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NEW DIMORPHIC SPECIES OF THE GENUS *ROLLIERITES* JEANNET FROM SOUTHERN POLAND

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Abstract: A new ammonite assemblage from the lower beds of the Ogrodzieniec Quarry (southern Poland), the only Callovian section in the middle part of the Polish Jura Chain, is described. It includes the presence of *Kosmoceras rotundum* (Quenstedt), followed by the first example of co-occurring micro- and macroconchs in the genus *Rollierites* (*R*. *biplicatum* sp. n.) and above it, the association of *Euaspidoceras* sp. and *Peltoceratoides* (*Parawedekindia*) *gerberi* Prieser. Both *R. biplicatum* sp. n. (m and M; microconch and macroconch) and *K. rotundum* are assigned to the late Callovian Lamberti Zone. *P.* (*P.*) *gerberi* characterizes the early Oxfordian Cordatum Zone. This is the first record of the genus *Rollierites* from Poland. This study extends the upper age limit of the middle Callovian *Rollierites* up to the late Callovian Lamberti Zone. On the basis of morphological and stratigraphical data, it is tentatively proposed that the origin of the early–middle Oxfordian *Tornquistes* may be in the middle–late Callovian *Rollierites*, rather than the previously proposed late Callovian *Pachyceras*. However, this is speculation, as the present data set is insufficient.

Key words: *Rollierites*, dimorphism, Callovian, Oxfordian, Jurassic, Ogrodzieniec Quarry, Poland.

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INTRODUCTION

Rocks of the Tethyan and peri-Tethyan Callovian–Oxfordian transition include condensed nodular limestones, ferruginous oolites and omission surfaces (Różycki, 1953; Arkell, 1956; Aurell *et al.*, 1994; Norris and Hallam, 1995; Azerêdo *et al.*, 2002; Rais *et al.*, 2007), indicating significant condensations and hiatuses (Kopik, 1997; Dembicz and Praszkier, 2003). This brief event also coincided with a decline of carbonate platforms and a possible crisis in carbonate sedimentation (Bartolini *et al.*, 1996; Morettini *et al.*, 2002; Dromart *et al.*, 2003; Cecca *et al.*, 2005).

The Polish Jura Chain (Fig. 1A) in central Poland formed part of the North-Tethyan shelf during the Mid–Late Jurassic with marine connections with the Boreal Sea; the duration of the Callovian–Oxfordian, in particular, witnessed the dominance of the Submediterranean ammonites (Matyja and Giżejewska, 1979). The Callovian rocks from the southern margin of the Polish Jura Chain were deposited in a deep marine basin and are marked by a decreasing supply of terrigenous material and increased abundance of nektonic faunas (Giżejewska and Wieczorek, 1977; Dembicz and Praszkier, 2007).

The Ogrodzieniec Quarry (Fig. 1B) is an important site, not just for Callovian and Oxfordian stratigraphical studies (Rożycki, 1953; Kopik, 1998; Głowniak, 2002; Matyja and Głowniak, 2003; Barski *et al.*, 2004; Dembicz *et al.*, 2006), but is also an important sampling locality for isotopic studies toward a better understanding of the Mid–Late Jurassic sea-level fluctuations (see Wierzbowski *et al.*, 2009).

Well-preserved late Callovian–early Oxfordian ammonites are described from the lower strata of the Ogrodzieniec Quarry (Fig. 1C–F). This is also the first illustrated record from this important site that so far only was featured in brief references to ammonite finds by various workers (see Różycki, 1953; Głowniak, 2002; Matyja and Głowniak, 2003; Barski *et al.*, 2004; Dembicz *et al.*, 2006) and in the illustrated record of a few specimens of a new early Oxfordian subfamily Prososphinctinae Głowniak (Głowniak, 2012). The fauna described in the present account includes the first record of a new dimorphic pair of the ammonite genus *Rollierites* Jeannet (*R*. *biplicatum* sp. n.), along with *Kosmoceras* (*Kosmoceras*) *rotundum* (Quenstedt), *Euaspidoceras* sp. and *Peltoceratoides* (*Parawedekindia*)

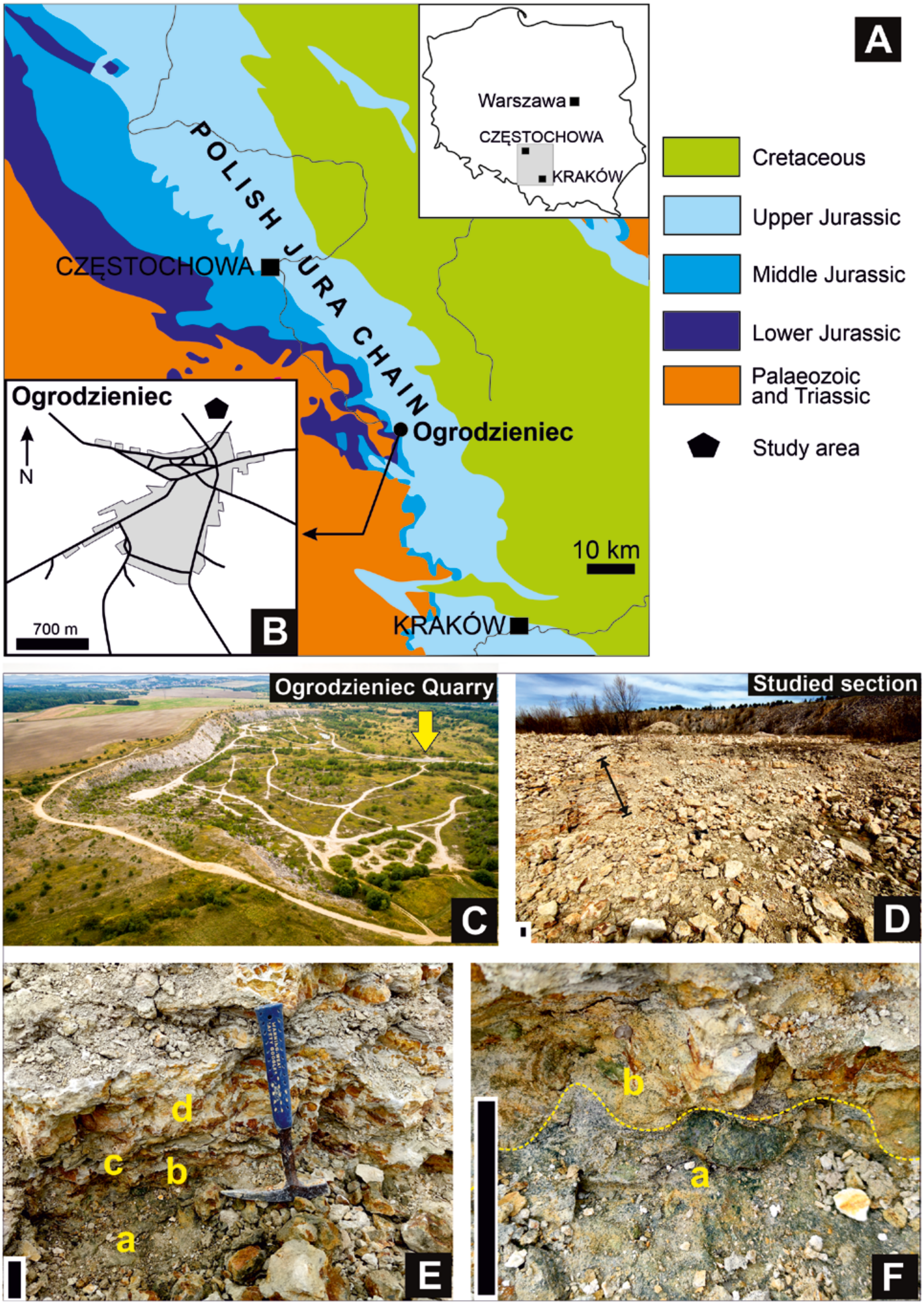

Fig. 1. Geological map and the abandoned Ogrodzieniec Quarry. **A.** Geological map of the Polish Jura Chain showing the locations of the Ogrodzieniec Quarry (inset). **B.** Ogrodzieniec Quarry. **C.** Location of the beds studied in the quarry. **D.** Exposure of the section studied. **E.** Lower beds identified in the present study. **F.** Close-up of beds "a" and "b" identified in the present study. The dotted lines mark the boundary between beds "a" and 'b" of present work. Black scale bar is 10 cm.

gerberi Prieser. Their implications for regional biostratigraphy and global correlations of ammonite zones also are discussed.

LOCATION AND STRATIGRAPHIC POSITION OF THE AMMONITE FAUNA STUDIED

The lower beds at the abandoned Ogrodzieniec Quarry were investigated (Fig. 1C–F). The base of the section at this site (50°27′52.1″N, 19°31′07.3″E) starts with a dark green glauconitic marl with limestones (bed "a" of the present work), overlain by marly limestones with glauconite (bed "b", Fig. 1E, F). These are followed upwards by marls (bed "c") and nodular marly limestones (bed "d"); the glauconite content undergoes a reduction up-section (Fig. 2). In the present work, the stratigraphic framework of Głowniak (2012) is utilized (Fig. 2). The lower part of bed "a" (limestones; bed β of Głowniak, 2012) contained *Kosmoceras rotundum* (Quenstedt) and above it (Fig. 2), the glauconitic marls (bed α of Głowniak, 2012) yielded the dimorphic pair of *Rollierites* (*Rollierites biplicatum* sp. n.). Bed "b" (bed 1a of Głowniak, 2012) was where *Peltoceratoides* (*Parawedekindia*) *gerberi* Prieser and *Euaspidoceras* sp. were found (see Fig. 2); these are the first, illustrated ammonite records from this section.

MATERIALS AND REPOSITORY

All specimens are from the abandoned Ogrodzieniec Quarry, Poland (see Fig. 1). *Rollierites biplicatum* sp. n., MM/OQ/A1–A3, GPS: 50°27′52.1″N, 19°31′07.3″E (Figs 3–5); *Kosmoceras* (*Kosmoceras*) *rotundum* (Quenstedt), MM/OQ/A4, GPS: 50°27′52.1″N, 19°31′07.3″E (A. Płaczek collection; Fig. 6 A–C); *Peltoceratoides* (*Parawedekindia*) *gerberi* Prieser, MM/OQ/B1, GPS: 50°27′52.0″N, 19°31′07.3″E (Fig. 6D–F), and *Euaspidoceras* sp., MM/OQ/B2, GPS: 50°27′52.0″N, 19°31′07.3″E (Fig. 6G). All specimens, except for *K.* (*K.*) *rotundum*), are kept in the collection of one of the authors (M. Mazur) at Ruda Śląska (Poland). Figure 2 displays their exact stratigraphical positions and Table 1, their measurements.

SYSTEMATIC PALAEONTOLOGY

Order Ammonoidea Fischer, 1882
Suborder Ammonitina Fischer, 1882
Superfamily Perisphinctoidea Steinmann in Steinmann and Döderlein, 1890
Family Pachyceratidae Buckman, 1918
Genus *Rollierites* Jeannet, 1951

Type species: *Stephanoceras renardi* Nikitin, 1881.
Remarks: Recently, Énay and Howarth (2019, p. 73), under *Erymnoceras* Hyatt, defined *Rollierites* as "Evolute forms with more or less tuberculate inner whorls, whorl section more compressed and less thick than *Erymnoceras*, coarsely ribbed up to the aperture, the secondaries branching from the tuberculate primary ribs are microconchs (*Rollierites*)". However, *Rollierites* Jeannet contains both "tuberculate" (*R. minuendum* Rollier: Jeannet, 1951, pl. 46, fig. 14; *R. tuba* Rollier; Jeannet, 1951, pl. 47, figs 1, 2; *R. tenue* Rollier; Jeannet, 1951, pl. 47, figs 8, 9) and "non-tuberculate" forms (*R. dimidiatum* Rollier; Jeannet, 1951, pl. 47, figs 1–7).

Erymnoceras is distinctly "tuberculate" and resembles the "tuberculate" *R. minuendum* Rollier but it certainly does not fit the description of Énay and Howarth (2019, p. 73) as "Large forms resembling inner whorls of *Teloceras* or *Tulites*, the outer whorl of which may become smooth and contracted". Here, pending the collection of more

Table 1

Measurements and abbreviations used.
D: diameter, Dls: diameter at last septum, H: whorl height, T: whorl width, U: umbilical diameter, P: primary ribs, n/2 = primary ribs per half whorl; all in mm, (m) = microconch, (M) = macroconch

	M/m	Sp. no.	D	H	T	U	T/H	U/D	P/2	D/(n/2)	Figure
Rollierites biplicatum sp. n.	(m), (D_{ls} = 75)	MM/OQ/A1	93	31	29	39	0.94	0.42	13	7.15	3A–E
			76	27	27	29	1.00	0.38			
	(m), (D_{ls} = 80)	MM/OQ/A2	99	33	31	41	0.94	0.41	12	8.25	3F–H
			80	29	28	32	0.97	0.40			
	(M), (D_{ls} = 116)	MM/OQ/A3	118	38	35	52	0.92	0.44	11	10.75	3I–L
			101	36	37	40	1.03	0.40			
			75.6	27	27	30	1.01	0.40			
Kosmoceras rotundum (Quenstedt)	(M), (D_{ls} = 120)	MM/OQ/A4	126	46	49	47	1.05	0.37	6A–C		
Peltoceratoides (*Parawedekindia*) *gerberi* Prieser	(m), (D_{ls} = 87)	MM/OQ/B1	87	23	21	43	0.91	0.49	6D–F		

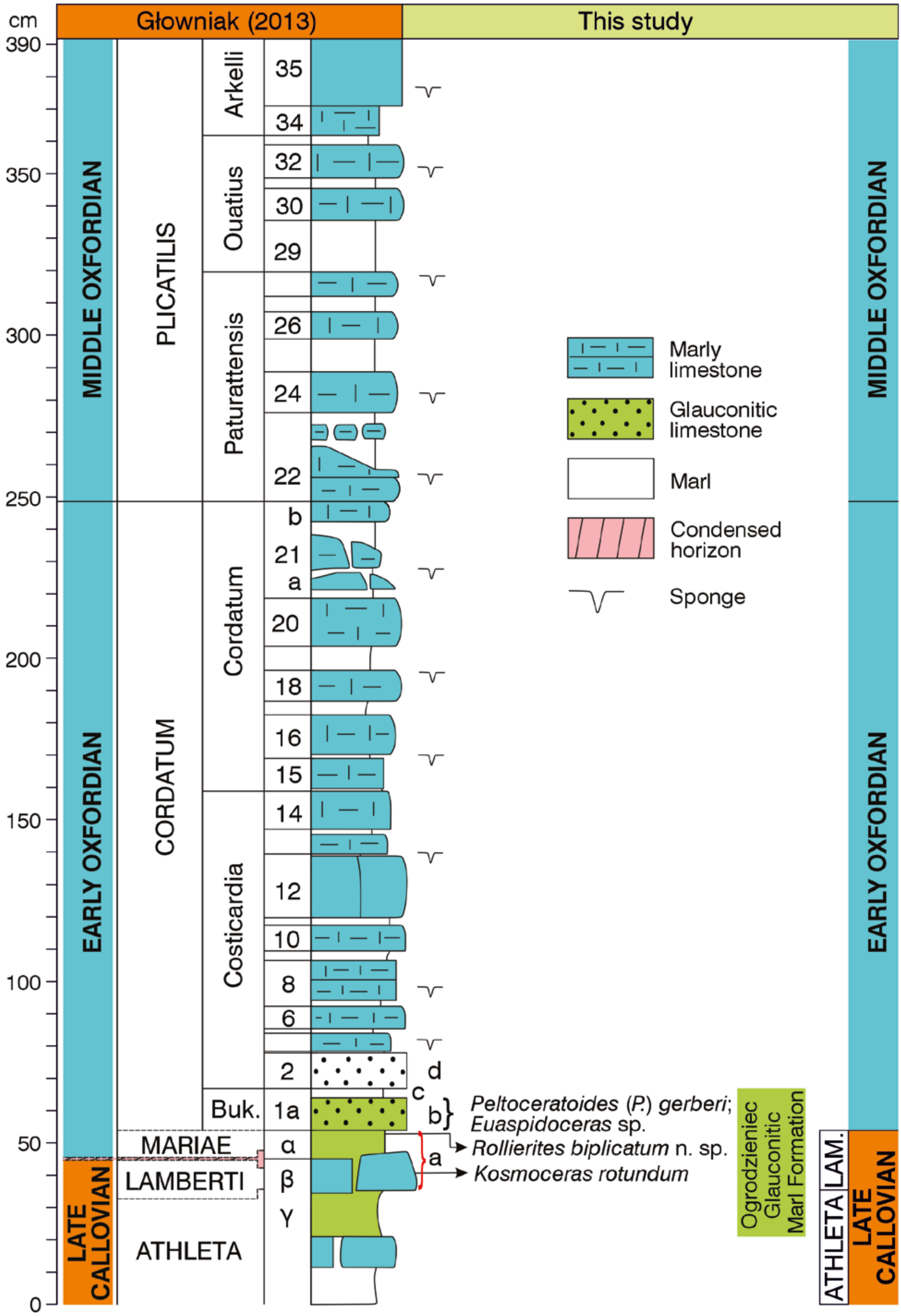

Fig. 2. Profile section. Geological column, correlation of beds with Głowniak (2012) and the occurrence of specimens noted in the present study (modified after Głowniak, 2012).

stratigraphically constrained specimens, Jeannet's (1951, p. 124) generic status for *Rollierites* is followed, containing both "non-tuberculate" and "tuberculate" forms; the latter are possibly allied to *Erymnoceras* Hyatt.

Rollierites biplicatum sp. n.
(m, microconch; M, Macroconch)
Figs 3, 4; Table 1

Etymology: Named after its characteristic biplicate ribbing pattern.
Material: 3 specimens; Holotype: a nearly complete adult (m), MM/OQ/A1 (Fig. 3A–E), a nearly complete adult (M), MM/OQ/A3 (Fig. 3I–L); paratype (m), MM/OQ/A2 (Fig. 3F–H).
Type locality and section: Ogrodzieniec Quarry, Poland (see Fig. 1), GPS: 50°27′52.1″N, 19°31′07.3″E).
Type horizon: Top of bed "a" (Fig. 2), late Callovian.
Diagnosis: Non-coronate, compressed, stout and serpenticonic; bifurcating and prosocline primaries in the inner and middle whorls that change to single ribs at the outer whorls (body chamber); shell densely ribbed up to the body chamber, oval whorl section with incipient uncoiling.
Description: Microconch (Fig. 3A–E): non-coronate, stout serpenticone, evolute and compressed. Inner whorls comparable with those of the macroconch: densely ribbed by prosocline primaries borne in the upper part of the umbilical wall. The outermost whorl (end of phragmocone and body chamber) has oval section and shows incipient uncoiling; the ribbing remains dense and prosocline but becomes stronger and regularly bifurcated in the uppermost flank. The presence of a rare, single intercalatory rib is also noted. The ribs cross the narrowly rounded venter straight and unchanged. There are 12–13 primaries and 25–27 secondaries per half whorl (see Tab. 1). At the end of the body chamber (judging by the absence of a suture line and the umbilical seam), two characteristic features were noted, namely the presence of relatively straight, single ribs and a distinct, broad and smooth inter-rib space, possibly an adult modification.

The suture line (exposed in sample Fig. 3A and drawn in Fig. 3E) has a deep siphonal lobe (E) comprising a short trifid saddle (bottom) and on its rising branch, a small and narrow saddle. The siphonal lobe is followed by a large and massive, external saddle that is divided into two asymmetric parts; the wider is towards the ventral edge. The side saddle is thinner and divided into three, followed by two lobes (L and U_2); L is relatively deep. The U_3 lobe crosses the umbilical line of septum (dotted line); the succeeding saddle is broad with a single small lobe.

Macroconch (Fig. 3F–I): non-coronate, stout serpenticone, evolute, compressed and strongly ornamented with gross ribs borne in the umbilical wall. Innermost whorls poorly preserved, showing prosocline ribs. The outermost whorl has an oval section and shows incipient uncoiling; the lateral ribbing is composed of strong prosocline primaries, bifurcating in the uppermost flank but becoming even stronger and undivided towards the end (as in the microconch). The macroconch also shows a distinct, broad and smooth inter-rib space. All ribs cross the narrowly rounded venter straight and unchanged. There are 11 primaries per half whorl (see Tab. 1).
Remarks: The close resemblance of the inner whorls and the co-occurrence of these specimens together indicate they can be considered as a sexual dimorphic pair. All specimens are considered to be mature on the basis of (1) the change in their ribbing pattern; from bi-plicate ribbing to single ribs at the body chamber (i.e., "variocostates" of Arkell, 1934–48, p. 13; ribbing on the outer whorl differs markedly in style from that on the inner whorls; see also Callomon, 1963; Matyja, 1986), and (2) the presence of a distinct, broad and smooth inter-rib space (= smooth band) in both micro- and macroconch specimens, possibly an example of an adult modification (Fig. 3).

The generic assignment of the present specimens is not straight forward, as they are very compressed with whorls that are densely ribbed in comparison to typical Pachyceratids (Waagen, 1875; Spath, 1928; Thierry and Charpy, 1982; Énay and Howarth, 2019). Their assignment to Callovian forms of *Erymnoceras* Hyatt and *Pachyerymnoceras* Breistroffer can be ruled out, as both possess coronate inner whorls (Spath, 1928; Mangold, 1988; Énay *et al.*, 2002; Jain, 2017; Jain *et al.*, 2020). The late Callovian–middle Oxfordian forms, commonly assigned to *Pachyceras* Bayle (non-tuberculate) and *Tornquistes* Lemoine (non-tuberculate), have their inner whorls typically globose (Charpy, 1976; Thierry and Charpy, 1982; Énay and Howarth, 2019), but not coronate.

The closest comparison to the present specimens is the Middle Callovian genus *Rollierites* Jeannet (Jeannet, 1951). However, the four species of *Rollierites* described by Jeannet (1951, pp. 124–127), are much smaller forms (*R. minuendum*: shell diameter, D = 35–75 mm; *R. tuba*, ~35 mm; *R. dimidiatum*, 35–38 mm; *R. tenue*, 44 mm), with an occasional triplicate ribbing pattern and a somewhat rounded whorl section. Nevertheless, the most closely comparable form is the middle Callovian Coronatum Zone *Rollierites dimidiatum* Jeannet (1951, pl. 47, figs 1–6, text-fig. 200; particularly figs 4, 6) from Herznach (Switzerland). *R. dimidiatum* matches with the present microconch specimens, both in terms of morphological characteristics (non-coronate inner whorls, compressed outer whorls, prosocline biplicate ribbing and oval whorl section) and dimensional proportions (Fig. 4). Despite this close similarity, there also are differences in (1) primarily the presence of triplicate ribbing in the outermost whorl, (2) the absence of ventral rib-pairing (see Jeannet, 1951, pl. 47, figs 4b, 6b), (3) whorl compression (whorl thickness/height ratio; Fig. 4B), and (4) the fact that *R. dimidiatum* is much smaller in size (35–38 mm; see Jeannet, 1951).

The other comparable form, albeit superficially, is the sparsely and more coarsely ribbed *Rollierites minuendum* Jeannet (1951, p. 125, pl. 46, figs 1–4). However, in *R. minuendum*, the inner whorls are strongly tuberculated in coronate style (persisting up to the outer whorls; a feature resembling *Erymnoceras*), the primaries are relatively straighter and less flexuous, and the whorl section is somewhat sub-rounded (see Jeannet 1951, p. 125, text-figs 291–293).

The other species of *Rollierites*, *R. tenue* (Rollier) (see Jeannet, 1951, pl. 47, figs 8, 9) is not just more compressed,

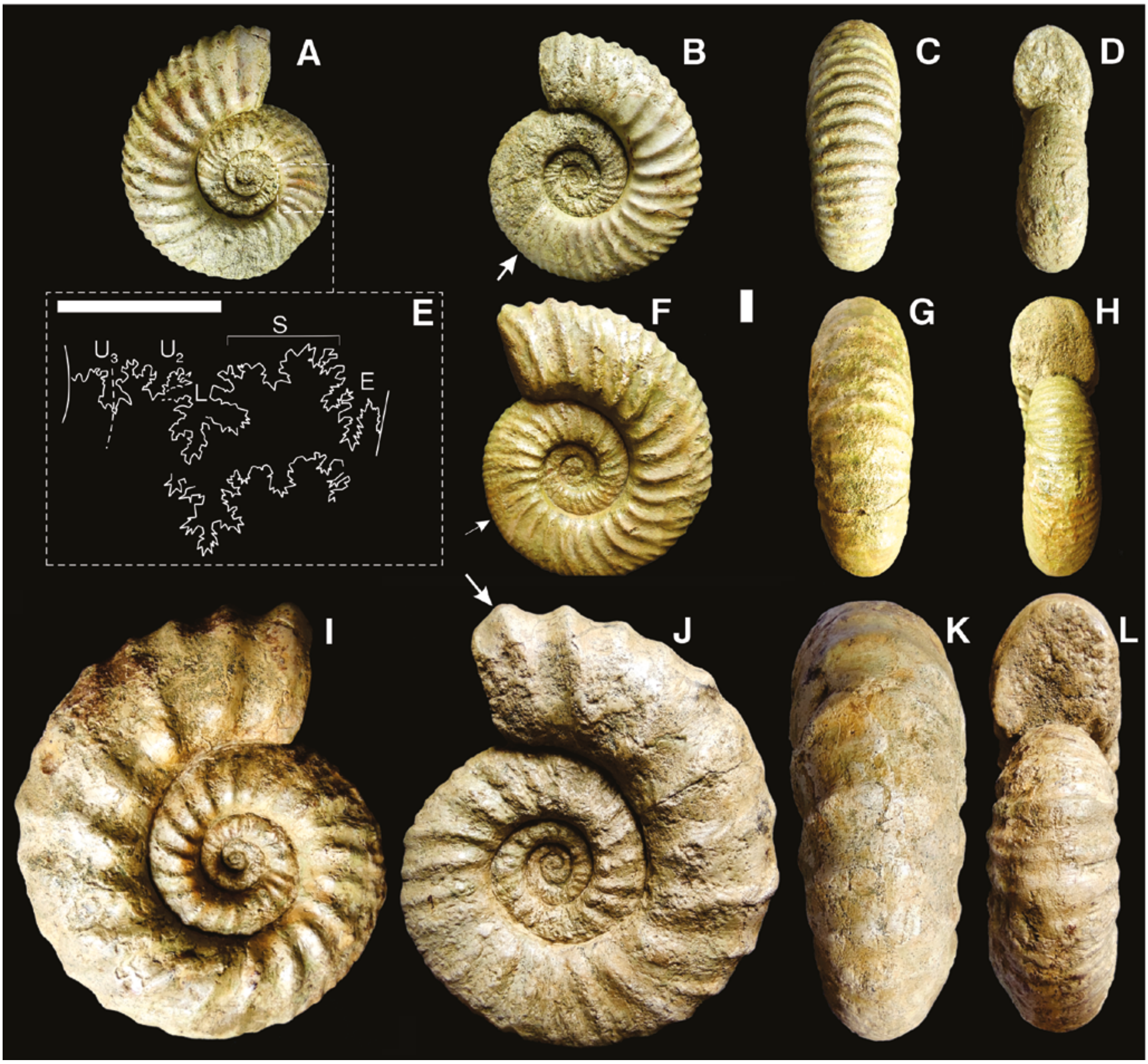

Fig. 3. Dimorphic pair of *Rollierites biplicatum* sp. n. from bed "a" of present work. **A–H.** Microconch. **I–L.** Macroconch (see Fig. 2 for their exact stratigraphic position).

evolute and sparsely ribbed, but the ribbing is also much straighter and more crested with rib trifurcations starting relatively earlier. Imlay's (1970, p. D13, pl. 1, figs 16, 17) poorly preserved specimen of *R.* cf. *tenue* (Rollier) from the Saudi Arabian Dhruma Fm. also has a similar ribbing pattern but has somewhat bullate primaries, as noted in another *Rollierites* species, *R. tuba* (Jeannet, 1951, pl. 47, figs 1, 2). Additionally, both *R. tenue* and *R. tuba* possess shorter and swollen primary ribs with rib bifurcations at the lower third of flank height, besides being much smaller in size.

The present microconch specimens (Fig. 3A–F) also superficially resemble the French early Oxfordian *Tornquistes* gr. *leckenbyi* (Arkell), as illustrated by Courville *et al.*, (2013, p. 59, pl. 17, fig. 2b), in terms of the ribbing pattern (especially the prosocline primary ribs). However, the secondary ribs are bent somewhat backward (proverse) and bifurcate (and rarely trifurcate) at the outer third of flank height. As well, the shell is less evolute with a more gradual opening of the shell (extrumbilication) and the ventrolateral margin is acutely rounded, giving the appearance of a somewhat subtriangular whorl section, rather than oval in the present specimens (Fig. 3D, H; see also Fig. 3L). Another French specimen of *T. leckenbyi* from the early Oxfordian Cordatum Zone of Blieux (southeastern France) as figured by Bert (2009, fig. 7) also superficially resembles the present microconch specimens. However, in the French specimen, the primary ribs are much straighter, rib bifurcation is much lower (at mid-flank height) and the ventrolateral margin is arched, producing a relatively narrow venter.

The present microconch specimens (Fig. 3A–F) also resemble *Tornquistes multicostatum* variety *multicostatum* Charpy (1976, pl. 7, figs 5, 7; re-illustrated by Thierry and Charpy, 1982, p. 636–637, pl. 3, fig. 1 and pl. 13, fig. 1, respectively) in possessing similar prosocline ribs and a compressed shell, but this Moroccan specimen is much larger, considerably less evolute (U/D = 0.19), with rib-bifurcations at mid-flank height and with more numerous tri-furcating ribbings.

Additionally, there are no other comparable forms, even within the Perisphinctoidea (see Énay and Howarth, 2019). Hence, the present dimorphic specimens are assigned to a new species, *Rollierites biplicatum*.

Family Aspidoceratidae Zittel, 1895
Subfamily Peltoceratinae Spath, 1924
Genus Peltoceratoides Spath, 1924

Type species: *Ammonites constantii* d'Orbigny, 1848 in 1842–1851, p. 502, by original designation.

Peltoceratoides (*Parawedekindia*) *gerberi* Prieser, 1937
(m, microconch)
Fig. 5D–F

1898 *Peltoceratoides caprinum* – de Loriol, pl. 7, fig.

1925 *Peltoceratoides torosum* (Oppel) – Buckman, pl. 163.

1937 *Peltoceratoides gerberi* – Prieser, p. 77, pl. 8, fig. 1.

1941 *Peltoceratoides* cf. *gerberi* Prieser – Arkell, p. 166

1977 *Peltoceratoides* (*Parawedekindia*) gr. *gerberi* Prieser – Bourseau, p. 77, pl. 10, figs 4, 11.

1992 *Peltoceratoides gerberi* Prieser – Tchoumatchenco and Khrischev, p. 50.

Description: Shell nearly complete, medium-sized, compressed, non-tuberculate, densely ribbed and evolute. Ornamentation consists of sharp and crested primary ribs that arise from the umbilical seam, straight, or in the outermost whorl, with a backward bend at the rounded, umbilical shoulder. The primary ribs bifurcate at the middle to lower third of flank height into two slightly backwardly bent (proverse) sharp secondaries that cross the tabulate venter straight but with a noticeable thickening. With increasing shell diameter, the rib bifurcation shifts slightly down in the flank height, from the middle to lower third in inner to middle whorls to the lower third in the outer whorls. Rare, single primary ribs cross the venter straight. Umbilical walls are high with a rounded, umbilical shoulder. Shell opening is noticeable as reflected in more exposure of the succeeding whorls. The end of the outermost whorl displays a broad, smooth and flat constriction-like band that may well be a mature shell modification or part of a broken lappet. Maturity is also reflected in the absence of any umbilical seam on the outermost whorl. Suture line not visible.

Remarks: The present specimen is a close match with the early Oxfordian Cordatum Zone *Peltoceratoides* (*Parawedekindia*) *gerberi* as illustrated by Prieser (1937, p. 77, pl. 8, fig. 1a,b) and Bourseau (1977, p. 77, pl. 10, figs 4, 11) both in terms of morphological characteristics (compressed, non-tuberculate, densely ribbed, evolute and the ribbing pattern: bifurcation of sharp and crested primary ribs at middle to lower third of flank height into two slightly backwards bent secondaries) and dimensional proportions.

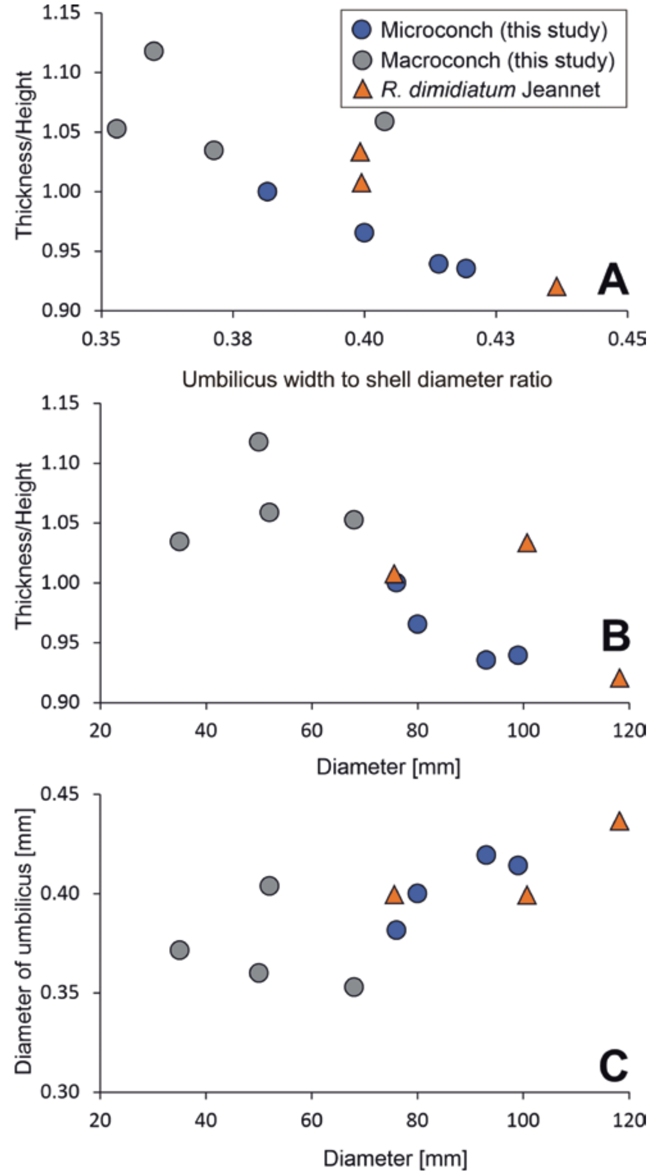

Fig. 4. Comparative dimensional proportions of the present dimorphic pair of *Rollierites biplicatum* sp. n. with *R. dimidiatum* Rollier (as recorded by Jeannet, 1951). Diameter in mm.

The other somewhat comparable form is the late Callovian Lamberti Zone (praelamberti Horizon, Lamberti Subzone) *Peltoceras* (*Rursiceras*) *annulosum* (Quenstedt) as illustrated by Quenstedt (1887, p. 784, pl. 88, figs 21, 22), Prieser (1937, pl. 3, fig. 9, pl. 5, fig. 4), Bonnot and Marchand (1996, pl. 1, figs 1, 2), Bonnot (1995, pl. 1, figs 1–6; pl. 2, figs 1–3) and Kiselev *et al.* (2013, p. 67, pl. 3, figs 8, 9). However, *P.* (*R.*) *annulosum* is less evolute, with a more proverse ribbing and rib bifurcation point relatively lower at mid-flank height.

The present specimen, in its compressed shell, pattern of ribbing, evolute nature and thickened primaries at the venter also resembles the early Oxfordian *Peltoceratoides* (*Parawedekindia*) *arduennensis* (d'Orbigny) (see d'Orbigny

1848, p. 500, pl. 187, figs 4, 5; see also Fischer, 1994, p.164). However, in *P.* (*P.*) *arduennensis*, the ribbing is somewhat flexuous and the primaries bifurcate (and rarely trifurcate) at the lower third of flank height (see also d'Orbigny, 1848, p. 500; pl. 185, figs 4–7; Prieser 1937, pl. 6, fig. 4; Jeannet, 1951, p. 178, pl. 79, fig. 3; Bonnot, 1995 p. 259; pl. 6, figs 4, 5; pl. 7, figs 1–3).

Family Aspidoceratidae Zittel, 1895
Subfamily Euaspidoceratinae Spath, 1931
Genus *Euaspidoceras* Spath, 1930

Type species: *Ammonites perarmatus* Sowerby, 1822, by original designation.

Euaspidoceras sp. (M)
Fig. 5G

Remarks: Shell large (diameter equals 180 mm), compressed, evolute and bi-tuberculate with two rows of lateral tubercles that are connected by a wide, lateral rib. The present specimen closely resembles *Euaspidoceras subbabeanum* (Sintzov) *sensu* Jeannet, as illustrated by Jeannet (1951, p. 204, pl. 93, fig. 4, pl. 94, fig. 2, pl. 95, fig. 2), Bonnot (1995, p. 182, pl. 11, figs 1–10) and Kiselev *et al.* (2013, pl. 2. fig. 33). Owing to the poor preservation of the specimen, only generic level identification is possible.

Family Kosmoceratidae Haug, 1887
Subfamily Kosmoceratinae Haug, 1887
Genus *Kosmoceras* Waagen, 1869

Type species: *Kosmoceras spinosum* (Sowerby, 1826; J.C.Z.N. opinion 303).

Kosmoceras rotundum (Quenstedt, 1856)
Fig. 5A–C

Description: Shell medium sized, evolute, compressed and with part of the body chamber preserved. Phragmocone measures 118 mm. Sharp primaries arise from below the rounded umbilical shoulder with a slight concavity and are then prorsiradiate. Primaries divide at mid-flank height into two slightly backwardly bent secondaries. Rare single intercalatory rib is also present. The point of rib-bifurcation is marked by a tubercle that persists only until 42 mm. Thereafter, the tubercle fades into sharp crested clavi. After 42 mm, the rib-bifurcation a shifts from mid- to the outer third of flank height. Umbilical wall remains high and vertical until 70 mm and thereafter, it becomes slanted and the umbilical shoulder becomes broadly rounded. Venter is flat-topped with somewhat arched ventrolateral margins. At the ventro-lateral edge, the secondaries form sharp crested clavi, thus forming a shallow mid-ventral furrow between the two ventro-lateral clavi. Whorl section is trapezoidal (owing to converging flanks) to somewhat squarish. Shell begins to open (extraumbilication) at 80 mm.

Remarks: The closest comparable form is *Kosmoceras* (*K.*) *rotundum* variety *rotundum* (Quenstedt) as illustrated by Kiselev and Rogov (2018, pl. 3, figs 3, 4). It also shows similar morphological characteristics of a tubercle at the rib-bifurcation in the early whorls and its subsequent disappearance in outer whorls with prorsiradiate primaries and backwardly bent secondaries; however, this form is much more densely ribbed. Recently, Kieslev and Rogov (2018) noted that the earliest species of this group came from the upper part of the Athleta Zone and such late forms were assigned to *K. rotundum* (Quenstedt). Gulyaev *et al*. (2002) recorded its presence in the late Callovian Mojarowskii horizon (Lamberti Subzone, Lamberti Zone).

The present specimen also is very closely comparable to *Kosmoceras* (*K.*) *spinosum* (Sowerby); as illustrated by Gauthier *et al.* (in Fisher, 1994, p. 147, pl. 66, fig. 1) but is somewhat more densely ribbed. The form illustrated by Martill and Hudson (1991, p. 106, pl. 16, figs 4, 5) as *K.* (*K.*) *spinosum* (Sowerby) is also close to the present specimen but is less evolute, lacks tubercles in inner whorls and has a relatively finer ribbing pattern. Kieslev and Rogov (2018) assigned the late forms of *Kosmoceras* from the Lamberti Zone to *K. spinosum*; the type of K. *spinosum* also came from the Lamberti Zone (Arkell, 1939, pl. 11, fig. 1).

DISCUSSION

Dimorphism

Callomon (1963, p. 32), for the middle Callovian pachyceratids, considered *Rollierites* as the microconchiate counterpart of genus *Erymnoceras*, and since then, this has been widely accepted by other workers (Mitta, 1992; Énay and Howarth, 2019). However, recently, Kiselev and Rogov (2018, p. 117, table 6) mentioned the presence of separate micro- and macroconchs for both *Erymnoceras* and *Rollierites* but provided no further details. Here, the present authors document the first, figured example of co-occurring macro- and microconchs in genus *Rollierites*.

Stratigraphic position of *Rollierites biplicatum* sp. n.

In the present study, the lower part (limestones) of bed "a" (i.e., bed β of Głowniak, 2012) yielded *Kosmoceras rotundum* (Quenstedt) whereas the dimorphic pair of *Rollierites biplicatum* sp. n. comes from the upper part, the glauconitic marls (i.e., bed α of Głowniak, 2013; see Fig. 2). It must be noted that late Callovian Athleta Zone forms (various species of *Kosmoceras* along with *Peltoceras* (*Peltoceras*) *trifidum*) have been mentioned (but not described or illustrated) from the lower beds of the Ogrodzieniec Quarry (and below the occurrences of *K. rotundum* and *R. biplicatum*) by various authors (see Różycki, 1953; Głowniak, 2002; Matyja and Głowniak, 2003; Barski *et al.*, 2004; Dembicz *et al.*, 2006; Fig. 2).

The upper part of bed "a", the glauconitic marls, on lithological grounds, is equivalent to bed 16 of Barski *et al.* (2004; = dark green sandy-glauconite marls) and bed 25 of Różycki (1953). None of these authors, in their papers, have illustrated any of the recorded forms mentioned from the Ogrodzieniec Quarry. Różycki (1953) mentioned the presence of *Peltoceras athletoides* (= *Peltoceratoides athletoides*), *Quenstedtoceras lamberti*, *Q. mariae*, *Q. henrici* and *Q. vertumnus*, whereas Barski *et al.* (2004) mentioned the co-occurrence of *Quenstedtoceras lamberti* and *Q. mariae*

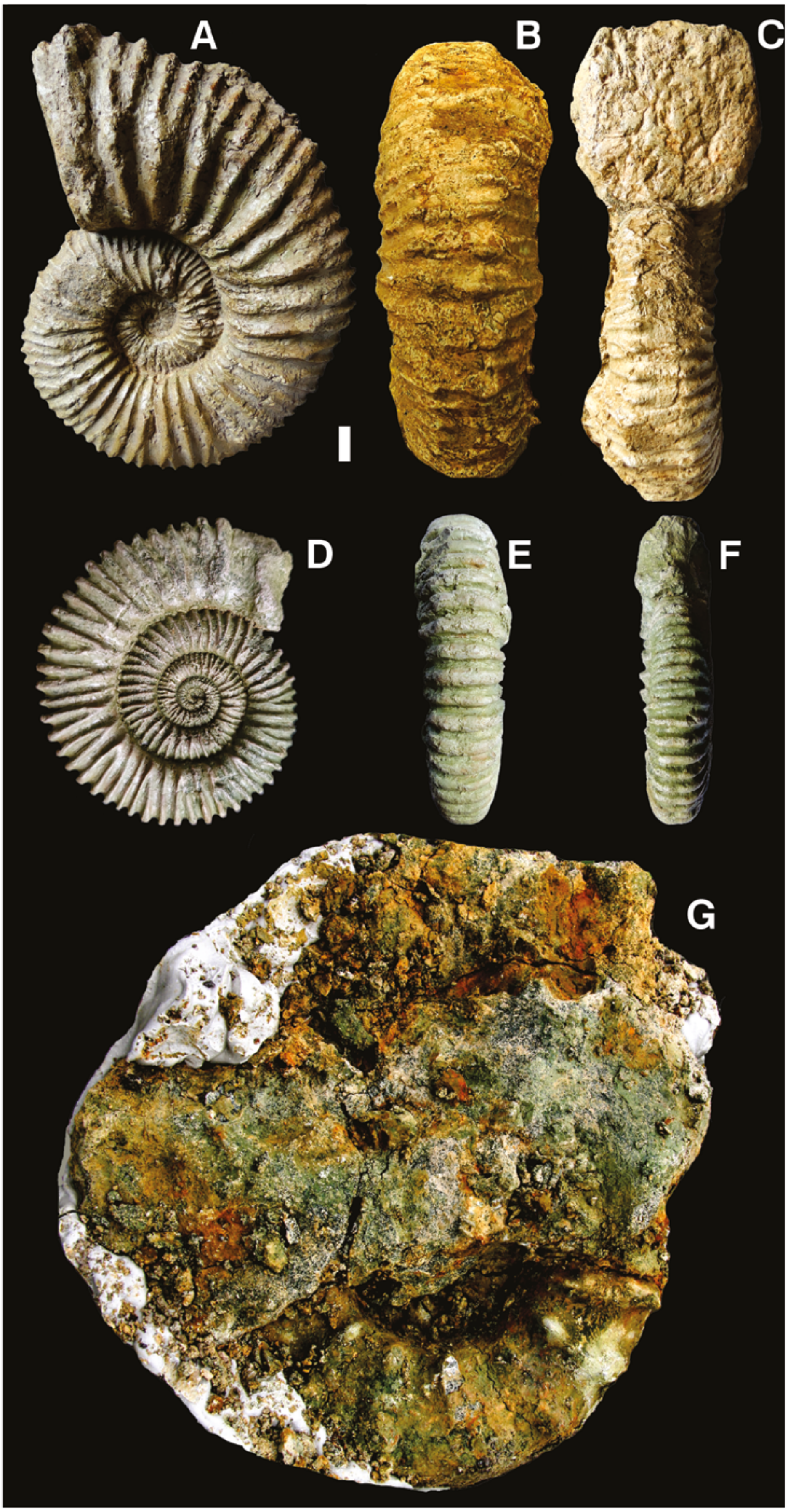

Fig. 5. Assemblage of bed “b” (bed 1a of Głowniak, 2012). **A–C.** *Kosmoceras rotundum* (Quenstedt). **D–F.** *Peltoceratoides* (*Parawedekindia*) *gerberi* Prieser (m). **G.** *Euaspidoceras* sp.

from the upper part of bed "a", i.e., bed α of Głowniak (2012; Fig. 2). It is noteworthy that the distinction between *Q. mariae* and the late Callovian "*Vertumniceras*" without proper illustration, is difficult and can easily be misinterpreted.

On the basis of the present data, the presence of *Kosmoceras rotundum* (= lower part of bed "a"; limestones), a late Callovian Lamberti Zone is assigned (= i.e., bed β of Głowniak, 2012l; Figs 2, 6). The upper part of bed "a" (i.e., bed α of Głowniak, 2012) that yielded *Rollierites biplicatum* sp. n. is also assigned to the late Callovian Lamberti Zone (Figs 2, 6).

The overlying bed "b" that yielded *Peltoceratoides* (*Parawedekindia*) *gerberi* Prieser is assigned an early Oxfordian Bukowskii Subzone, Cordatum Zone (see also Prieser, 1937; Bourseau, 1977; Tchoumatchenco and Khrischev, 1992). This early Oxfordian Bukowskii Subzone assignment to bed "b" also matches with the age inferred by other works (see Różycki 1953; Głowniak 2002; Matyja and Głowniak 2003; Barski *et al.*, 2004; Dembicz *et al.*, 2006). *Euaspidoceras*, the co-occurring species with *P.* (*P.*) *gerberi* is a long ranging form, spanning from the late Callovian Athleta Zone to the late Oxfordian Bimammatum Zone (see Énay and Howarth, 2019; Fig. 6).

Thus, it is clear that a thorough, illustrated record of the ammonite succession at the Ogrodzieniec Quarry is urgently needed to clearly define the late Callovian–early Oxfordian interval. A quarry-based, sedimentological record is also needed to better understand the role and effects of condensation, proposed for this period of time (see Fig. 2). On the basis of the illustrated record presented here, the upper

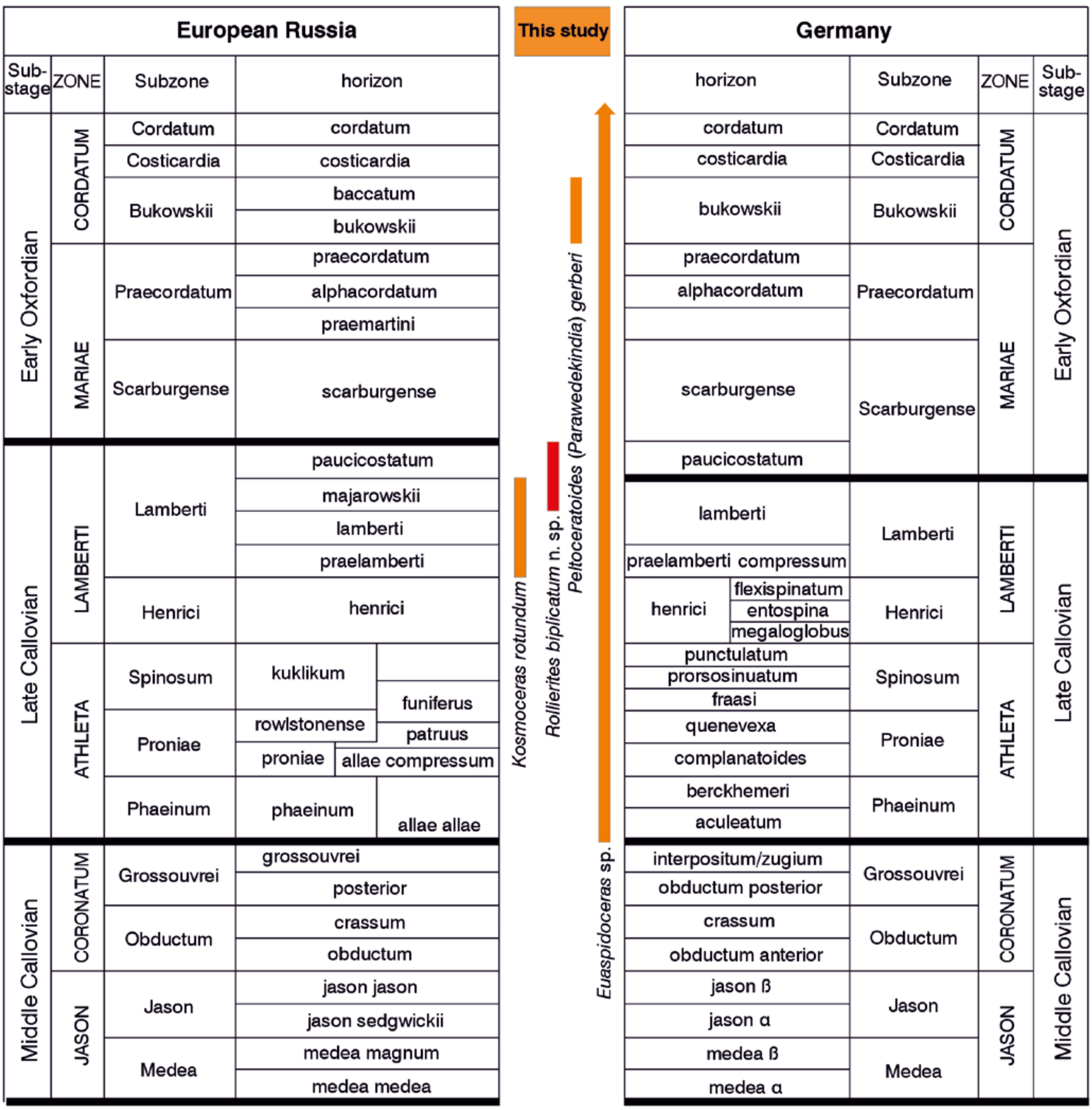

Fig. 6. Biozonation (after Kieslev and Rogov, 2018) and species ranges based on the present study.

part of bed "a" (i.e., bed α of Głowniak, 2012) that yielded *Rollierites biplicatum* sp. n. is assigned to the late Callovian Lamberti Zone (Fig. 2). This late Callovian Lamberti Zone age-assignment to *R. biplicatum* sp. n. would also mean that the stratigraphic gap between *Rollierites* and the closely allied genus *Tornquistes* (see also Fig. 6) is now much narrower as the earliest *Tornquistes* species, *T. greppini* (de Loriol) spans from the Mariae Zone (Praecordatum Subzone) to the Cordatum Zone (Costicardia Subzone). Contextually, it is also interesting to note that the origin of the early–middle Oxfordian *Tornquistes* has been proposed to lie within late Callovian–early Oxfordian genus *Pachyceras* Bayle (see Bert, 2009). But, considering the present data and the fact that *Rollierites* is morphologically closer to *Tornquistes*, perhaps it gave rise to the latter. However, more data are needed to corroborate this.

Morphological plasticity

Recently Bert (2009), while analyzing the morphodiversity (i.e., relative whorl section and rib-index) of the Oxfordian genus *Tornquistes* Lemoine, noted that morphological features that are usually considered to establish species designations (such as thickness of the whorl section, strength and density of ornamentation, and the widening of the umbilicus) are in fact manifestations of the laws of covariation, where the extreme morphologies are interrelated by way of intermediaries.

In this regard, the two closely related species, *R. dimidiatum* and *R. minuendum*, are indeed well-constrained and fall very closely together (Fig. 7A). However, morphologically, *R. dimidiatum* is non-tuberculate, whereas *R. minuendum* is distinctly tuberculated (see Jeannet, 1951). In terms of the

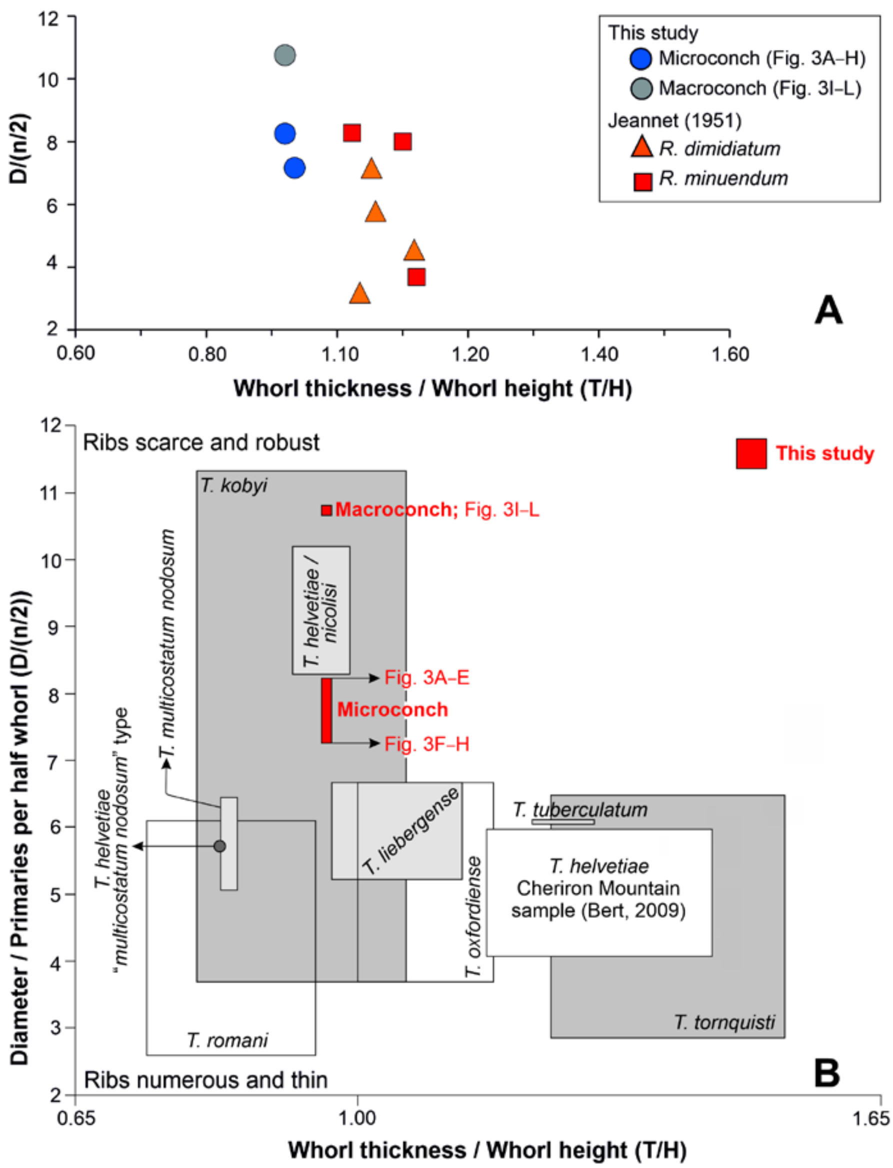

Fig. 7. Morphodiversity (relative whorl section and rib-index) analysis. **A.** *Rollierites* morphodiversity. The relative position of the dimorphic pair of *Rollierites biplicatum* sp. n. and those of *R. dimidiatum* Rollier and *R. minuendum* Rollier (as recorded by Jeannet, 1951). **B.** *Tornquistes* morphodiversity occupied by different species (after Bert, 2009). Bert (2009) considered all named "species" as morphological variants of one single species, *Tornquistes helvetiae* (Tornquist, 1894). Red bars represent the relative position of the dimorphic pair of *Rollierites biplicatum* sp. n. (see Figure 2 for the exact stratigraphic positions of specimens mentioned).

morphodiversity index of Bert (2009), the position of the present specimens with respect to its closely related genus, *Tornquistes*, is equally interesting (Fig. 7B). The present specimens fall close to the *T. helvetiae–T. nicolisi* morphospace and within the broad range of *T. kobyi* (see Fig. 7B). However, *R. biplicatum* sp. n., both in terms of morphological characteristics and dimensional proportions, is distinctly different from both *T. helvetiae–T. nicolisi* and *T. kobyi* (see Charpy, 1976; Bourseau, 1977, 1979; Thierry and Charpy, 1982). Additionally, *T. leckenbyi* (Arkell) is also distinctly different from both *T. helvetiae–T. nicolisi* or *T. kobyi* (see Thierry and Charpy, 1982). However, Bert (2009), following the concept of the laws of covariation of characteristics, considered the morphologically disparate species: *T. nicolisi* (Parona), *T. multicostatum nodosum* Thierry and Charpy, *T. kobyi* (de Loriol), *T. liesbergensis* (de Loriol), *T. tornquisti tuberculatum* Thierry and Charpy, *T. tornquisti* (de Loriol), *T. oxfordiensis* (Tornquist) and *T. romani* (Douvillé) to be morphological variants of one palaeospecies of *Tornquistes helvetiae* (Tornquist); see Figure 7B.

Even though the data on *Rollierites* are scarce, its example does beg the question: should variation in morphological characteristics (= morphological plasticity) such as tuberculate and non–tuberculate species occurring within the same time interval (*R. dimidiatum* and *R. minuendum*), also be considered as a single palaeospecies? Additionally, the present specimens are closely related in morphology to *Tornquistes*, but they certainly do not belong to this genus. Therefore, the question arises: did *Rollierites* gave rise to *Tornquistes* or did the latter evolve from a similar, non-tuberculate *Pachyceras*, a genus that is morphologically more distant than *Rollierites*. More data are needed to explain this ambiguity.

CONCLUSIONS

The Ogrodzieniec Quarry (southern Poland) is the only section in the middle part of the Polish Jura Chain, where Bathonian–Oxfordian rocks are exposed and therefore is considered to be an important site for Callovian–Oxfordian stratigraphical studies.

A new, well-preserved ammonite assemblage is reported from the lower beds of the Ogrodzieniec Quarry. The fauna includes *Kosmoceras rotundum* (Quenstedt) in the lower part of bed "a"; limestones, followed by the dimorphic pair of *Rollierites biplicatum* sp. n. in the glauconitic marls of bed "a" and above it, the association of *Euaspidoceras* sp. and *Peltoceratoides* (*Parawedekindia*) *gerberi* Prieser in bed "b".

Kosmoceras rotundum (Quenstedt) is assigned to the late Callovian Lamberti Zone.

The upper part of bed "a", the glauconitic marls, where *Rollierites biplicatum* sp. n. was recorded, is also assigned to the late Callovian Lamberti Zone.

Bed "b" yielded *Peltoceratoides* (*Parawedekindia*) *gerberi* Prieser, which typifies the early Oxfordian Bukowskii Subzone, Cordatum Zone. It co-occurs with *Euaspidoceras*, which has a long range, spanning from the late Callovian Athleta Zone to the late Oxfordian Bimammatum Zone.The study begs the question – should morphologically disparate groups of species be placed into a single palaeospecies, i.e., should a non-tuberculate species such as Rollierites biplicatum n. sp. and R. dimidiatum be lumped with the distinctly tuberculated R. minuendum; as both fall very closely together within the morphodiversity (i.e., relative whorl section and rib-index) analysis?

On the basis of morphological and stratigraphical considerations, it is tentatively proposed that the origin of the early–middle Oxfordian *Tornquistes* may lie within the middle–late Callovian *Rollierites*, rather than the previously proposed late Callovian–early Oxfordian *Pachyceras*. However, this is just speculation, as the present data set is insufficient.

Some of the species of *Rollierites* have tuberculate inner whorls resembling *Erymnoceras*, whereas others, like the present specimens, are non-tuberculate. More stratigraphically controlled specimens are needed to justify the recognition of *Rollierites* as a subgenus of *Erymnoceras*.

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