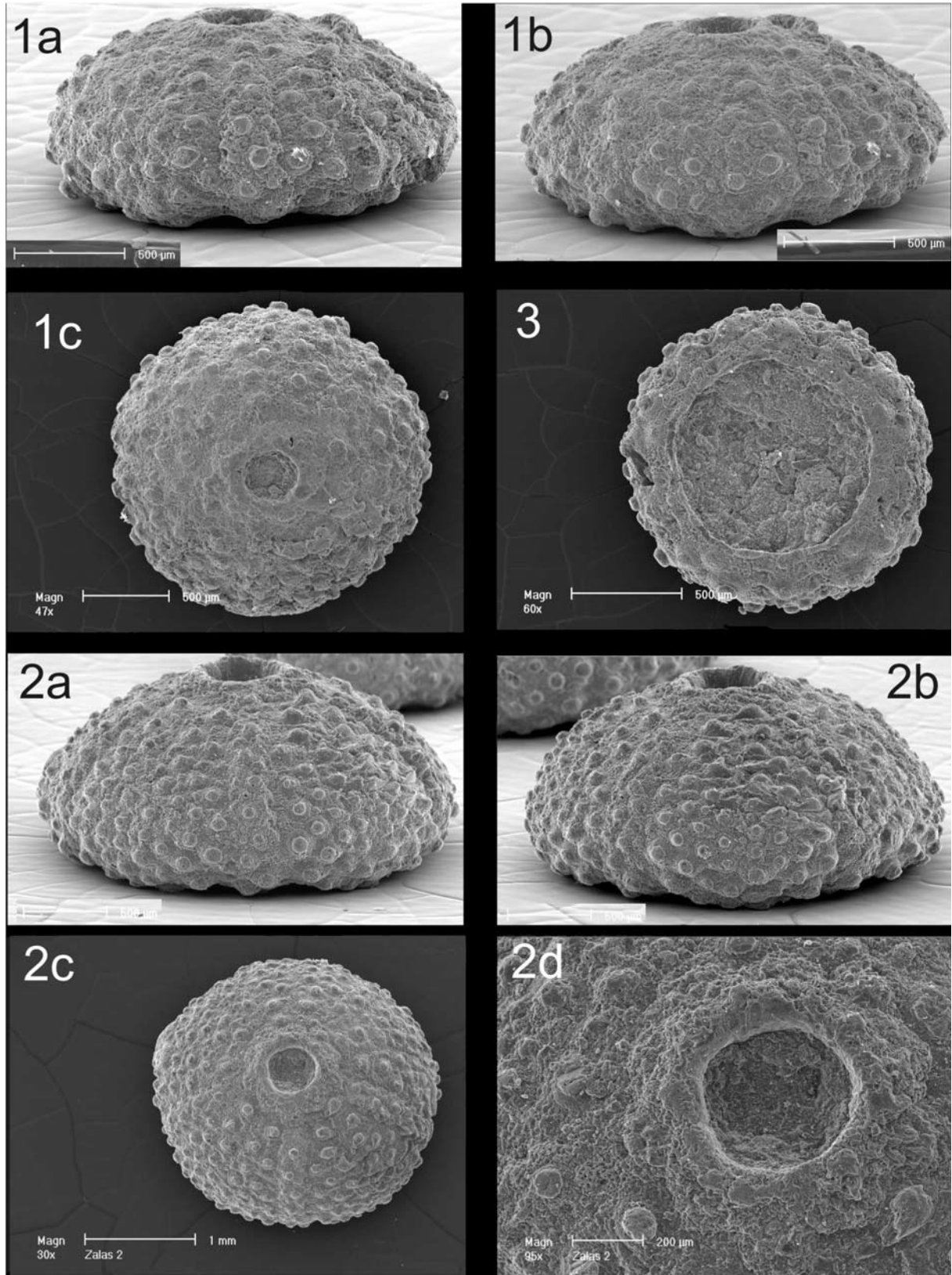


PLATE 7

1 – *Glypticus hieroglyphicus* (Goldfuss, 1829); 1a – Lateral view of the test, to show ambulacrum, 1b – Lateral view of the test, to show interambulacrum, 1c – Aboral view of the test, 1d – Oral view of the test; × 4; Specimen from Bałtów, No. MWGUW/ZI/56/280;

2-3 – *Desorella* sp.; 2 – Oral view of the test; × 2; Specimen from Niegowonice, No. MWGUW/ZI/56/318; 3 – Oral view of the test; × 2; Specimen from Niegowonice, No. MWGUW/ZI/56/319

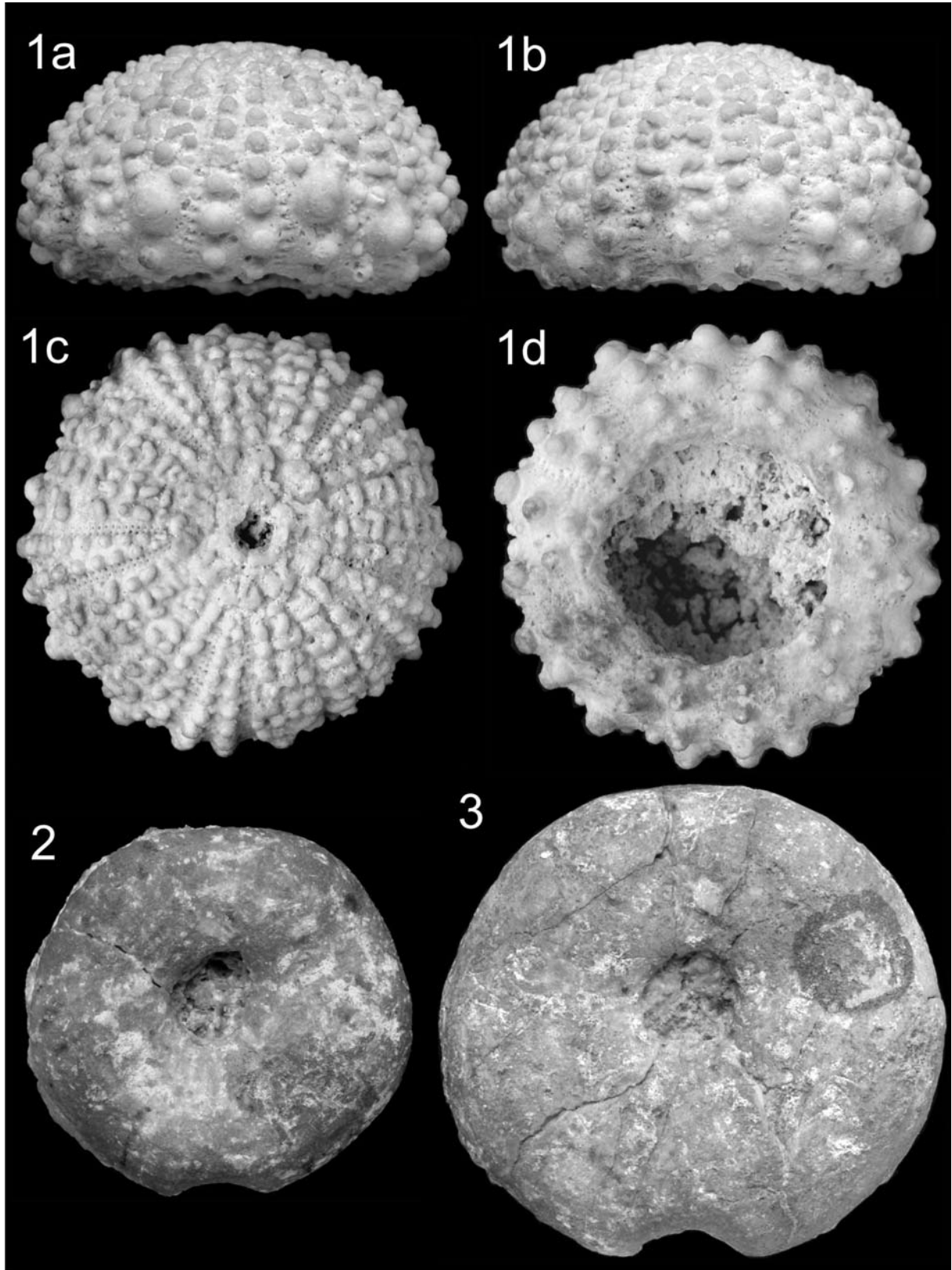


PLATE 8

Glypticus hieroglyphicus (Goldfuss, 1829)

1a – Aboral view of the test; **1b** – Close-up view of the apical disc; **1c** – Lateral view of the test, to show ambulacrum; **1d** – Lateral view of the test, to show interambulacrum; **1e** – Close-up view of the ambulacrum; **1f** – Close-up view of the interambulacrum; **1g** – Close-up view of ambital isopores; **1h** – Close-up view of interambulacrum, to show its ornamentation; Juvenile specimen from Bałtów, No. MWGUW/ZI/56/281

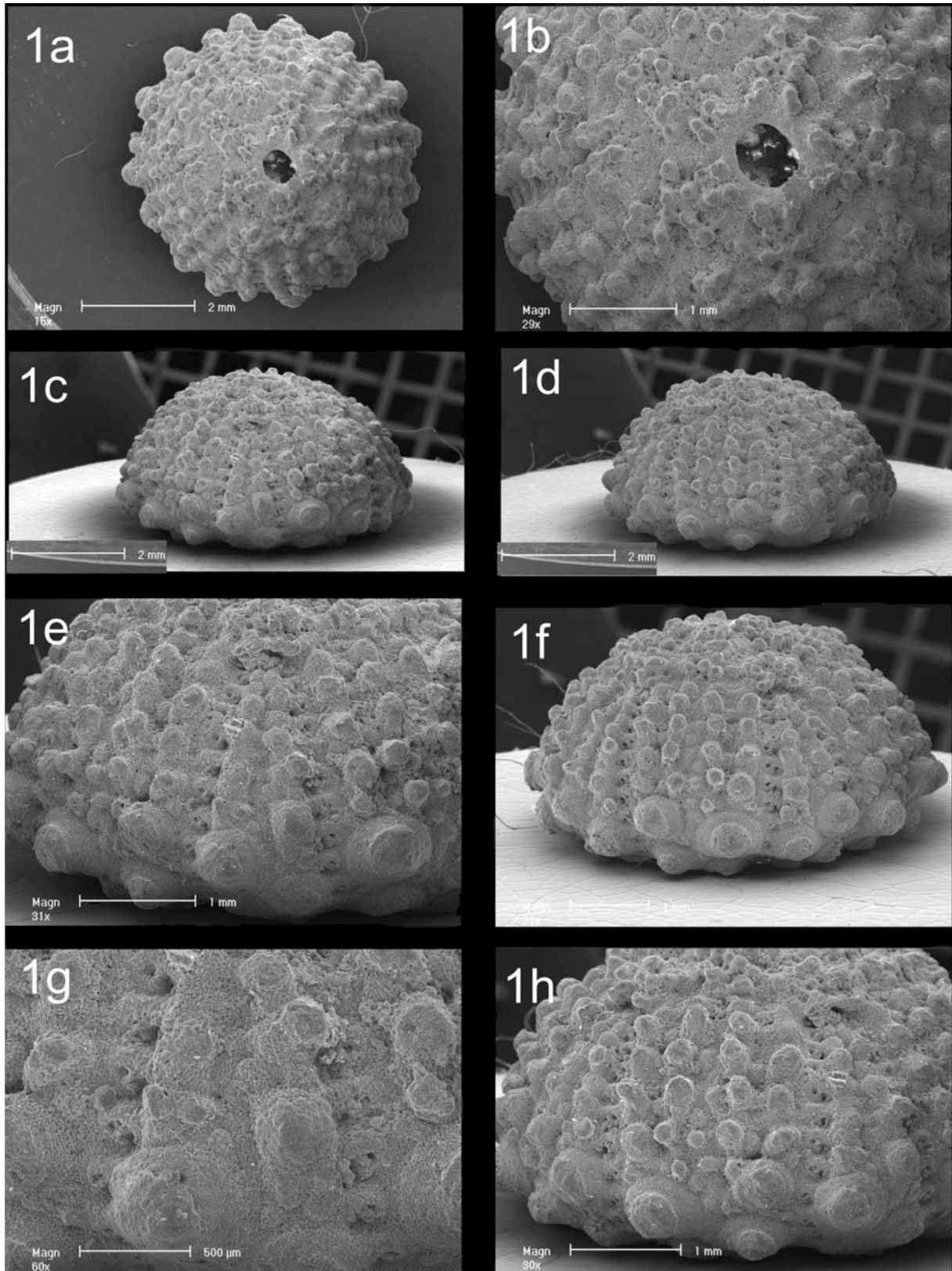


PLATE 9

Pleurodiadema stutzi Desor in Desor and de Loriol, 1871

1a – Lateral view of the test, to show interambulacrum; **1b** – Lateral view of the test, to show ambulacrum; × 4; Specimen from Wrzosowa, No. MWGUW/ZI/56/286; **2a** – Lateral view of the test, to show ambulacrum; **2b** – Oral view of the test; × 4; Specimen from Zalas, No. MWGUW/ZI/56/283; **3** – Oral view of the test; × 4; Specimen from Wrzosowa, No. MWGUW/ZI/56/287; **4a** – Lateral view of the test, to show ambulacrum; **4b** – Aboral view of the test; × 4; Specimen from Zalas, No. MWGUW/ZI/56/284; **5** – Aboral view of the test, to show its ornamentation and apical disc; × 3; Specimen from Zalas, No. MWGUW/ZI/56/285

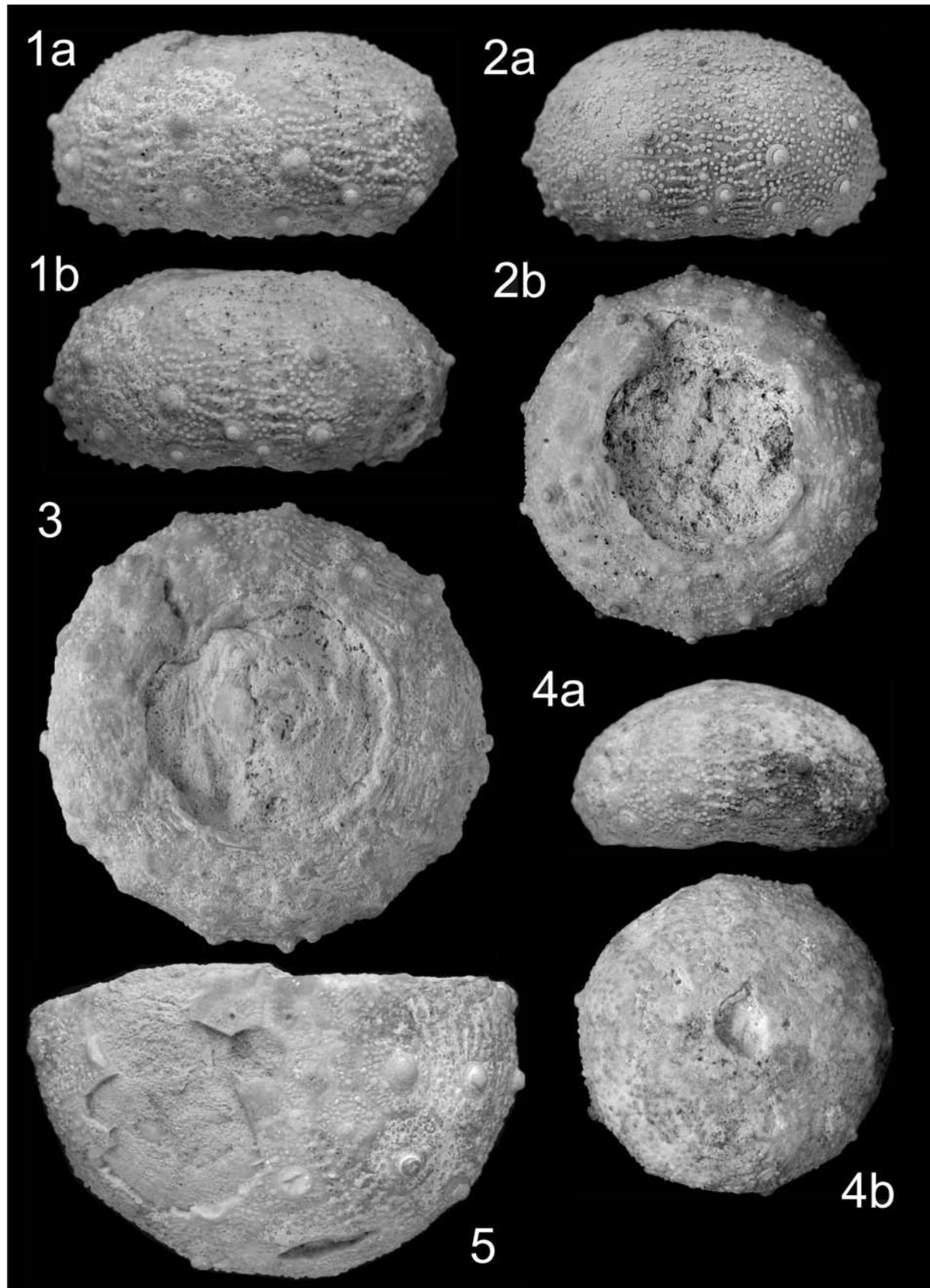


PLATE 10

Pleurodiadema stutzi Desor in Desor and de Loriol, 1871

1a – Lateral view of the test, to show ambulacrum; **1b** – Close-up view of the adapical part of ambulacrum; **1c** – Close-up view of the ambital part of ambulacrum, to show ornamentation; **1d** – Close-up view of the adoral part of ambulacrum, to show isopores and buccal notches; **1e** – Lateral view of interambulacrum; **1f** – Close-up view of the ambital part of ambulacrum, to show P2 isopores; **1g** – Close-up view of the interambulacrum, to show its ornamentation; **1h** – Close-up view of the interambulacral primary tubercle, to show a weakly crenulated mamelon; Specimen from Ogrodzieniec, No. MWGUW/ZI/56/288

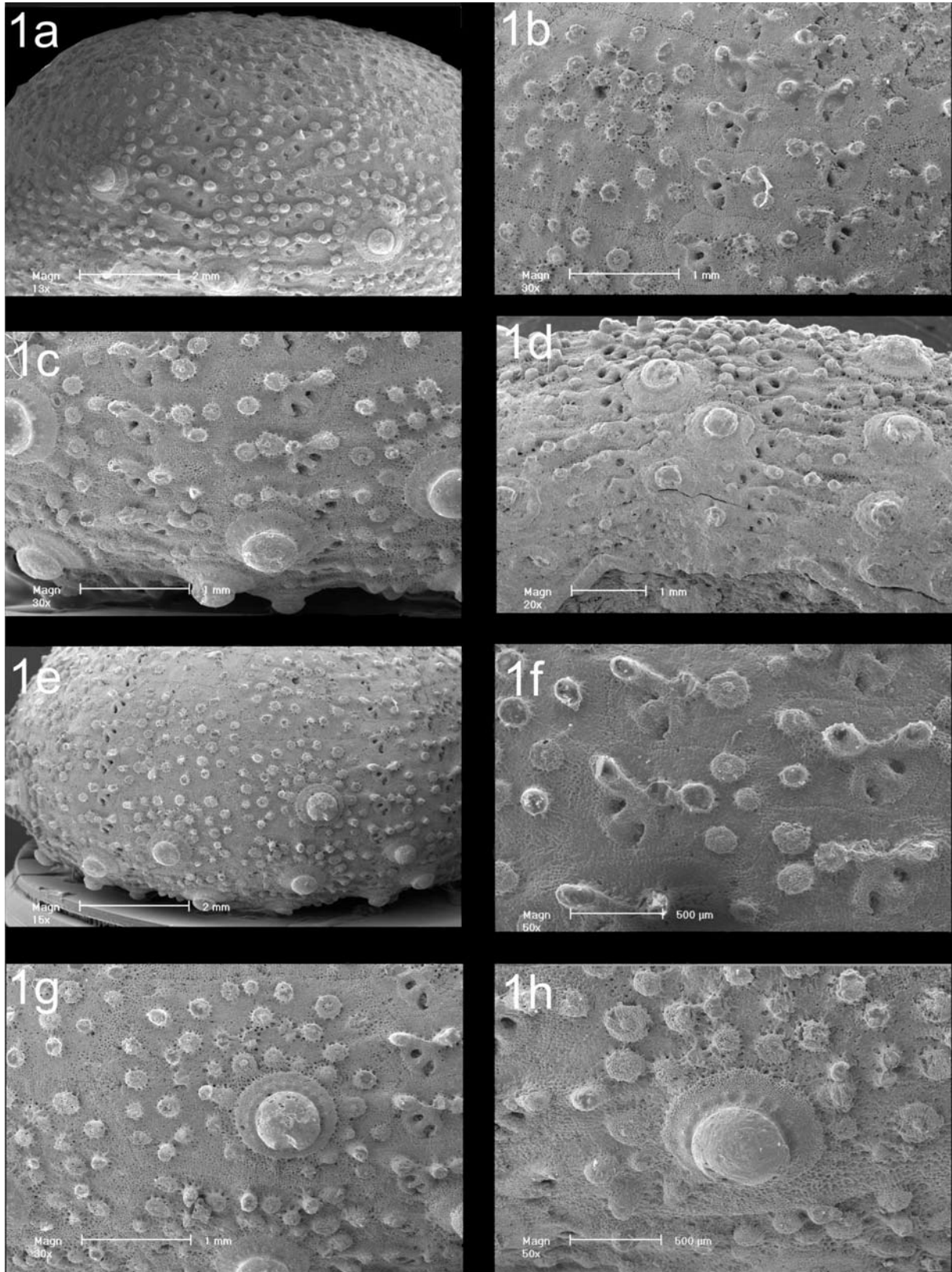


PLATE 11

Pleurodiadema stutzi Desor in Desor and de Loriol, 1871

1a – Aboral view of the test, to show apical disc; **1b** – Lateral view of the test; Juvenile specimen from Zalas, No. MWGUW/ZI/56/292; **2a** – Lateral view of the test, to show ambulacrum; **2b** – Lateral view of the test, to show interambulacrum; **2c** – Apical view of the test; **2d** – Close-up view of the apical disc; Juvenile specimen from Zalas, No. MWGUW/ZI/56/293

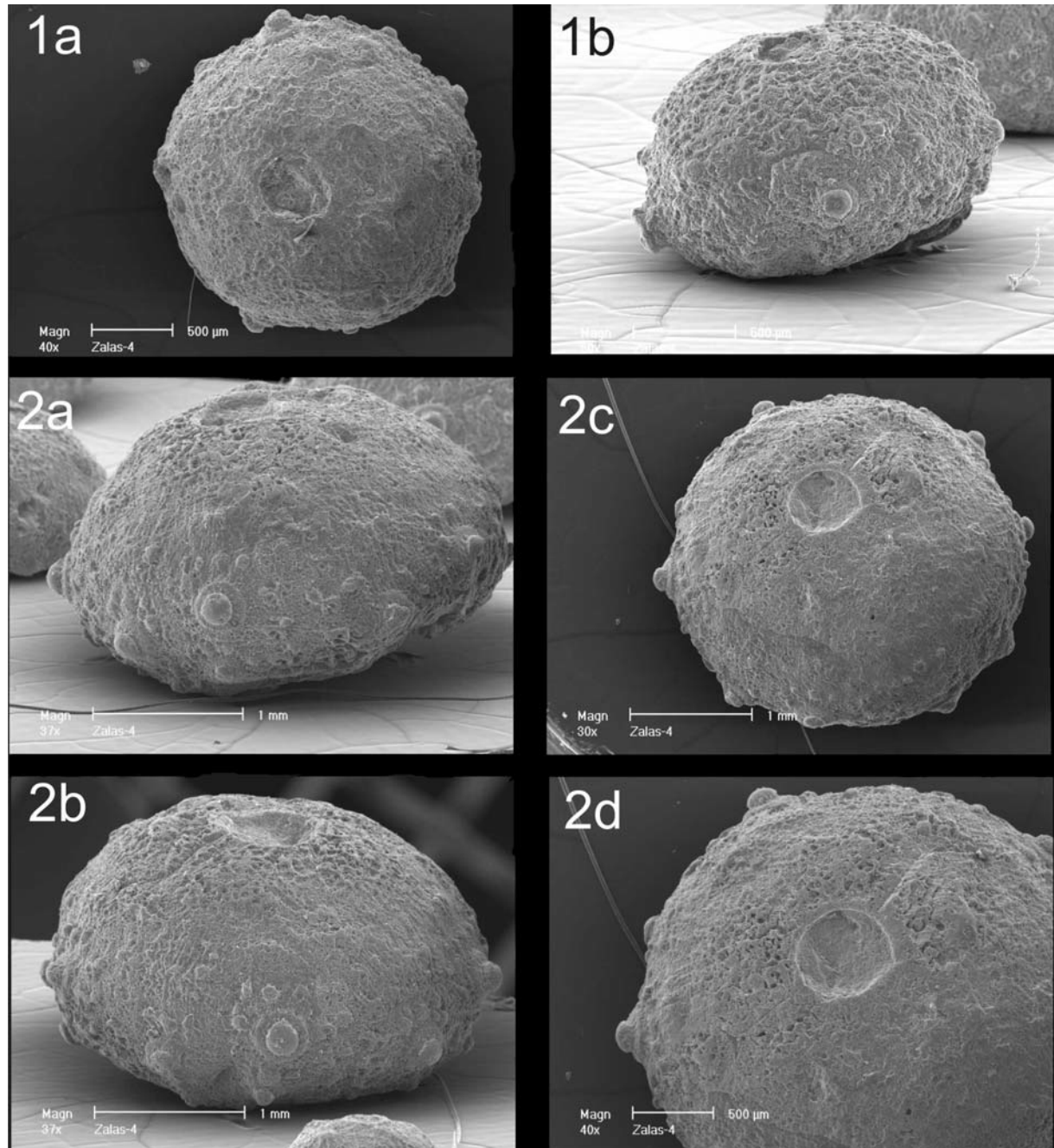


PLATE 12

Pleurodiadema stutzi Desor in Desor and de Loriol, 1871

1a – Aboral view of the test; **1b** – Lateral view of the test, to show ambulacrum; **1c** – Lateral view of the test, to show interambulacrum; **1d** – Close-up view of the apical disc, to show epistromal ornamentation; Juvenile specimen from Żalas, No. MWGUW/ZI/56/294; **2a** – Close-up view of the apical disc, to show the ocular plate; **2b** – Lateral view of the test, to show ornamentation; Juvenile specimen from Żalas, No. MWGUW/ZI/56/295

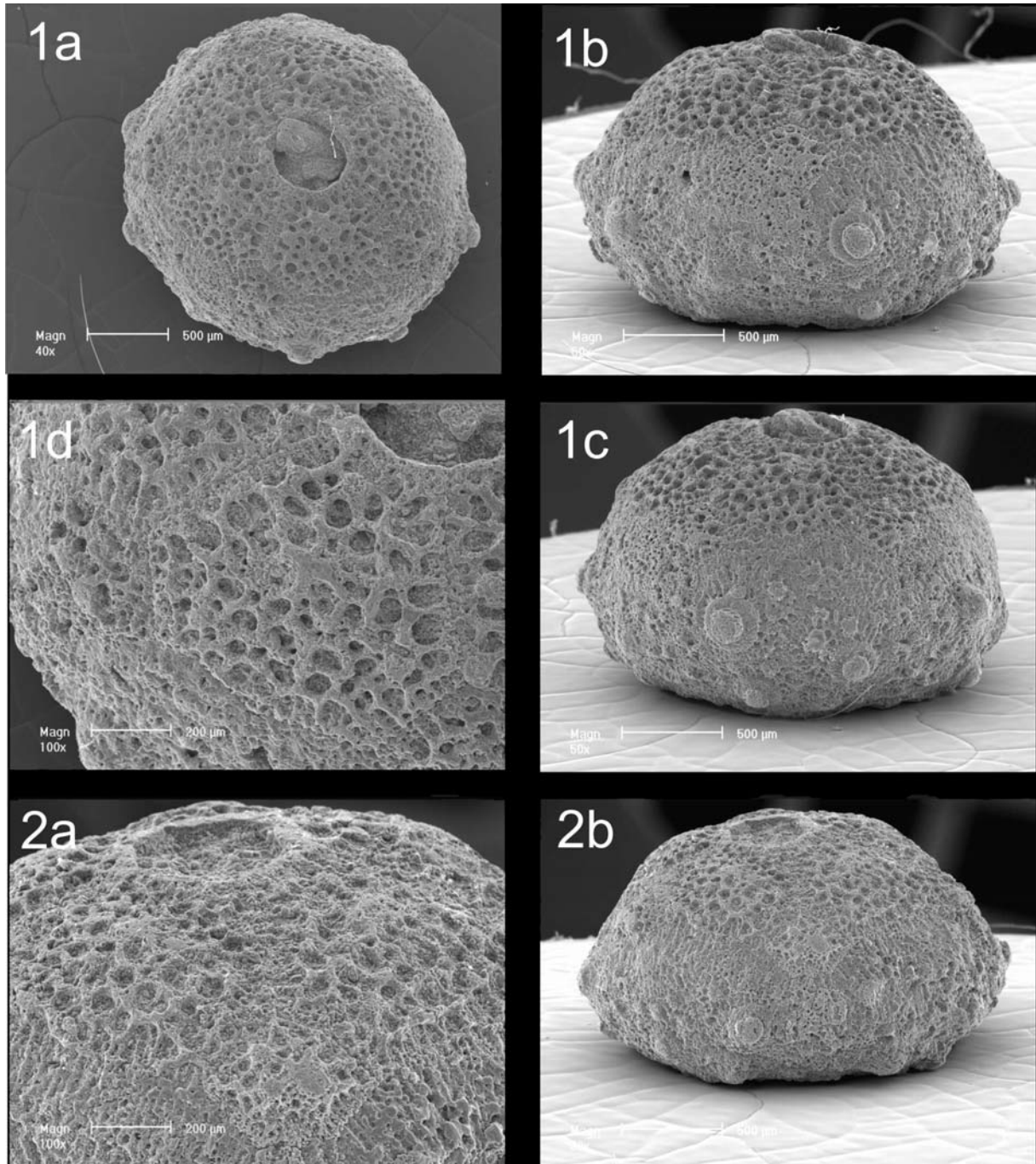


PLATE 13

Family Acropeltidae Lambert and Thiéry, 1914
genus and species indet.

1a – Aboral view of the test, **1b** – Close-up view of the apical disc, to show ornamentation; **1c** – Lateral view of the test, to show ambulacrum; **1d** – Lateral view of the test, to show interambulacrum; Juvenile specimen from Bielawy, No. MWGUW/ZI/56/296; **2a** – Aboral view of the test, to show apical disc; **2b** – Lateral view of the test, to show interambulacrum; **2c** – Lateral view of the test, to show ambulacrum; **2d** – Close-up view of the ambulacrum, to show trigeminate plates; Juvenile specimen from Bielawy, No. MWGUW/ZI/56/297

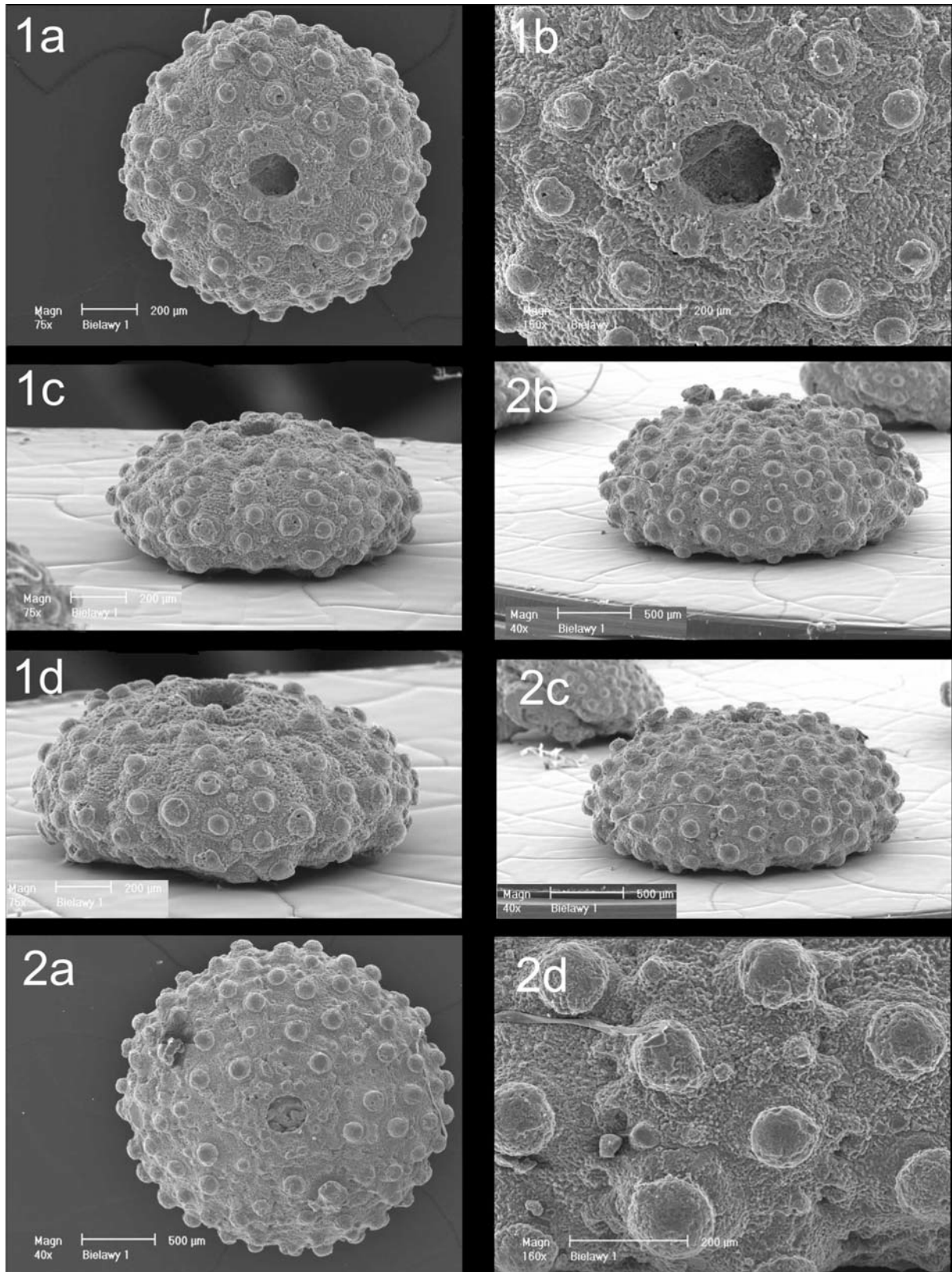


PLATE 14

Diplopodia aequale (L. Agassiz, 1840)

1 – Lateral view of the test, to show ambulacrum; × 2; Specimen from Gnieździska, No. MWGUW/ZI/56/298; **2a** – Lateral view of the test, to show ambulacrum; **2b** – Lateral view of the test, to show interambulacrum; **2c** – Oral view of the test, to show the peristome with buccal notches; × 2; Specimen from Wrzosowa, No. MWGUW/ZI/56/299; **3a** – Aboral view of the test, **3b** – Lateral view of the test, to show ambulacrum, **3c** – Lateral view of the test, to show ornamentation; × 3; Specimen from Wrzosowa, No. MWGUW/ZI/56/300; **4** – Oral view of the test, to show the peristome; × 2; Specimen from Ogródzieniec, No. MWGUW/ZI/56/301

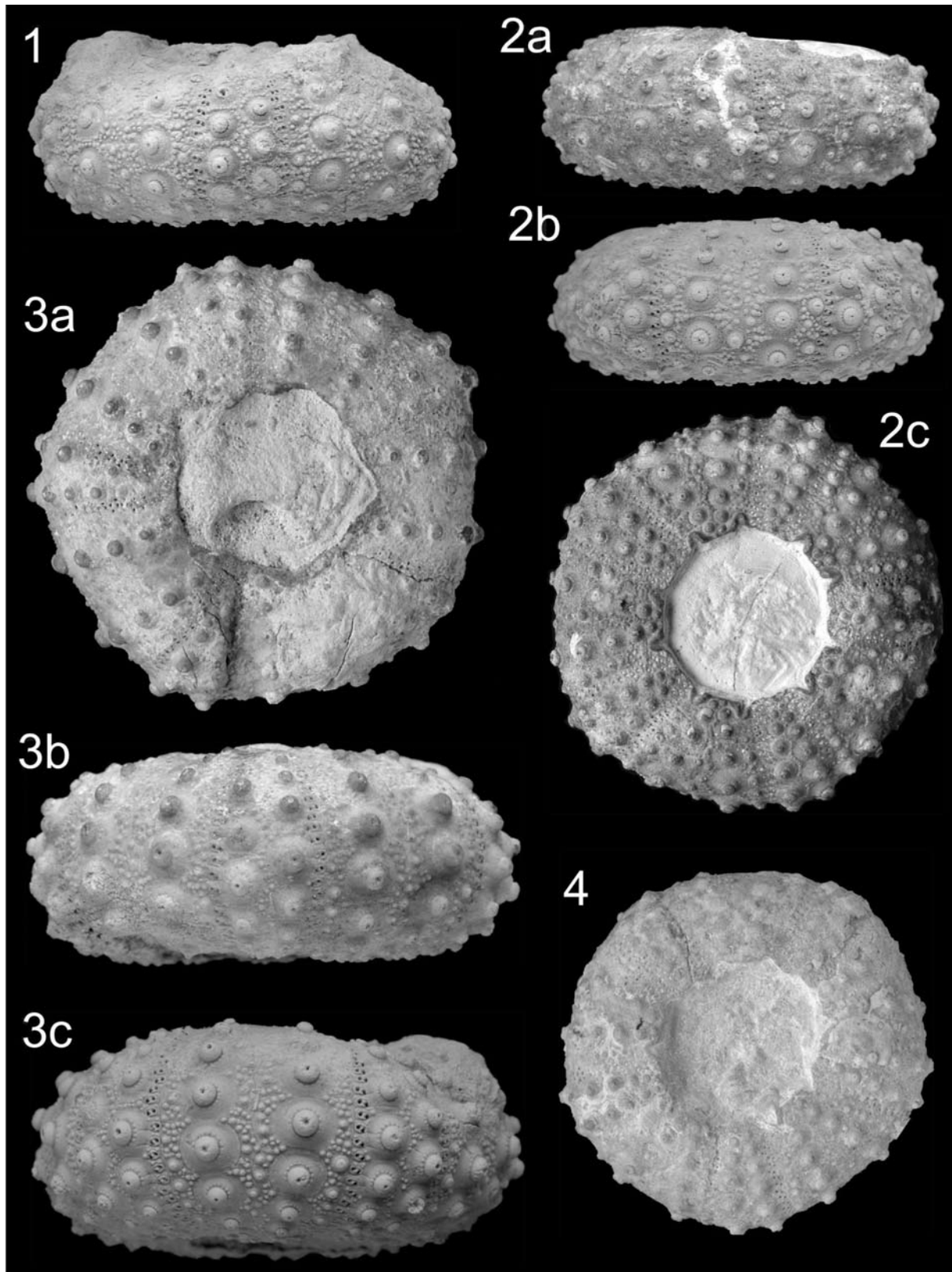


PLATE 15

Trochotiara langi (Desor, 1856)

1a – Aboral view of the test, **1b** – Oral view of the test, to show the peristome with shallow buccal notches; **1c** – Lateral view of the test, to show ambulacrum; × 4; Specimen from Wrzosowa, No. MWGUW/ZI/56/302; **2a** – Lateral view of the test, to show ambulacrum; **2b** – Lateral view of the test, to show interambulacrum; **2c** – Aboral view of the test; **2d** – Oral view of the test; × 4; Specimen from Zalas, No. MWGUW/ZI/56/303

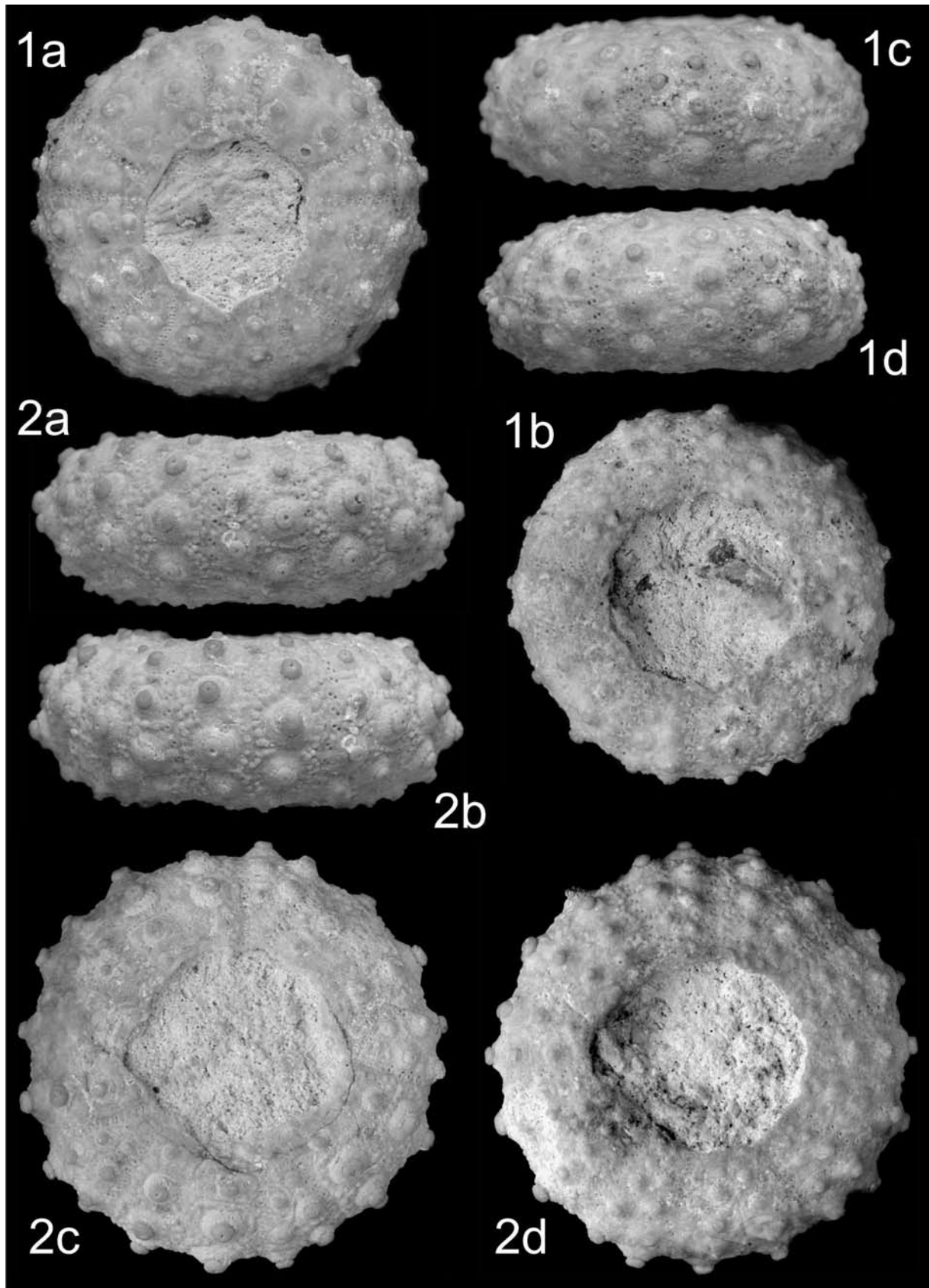


PLATE 16

Trochotiara langi (Desor, 1856)

1a – Lateral view of the test, to show ambulacrum; **1b** – Lateral view of the test, to show interambulacrum; **1c** – Close-up view of the ambital part of ambulacrum; **1d** – Close-up view of the adoral part of ambulacrum; **1e** – Close-up view of the ambital quadrigeminate plate; **1f** – Close-up view of the ambital part of interambulacrum; **1g** – Close-up view of the adoral part of ambulacrum, to show short phyllodes and buccal notches; **1h** – Close-up view of the adoral P3 isopores; Specimen from Wrzosowa, No. MWGUW/ZI/56/304

