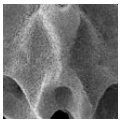
Late Turonian ophiuroids (Echinodermata) from the Bohemian Cretaceous Basin, Czech Republic

RICHARD ŠTORC & JIŘÍ ŽÍTT



Diverse ophiuroid faunules from the basal Teplice Formation, of Late Turonian age, exposed at Úpohlavy in the northwestern part of the Bohemian Cretaceous Basin, northwest Bohemia, are based on only dissociated lateral arm plates, vertebrae and some other skeletal elements of the disc. The material can be ascribed to ten species, including a new taxon named *Stegophiura*? *nekvasilovae* sp. nov. Three additional species are represented in the material but these are left in open nomenclature. Relative species abundance is evaluated and discussed. • Key words: Echinodermata, Ophiuroidea, Upper Cretaceous, taxonomy, Bohemian Cretaceous Basin, Czech Republic.

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Richard Štorc, Smetanova 380, CZ-251 64 Mnichovice, Czech Republic; RStorc@seznam.cz • Jiří Žítt, Institute of Geology of the Academy of Sciences of the Czech Republic, v.v.i., Rozvojová 269, CZ-165 02 Praha 6, Czech Republic; zitt@gli.cas.cz

Until recently, knowledge of ophiuroids from the Bohemian Cretaceous Basin (BCB) was poor although skeletal remains of such echinoderms had already been recorded by Reuss (1845–46) and Frič (1895). Recent work by Štorc (1996a, b, 1997, 2002, 2004a, b) was based on rich assemblages of dissociated ossicles collected from Upper Cenomanian–Lower Turonian shallow-water strata exposed along the southern margin of the BCB. Fairly diverse material has recently been recovered also from the Upper Turonian Teplice Formation in a large working quarry at Úpohlavy, near Lovosice and Litoměřice (Fig. 1). The section exposed there has lately been the subject of detailed sedimentological, geochemical and biostratigraphical studies, subsequently supplemented by targeted palaeontological collecting (Čech *et al.* 1996, Ekrt *et al.* 2001, Svobodová *et al.* 2002, Sklenář 2003, Vodrážka 2003, Wiese *et al.* 2004, Mikuláš 2006, Svobodová & Žítt 2006). Comparable fieldwork was carried out in the vicinity of Úpohlavy (Vodrážka *et al.* in press). Consequently, current knowledge of the stratigraphic age of the strata, as well as of sedimentary environments and some faunal groups represented, is good. With quarrying continuing, new sections will become accessible for study.

This paper is dedicated to RNDr. Olga Nekvasilová, CSc. (born in 1928), who was the first to note that ophiuroids were an important component in the taphocoenoses of the Bohemian Upper Cretaceous.

Geographical and stratigraphical setting

The material described here was collected from the large working quarry of Čížkovické cementárny, a.s. (Lafarge Cement) near the village of Úpohlavy in northwest Bohemia (Fig. 1). Here, a succession of rocks from the Upper Turonian Teplice Formation [units Xa, b, c(?)] is exposed, which rests on the uppermost portion of the Jizera Formation (unit IX) (Fig. 2). The boundary between the two units is situated close to the quarry floor. The Teplice Formation comprises an irregular alternation of hemipelagic limestone and marlstone beds; a total thickness of some 23–24 m is accessible (Wiese *et al.* 2004). Ophiuroid material was collected from beds referred to as the "Hundorfer Kalkstein" (= Hundorf limestone; Xb_{α}), for which a *perplexus/lamarcki/stuemckei/inaequivalvis* inoceramid assemblage has been documented, and the overlying "Rhynchonellenschichten" (= *Rhynchonella* beds; Xb_{β}), with a *labiatoidiformis/striatoconcentricus* inoceramid assemblage (see Wiese *et al.* 2004, Svobodová *et al.* 2002).

The base of the 'Hundorf limestone' is erosive and comprises a slightly glauconitic and coprolitic horizon (the so-called upper coprolite bed, see *e.g.*, Wiese *et al.* 2004). This bed yields phosphatic intraclasts, coprolites and a phosphatised macrofauna, and also fills the burrows piping down from the erosion surface into the underlying unit Xa (Fig. 2). The coprolite bed passes upwards into a clayey limestone with thin marl intercalations only. The thickness

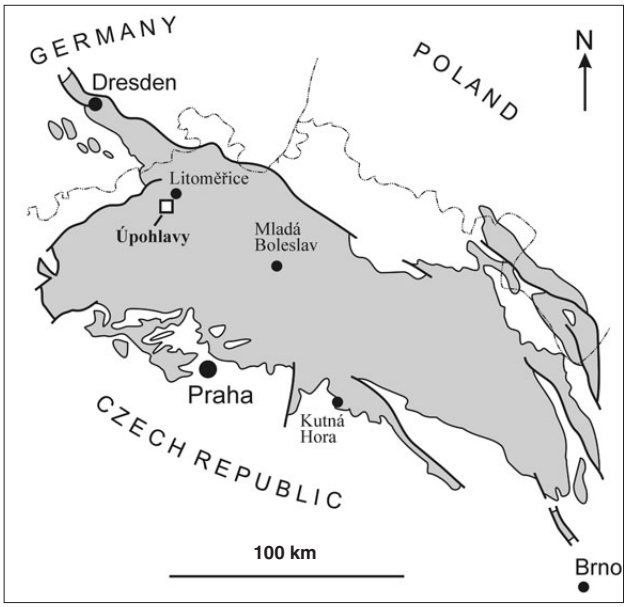


Figure 1. Sketch map of the Bohemian Cretaceous Basin (shaded), showing the location of Úpohlavy.

of unit Xb_{α} is nearly 3 m. The '*Rhynchonella* beds' comprise about 5.5 m of marls alternating with limestones. Concentrations of small fossils such as brachiopods, serpulids, bryozoans and others (see Fig. 3), either complete or fragmentary, occur in units Xb_{α} and Xb_{β}.

Material and methods

The ophiuroid ossicles studied originate from the above-mentioned concentrations of organic debris in the Teplice Formation (*e.g.*, Fig. 3), which probably filled small-scale erosion scours and burrows. At the site, such fills have mostly been collected in the form of massive, mostly tabular or lense-shaped bodies of carbonate-rich rock, several centimetres large and around 0.5–2 cm thick, weathered out from the surrounding rock. Their bases often are convex, while upper surfaces are planar or slightly concave. The upper portions of such bodies contain more clay, while the basal portions are firmer and reveal densely packed fossil remains and carbonate cement.

Occasionally, such concentrations were observed cross cut directly in quarry faces, and were seen to show a gradual lateral thinning away from the thick central portions. In cross section, they are exceptionally up to 30 cm in size, demonstrating the maximum size of scoured bottom depressions. About 20 scour fills were studied but only some of them yielded ophiuroid remains. Those with brittle star material were partially dissolved either in thick sulphuric acid or potassium hydroxide, and individual fossils thus were partially or completely freed from the rock. This method yielded numerous ophiuroid ossicles in a good state of preservation, although only isolated ossicles were encountered. In each of the scour fills, elements of several ophiuroid species were found to be mixed with disarticulated echinoid, crinoid and, less commonly, asteroid skeletal elements, as well as small brachiopods, serpulid tubes, bryozoans and foraminifera. In this way, 700 ophiuroid ossicles were obtained for the present study.

Systematic palaeontology

Classification of ophiuroids follows that of Smith *et al.* (1995), Jagt (2000) and Kutscher & Jagt *in* Jagt (2000). All studied specimens are deposited in the collections of the National Museum, Prague (Nos. OS 527–OS 543, O 6495–O 6499). Abbreviations used: FGWG – Institut für geologische Wissenschaften, Ernst-Moritz-Arndt Universität Greifswald, SGWG – Sektion geologische Wissenschaften, Ernst-Moritz-Arndt-Universität Greifswald, BMNH – Natural History Museum, London, NHMM MB – Natuurhistorisch Museum Maastricht, M.J. van Birgelen Collection.

Class Ophiuroidea Gray, 1840
Subclass Ophiuridea Gray, 1840
Incertae ordinis et familiae
Subfamily Ophiobyrsinae Matsumoto, 1915

Genus *Ophiosmilax* Matsumoto, 1915

Type species. – *Ophiosmilax mirabilis* Matsumoto, 1915.

Ophiosmilax? *alternatus* Kutscher & Jagt *in* Jagt, 2000

Figure 4A–F

1950 *Transspondylus bubnoffi* A.H. Müller, p. 20, pl. 2, fig. E1–5.
1952 *Transspondylus bubnoffi* Müller. – Rasmussen, p. 53.
1996a *Transspondylus bubnoffi* Müller, 1950. – Štorc, p. 111, pl. 83, figs 1–5.
1997 *Transspondylus* cf. *bubnoffi* Müller, 1950. – Štorc, p. 173.
1999 *Ophiosmilax*? n. sp. – Jagt, p. 199, pl. 1, figs 1, 2.
2000 *Ophiosmilax*? *alternatus* Kutscher & Jagt. – Jagt, p. 7, pl. 1, figs 1, 2.
2000 *Ophiosmilax*? *alternatus* Kutscher & Jagt, sp. nov. Kutscher & Jagt *in* Jagt, p. 47, pl. 31, figs 8–12; pl. 33, figs 9–11.
2002 *Ophiosmilax*? *alternatus* Kutscher & Jagt *in* Jagt, 2000. – Štorc, p. 369, figs 170–172, 350–352.
2004b *Ophiosmilax*? *alternatus* Kutscher & Jagt *in* Jagt, 2000. – Štorc, pp. 398–400, figs 5–8.

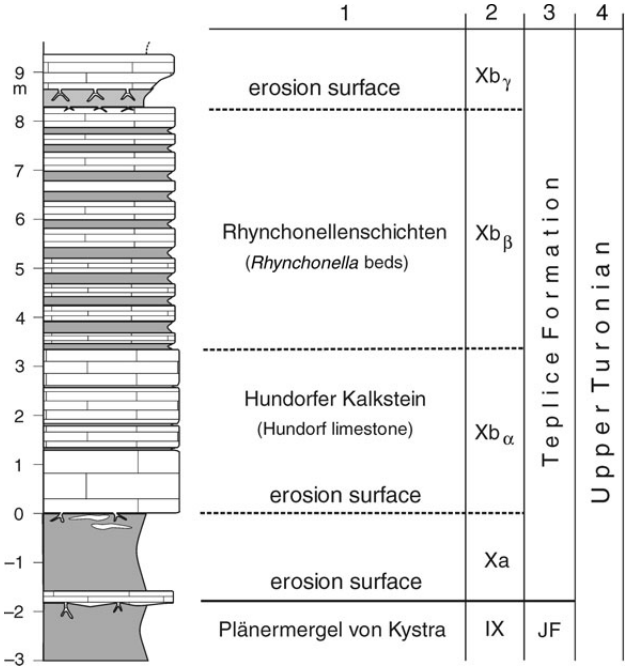


Figure 2. Lithology (shaded = marlstones; for other characters see chapter on geographical and stratigraphical setting) and stratigraphy of the Úpohlavy section (lower part; modified after unpublished data by S. Čech, Czech Geological Survey, Prague). Lithostratigraphic units are as follows: 1 – Frič (1889), 2 – Váně *in* Krutský *et al.* (1975), 3 – Čech *et al.* (1980), 4 – chronostratigraphy. Abbreviation: JF – Jizera Formation. Studied ophiuroids come from units Xb_{α} and Xb_{β}.

Type. – Holotype is FGWG 112/5; see Kutscher & Jagt *in* Jagt (2000, pl. 31, fig. 8). Holotype of *Transspondylus bubnoffi* is SGWG 103/5 (Ernst-Moritz-Arndt Universität Greifswald, Germany).

Type horizon and locality. – White chalk facies of late Early Maastrichtian age (*sumensis, cimbrica* and *fastigata* zones); Rügen, NE Germany.

Material. – 6 lateral arm plates (No. OS 527), 58 vertebrae (No. OS 528).

Description. – Transspondylous vertebrae are slightly saddle-shaped dorsally, elliptical and relatively wide proximally and distally. The distal articulation surface shows two prominent, laterally placed, dorso-ventrally elongated condyles and a small articulatory peg is ventrally placed between them. Proximal vertebral wings are laterally wider than distal ones. Lateral arm plates are of medium size, stout, domed, with a smooth outer surface, and have a slightly curved distal margin and convex proximal margin. A long and narrow, sickle-shaped, proximally directed ventral portion is highly typical. Spine tubercles are relatively large and bear two pores. The tentacle pore notches are large.

Discussion. – The lateral arm plates and vertebrae correspond to those described previously from the Lower Turonian of the BCB (Štorc 1996a, 1997, 2002, 2004b). In terms of abundance, the present species, as based on lateral arm plates, accounts for about 1.4% only, but when vertebrae are considered it equals about 31.7%, which is about 22 times more. This can be explained by vertebral construction; these are more massive in this species than the lateral arm plates and thus stood a better chance to be preserved. While *Ophiosmilax*? *alternatus* is very rare in Lower Turonian strata of the BCB (Štorc 2004b), it is surprisingly abundant at Úpohlavy.

Figure 3. Part of a scour fill with concentrated fossil remains; in upper left, lateral arm plate, probably of *Ophiocoma*? *senonensis* (outer surface). Scale bar equals 250 μm.

Palaeogeography and stratigraphy. – *Ophiosmilax*? *alternatus* is currently known from the BCB [Lower Turonian, Korycany Member (Peruc-Korycany Formation) and Bílá hora Formation; Upper Turonian, Teplice Formation]; from the middle Middle Turonian of Tunisia; Upper Campanian to lower Upper Maastrichtian of northeast Belgium; and from the Lower Maastrichtian of Rügen (Germany) and Møn (Denmark).

Order Ophiurida Müller & Troschel, 1840
Suborder Ophiomyxina Fell, 1962
Family Ophiomyxidae Ljungman, 1867

Genus *Ophiomyxa* Müller & Troschel, 1842

Type species. – *Ophiura pentagona* Lamarck, 1816.

***Ophiomyxa*? cf. *curvata* Kutscher & Jagt *in* Jagt, 2000**
Figure 4G–K

1950 *Schizospondylus jasmundiana* A.H. Müller, p. 18, pl. 1, fig. D1–5.

1950 unbenanntes Lateralschild. – A.H. Müller, p. 29, pl. 3, fig. Q1, 2.
1952 *Ophiacantha*? *danica* Rasmussen, p. 52 (partim, reference to A.H. Müller 1950).
1952 *Schizospondylus jasmundiana* Müller. – Rasmussen, p. 53.
1998 sp. 17 = *Ophiomyxa*? n. sp. 1. – Jagt & Kutscher, fig. 1g.
2000 *Ophiomyxa*? *curvata* Kutscher & Jagt *in* Jagt, p. 53, pl. 31, figs 4–7.

Type. – Holotype is FGWG 112/2; see Kutscher & Jagt *in* Jagt (2000, pl. 31, fig. 4).

Type horizon and locality. – White chalk facies of late Early Maastrichtian age (*sumensis, cimbrica* and *fastigata* zones); Rügen, NE Germany.

Material. – 14 lateral arm plates (No. OS 529), 10 vertebrae (No. OS 530).

Description. – The sickle-shaped, narrow, but robust lateral arm plates have a narrow outer surface which widens slightly dorsally. This shows well-developed, ring-shaped spine tubercles. Tubercle size gradually increases dorsally and simultaneously the distance between them grows. The height of the dorsal portion of each tubercle exceeds that of the ventral. Proximally of the tubercle row, the outer surface ends in a sharp ridge and continues into the proximal margin, which is only slightly indented above the ventral portion, but lacks other notable features. The inner surface shows a dorsoproximally curved narrow crest for vertebral articulation.

Discussion. – The lateral arm plates found differ slightly from those described by Kutscher & Jagt (*in* Jagt 2000, p. 54, pl. 31, figs 4–7), in being more slender and in their dorsal portions, which also differ slightly. Kutscher & Jagt (*in* Jagt 2000, p. 54) noted that the present species, "has 9–10 spine tubercles on proximal plates, 7–9 in median arm positions and 6–8 on distal plates". Unfortunately, since we have only a few lateral arm plates in our material, we cannot be more specific on spine tubercle count and structure. Kutscher & Jagt (*in* Jagt 2000, p. 54) also noted that, "curved narrow crest ends dorsally in a knob, which highly restricts the height of the associated vertebra". This 'knob' is not seen in the Czech specimens. These differences may indicate the occurrence of an undescribed species which is closely related to *Ophiomyxa*? *curvata*. The limited material available precludes any firm conclusion in this respect.

In addition to lateral arm plates, about 10 vertebrae with "transspondyline" articulation (they were described as "transspondylous" by Štorc (2004b) are available in our material. These are distinctly larger and morphologically differ from the more or less similar vertebrae of *Ophiosmilax*? *alternatus*. Moreover, Kutscher & Jagt (*in* Jagt 2000, p. 54) noted that vertebrae of *Ophiomyxa*? *curvata* "correspond to Müller's (1950) vertebrae type D (*Schizospondylus jasmundiana*)". Large proximal vertebrae of this type from Úpohlavy are similar to Müller's specimen (1950, pl. 1, figs D1–5) as well. In our material, the distal articulation surface shows two prominent elongated condyles, comparable to condyles in streptospondylous vertebrae, and a small articulatory peg placed ventrally between the condyles. Even though this peg (or zygophiuroid peg) is not illustrated by Müller (1950, see his fig. D2), the presence of a rudimentary articulatory peg was mentioned (Müller 1950, p. 18). Smaller distal vertebrae of this type from Úpohlavy are also similar to those of *Ophiomyxa*? *rhipidata* Kutscher & Jagt (see Kutscher & Jagt *in* Jagt 2000, pl. 33, figs 6, 7). Despite this, all uniquely transspondylous vertebrae from Úpohlavy referred to above are here assigned to *Ophiomyxa*? cf. *curvata*. In terms of abundance, the present species, based on lateral arm plates, accounts for about 3.3%, and based on vertebrae, for about 5.5%.

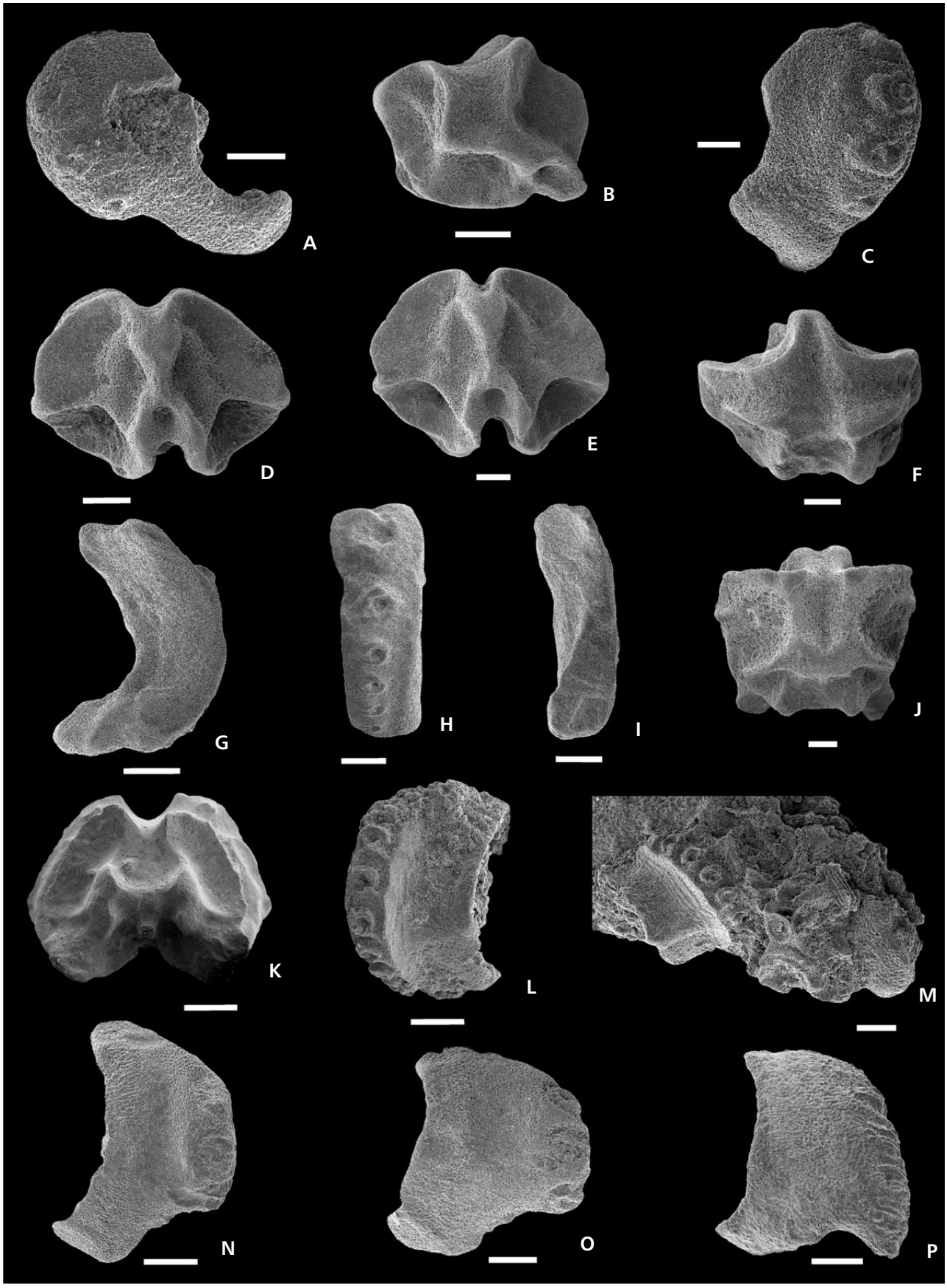
Palaeogeography and stratigraphy. – Currently known from the Upper Turonian (Teplice Formation) of the BCB; the upper Lower Campanian of southern Sweden; and the Lower Maastrichtian of Kronsmoor (Germany), Rügen (Germany) and Møn (Denmark).

Suborder Ophiurina Müller & Troschel, 1840
Family Ophiacanthidae Perrier, 1891 s. lat.
Subfamily Ophiacanthinae *sensu* Paterson, 1985

Genus *Ophiacantha* Müller & Troschel, 1842

Type species. – *Ophiacantha spinulosa* Müller & Troschel,

Figure 4. A–F – *Ophiosmilax*? *alternatus*. • A – OS 527/1, outer surface of lateral arm plate (distal = left). • B – OS 528/1, vertebra in lateral view (distal = right). • C – OS 527/2, outer surface of lateral arm plate (distal = right). • D, E – OS 528/2 and OS 528/3, vertebrae in proximal view. • F – OS 528/4, vertebra in dorsal view (distal = down). • G–K – *Ophiomyxa*? cf. *curvata*. • G – OS 529/1, inner surface of lateral arm plate (distal = right). • H – OS 529/2, outer surface of lateral arm plate. • I – OS 529/3, inner surface of lateral arm plate. • J – OS 530/1, vertebra in dorsal view (distal = down). • K – OS 530/2, vertebra in distal view. • L, M – *Ophiacantha*? aff. *striata*. • L – OS 531/1, outer surface of lateral arm plate (distal = left). • M – OS 531/2, lateral arm plate (in outer view) associated with other indeterminate ophiuroid remains. • N, O – *Ophiocoma*? *senonensis*; OS 532/1 and OS 532/2, outer surface of lateral arm plates (distal = right). • P – *Amphiura*? *plana*; OS 533/1, outer surface of lateral arm plate (distal = right). Scale bars equal 250 μm, except in Fig. 4G–I, K, where they represent 500 μm.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1842 = *Asterias bidentata* Retzius, 1805, by subsequent designation of Clark (1915).

Ophiacantha? aff. *striata* Kutscher & Jagt *in* Jagt, 2000
Figure 4L, M

1996a *Ophiacantha*? cf. *danica* Rasmussen, 1951. – Štorc, pp. 156–161, figs 110–114.
1997 *Ophiacantha*? aff. *danica* Rasmussen, 1951. – Štorc, p. 173, fig. 3.
2000 *Ophiacantha*? *striata* Kutscher & Jagt *in* Jagt, p. 11, pl. 13, figs 2, 3; pl. 19, fig. 10, pl. 20, figs 1–3, 5.
2000 *Ophiacantha*? *striata* Kutscher & Jagt *in* Jagt, p. 64, pl. 25, figs 8–10.
2002 *Ophiacantha*? aff. *striata* Kutscher & Jagt *in* Jagt, 2000. – Štorc, p. 384, figs 180–185, 592–602.

Type. – Holotype is FGWG 112/12; see Kutscher & Jagt *in* Jagt (2000, pl. 25, fig. 8).

Type horizon and locality. – White chalk facies of late Early Maastrichtian age (*sumensis, cimbrica* and *fastigata* zones); Rügen, NE Germany.

Material. – 3 lateral arm plates (No. OS 531).

Description. – The small and fragile (especially proximal portions) lateral arm plates have horseshoe-shaped tubercles, closely spaced and increasing in size dorsally. The constricted outer surface shows a pronounced oblique striation or corrugation. The proximal margin does not show any articulation elements, and is rather thin.

Discussion. – In comparison to other Late Cretaceous species such as *Ophiacantha*? *danica* Rasmussen, 1952, *O*.? *punctata* Kutscher & Jagt *in* Jagt, 2000 and *O*.? *rugosa* Kutscher & Jagt *in* Jagt, 2000, the Czech material most closely resembles *O*.? *striata*. However, with only three imperfectly preserved lateral arm plates available from Úpohlavy, a definitive assignment currently is impossible.

Palaeogeography and stratigraphy. – Recorded from the Lower Turonian [Korycany Member (Peruc-Korycany Formation), Bílá hora Formation] and the Upper Turonian (Teplice Formation) of the BCB; the Lower Maastrichtian of Rügen (Germany) and Møn (Denmark); and from the Upper Campanian, Upper Maastrichtian and Lower Paleocene in the type area of the Maastrichtian Stage (southeast Netherlands and northeast Belgium).

Infraorder Chilophiurina Matsumoto, 1915
Family Ophiuridae Lyman, 1865

Genus *Stegophiura* Matsumoto, 1915

Type species. – *Ophiura nodosa* Lütken, 1855.

Stegophiura? *nekvasilovae* sp. nov.
Figures 5A–F, 8D

Derivatio nominis. – In honour of RNDr. Olga Nekvasilová, CSc., retired scientific worker of the Institute of Geology AS CR, Prague.

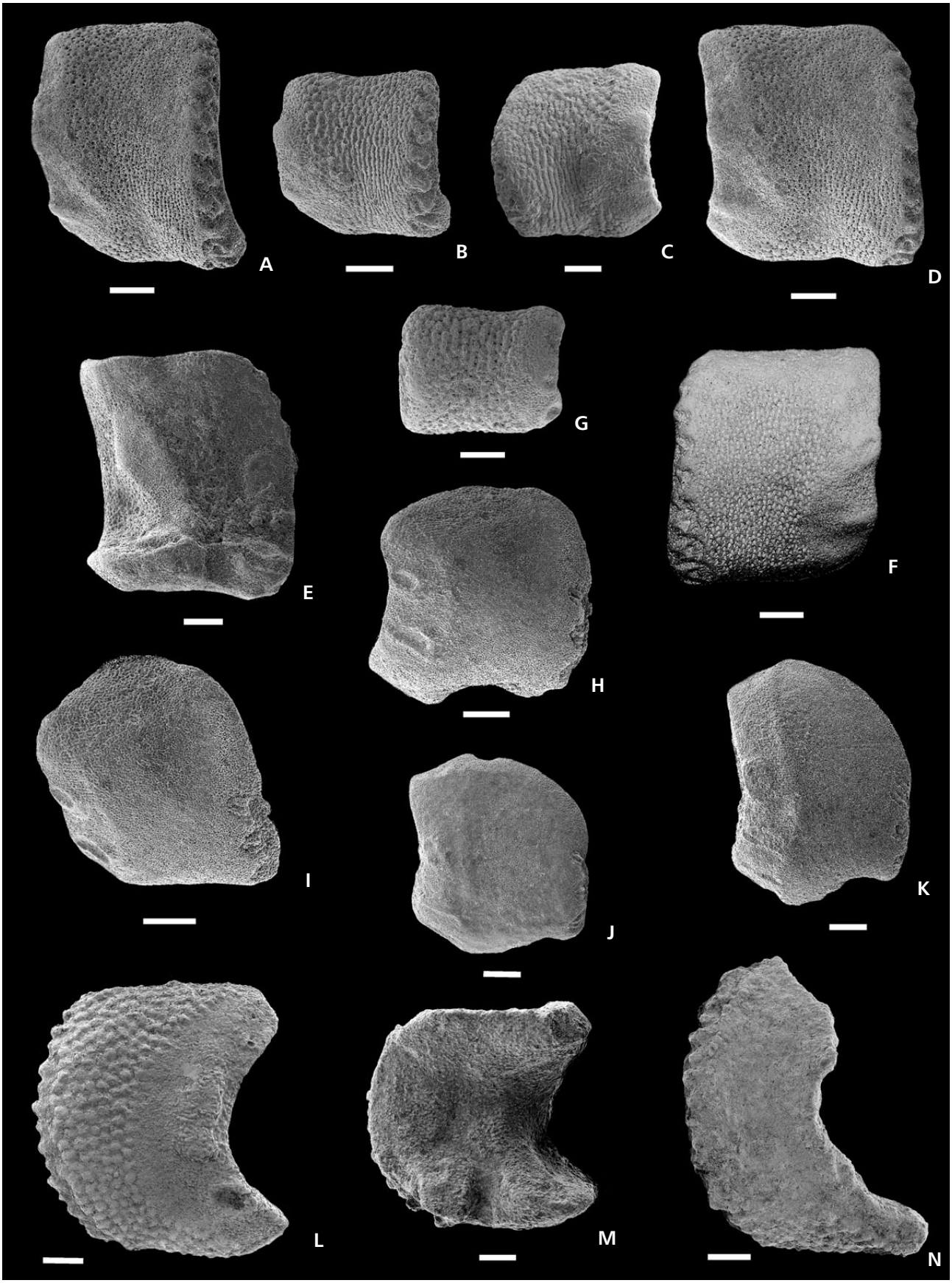
Types. – Holotype is O 6495 (Fig. 5A, D); paratypes are O 6496–O 6499 (Fig. 5B, C, E and F). All types are deposited in the National Museum, Prague.

Type horizon and locality. – Teplice Formation, so-called Hundorf limestone and *Rhynchonella* beds, lower Upper Turonian; active quarry at Úpohlavy (Lafarge Cement), northwest Bohemia, Czech Republic.

Material. – In addition to type specimens other 86 lateral arm plates (No. OS 541), and probably also two vertebrae (No. OS 539) and one radial shield (No. OS 540).

Description. – Lateral arm plates are constricted, medium-sized and moderately thick. The distal plates are markedly elongated. On the distal part are closely spaced spine tubercles; proximal plates have 11–12 and distal plates 5–6 tubercles. The small secondary spine tubercles are positioned distally, but ventral primary tubercles are oriented more laterally, are larger, oval and better developed

Figure 5. A–F – *Stegophiura*? *nekvasilovae* sp. nov. • A, D – O 6495, holotype, outer surface of median or proximal lateral arm plate (distal = right), A – in distal oblique view. • B – O 6496, paratype, outer surface of distal lateral arm plate in distal oblique view (distal = right). • C – O 6497, paratype, outer surface of distal or median lateral arm plate. • E – O 6498, paratype, inner surface of proximal lateral arm plate (distal = right). • F – O 6499, paratype, outer surface of proximal or median lateral arm plate (distal = left). • G – *Ophiomusium* sp.; OS 534, outer surface of distal lateral arm plate (distal = left). • H–K – *Ophiolepis*? cf. *pulchra*; lateral arm plates in outer view (distal = right). • H, I – OS 535/1, I – in oblique, dorso-distal view. • J – OS 535/2. • K – OS 535/3. • L–N – *Ophioderma*? *substriatum*. • L – OS 536/1, probably median lateral arm plate in outer view (distal = left). • M – OS 536/2, probably median lateral arm plate in inner view (distal = left). • N – OS 536/3, proximal lateral arm plate in outer view (distal = left). Scale bars equal 250 μm.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than the secondary ones. The primary tubercles are four in number (in proximal or median plates), are well developed, ventrally start directly above the tentacle pore notch and recede slightly from the distal margin. Smaller secondary spine tubercles are positioned over the primary tubercles and are close to the margin, so that this appears denticulate. The constricted outer surface shows a highly typical ornament created by longitudinal striation (and in part by fine granulation on some places). The ornament is lacking from the raised proximal margin, where two weakly developed articulation bosses are seen. The dorsal articulation is placed almost at mid-height of the plate. Correspondingly, there are two articulation elements on the distal margin of the inner surface. The inner surface also shows a well-developed curved element for vertebral articulation. The tentacle pore indentation is well developed, relatively large and obvious in all plates.

Discussion. – This new species is erected on the basis of lateral arm plates which easily distinguish it from all other Cretaceous brittle stars known from the BCB. The spine tubercles are also typical and differ from those of all other Bohemian species. However, von Hagenow (1840), Müller (1950), Rasmussen (1950, 1952, 1972), Maryańska & Popiel-Barczyk (1969), Jagt & Kutscher (1998), Kutscher (1998), Helm *et al.* (1999), Jagt (2000), Kutscher & Jagt (*in* Jagt 2000) and Jagt & Odin (*in* Odin, 2001) described from the Upper Cretaceous (Campanian-Maastrichtian) and Lower Paleocene of Great Britain, France, Germany, the Netherlands, northeast Belgium, Denmark and central Poland a similar species, *Stegophiura*? *hagenowi* (Rasmussen, 1950). Jagt (1999, 2000) and Jagt & Kutscher (2000) assigned this species to the extant genus *Stegophiura* in the family Ophiuridae, albeit with a query. The resemblance between the present species and *S*.? *hagenowi* pertains predominantly to the structure of lateral arm plates (compare Rasmussen 1950, p. 114, pl. 17, figs 1–5; Helm *et al.* 1999, pl. 1, figs 1, 2, pl. 3, fig. 6; Jagt 2000, pl. 3, figs 1, 2; and Kutscher & Jagt *in* Jagt 2000, pl. 24, figs 1–6). Closely similar is the arrangement of spine tubercles; compare Kutscher & Jagt (*in* Jagt, 2000, p. 69). However, numerous features (see above) distinguish the present taxon from *S*.? *hagenowi* and therefore a new species is warranted. Both species are apparently closely related and both are here assigned to the Ophiuridae. It should also be noted, that about twenty vertebrae collected at Úpohlavy resemble those of *Stegophiura*? *hagenowi* illustrated by Rasmussen (1950, pl. 17, fig. 3; 1952, fig. 1) and Kutscher & Jagt (*in* Jagt 2000, pl. 33, fig. 1) and thus can be considered to belong to the new species as well.

Palaeogeography and stratigraphy. – Apparently confined to the Upper Turonian (Teplice Formation) of the BCB.

Infraorder Gnathophiurina Matsumoto, 1915
Superfamily Gnathophiuridea Matsumoto, 1915
Family Amphiuridae Ljungman, 1867

Genus *Amphiura* Forbes, 1843

Type species. – *Amphiura chiajii* Forbes, 1843, by subsequent designation of Verrill (1899).

Amphiura? *plana* Kutscher & Jagt *in* Jagt, 2000

Figure 4P

1996 type R – Štorc, p. 204, figs 84, 137–141.
1998 sp. 14 = *Amphiura*? n. sp. 1. – Jagt & Kutscher, fig. 2f.
1999 *Amphiura*? n. sp. – Jagt, p. 200, pl. 2, fig. 4.
2000 *Amphiura*? *plana* Kutscher & Jagt *in* Jagt, p. 21, pl. 0, fig. 11; pl. 11, fig. 1.
2000 *Amphiura*? *plana* Kutscher & Jagt *in* Jagt, p. 71, pl. 29, figs 1–5; pl. 33, fig. 3.
2002 *Amphiura*? *plana* Kutscher & Jagt *in* Jagt, 2000. – Štorc, p. 394, figs 196, 206–210.
2004a *Amphiura*? *plana* Kutscher & Jagt *in* Jagt, 2000. – Štorc, p. 37, fig. 3.

Type. – Holotype is FGWG 112/17; see Kutscher & Jagt *in* Jagt (2000, pl. 29, fig. 2).

Material. – 17 lateral arm plates (No. OS 533).

Type horizon and locality. – White chalk facies of late Early Maastrichtian age (*sumensis, cimbrica* and *fastigata* zones); Rügen, NE Germany.

Description. – Lateral arm plates are relatively small and thin, with dorsally receded distal margin. Plate thickness is more or less constant in all places; in cross-section the plate is semicircular. The ventral side is slightly flattened. The proximal part of the outer surface shows a fine, but poorly, developed striation and articulation elements are not visible. Typical is the ornament consisting of a fine granulation, except for the proximal part, which has a fine striation. This granulation runs to the distal margin between the tubercles. The horseshoe-shaped tubercles are almost of equal size, positioned directly on the distal margin. The inner surface shows only a curved element for vertebral articulation. The tentacle pore indentation is relatively large and obvious in all plates.

Discussion. – The lateral arm plates are identical to those recorded previously from the Lower Turonian of the BCB (Štorc 1996a, 2002, 2004a; see synonymy).

Palaeogeography and stratigraphy. – Currently known from the Lower Maastrichtian of Rügen (Germany) and Møn (Denmark); the Lower Campanian of southern Sweden; the Upper Campanian and Lower-Upper Maastrichtian of the Netherlands and Belgium; and the Lower (Bílá hora Formation) and Upper Turonian (Teplice Formation) of the BCB.

Superfamily Ophiocomidea Ljungman, 1867
Family Ophiocomidae Ljungman, 1867

Genus *Ophiocoma* Agassiz, 1835

Type species. – *Ophiura echinata* Lamarck, 1816, by subsequent designation of Clark (1915).

***Ophiocoma*? *senonensis* (Valette, 1915)**
Figure 4N, O

1915 *Amphiura senonensis* Valette, p. 140, fig. 6.
1950 *Amphiura*(?) *senonensis* (Valette). – Rasmussen, p. 118, pl. 15, figs 6–10.
1952 *Amphiura*? s*enonensis* (Valette). – Rasmussen, p. 50, figs 4, 5.
1960 *Amphiura*? *senonensis* (Valette 1915). – Hess, p. 755.
1972 *Amphiura*? *senonensis* Valette, 1915. – Rasmussen, p. 59, pl. 6, fig. 1.
1996a *Amphiura*? *senonensis* Valette, 1915. – Štorc, pp. 148–155, figs 105–109.
1996b *Amphiura*? *senonensis* (Valette). – Štorc, p. 169.
1997 *Amphiura*? *senonensis* Valette, 1915. – Štorc, p. 172.
1998 sp. 7 = *Ophiocoma*? *senonensis*. – Jagt & Kutscher, fig. 2b.
1998 *Ophiocoma*? *senonensis.* – Kutscher, p. 41, fig. 3.
2000 *Ophiocoma*? *senonensis* (Valette, 1915). – Jagt, p. 27, pl. 2, figs 8, 9; pl. 11, figs 8?, 9, 10; pl. 17, fig. 10?; pl. 19, figs 8, 9.
2000 *Ophiocoma*? *senonensis* (Valette, 1915). – Kutscher & Jagt *in* Jagt, p. 78, pl. 27, figs 15, 16; pl. 28, figs 1–4, 7; pl. 33, figs 4, 5, 8.
2001 *Ophioderma*? *senonensis* (Valette, 1915). – Jagt & Odin *in* Odin, p. 419, pl. 2, figs 16, 18, 20, ?28, ?29, 30, 31.
2002 *Ophiocoma*? *senonensis* (Valette, 1915). – Štorc, p. 389, figs ?159, 169, 179, 193–205, ?390, ?520–526, ?544–547, 604.

Type. – The specimen illustrated by Valette (1915, fig. 6/1) is holotype by monotypy. Its present whereabouts are unknown.

Type horizon and locality. – Campanian, Sens (département Yonne, France).

Material. – 4 lateral arm plates (No. OS 532).

Description. – The medium-sized, strong lateral arm plates have a slightly constricted outer surface. The long and narrow ventral portion of the plate is highly typical. Ornament of outer surface is created by very slight vertical striation. At the distal margin there generally are three large, horseshoe-shaped tubercles, which are notched in their curved portion and "cut into" the outer surface. At the proximal margin, almost at mid-height, there is an almost circular depression, which corresponds to an element at the distal margin on the inner surface. On the inner surface are the tentacle pore notch and vertebral articulation, which runs from a curved ridge at the tentacle pore indentation to the proximal and dorsal margin.

Discussion. – The lateral arm plates are identical with those described previously from the Lower Turonian of the BCB (Štorc 1996a, b, 1997, 2002; see synonymy). The lateral arm plate figured on Fig. 3 of this paper may belong also to *O*.? *senonensis* but differs in shape, and markedly thin construction. Moreover, not all fetaures are visible due to its position in the rock.

Palaeogeography and stratigraphy. – Currently known from the Lower Turonian [Korycany Member (Peruc-Korycany Formation) and Bílá hora Formation], the Upper Turonian (Teplice Formation) of the BCB; the middle Middle (and ?Upper) Turonian, Lower Coniacian and Lower Santonian of Tunisia; the Lower Maastrichtian of Rügen (Germany), Møn (Denmark) and Kronsmoor (Germany); the upper Lower Campanian of southern Sweden; the Gulpen, Maastricht and Houthem formations (Upper Campanian-Lower Paleocene) of the type area of the Maastrichtian Stage (southeast Netherlands and northeast Belgium); the Upper 'Senonian' of France, Germany and Denmark (?and England); the Maastrichtian of Spain, Lower Danian (Lower Paleocene) of Denmark; Upper Danian of Sweden; and probably also the Danian of New Jersey, USA. A record from the Cenomanian of Great Britain may also be considered.

Infraorder Ophiodermatina Smith, Paterson & Lafay, 1995
Family Ophiodermatidae Ljungman, 1867

Genus *Ophioderma* Müller & Troschel, 1840

Type species. – *Asterias longicauda* Retzius, 1805, by subsequent designation of Clark (1915).

***Ophioderma*? *substriatum* (Rasmussen, 1950)**
Figure 5L–N

1950 *Ophiura*? *substriata* Rasmussen, p. 116, pl. 18, figs 1–9.
1950 *Ophiaxina intercarinata* A.H. Müller, p. 21, pl. 2, figs 1–5.
1952 *Ophiura*? *substriata* W. Rasmussen. – Rasmussen, p. 52, fig. 3.
1996a *Ophiura*? *substriata* Rasmussen, 1950. – Štorc, pp. 95, 96, fig. 66.
1996a type X – Štorc, pp. 187–192, figs 127–129.
1996a type Z – Štorc, pp. 198–201, figs 135, 136.
1997 *Ophiura*? *substriata* Rasmussen, 1950. – Štorc, p. 173, fig. 2.
1998 sp. 6 = *Ophioderma*? *substriata* [sic]. – Jagt & Kutscher, fig. 1h.
1998 *Ophioderma*? *substriata* [sic]. – Kutscher, p. 41, fig. 5.
1999 *Ophioderma*? *substriatum* (Rasmussen, 1950). – Helm *et al.*, pp. 163, 164, 170, 171, pl. 2, figs 1, 2.
2000 *Ophioderma*? *substriatum* (Rasmussen, 1950). – Jagt, p. 28, pl. 12, figs 4, 5.
2000 *Ophioderma*? *substriatum* (Rasmussen, 1950). – Kutscher & Jagt *in* Jagt, p. 81, pl. 27, figs 1–6; pl. 33, fig. 2.
2001 *Ophioderma*? cf. *substriatum* (Rasmussen, 1950). – Jagt & Odin *in* Odin, p. 416, pl. 1, figs 7, 8.
2002 *Ophioderma*? *substriatum* (Rasmussen, 1950). – Štorc, p. 419, figs 226–228, 250–253, 433.

Type. – Holotype is BMNH E13116 (Lewis 1993); holotype of *Ophiaxina intercarinata* is SGWG 103/6.

Type horizon and locality. – Lower 'Senonian', Dover, Kent (England) (according to Rasmussen 1950).

Material. – 44 lateral arm plates and probably 4 vertebrae (all ossicles under No. OS 536).

Description. – The lateral arm plates are comparatively large and stout. Behind a distal tongue are more dumbbell-shaped, ventro-dorsally oriented spine tubercles. Typical marked granules of varying sizes cover the outer surface up to the centre of these plates, the proximal half being unornamented, but with two weakly developed articulation bosses at the proximal margin. Proximal and median lateral arm plates have tentacle pore indentations, distal ones a corresponding pore. On the inner surface there is a broad vertebral articulation.

The vertebrae are broad, the distal articulatory pegs widely jutting out distally, and considerably extending ventro-distally.

Discussion. – The lateral arm plates and vertebrae correspond to those recorded previously from the Lower Turonian of the BCB (Štorc 1996a, 1997, 2002; see synonymy).

Palaeogeography and stratigraphy. – Currently known from the Lower Turonian [Korycany Member (Peruc-Korycany Formation) and Bílá hora Formation] and Upper Turonian (Teplice Formation) of the BCB; the Lower Maastrichtian of Rügen (Germany) and Møn (Denmark); the Lower Santonian of England; the Lower Campanian of Lower Saxonia (Germany); the 'Upper Senonian' of Denmark; and from the Campanian-Upper Maastrichtian (Gulpen Formation) of the type area of the Maastrichtian Stage (southeast Netherlands and northeast Belgium).

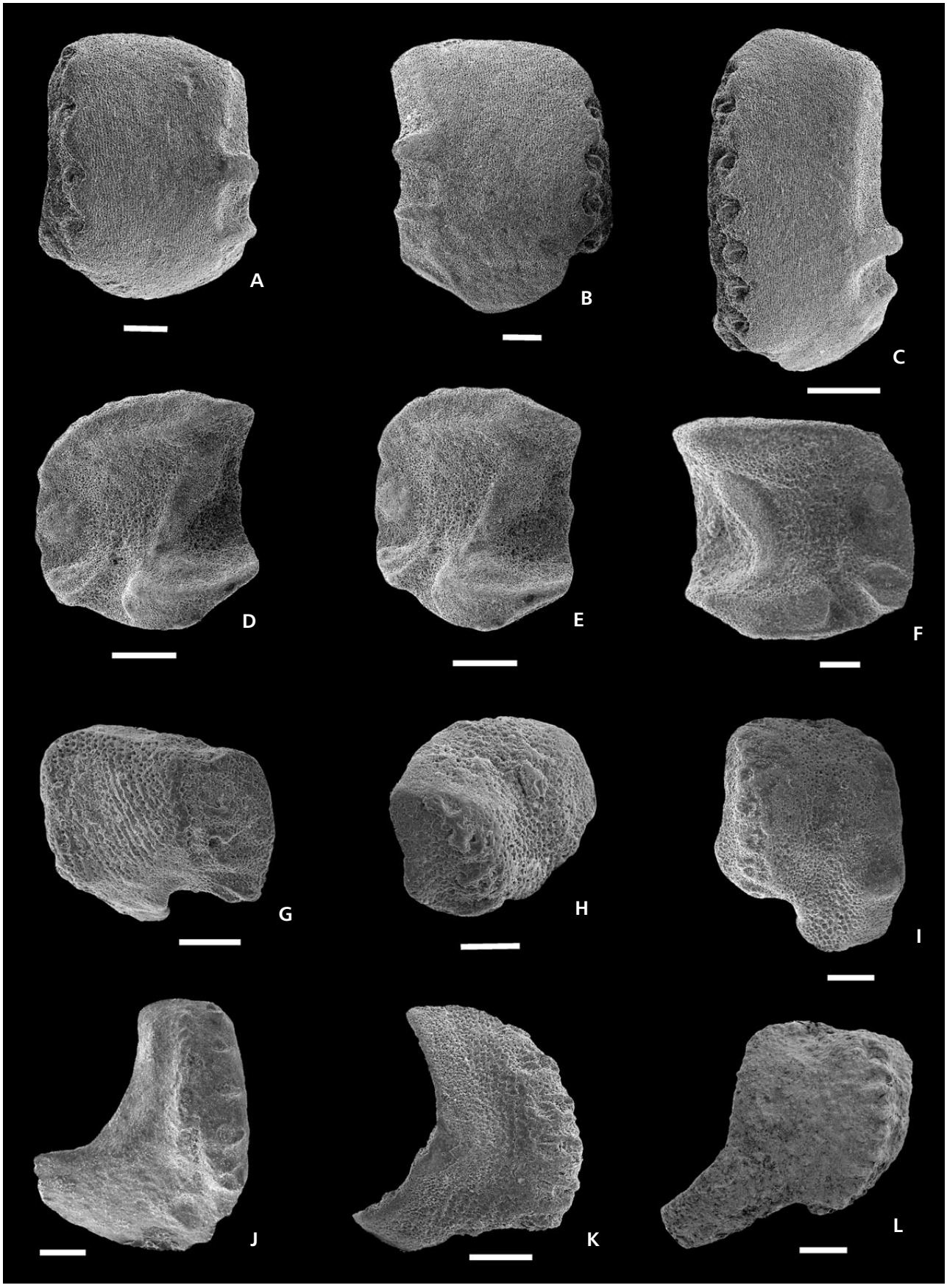
Genus *Ophiotitanos* Spencer, 1907

Type species. – *Ophiotitanos tenuis* Spencer, 1907.

***Ophiotitanos serrata* (Roemer, 1840)**
Figures 6A–F, 7B, H

1840 *Ophiura serrata* Roemer, p. 28, pl. 6, fig. 23.
1843 *Ophiura serrata* Roemer. – Forbes, p. 234, fig. 2.
1846 *Ophiura serrata* Roemer. – Reuss, p. 58, pl. 20, fig. 26.
1850 *Ophiura serrata* Roemer. – Forbes *in* Dixon, p. 337, pl. 23, figs 2, 3.
1869 *Ophioglypha serrata* Roemer. – Lütken, p. 73.
1887 *Ophioglypha* aff. *serrata* Roemer. – Peron, p. 214, pl. 3, figs 40–42.
1907 *Ophiura serrata* Roemer. – Spencer, p. 102, pl. 27, fig. 3.
1907 *Ophiura parvisentum* Spencer, p. 103, pl. 27, fig. 4.
1908 *Ophiura parvisentis* Spencer, p. 135.
1915 *Ophioglypha parvisentis* (Spencer). – Valette, p. 131, fig. 2.
?1915 *Ophioglypha gracilis* Valette, p. 135, fig. 3.

Figure 6. A–F – *Ophiotitanos serrata*. • A – OS 537/1, probably median lateral arm plate in outer view (distal = left). • B – OS 537/2, probably median lateral arm plate in outer view (distal = right). • C – OS 537/3, proximal lateral arm plate in outer, oblique distal view (distal = left). • D, E – OS 537/4, probably median lateral arm plate in inner view (distal = left), E – in oblique proximal view. • F – OS 537/5, probably median lateral arm plate in inner view (distal = right). • G–L – OS 538/1–OS 538/6, indeterminate lateral arm plates in outer view; G, J–L – distal = right, H, I – distal = left, H – oblique distal-lateral view. Scale bars equal 250 μm, except in Fig. 6C–E, where they represent 500 μm.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1950 *Ophiura serrata* Roemer. – Rasmussen, p. 111, pl. 16, figs 1–8.
1950 *Ophiura tener* A.H. Müller, p. 16, pl. 1, fig. B1–5 (*non* pl. 3, figs. O1, 2).
1950 *Ophioderma arkonensis* A.H. Müller, p. 29, pl. 3, fig. P1, 2 (*non* pl. 1, fig. C1–5).
1952 *Ophiura*? *serrata* (Roemer). – Rasmussen, p. 50, fig. 7.
1960 *Ophiotitanos serrata* Roemer. – Hess, p. 751.
1969 *Ophiura serrata* Roemer. – Maryańska & Popiel-Barczyk, p. 137.
1972 *Ophiura serrata* Roemer, 1840. – Rasmussen, p. 60.
1996a *Ophiura*? *serrata* Roemer, 1841. – Štorc, pp. 116–147, figs 85–104.
1996b *Ophiura*? *serrata* (Roemer). – Štorc, p. 169.
1997 *Ophiura*? *serrata* Roemer, 1841. – Štorc, p. 172.
1998 sp. 4 = *Ophiotitanos serrata*. – Jagt & Kutscher, fig. 1c.
1999 *Ophiotitanos serrata* (Roemer, 1840). – Helm *et al.*, pp. 168–173, pl. 1, figs 12–17; pl. 2, figs 3–5; pl. 3, fig. 4.
2000 *Ophiotitanos serrata* (Roemer, 1840). – Jagt, p. 28, pl. 7, figs 4, 5?; pl. 8, figs 3, 4; pl. 15, figs 9–12; pl. 16, figs 1–3; pl. 17, figs 2, 3?; pl. 19, figs 1, 2; pl. 20, figs 7, 8; pl. 21, figs 1–4.
2000 *Ophiotitanos serrata* (Roemer, 1840). – Kutscher & Jagt *in* Jagt, p. 83, pl. 26, figs 8–11; pl. 32, figs 10, 11.
2001 *Ophiotitanos serrata* (Roemer, 1840). – Jagt & Odin *in* Odin, p. 416, pl. 1, fig. 12; pl. 2, figs 15, 19.
2002 *Ophiotitanos serrata* (Roemer, 1840). – Štorc, p. 428, figs 268–286, 295, 296, 299, 303–305, ?306, 311, ?312, ?347, ?388, ?408–?414, ?428–?430, ?493–?508, ?532, ?533, 560–566, 568, ?585, 587–589.

Types. – Holotype, by monotypy, of *O. serrata* is the specimen illustrated by Roemer (1840), the present whereabouts of which could not be established. Holotype of *O. parvisentis* is BMNH E 5052. Holotype of *O. gracilis* is the specimen figured by Valette (1915), the current whereabouts of which could also not be established.

Type horizon and locality. – *Quadratus* Zone, Lower Campanian; Lindener Berge near Hannover, Germany.

Material. – 150 lateral arm plates (No. OS 537), 2 vertebrae (OS 542) and probably some dorsal and ventral arm plates and radial shields (No. OS 540, see Fig. 8).

Description. – Lateral arm plates are of medium size and moderately thick. In cross-section the plate is semicircular. Distal lateral arm plates are markedly longer than high. In proximal and median arm segments, lateral arm plate height exceeds length. Distal and proximal margins are virtually parallel. Behind a distal tongue lie tubercles arranged in pockets. The outer surface is not constricted and shows a fine, close-set longitudinal striation. At the proximal margin there are two narrow, proximally pointed articulation bosses. Tentacle pore indentations are well developed. In distal plates occur tentacle pores. The inner surface shows a curved element for vertebral articulation. Typical zygospondylous vertebrae have long, slender articulatory pegs distally. Distal vertebrae are elongated.

Discussion. – *Ophiotitanos serrata* is the predominant form in the ophiuroid fauna from Úpohlavy, as documented by numerous lateral arm plates and vertebrae and perhaps even other rare disc and arm ossicles of this species. In terms of abundance, the present species accounts for, based on lateral arm plates, about 35%.

Palaeogeography and stratigraphy. – Currently known from the Cenomanian and Lower Turonian [Korycany Member (Peruc-Korycany Formation) and Bílá hora Formation], Upper Turonian (Teplice Formation) and the ?Coniacian of the BCB. This is a long-ranging species with records from the Cenomanian to Lower Paleocene in Great Britain, Germany, the Netherlands, Belgium, France, Denmark, Sweden and probably also Poland, Spain, New Jersey (USA) and Tunisia.

Infraorder Ophiolepidina Ljungman, 1867
Family Ophiolepididae Ljungman, 1867

Genus *Ophiolepis* Müller & Troschel, 1842

Type species. – *Ophiura annulosa* de Blainville, 1834, *non* Lamarck, 1816, by subsequent designation of Lyman (1865) (= *Ophiolepis superba* Clark, 1915).

Ophiolepis? cf. *pulchra* (Valette, 1915)
Figure 5H–K

1915 *Ophioglypha pulchra* Valette, p. 137, fig. 4.
1996a type P. – Štorc, pp. 213–216, figs 144–146.
2002 *Ophiolepis*? *granulata* Kutscher & Jagt *in* Jagt, 2000. – Štorc, p. 402, figs 232–234, 237.

Type. – The specimen illustrated by Valette (1915, p. 137, fig. 4) is holotype, by monotypy.
Its present whereabouts are unknown to us.

Type horizon and locality. – Turonian (Angoumien), Armeau (département Yonne, France).

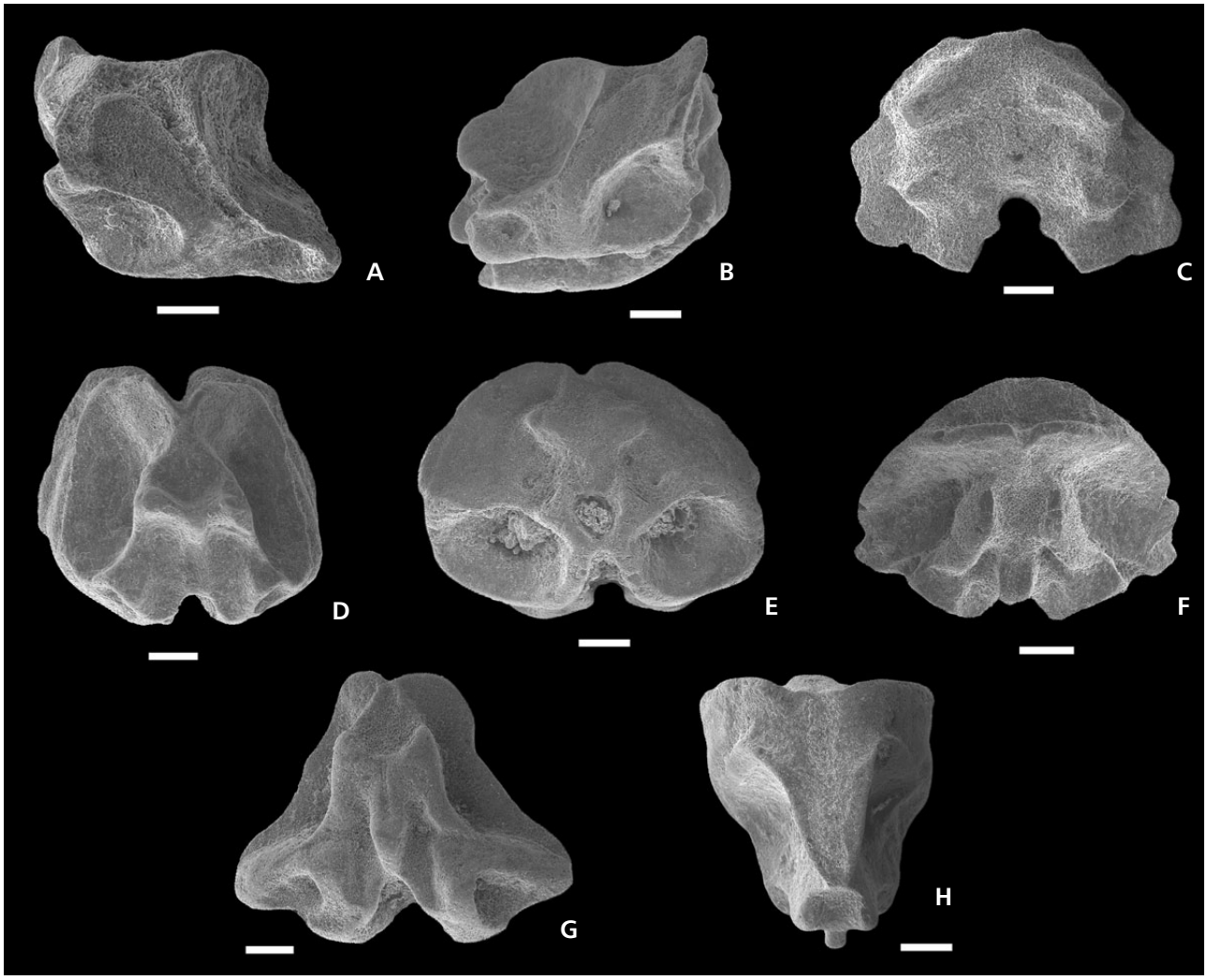


Figure 7. Zygospondylous vertebrae, ventral = down (except in Fig. 7H). • A – OS 539/1, ?*Ophiotitanos serrata*, ?*Stegophiura*? *nekvasilovae*, lateral view (distal = right), distal articulatory pegs are broken off. • B – OS 542/1, *Ophiotitanos serrata*, oblique latero-ventral view (distal = left). • C – OS 543/1, proximal view of the first (mouth) vertebra. • D – OS 539/2, ?*Ophiotitanos serrata*, ?*Stegophiura*? *nekvasilovae*, distal view. • E – OS 543/2, proximal view. • F – OS 543/3, oblique dorso-distal view. • G – OS 543/4, short proximal vertebra in distal view. • H – OS 542/2, *Ophiotitanos serrata*, dorsal view. Scale bars equal 250 μm.

Material. – 48 lateral arm plates (No. OS 535).

Description. – The small, relatively robust and smooth lateral arm plates are very slightly constricted and have convex dorsal margin. Outer and inner surfaces meet distally under an acute angle, so that these plates appear sharpened. At the proximal margin occur, oriented ventrally, two bar-like articulation bosses, which correspond to two such elements at the distal margin on the inner surface. Near the ventral part of the distal margin occur mostly three small spine tubercles. Of these, the dorsal one has a different orientation. The inner surface shows a proximally directed ridge for vertebral articulation. All plates have well-developed tentacle pore notches.

Discussion. – There is a close resemblance of the present species and *Ophiolepis*? *granulata* Kutscher & Jagt *in* Jagt, 2000 (see Jagt 2000, p. 31, pl. 13, figs 8, 9; Kutscher & Jagt *in* Jagt 2000, p. 85, pl. 25, figs 11, 12; pl. 26, figs 1, 2, 7) from the Lower Maastrichtian of Rügen (Germany) and Møn (Denmark) and from the Upper Campanian–Upper Maastrichtian (Gulpen Formation) of northeast Belgium. Closely similar is specimen NHMM MB 808–9e (see Jagt 2000, pl. 13, fig. 9). However, in Valette's (1915) small arm fragment three spines are recorded, whereas *Ophiolepis*? *granulata* generally has but two. Kutscher & Jagt (*in* Jagt 2000, p. 85) also noted that, "lateral arm plates of this species, when well preserved, show a coarsely granulate outer surface". Valette (1915), however, did not refer to any granules. Ossicles from the Bohemian Cretaceous Basin (see Štorc 1996a, figs 144–146; 2002, p. 402, figs 232–234, 237) are also

smooth (under higher magnification a weakly granulate or microscopic longitudinal striation is seen). The French and Czech material is also of comparable, or even identical, Turonian age.

Valette (1915) assigned this form to the extant genus *Ophioglypha*, but Kutscher & Jagt (*in* Jagt 2000, p. 86) noted that their material was close to the modern genus *Ophiolepis* (*e.g.*, *Ophiolepis cincta* Müller & Troschel, 1842) and therefore assigned it to that taxon. In view of the comparable morphology, we here transfer *Ophioglypha pulchra* to *Ophiolepis*? as well. *O.*? *pulchra* resembles also the species *Ophiolepis*? *linea* Kutscher & Jagt *in* Jagt, 2000, from which it differs mainly in being relatively more hemispherical and robust and in having the spine tubercles concentrated only in the ventral part of the distal end of the lateral arm plate. *O.*? *linea* seems to be more elongate (see Kutscher & Jagt *in* Jagt 2000, pl. 26, figs 3–6).

Palaeogeography and stratigraphy. – Known from the Lower Turonian [Korycany Member (Peruc-Korycany Formation) and Bílá hora Formation] and Upper Turonian (Teplice Formation) of the BCB; and from the Turonian of Yonne (France).

Genus *Ophiomusium* Lyman, 1869

Type species. – *Ophiomusium eburneum* Lyman, 1869.

***Ophiomusium* sp.**
Figure 5G

Material. – 1 lateral arm plate, OS 534.

Description. – This small ossicle is concave ventrally and dorsally, the dorsal area being more strongly constricted. The outer surface is evenly coarsely granulate, with the exception of the proximal margin which bears flatter articulation elements. As the granulation extends to the distal margin and includes the diminutive tubercles, these can hardly be observed due to the poor state of preservation.

Discussion. – This ossicle closely resembles the ones described from the locality Kutná Hora-Kaňk A (Štorc 2002) under the name of *Ophiomusium biconcavum* Kutscher & Jagt *in* Jagt, 2000 (see *e.g.*, Kutscher & Jagt *in* Jagt 2000, p. 87, pl. 22, figs 9, 10). Material from Kaňk and Úpohlavy currently is difficult to assign to any known species, and in view of the small sample size, this form is left in open nomenclature.

Palaeogeography and stratigraphy. – Known to date only from the Upper Turonian (Teplice Formation) of the BCB.

Note

In the material studied at least three additional species may be represented. However, the limited number of ossicles available and/or their frequently poor preservation prevents us from assigning them at the generic and specific level, or from describing them as new.

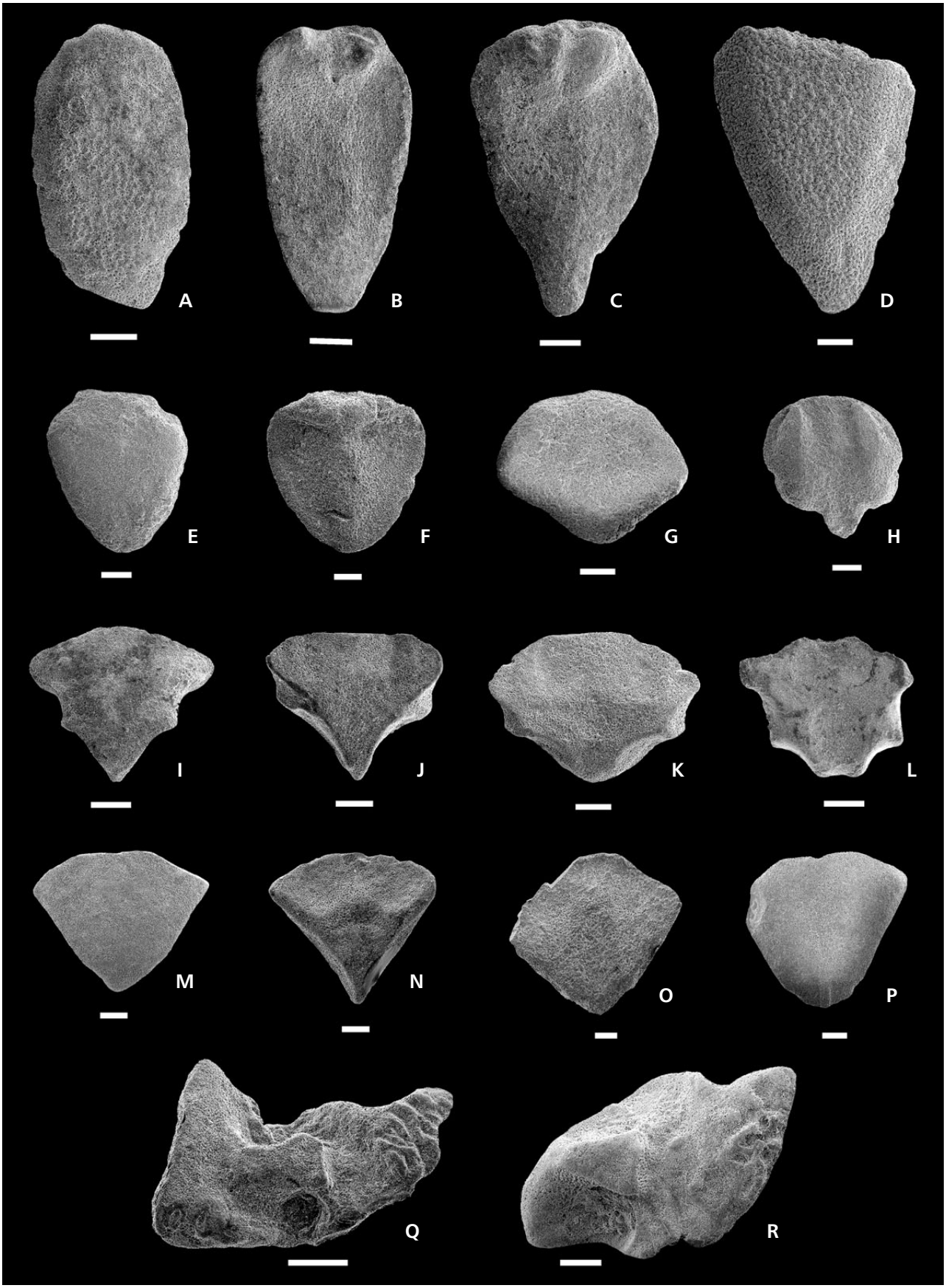
Quantitative analysis

The 700 ophiuroid skeletal elements, of which 431 are lateral arm plates, collected at Úpohlavy permit a simple quantitative evaluation. In terms of abundance, individual species, as based on lateral arm plates, rank as follows: *Ophiotitanos serrata* 34.8% (150 specimens), *Stegophiura*? *nekvasilovae* 21.1% (91 specimens), *Ophiolepis*? cf. *pulchra* 11.1% (48 specimens), *Ophioderma*? *substriatum* 10.2% (44 specimens), *Amphiura*? *plana* 3.9% (17 specimens), *Ophiomyxa*? cf. *curvata* 3.3% (14 specimens), *Ophiosmilax*? *alternatus* 1.4% (6 specimens), *Ophiocoma*? *senonensis* 0.9% (4 specimens), *Ophiacantha*? aff. *striata* 0.7% (3 specimens), *Ophiomusium* sp. 0.2% (1 specimen) and indeterminate 12.3% (53 lateral arm plates). A set of 183 vertebrae comprises zygospondylous and transspondylous in the following proportions: zygospondylous vertebrae predominate (115 specimens; mostly assignable to *Ophiotitanos serrata* and *Stegophiura*? *nekvasilovae*), followed by transspondylous vertebrae [*Ophiosmilax*? *alternatus* (58 vertebrae) and *Ophiomyxa*? cf. *curvata* (10 vertebrae)]. Streptospondylous vertebrae are completely absent in the studied material.

On the basis of lateral arm plates, the following groups of species can be distinguished:

1) Abundant taxa (*i.e.* > 10%): *Ophiotitanos serrata*, *Stegophiura*? *nekvasilovae*, *Ophiolepis*? cf. *pulchra* and *Ophioderma*? *substriatum*. Somewhat problematic is *Ophiosmilax*? *alternatus* with only 1.4% abundance, but when vertebrae are counted, it accounts for 31.7% (see above).

Figure 8. A–C – OS 540/1–OS 540/3, indeterminate radial shields. • D – OS 540/4, ?*Stegophiura*? *nekvasilovae*, radial shield. • E–G – OS 540/5–OS 540/7, unidentified ossicles (?radial shields); E, G – outer views, F – inner view. • H – OS 540/8, inner view of indeterminate ossicle (?ventral arm plate), proximal = down. • I–L – OS 540/9–OS 540/12, ventral arm plates, proximal = down; I – outer surface, J–L – inner surfaces. • M–P – OS 540/13–OS 540/16, dorsal arm plates, proximal = down; M, P – outer surfaces, N, O – inner surfaces. • Q, R – OS 540/17, OS 540/18, oral plates of two unidentified species in adradial views, adoral = left. Scale bars in Fig. 8A–C and Q equal 500 μm, in all others they represent 250 μm.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2) Fairly common species (*i.e.* > 3%): *Amphiura*? *plana* and *Ophiomyxa*? cf. *curvata*.

3) Rare species (*i.e.* < 1%): *Ophiocoma*? *senonensis*, *Ophiacantha*? aff. *striata* and *Ophiomusium* sp.

Conclusions

Based on a detailed study of 700 dissociated skeletal elements, new data on Late Turonian brittle stars from the locality Úpohlavy (Teplice Formation, Bohemian Cretaceous Basin) have been obtained. No difference in ophiuroid assemblage composition between the 'Hundorf limestone' and '*Rhynchonella* beds' was observed. However, ophiuroids at the site are fairly diverse and, in taxonomic composition, resemble assemblages recorded from Lower Turonian deposits in the BCB (Štorc 2002). At least eight taxa occur in both localities and levels. The commonest species in these assemblages is *Ophiotitanos serrata*; *Ophioderma*? *substriatum* is abundant as well. *Ophiolepis*? cf. *pulchra* and *Ophiosmilax*? *alternatus* are both rare in the Lower Turonian (Štorc 2002, 2004b) but common in the Upper Turonian. In contrast, *Ophiocoma*? *senonensis* occurs commonly in the Lower Turonian (Štorc 2002) but is rare in the Upper Turonian. There is limited material of *Amphiura*? *plana*, and *Ophiacantha*? aff. *striata* and *Ophiomusium* sp. are rare in both assemblages (Štorc 2002, 2004a). *Stegophiura*? *nekvasilovae* sp. nov. and *Ophiomyxa*? cf. *curvata* appear to be confined to the Upper Turonian; the former is represented by a fairly large number of lateral arm plates and possibly even vertebrae as well as a radial shield. This ophiuroid, which appears closely related to *Stegophiura*? *hagenowi* (Rasmussen, 1950), is common at Úpohlavy, while *Ophiomyxa*? cf. *curvata* is, according to the lateral arm plates and unique transspondylous vertebrae, less abundant. An important feature of the Úpohlavy ophiuroid assemblage is the absence of streptospondylous vertebrae, which demonstrates the absence of representatives of the order Euryalida, which, in contrast, are common in the Lower Turonian of the BCB (Štorc 1996a, 1997, 2002).

It can be concluded that at least 13 ophiuroid species were present in the benthic communities of the Úpohlavy area during the early Late Turonian. This species diversity is considerably lower than in the Upper Cenomanian–Lower Turonian highly varied rocky-coast environments from which 20–23 ophiuroid species of mostly Early Turonian age have been recorded (Štorc 2002). Varying species diversity has also been documented for other echinoderm groups, *e.g.* from the Upper Turonian about 6–8 crinoid, as well as echinoid and some asteroid species are known, whereas the Lower Turonian yields about 15 crinoid and echinoid species and numerous asteroids. A comparable divergence has been reported for other invertebrate groups. Despite this, in view of the relatively stable depositional environment and low niche diversity in the Úpohlavy area during deposition of the "Hundorf limestone" and "*Rhynchonella* beds" (units Xb_{α}, Xb_{β}), ophiuroid diversity may still be considered relatively high.

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