

An artificial system of dispersed cordaitalean cuticles from the Upper Silesian Basin (Pennsylvanian, Poland) and its application to dispersed cordaitalean cuticles from the Intrasudetic Basin (Pennsylvanian, Czech Republic)

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Introduction

The taxonomic study of cordaitalean foliage has for long been problematic. From about 150 cordaitalean species mentioned in Jongmans and Dijkstra [1968, 1969], only 32 fossil species have been adequately described from adpressions and eight species from permineralized material in Europe based on morphology alone. Barthel [1962b] revealed that some morphologically defined species have several «cuticular morphotypes» – e.g. from *Cordaitea principalis*. Barthel [1964] also described dispersed cordaitalean cuticles. *In situ* cordaitalean cuticles were described by other authors [Pant, Verma, 1964; Leduc, 1966; Rabitz, 1966]. These authors used the cuticular information as a supplement to morphological descriptions of leaves. Only Liu et al. [1998] from China and subsequently Šimůnek [2007] from the Czech Republic used the cuticular characteristics as the most important features for classifying cordaitalean species. Florjan [1997] studied dispersed cuticles isolated from coals from the Polish part of the Upper Silesian Basin. Many of these cuticles belonged to cordaitaleans. Florjan [1997] did not classify them at that time. The classification of these

cuticles were published later [Šimůnek, Florjan 2013]. Two artificial genera have been erected: *Cordaadaxicutis* Šimůnek et Florjan and *Cordaabaxicutis* Šimůnek et Florjan to accommodate adaxial and abaxial cordaitalean cuticles, respectively. Florjan's collection of dispersed cordaitalean cuticles did not contain cuticles of already known species; therefore they have been described as new species. Only cuticles *Cordaabaxicutis borassifolioides* Šimůnek et Florjan resemble cuticles of *Cordaitea borassifolius* (Sternberg) Unger, however, some differences occur.

By studying the dispersed cuticles from the Czech part of the Intrasudetic Basin, Z.Šimůnek revealed many cordaitalean cuticles. Some of them belonged to already known species from the Upper Silesian Basin, the others could be compared with *in situ* cuticles of *Cordaitea schatzlarensis* Šimůnek et Libertín and *C. odolovensis* Šimůnek. We are describing here new forms from the Intrasudetic Basin *Cordaadaxicutis* sp. A and B and *Cordaabaxicutis* sp. A, and further cuticular fragments remain to be described.

Material and Methods

The coal samples for maceration were taken from the Polish part of the Upper Silesian Basin and from the Czech part of the Intrasudetic Basin. Both Basins are situated near the Czech-Polish boundary (Fig. 1).

The Upper Silesian Basin comprises up to 8,500 m of coal-bearing deposits, ranging in age from late Mississippian to Asturian in age. This succession consists of two parts: the Mississippian «Paralic Series» with evidence of repeated eustatic marine transgressions; and the Pennsylvanian purely conti-

nental «Limnic Series» (Tab. 1, Fig. 1) [Kotas, 1995].

Samples for bulk maceration were taken from two stratigraphical units – the Mudstone Series and Cracow Sandstone Series. More information will be given in the descriptions of the individual species. Altogether 55 permanent slides with more than 100 cordaitalean cuticular fragments from 18 coal mines and two boreholes were studied. From the Intrasudetic Basin, only samples from one coal mine, and

Key words: Cordaitea, dispersed cuticles, Upper Silesian Basin, Intrasudetic Basin, cuticular analysis, Westphalian.

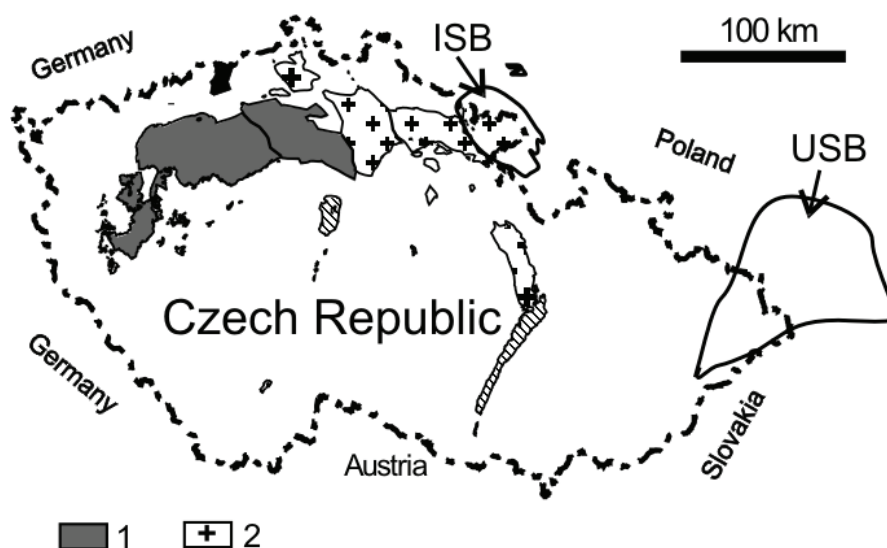


Fig. 1. Map of the Czech Republic with Permo-Carboniferous Basins: 1 – Westerns and Central Bohemian basins; 2 – Sudetic area with Krkonoše Piedmont and Intrasudetic basins; ISB – Intrasudetic Basin; USB – Upper Silesian Basin

samples from the construction of the pit Jan near Žacléř have been studied. These samples come from the Žacléř Formation, which is more than 1000 m thick and represents Langsettian and Duckmantian strata.

The Polish coal samples were crushed into 2–10 mm large fragments. Ten grams of coaly fragments were macerated in 100 ml of 96% fuming nitric acid (HNO_3) for 24 hours. In some cases, when the coalification was high, 120–150 ml of acid was used. After maceration, the remnants were dried in an oven at a temperature of 40°C. The cuticle fragments obtained can be stored under dry conditions or

mounted in glycerine jelly slides. The slides are stored in the Jagiellonian University in Krakow, Poland.

The Czech coal samples were macerated in Schulze's reagent [35 ml of 65% nitric acid (HNO_3) and 1 or 2 g of potassium chlorate (KClO_3)]. The maceration time was 3–5 days. After maceration and washing, the samples were treated in potassium hydroxide (KOH) to release the cuticles from other oxidation remnants. Finally, cuticles were either stored in glycerine and mounted in glycerine jelly slides, or mounted on a stub for observation under a scanning electron microscope.

Table 1

Stratigraphic correlation of the Upper Silesian Basin and the Intrasudetic Basin [Kotas, 1995; Pešek et al. 2001]

Chronostratigraphical units		Upper Silesian Basin			Intrasudetic Basin		
		Lithostratigraphical units		Coal seams	Formation	Member	Group of coal seams
WESTPHALIAN	Asturian	Cracow Sandstone Series	Libiąż Beds	110–119	Odolov	Lower Svatoňovice	
	Bolsovian		Łaziska Beds	201–218 (302)	Žaclěř	Petrovice	Petrovice Závřchy
	Duckmantian	Prkenný Důl-Žďárky				Strážkovice 1–8	
		Langsettian	Mudstone Series	Orzesze Beds		301 (303)–327	Lampertice
	Załęże Beds			328–364 401–406		upper 20–32 lower 1–16	
NAMURIAN	Upper	Upper Silesian Sandstone Series	Ruda Beds	407–420		Gap	
	Middle		Zabrze Beds	501–510			
	Lower	Paralic Series	Jejkowice Beds*				
			Poruba Beds	601–630			
			Jaklovec Beds	701–723			
			Hrušov Beds	801–850			
			Petřkovice Beds	901–920	Blazków		

*Only in the western part of the Upper Silesian Coal Basin

Description

Order Cordaitales (=Cordaitanthales sensu Meyen, 1984)

Adaxial cuticles

Cordaadaxicutis Šimůnek et Florjan, 2013

Type species. *Cordaadaxicutis tectostomatus* Šimůnek et Florjan, 2013.

Diagnosis. Dispersed adaxial cordaite cuticle, cells oblong, parallel oriented. Costal and intercostal fields (bands) not or poorly differentiated. Stomatal complexes formed by two guard cells, two polar subsidiary cells and two lateral subsidiary cells. Stomata isolated or in very short stomatal rows.

Cordaadaxicutis bracteatus Šimůnek et Florjan, 2013

Fig. 2a; Pl. III, figs 1, 2

Cordaadaxicutis bracteatus: Šimůnek, Florjan, 2013, Fig. 2a, pl. 1, figs 1–4.

Description. Cells are oblong, elongate, 40–80 µm long and 12–15 µm wide. Stomatal complexes (80–100 µm long and 40–50 µm wide) are in rare stomatal rows. Guard cells are reniform, polar and lateral subsidiary cells are ±oblong, papillate and the crypt is rounded.

Occurrences. Upper Silesian Basin: Duckmantian: Łaziska Beds – Siersza coal mine locality, coal seam 209 (slide 78) and Orzesze Beds – Bolesław Śmiały coal mine locality (slide 217) ? coal seam 302 (slide 29). Intrasudetic Basin: Duckmantian: Žacléř Formation, Lampertice Member: upper coal seam no. 6. (slides 582/1–19).

Remarks. This cuticle may belong to the bract of a cordaitalean fructification (e.g., *Florinanthus volkmannii* (Ettingshausen) Šimůnek et al.) that has similar cuticular features [Šimůnek et al., 2009]. The term «Florin ring» was first used by Buchholz and Gray [1948] for circular thickenings above the guard cells in younger conifers.

Cordaadaxicutis carpaticus Šimůnek et Florjan, 2013

Fig. 2b; Pl. III, fig. 3

Cordaites sp. type E: Florjan, Žoldani, 1999, pl. 1, fig. 6.

Cordaadaxicutis carpaticus: Šimůnek, Florjan, 2013, Fig. 2b, pl. 1, fig. 5.

Description. Cells are oblong, elongate, 40–120 µm long and 10–22 µm wide. Stomatal complexes (30–35 µm long and 23–28 µm wide) are isolated. Polar subsidiary cells are small, triangular, lateral subsidiary cells are small and reniform. Crypt is small, square or oblong. Adjoining stomatal cells are papillate.

Occurrences. Upper Silesian Basin: Duckmantian/Bolsovian: Łaziska Member – Siersza coal mine, coal seam 209.

Cordaadaxicutis zoldanii Šimůnek et Florjan, 2013

Fig. 2c; Pl. III, figs 4, 5

? *Cordaites* sp. type D: Florjan, Žoldani, 1999, pl. 1, figs 4, 5.

Cordaadaxicutis zoldanii: Šimůnek, Florjan, 2013, Fig. 2c, pl. 1, figs 6–7.

Description. Cells are oblong, elongate, with central ridge on periclinal walls, 60–150 µm long and 7–17 µm wide. Stomatal complexes are isolated 80–120 µm long and 40–45 µm wide. Guard cells are reniform, polar subsidiary cells are oval to oblong and lateral subsidiary cells are ±oblong. Crypt is oval, oriented longitudinally. Papillae are present on polar cells and their adjoining cells.

Occurrences. Upper Silesian Basin: Duckmantian/Bolsovian: Łaziska Member – Siersza coal mine, coal seam 209. Intrasudetic Basin: Duckmantian: Žacléř Formation, Lampertice Member: upper coal seam no. 6. (slides 582/1–19).

Cordaadaxicutis papillostomatus Šimůnek et Florjan, 2013

Fig. 2d; Pl. III, fig. 7

Cordaadaxicutis papillostomatus: Šimůnek, Florjan, 2013, Fig. 2d, pl. 2, fig. 1.

Description. Cells are oblong, 35–90 µm long and 10–17 µm wide. Stomatal complexes are isolated, 80–90 µm long and 40–45 µm wide. Polar subsidiary cells are oval, papillate; lateral subsidiary cells are oblong or trapezoidal. Crypt is small, oriented transversely. Large papillae occur near the stomata.

Occurrences. Upper Silesian Basin: Duckmantian: Łaziska Beds, Czechtal coal mine, coal seam 216.

Cordaadaxicutis tectostomatus Šimůnek et Florjan, 2013

Fig. 2e; Pl. III, fig. 6

Cordaadaxicutis tectostomatus: Šimůnek et Florjan, 2013, Fig. 2e, pl. 1, fig. 8–9.

Description. Cells are oblong, 35–70 µm long and 12–22 µm wide. Stomatal complexes are isolated, The whole stomatal complex is about 70 µm long and 65 µm wide. Polar subsidiary cells are rounded, lateral subsidiary cells broad, reniform or semicircular. The crypt is square.

Occurrences. Upper Silesian Basin: Duckmantian: Łaziska Beds – Jaworzno, coal seam 302.

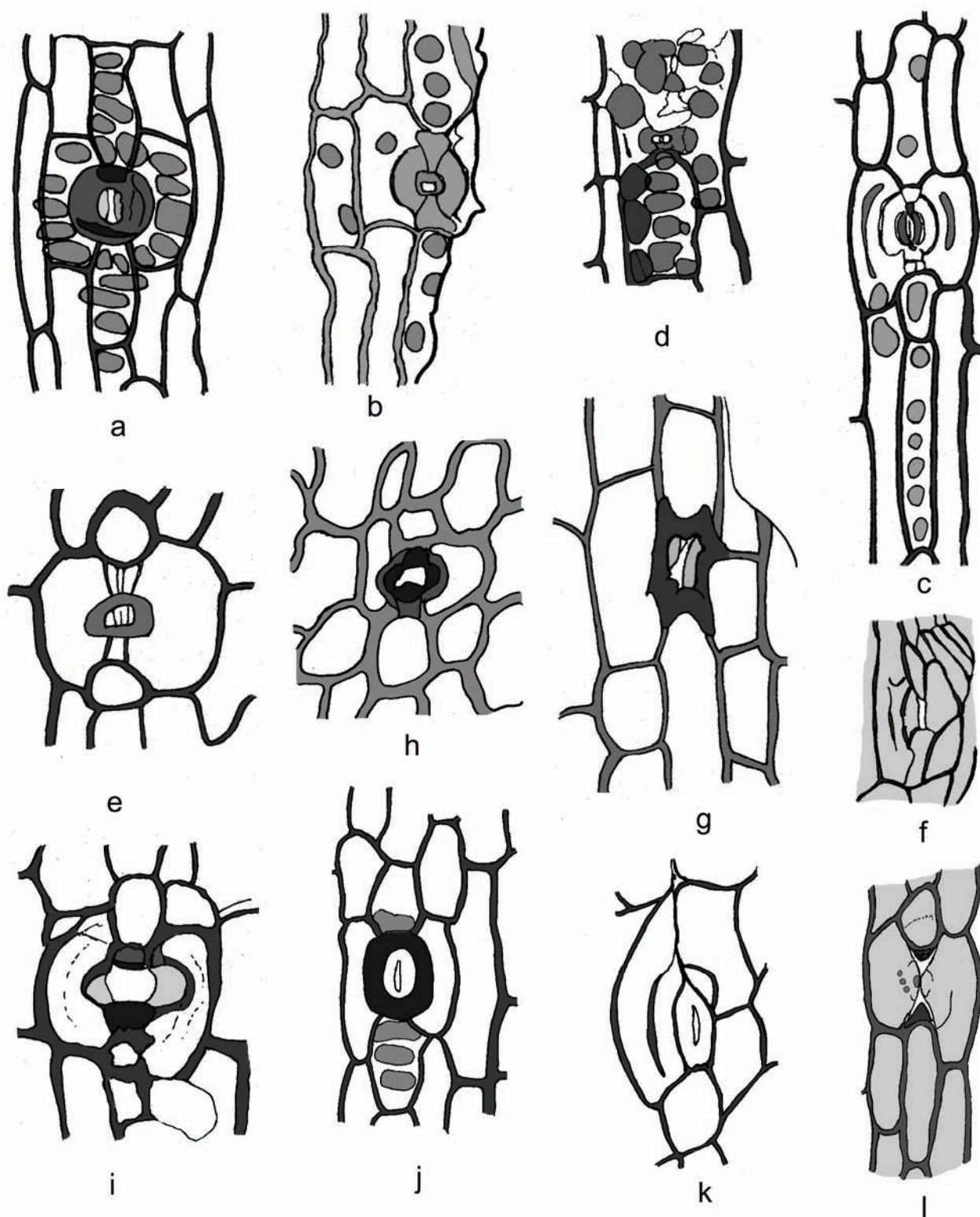


Fig. 2. *Cordaadaxicutis*, drawings of the stomatal complexes ($\times 500$): a – *C. bracteatus*, slide 217; b – *C. carpaticus*, slide 71; c – *C. zoldanii*, slide 72; d – *C. papillostomatus*, slide 360; e – *C. tectostomatus*, slide 144; f – *C. pusillostomatus*, slide 70; g – *C. zalezensis*, slide 401; h – *C. krajewskae*, slide 344; i – *C. janinae*, slide 124; j – *C. sp. A.*, slide 581/2; k – *C. sp. B.*, slide 583/15; l – *Cordaites odolovensis* (adaxial cuticle), slide 581/3

***Cordaadaxicutis pusillostomatus* Šimůnek
et Florjan, 2013**

Fig. 2f; Pl. III, fig. 8

Cordaadaxicutis pusillostomatus: Šimůnek et Florjan, 2013, Fig. 2f, pl. 2, fig. 4.

Description. Cells are oblong, 20–65 µm long and 7–15 µm wide, with a longitudinal ridge in the middle of the periclinal wall. Stomatal complexes (28–30 µm long and about 20 µm wide) are either isolated, or in short rows. Polar subsidiary cells are small and square, lateral subsidiary cells are small and ±oblong. Crypt is absent.

Occurrences. Upper Silesian Basin: Duckmantian/Bolsovian: Łaziska Beds – Siersza coal mine, coal seam 209.

***Cordaadaxicutis zalezensis* Šimůnek
et Florjan, 2013**

Fig. 2g; Pl. III, fig. 9

Cordaadaxicutis zalezensis: Šimůnek, Florjan, 2013, Fig. 2g, pl. 2, fig. 2, 3.

Description. Cells are oblong, 25–70 µm long and 10–28 µm wide with lengthways ridges on the periclinal walls. Stomatal complexes (about 105 µm long and 60 µm wide) are isolated, polar subsidiary cells are oblong. Up to four lateral subsidiary cells are small and ±oblong; crypt is irregular, strongly cutinized.

Occurrences. Upper Silesian Basin: Langsettian: Zálezle Beds – Makoszowy, coal seam 402.

***Cordaadaxicutis krajewskae* Šimůnek
et Florjan, 2013**

Fig. 2h; Pl. IV, figs 1, 2

Cordaadaxicutis krajewskae: Šimůnek, Florjan, 2013, Fig. 2h, pl. 2, fig. 5, 6.

Description. Cells are oblong, oval, 25–50 µm long and of variable (7–25 µm) width. Stomatal complexes are about 50 µm long and 60 µm wide and isolated. Polar subsidiary cells are small and square and lateral subsidiary cells are trapezoidal. Crypt is square with rounded corners.

Occurrences. Upper Silesian Basin: Duckmantian: Łaziska Beds – Siersza coal mine, coal seam 301. Intrasudetic Basin: Duckmantian: Żaclęř Formation, Lampertice Member: Żaclęř, Jan pit, upper coal seam no. 6. (slide 582/1–19).

***Cordaadaxicutis janinae* Šimůnek et Florjan, 2013**

Fig. 2i, Pl. IV, fig. 3

Cordaadaxicutis janinae: Šimůnek et Florjan, 2013, Fig. 2i, pl. 3, fig. 1–3.

Description. Cells are oblong, 24–80 µm long and 10–20 µm wide. Stomatal complexes (about 64

µm long and 50–60 µm wide) are isolated, polar subsidiary cells are oblong to square, lateral subsidiary cells reniform, wide. Crypt strongly cutinized, transverse.

Occurrences. Upper Silesian Basin: Asturian: Libiąż Member – Janina coal mine, coal seam 117.

***Cordaadaxicutis* sp. A**

Fig. 2j; Pl. IV, figs 4, 5

Description. Cells are oblong, 40–100 µm long and 15–25 µm wide. Stomatal complexes (90–110 µm long and 40–60 µm wide) are arranged in rare stomatal rows, polar subsidiary cells oblong to square, lateral subsidiary cells reniform, relatively narrow, crypt is rounded, strongly cutinized. Numerous small papillae occur on polar subsidiary cells.

Occurrences. Intrasudetic Basin: Duckmantian: Odolov, Ida Gallery, stoup 3/507, Żaclęř Formation, Prkenný Důl-Žďárky Member, Strážkovice coal seam no. 3. (slides 581/1–13).

Remark. It was proved that *Cordaadaxicutis* sp. A is an adaxial cuticle of *Cordaabaxicutis sierzsae* (Fig. 3d; Pl. VI, figs 6, 7).

***Cordaadaxicutis* sp. B**

Fig. 2k; Pl. IV, figs 6, 7

Description. Cells are oblong, 30–90 µm long and 15–30 µm wide. Stomatal complexes (80–100 µm long and 50–60 µm wide) are arranged in rare stomatal rows, polar subsidiary cells are small ±square. Lateral subsidiary cells are oblong to reniform, bent along the guard cells, crypt is weakly developed or absent.

Occurrences. Intrasudetic Basin: Langsettian: Żaclęř, Jan pit, Żaclęř Formation, Lampertice Member, lower coal seam no. 14. (slides 583/1–30).

Supplement 1

Adaxial cuticle

of *Cordaites odolovensis* Šimůnek, 2007

Fig. 2l; Pl. IV, figs 8, 9

cf. *Cordaites* sp. typ 4 (adaxial cuticle): Barthel, 1962b, p. 38, Fig. 1, Pl. 7, figs 3–5.

Cordaites odolovensis: Šimůnek, 2007, p. 130, 131, text-fig. 28b, pl. 23, figs 2, 3 (adaxial cuticle).

Description. Adaxial cuticle: The cells are oblong 32–60 µm long and 15–22 µm wide, the stomatal complexes are irregularly arranged. They consist of a pair of elliptical, strongly sunken guard cells, two oval polar and two elongate oblong to oval lateral subsidiary cells that are usually more cutinized and more prominent. The stomatal complex is about 90 µm long and 40 µm wide. Crypt is not developed.

Table 2

 Stomatal densities and stomatal indices of studied species *Cordaadaxicutis*, *Cordaabaxicutis* and *Cordaites*

Adaxial cuticles	Stomatal density	Stomatal index	Abaxial cuticles	Stomatal density	Stomatal index
<i>Cordaadaxicutis</i>			<i>Cordaabaxicutis</i>		
<i>C. bracteatus</i> (U)	25	1.8	<i>C. jaworznoensis</i> (U)	403–418	19–22–
<i>C. bracteatus</i> (I)	6.3	0.8	<i>C. laziskae</i> (U)	476	20.8
<i>C. carpaticus</i> (U)	11	0.7–0.8	<i>C. laziskae</i> (I)	307	15.9
<i>C. zoldanii</i> (U)	23	2.1	<i>C. brzyskii</i> (U)	628	20.3
<i>C. zoldanii</i> (I)	7.2	0.66	<i>C. brzyskii</i> (I)	833	27.3
<i>C. papillostomatus</i> (U)	25	?1–2	<i>C. sierszae</i> (U)	181	15–17
<i>C. tectostomatus</i> (U)	3.5	0.3	<i>C. sierszae</i> (I)	254	14.5
<i>C. pusillostomatus</i> (U)	42	2	<i>C. gorae</i> (U)	224	13
<i>C. zalezensis</i> (U)	7	0.8	<i>C. boleslawii</i> (U)	209	13
<i>C. krajevskae</i> (U)	4	0.5	<i>C. czeczottensis</i> (U)	361–575	15–16
<i>C. krajevskae</i> (I)	10	2	<i>C. borassifolioides</i> (U)	400–500	18
<i>C. janinae</i> (U)	7	0.5	<i>C. papilloborassifolius</i> (U)	600–770	17.5
<i>C. sp. A</i> (I)	34.4	3	<i>C. papilloborassifolius</i> (I)	391	20.1
<i>C. sp. B</i> (I)	14.5	1.3	<i>C. sp. A</i> (I)	76	6.2
<i>Cordaites</i> (adaxial)			<i>Cordaites</i> (abaxial)		
<i>C. odolovensis</i> (I)	14 (44)	1.8–2.2 (3.4)	<i>C. schatzlarensis</i> (I)	270–320	11–15
			<i>C. neimengensis</i> (I)	163 (523*)	10.2 (22.2*)

U – Upper Silesian Basin; I – Intrasudetic Basin

*Stomatal index and stomatal density in the stomatiferous band

Comments: There is no wonder that stomatal densities and stomatal indices of adaxial cuticles differ in the same species from both basins. The stomata are usually irregularly dispersed on the adaxial cuticle, and in some parts stomata nearly absent and in other parts stomata are more common. This feature is not known from the abaxial cuticles, however, leaves have some extent of variability and differences in measurements of the same species from the Upper Silesian Basin and the Intrasudetic Basin can be explained within this variability and also lack of measurement that could express the values by an interval.

Occurrences. Intrasudetic Basin: Duckmantian: Odolov, Ida Gallery, Prkenný Důl-Žďárky Member, Strážkovice coal seam no. 3 (dispersed and *in situ* cuticles).

Comparison of species *Cordaadaxicutis* Šimůnek et Florjan and adaxial cuticles of *Cordaites* Unger

The genus *Cordaadaxicutis* Šimůnek et Florjan was erected for adaxial *Cordaites* cuticles with stomata that usually occur very rarely and isolated. Nine *Cordaadaxicutis* species were distinguished in the Polish material (Tab. 2). Four species (*C. bracteatus*, *C. carpaticus*, *C. zoldanii* and *C. papillostomatus*) have papillae, at least in the vicinity of stomata or on the subsidiary cells. The remaining species are without papillae, but a crypt is usually well developed except in *C. pusillostomatus*. Several of these species were documented also in the Czech part of the Intrasudetic Basin: *Cordaadaxicutis bracteatus*, *C. carpaticus* and *C. krajevskae*. Except these forms, three other types of dispersed cordai-

tean adaxial cuticles have been described: *Cordaadaxicutis* sp. A, *Cordaadaxicutis* sp. B. and *Cordaites odolovensis*. *Cordaadaxicutis* sp. A is characterized by a rounded, strongly cutinized crypt. *Cordaadaxicutis* sp. B has elongate guard cells with narrow reniform guard cells. The adaxial cuticle of *Cordaites odolovensis* is characterised by two papillae that grow from the lateral subsidiary cells and narrow the stomatal pore from the lateral side.

Abaxial cuticles

Cordaabaxicutis Šimůnek et Florjan, 2013

Type species. *Cordaabaxicutis jaworznoensis* Šimůnek et Florjan, 2013.

Diagnosis. Dispersed abaxial cordaite cuticle, cells oblong, parallel oriented. Costal and intercostal fields (bands) differentiated. Stomatal complexes formed by two guard cells, two polar subsidiary cells and two lateral subsidiary cells. Stomata are arranged in stomatal rows or in stomatiferous bands.

***Cordaabaxicutis jaworznoensis* Šimůnek
et Florjan, 2013**

Fig. 3a; Pl. V, fig. 1

Cordaabaxicutis jaworznoensis: Šimůnek, Florjan, 2013, Fig. 3a, pl. 4, figs 1–4.

Description. Stomata are arranged in single or double rows. Cells are oblong, 25–80 µm long and 8–14 µm wide, with a row of papillae. Guard cells are reniform, sunken. Polar subsidiary cells are small and rounded and lateral subsidiary cells are more or less oblong, the crypt is elliptical, oval, strongly cutinized, formed by fused papillae. The stomatal complex is 48–68 µm long and 31–46 µm wide.

Occurrences. Upper Silesian Basin: Duckmantian: Łaziska Beds – Jaworzno, coal seam 302.

***Cordaabaxicutis laziskae* Šimůnek
et Florjan, 2013**

Fig. 3b; Pl. V, figs 2, 3

Cordaabaxicutis laziskae: Šimůnek, Florjan, 2013, Fig. 3b, pl. 4, figs 5–7.

Description. Stomata are in one to three, occasionally five, rows. Ordinary cells are oblong 40–75 µm long and 11–17 µm wide, with one or two rows of small papillae. Guard cells are reniform, sunken, polar subsidiary cells small, rounded, irregular, or trapezoidal and lateral subsidiary cells are more or less reniform. The Upper Silesian samples are strongly papillate with rounded crypt, strongly cutinized; the Intrasedimentary samples are virtually non-papillate and the crypt is less cutinized. The stomatal complex is 60–70 µm long and 40–50 µm wide.

Occurrences. Upper Silesian Basin: Duckmantian/Bolsovian: Łaziska Beds – Siersza coal mine, coal seam 209. Intrasedimentary Basin: Duckmantian: Żaclę Formation, Lampertice Member, upper coal seam no. 6. Żaclę, Jan pit (slides 582/1–19).

***Cordaabaxicutis brzykii* Šimůnek et Florjan, 2013**

Fig. 3c; Pl. V, figs 4, 5

Cordaabaxicutis brzykii: Šimůnek, Florjan, 2013, Fig. 3c, pl. 5, figs 1–5.

Description. Stomata are in stomatiferous bands formed by up to five rows separated by a row of ordinary cells. Ordinary cells are oblong, 65–135 µm long and 10–15 µm wide, with a row of large papillae. Anticlinal walls are slightly undulated. Polar subsidiary cells are rhomboidal. An oblong, elongate lateral subsidiary cell can be common to two or more stomata. Crypt strongly cutinized, transverse. The stomatal complex is 32–43 µm wide.

Occurrences. Upper Silesian Basin: Duckmantian/Bolsovian: Łaziska Member – Siersza coal mine, coal seam 209. Intrasedimentary Basin: Duck-

mantian: Żaclę Formation, Lampertice Member: upper coal seam no. 6. (slides 582/1–19).

***Cordaabaxicutis sierszae* Šimůnek
et Florjan, 2013**

Fig. 3d; Pl. V, fig. 6, 7

Cordaabaxicutis sierszae: Šimůnek, Florjan, 2013, Fig. 3d, pl. 5, figs 6, 7.

Description. Stomata are arranged in single rows, but they can form stomatiferous bands consisting of up to 3 stomatal rows. Ordinary cells are oblong, 40–80 µm long and 10–20 µm wide. The guard cells are reniform, sunken. The polar subsidiary cells are small, oblong to rounded, lateral subsidiary cells are narrow ±reniform, crypt is oval, strongly cutinized, lengthways oriented. The stomatal complex is 42–60 µm long and 35–55 µm wide. Anticlinal cell walls are strongly and sometimes irregularly cutinized.

Occurrences. Upper Silesian Basin: Duckmantian/Bolsovian: Łaziska Beds – Siersza coal mine, coal seam 209. Intrasedimentary Basin: Duckmantian: Żaclę Formation, Lampertice Member, Prkenný Důl-Žďárky Member, Strážkovice coal seam no. 3, Odolov, stope 3/507 (slides 581/1–13).

Remark. It was proved that these cuticles from the Intrasedimentary Basin belong to adaxial cuticle *Cor-daadaxicutis* sp. A described herein.

***Cordaabaxicutis gorae* Šimůnek et Florjan, 2013**

Fig. 3e; Pl. V, fig. 8

Cordaabaxicutis gorae: Šimůnek, Florjan, 2013, Fig. 3e, pl. 6, figs 1, 2.

Description. Stomata are in single stomatal rows. Ordinary cells are oblong or elongated hexagonal, 50–80 µm long and 13–18 µm wide. Polar subsidiary cells are triangular to rhomboidal, lateral subsidiary cells are trapezoidal, or more or less reniform. Crypt is not developed. The stomatal complex is 48–68 µm long and 45–50 µm wide.

Occurrences. Upper Silesian Basin: Duckmantian: Góra, Orzesze Beds – borehole IG 29.

***Cordaabaxicutis boleslawii* Šimůnek
et Florjan, 2013**

Fig. 3f; Pl. V, fig. 9

Cordaabaxicutis boleslawii: Šimůnek, Florjan, 2013, Fig. 3f, pl. 5, figs 3–6.

Description. Stomata occur in rows. Ordinary cells are elongated oblong, 35–60 µm long and 8–14 µm wide. Guard cells are sunken, reniform with sharp polar ends. Polar subsidiary cells are small, rounded or oval, lateral subsidiary cells are oblong or trapezoidal and the crypt is not developed. The stomatal complex is 40–50 µm long and 45–55 µm wide.

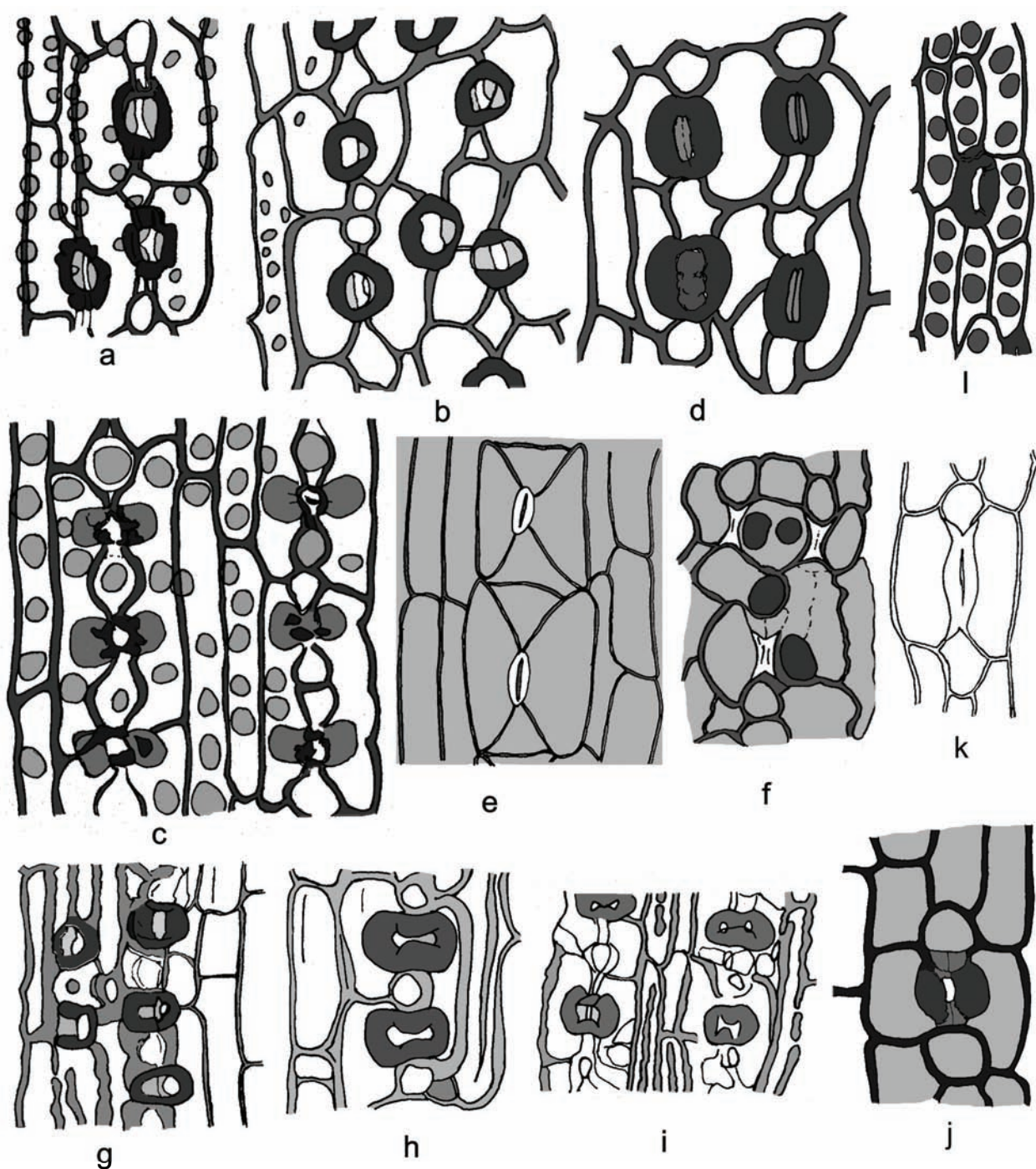


Fig. 3. *Cordaabaxicutis*, drawings of the stomatal complexes ($\times 500$): a – *C. jaworznoensis*, slide 148; b – *C. laziska*, slide 65; c – *C. brzykii*, slide 84(a–d); d – *C. sierszae*, slide 84(e–f); e – *C. gorae*, slide W77; f – *C. bolestawii*, slide 223; g – *C. czeczottensis*, slide 66; h – *C. borassifolioides*, slide 73; i – *C. papilloborassifolius*, slide 259; j – *C. sp. A*, slide 581/6; k – *Cordaites schatzlarensis*, slide 583/4; l – *Cordaites cf. nemeigensis*, slide 581/3

Occurrences. Upper Silesian Basin: Duckmantian: Orzesze Beds – Bolesław Śmiały coal mine, coal seam 310 (slides 223, 228, 230 and 235).

***Cordaabaxicutis czeczottensis* Šimůnek
et Florjan 2013**

Fig. 3g; Pl. VI, fig. 1

Cordaabaxicutis czeczottensis: Šimůnek, Florjan, 2013, Figs 3g, h, pl. 6, figs 7–9, pl. 7, figs 1–6.

Description. Stomata are arranged in rows. The ordinary cells are narrow, oblong, elongated, 60–100 µm long and 8–12 µm wide. The guard cells are reniform and sunken. The polar subsidiary cells are small and narrow, and the crypt is strongly cutinized, square (oblong) and transverse. Papillae are arranged in rows on periclinal cell walls and can be joined into ridges. The stomatal complex is 50–80 µm long and 30–40 µm wide.

Occurrences. Upper Silesian Basin: Duckmantian and Duckmantian/Bolsovian: Łaziska Beds Czeczott coal mine, coal seam 216 (slides 361, 362); Siersza, coal seam 209 (slide 66).

***Cordaabaxicutis borassifolioides* Šimůnek
et Florjan, 2013**

Fig. 3h; Pl. VI, fig. 2

Cordaabaxicutis borassifolioides: Šimůnek, Florjan, Fig. 3i, pl. 7, figs 7–10, pl. 8, figs 1–6.

Description. Stomata are arranged in single or double rows. Ordinary cells are oblong, elongate, 40–70 µm long and 10–15 µm wide. The guard cells are reniform, sunken, the polar subsidiary cells small, rounded and the lateral subsidiary cells are wide and reniform. The crypt is transverse, strongly cutinized, with two papillae on the polar areas. Epidermal papillae are only on stomatal complexes that are 40–50 µm long and 32–40 µm wide.

Occurrences. Upper Silesian Basin: Duckmantian and Duckmantian/Bolsovian: Łaziska Beds – Siersza coal mine, coal seams 209 and 301. Intrasudetic Basin: Langsettian: Žaclěř Formation, Lampertice Member, upper coal seam no. 30 (slides 593/1–14).

***Cordaabaxicutis papilloborassifolius* Šimůnek
et Florjan, 2013**

Fig. 3i; Pl. VI, figs 3–5

? *Cordaites* sp. typ 6: Barthel, 1964, p. 62–63, Fig. 1, pl. 6, figs. 1–7.

Cordaabaxicutis papilloborassifolius: Šimůnek, Florjan, 2013, Figs 3j–n, pl. 8, figs 6–9, pl. 9.

Description. Stomata are in rows. Ordinary cells are oblong or wide oblong, papillate, 25–70 µm long and 10–15 µm wide. The guard cells are reniform

and sunken; the polar subsidiary cells are small, rounded and the lateral subsidiary cells wide, reniform; the crypt is transverse, with two papillae in the polar areas. The stomatal complex is 30–38 µm long and 32–40 µm wide.

Occurrences. Upper Silesian Basin: Duckmantian and Duckmantian/Bolsovian: Łaziska Beds – Siersza coal mine, coal seam 209 (slides 67, 68, 69, 73), coal seam 301 (slide 345). Intrasudetic Basin: Langsettian and Duckmantian: Žaclěř Formation, Lampertice Member, upper coal seam no. 30 and 13 (slides 593/1–14 and 541/1–4).

***Cordaabaxicutis* sp. A**

Fig. 3j; Pl. VI, figs 6, 7

Description. Stomata are arranged in single stomatal rows. Ordinary cells are ±oblong, sometimes with rounded corner, 40–80 µm long and 12–20 µm wide. The guard cells are reniform, sunken. The polar subsidiary cells are square to oblong with strongly bent walls, lateral subsidiary cells are irregularly tetragonal, crypt is oval, strongly cutinized, lengthways oriented, sometimes narrowed in the middle. The stomatal complexes are 80–130 µm long and 45–60 µm wide. Stomatal rows are darker than non-stomatal rows; subsidiary cells bear small, but prominent papillae. Two lengthways furrows or ridges are visible on ordinary cells.

Occurrences. Intrasudetic Basin: Duckmantian: Odolov, Ida Gallery, Prkenný Důl-Žďárky Member, Strážkovice group of coals, coal seam no. 3 (slides 581/1–13).

Remark. This cuticle has very low stomatal density and very low stomatal index (Tab. 2), therefore cannot be expelled that it is adaxial cuticle in the reality.

Suplement 2

Abaxial cuticle of *Cordaites* Unger

***Cordaites schatzlarensis* Šimůnek
et Libertín, 2006**

Fig. 3k; Pl. VII, figs 1–3

Cordaites schatzlarensis: Šimůnek, Libertín, 2006, p. 47–55, Fig. 4, pls 1–3, pl. 4, figs 1–2.

Cordaites schatzlarensis: Šimůnek, 2007, p. 119–120, Fig. 19, pl. 12, pl. 13, fig. 1.

Cordaites schatzlarensis: Šimůnek, Tenchov, 2011, p. 46–50, figs. 7–9.

Description. The leaves are large, narrow, of lanceolate shape, 250–700 mm long and 15–70 mm wide (Pl. VII, fig. 1). Venation is parallel; vein density varies from 18 to 36 veins per 1 cm. Usually one to three thin veins occur between two thick veins. The thick veins are not very prominent and the thin veins are often discontinuous.

Adaxial cuticle is formed from elongated oblong cells with very rare dispersed stomata, or stomata in very short incomplete stomatal rows [Šimůnek, Libertín, 2006].

Abaxial cuticle (Pl. VII, figs 2, 3) is formed by costal non-stomatiferous bands with elongated oblong (to pentagonal) cells, 32–60 µm long and 15–22 µm wide, and intercostal stomatiferous band formed by single or double stomatal rows. The stomatal complex is haplocheilic, 50–62 µm long to reniform and 40–45 µm wide, and consists of two small, circular polar subsidiary cells, two oblong lateral subsidiary cells and a pair of sunken guard cells with swallow-tail extensions of their polar ends.

Occurrences. Intrasedimentary Basin: Langsettian and Duckmantian: Žacléř Formation, Žacléř, Jan pit, Lampertice Member, coal seams: lower no. 14, upper nos 30, 13 and 6, Rtyň v Podkrkonoší and Odolov, Ida Gallery, Prkenný Důl-Žďárky Member, Strážkovice coal seams, coal no. 3 (Duckmantian) (slides 541/1-4, 581/1-13, 582/1-19, 583/1-30 and 593/1-14).

Cordaitea cf. *neimengensis* Liu, Geng, Wang et Li, 1998

Fig. 3l; Pl. VII, figs 4, 5

cf. *Cordaitea* sp. typ 2: Barthel 1962a, p. 38, Fig. 1, pl. 7, figs 3–5 (only abaxial cuticle).

cf. *Cordaitea neimengensis*: Liu et al., 1998, p. 383, 384, Fig. 1b, pl. 1, fig. 4, pl. 2, figs 1–5.

Description. Abaxial cuticle. The cells are oblong, 60–145 µm long and 10–17 µm wide. Stomatal complexes are arranged into stomatal rows and they are 40 µm long and 50 µm wide. Guard cells are sunken, the polar subsidiary cells are round, oblong or rhomboid, the lateral subsidiary cells are oblong to reniform. Presence of small papillae is a characteristic feature on outer periclinal walls of all cells.

Occurrences. Intrasedimentary Basin: Duckmantian: Odolov, Ida Gallery, Prkenný Důl-Žďárky Member, Strážkovice group of coals, coal seam no. 3 (slides 581/1-13).

Comparison of species *Cordaabaxicutis* Šimůnek et Florjan

Nine species of *Cordaitea* abaxial cuticles have been recognised in the Polish material. Six of the

Cordaabaxicutis species have papillate cells; three (*C. sierzae*, *C. gorae* and *C. borassifolioides*) lack papillae. *Cordaabaxicutis jaworznoensis* is a distinctive species with a prominent, strongly cutinized longitudinal-oval crypt formed by fused papillae. Numerous small papillae are present on each cell. The stomata are arranged into single or double stomatal rows. Such cuticles have not been found before. A similar species is *C. laziskae*, which also has a strongly cutinized, circular to oval crypt, but it is not formed by fused papillae. Papillae are small and not so prominent. The stomata are arranged into multiple stomatiferous bands. *Cordaabaxicutis brzykii* is also a very distinct cuticular type, with stomata that are relatively small and with a strong cuticular thickening laterally from the guard cells. The cells are elongate so that a lateral subsidiary cell can be shared by two or three stomatal complexes. The papillae of this species are relatively large and prominent. *Cordaabaxicutis sierzae* is characterised by its very strongly cutinized crypt that is longitudinally oriented, and by the absence of papillae. *Cordaabaxicutis gorae* also lacks papillae; the polar and lateral subsidiary cells are triangular in outline, so the whole stomatal complex looks like an envelope, and no crypt is developed. *Cordaabaxicutis boleslawii* is not very well preserved but shows sunken guard cells, which pairs from swallow-tail polar ends. The cell outline is partly obscured and some dark spots are observable (? papillae). *Cordaabaxicutis* sp. A differs from above mentioned species by dark stomatiferous rows. Such rows are typical for adaxial cuticles and stomatal density of *Cordaabaxicutis* sp. A is comparable with some adaxial cuticles, therefore cannot be discounted that it is really an adaxial cuticle. Lateral subsidiary cells are oblong and polar subsidiary cells are more or less square. The crypt is lengthways oriented and very prominent. Abaxial cuticles of *Cordaitea schatzlarensis* are characterized by small rounded subsidiary cells and swallow-tail polar ends of guard cells; a crypt is absent. This species is very similar to *Cordaitea baodeensis* [Ge, 1991; Šimůnek, Libertín, 2006]. *Cordaitea* cf. *nemeigensis* is characterized by strongly papillate cells and strongly cutinized and lengthways oriented crypt.

Conclusion

Altogether, twelve adaxial and twelve abaxial dispersed cordaitalean cuticles from the Upper Silesian and Intrasedimentary basins, Poland and Czech Republic have been described.

Previously, nine adaxial and nine abaxial dispersed cordaitalean cuticular species were discovered

in the Polish part of the Upper Silesian Basin [Šimůnek, Florjan, 2013]. This paper proved that three *Cordaadaxicutis* and four *Cordaabaxicutis* species known from the Upper Silesian Basin were also discovered in the Intrasedimentary Basin: *Cordaadaxicutis bracteatus*, *C. brzykii*, and *C. krajewskae*

and *Cordaabaxicutis laziskae*, *C. sierszae*, *C. borassifolioides* and *C. papilloborassifolius*. Apart from these species, different types have been discovered that probably belong to new species: *Cordaadaxicutis* sp. A and B, and *Cordaabaxicutis* sp. A.

Among dispersed cuticles, there have been discovered forms that belong to already known species, based on «in situ» cuticles, e.g. adaxial cuticle of *Cordaitea odolovensis* or abaxial cuticle of *Cordaitea schatzlarensis*. The third cuticle is very similar to the Chinese *Cordaitea neimengensis*. It has been also proved that *Cordaadaxicutis* sp. A is the adaxial cuticle and *Cordaabaxicutis sierszae* is the abaxial cuticle of the same species.

The stomata of the genus *Cordaadaxicutis* are usually irregularly dispersed on the cuticle surface, whereas most of the *Cordaabaxicutis* species have stomata arranged into single or double stomatal rows. Some species (e.g. *Cordaabaxicutis brzykii*, *C. papilloborassifolius* and *Cordaitea* cf. *neimengensis*) form stomatiferous bands.

A typical feature for many of the cordaitaleans that lived on peat substrates is the presence of papillae on all epidermal cells or only on the subsidiary cells of stomata. On the adaxial cuticles (*Cordaada-*

xicutis), papillae do not occur in *Cordaadaxicutis tectostomatus*, *C. pussilostomatus*, *C. zalezensis*, *C. krajewskae*, *C. janinae*, *C. sp. B* and *Cordaitea odolovensis*. However, the situation is different in the case of abaxial cuticles, with papillae being absent only in *Cordaabaxicutis sierszae*, *C. gorae*, *C. borassifolioides*, *C. sp. A* and *Cordaitea schatzlarensis*.

Gastaldo et al. [1995] supposed that the fossil flora preserved in peat (coal) was different from that one preserved in roof-shale (which is an important source for «in situ» cordaitalean cuticles). Our knowledge supports this hypothesis. Most of the «dispersed» species have not been found in the roof-shales up to now, exceptions being *Cordaitea schatzlarensis* and *C. odolovensis* that occurred in both peat-forming and clastic environments.

According to material studied, it seems that *Cordaabaxicutis papilloborassifolius* prevails in the Upper Silesian Basin, and *Cordaitea schatzlarensis* dominates among cordaitaleans in the Intrasedimentary Basin. However, research into cordaitalean cuticles in the Intrasedimentary Basin is at its beginning and it is very probable that the future will bring discoveries of new cordaitalean forms.

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Explanation of plates

Plate III

Adaxial cuticles

Figs 1, 2. *Cordaadaxicutis bracteatus*, cuticles with stomatal complexes, crypts and papillae on the subsidiary cells: 1 – Upper Silesian basin, Bolesław Śmiały coal mine, Duckmantian, slide 217; 2 – Intrasudetic Basin, Žacléř, Jan pit, Lampertice Member, upper coal seam 6, Duckmantian, slide 582/1. Scale bar = 100 µm.

Fig. 3. *Cordaadaxicutis carpaticus*, very small stomatal complex with papillae on the subsidiary cells; Siersza coal mine, coal seam 209, Duckmantian/Bolshevik, slide 71. Scale bar = 25 µm.

Figs 4, 5. *Cordaadaxicutis zoldanii*, cuticle with stomata: 4 – Upper Silesian Basin, Siersza coal mine, coal seam 209, Duckmantian/Bolshevik, slide 72; 5 – Intrasudetic Basin, Odolov, Ida Gallery, stope 3/507, Prkenný Důl-Žďárky Member, Strážkovice group of coals, coal seam no. 3, Duckmantian, slide 581/3. Scale bar = 100 µm (4), 50 µm (5).

Fig. 6. *Cordaadaxicutis tectostomatus*, cuticle with a stomatal complex; Upper Silesian Basin, loc. Jaworzno, coal seam 302, Duckmantian. Scale bar = 100 µm.

Fig. 7. *Cordaadaxicutis papillostomatus*, detail of a small stomatal complex with large papillae on polar subsidiary cells; Upper Silesian Basin, Czechtal coal mine, coal seam 216, Duckmantian, slide 360. Scale bar = 20 µm.

Fig. 8. *Cordaadaxicutis pusillostomatus*, detail of a stoma without papillae; Upper Silesian Basin, loc. Siersza, coal seam 209/10, Duckmantian/Bolshevik, slide 70. Scale bar = 50 µm.

Fig. 9. *Cordaadaxicutis zalezensis*. Cuticle with a stoma, note the ridges in the middle of the epidermal cells; Upper Silesian Basin, Siersza coal mine, coal seam 302, Duckmantian. Scale bar = 100 µm.

Plate IV

Adaxial cuticle

Figs 1, 2. *Cordaadaxicutis krajewskae*, cuticle with stomata, epidermal cells with different colour: 1 – Upper Silesian Basin, Siersza coal mine, coal seam 301, Duckmantian; 2 – Intrasudetic Basin. Žacléř, Jan pit, Lampertice Member, upper coal seam 6, Duckmantian, slide 582/15. Scale bar = 200 µm (1), 100 µm (2); s – stomata.

Fig. 3. *Cordaadaxicutis janinae*; Janina coal mine, coal seam 117, Asturian, slide 124. Scale bar = 200 µm.

Figs 4, 5. *Cordaadaxicutis* sp. A; Intrasudetic Basin. Odolov, Ida Gallery, stope 3/507, Prkenný Důl-Žďárky Member, Strážkovice group of coals, coal seam no. 3, Duckmantian, slide 581/2: 4 – adaxial cuticle on the left and abaxial cuticle (*Cordaabaxicutis sierszae*) on the right; 5 – detail on two stomata from the adaxial cuticle. Scale bar = 200 µm (4), 50 µm (5).

Figs 6, 7. *Cordaadaxicutis* sp. B; Intrasudetic Basin. Žacléř, Jan pit, Lampertice Member, lower coal seam 14, Langsettian, slide 583/15. Scale bars = 100 µm (6), 20 µm (7).

Figs 8, 9. *Cordaitea odolovensis*, adaxial cuticle; Intrasudetic Basin, Odolov, Ida Gallery, stope 3/507, Prkenný Důl-Žďárky Member, Strážkovice group of coals, coal seam no. 3, Duckmantian, slide 581/3. Scale bars = 100 µm (8), 20 µm (9).

Plate V

Abaxial cuticles

Fig. 1. *Cordaabaxicutis jaworznoensis*, cuticle with stomatal rows; Upper Silesian Basin, Jaworzno, coal seam 302, Duckmantian, slide 148. Scale bar = 100 µm.

Figs 2, 3. *Cordaabaxicutis laziskae*, cuticle with stomatiferous bands: 2 – Upper Silesian Basin, Siersza coal mine, coal seam 209, Duckmantian/Bolshevik, slide 65; 3 – Intrasudetic Basin, Žacléř, Jan pit, Lampertice Member, upper coal seam 6, Duckmantian, slide 582/18. Scale bar = 50 µm (2), 100 µm (3).

Figs 4, 5. *Cordaabaxicutis brzyksii*, cuticle with dense stomatal rows: 4 – Upper Silesian Basin, Siersza coal mine, coal seam 209, Duckmantian/Bolshevik. slide 84; 5 – Intrasudetic Basin, Žacléř, Jan pit, Lampertice Member, upper coal seam 6, Duckmantian, slide 582/1. Scale bar = 200 µm (4), 50 µm (5).

Figs 6, 7. *Cordaabaxicutis sierszae*, cuticle with strongly cutinized anticlinal cell walls and three stomatal rows: 6 – Upper Silesian Basin, Siersza coal mine, coal seam 209, Duckmantian/Bolshevik, slide 84; 7 – Intrasudetic Basin, Odolov, Ida Gallery, stope 3/507, Prkenný Důl-Žďárky Member, Strážkovice group of coals, coal seam no. 3, Duckmantian, slide 581/2. Scale bar = 100 µm (6), 50 µm (7).

Fig. 8. *Cordaabaxicutis gorae*; Upper Silesian Basin, Góra, borehole IG 29, slide W 77, Duckmantian. Scale bar = 100 µm.

Fig. 9. *Cordaabaxicutis boleslawii*, cuticle with a stomatal row; Upper Silesian Basin, Loc. Bolesław Śmiały coal mine, coal seam 310, Duckmantian, slide 223. Scale bar = 100 µm.

Plate VI
Abaxial cuticles

Fig. 1. *Cordaabaxicutis czeczottensis*, close up the cuticle with four stomatal rows; Upper Silesian Basin, Siersza coal mine, coal seam 209, Duckmantian/Bolsovian. Scale bar = 100 µm.

Figs 2, 3. *Cordaabaxicutis borassifolioides*; Upper Silesian Basin, Siersza coal mine, coal seam 209, Duckmantian/Bolsovian: 2 – cuticle with stomatal rows, slide 73; 3 – cuticle with stomatiferous band consisting from three stomatal rows. Slide 68. Scale bar = 50 µm (2), 100 µm (3).

Figs 4, 5. *Cordaabaxicutis papilloborassifolius*: 4 – papillate cuticle with stomatal rows; Upper Silesian Basin, loc. Janina coal mine, coal seam 118, Asturians, slide 393; 5 – papillate cuticle with stomatiferous bands; Intrasudetic Basin, Žacléř, Jan pit, Lampertice Member, upper coal seam 13, Duckmantian, slide 541/1. Scale bar = 100 µm.

Figs 6, 7. *Cordaabaxicutis* sp. A; Intrasudetic Basin, Odolov, Ida Gallery, stope 3/507, Prkenný Důl-Žďárky

Member, Strážkovice group of coals, coal seam no. 3, Duckmantian, slide 581/6: 6 – scale bar = 100 µm; 7 – close up of a stoma from Pl. VI, fig. 6; scale bar = 50 µm.

Plate VII

Figs 1–3. *Cordaites schatzlarensis*; Intrasudetic Basin: 1 – leaf fragment with preserved apex; loc. Žacléř, Maire-Julie coal mine, Duckmantian, spec. ZŠ 96a; 2 – dispersed cuticles with typical stomata; loc. Žacléř, Jan pit, Lampertice Member, lower coal seam 14, Duckmantian, slide 583/4; 3 – close up of a stoma from Pl. VII, fig. 2. Scale bar = 2 cm (1), 100 µm (2), 50 µm (3).

Figs 4, 5. *Cordaites* cf. *neimengensis*, strongly papillate cuticle with a stomatal band; Intrasudetic Basin, Odolov, Ida Gallery, stope 3/507, Prkenný Důl-Žďárky Member, Strážkovice group of coals, coal seam no. 3, Duckmantian, slide 581/3. 5 – close up of papillate cells and stomata from Pl. VII, fig. 4. Scale bar = 100 µm (4), 50 µm (5).

Искусственная система дисперсных кордаитовых кутикул из Верхнесилезского бассейна (пенсильваний, Польша) и ее приложение к дисперсным кутикулам кордаитов из Интрасудетского бассейна (пенсильваний, Чешская республика)

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Кордаитовые обильно представлены в комплексах дисперсных кутикул из средне-, верхнепенсильванских и нижнепермских угольных пластов. Эти кутикулы легко различимы по наличию устьичных аппаратов с двумя полярными и двумя латеральными побочными клетками. Устьица на кутикуле абаксиальной стороны листа обычно образуют ряды или полосы. Поскольку во многих случаях трудно сопоставить дисперсные кутикулы с кордаитовыми кутикулами, снятыми с листа, З.Шимунек и С.Флориан [Šimůnek, Florjan, 2013] установили два рода по кутикулам: *Cordaadaxicutis* Šimůnek et Florjan – для кутикул адаксиальной и *Cordaabaxicutis* Šimůnek et Florjan – для кутикул абаксиальной стороны листа. Девять видов *Cordaadaxicutis* и девять видов *Cordaabaxicutis* были описаны из вестфальских отложений Верхнесилезского бассейна. Новые исследования обнаружили присутствие тех же видов в разновозрастных слоях Интрасудетского бассейна, в том числе, *Cordaadaxicutis bracteatus*, *C. laziskae* и *C. krajewskae*, а также *Cordaabaxicutis jaworznoensis*, *C. brzykii*, *C. borassifolioides* и *C. papilloborassifolius*.

Дисперсные кутикулы из Интрасудетского бассейна сопоставлены с некоторыми кутикулами, снятыми с листьев *Cordaites schatzlarensis* Šimůnek et Libertín и *C. odolovensis* Šimůnek. Другие кутикулярные виды оказались сравнимы с видами по листьям, описанным в XX столетии: *Cordaites* sp., типы 2, 3 и 4 [Barthel, 1962a, b] и *Cordaites neimengensis* [Liu et al., 1998], но эти виды имеют стратиграфически более молодой возраст (астурийский или раннепермский), чем кутикулы из Интрасудетского бассейна (лангзеттский и дакмантский). Некоторые виды по кордаитовым кутикулам, которые станут объектом дальнейших исследований, были обнаружены в чешской части Интрасудетского бассейна.

