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Carpatella rossica sp. nov., a new Late Paleocene–Eocene dinoflagellate species from European Russia and Ukraine

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ABSTRACT. Palynological study of two Paleogene core sections from the Voronezh and Rostov regions (SW Russia) and one outcrop in Ukraine revealed the presence of a new Late Paleocene–Eocene species, *Carpatella rossica* sp. nov. The new species is attributed to the genus *Carpatella* because of the presence of both apical and antapical horns. However, it is suggested that the taxon represents some features transitional between the three genera of the "Aptiana–Ventriosum complex" of Helenes (1986). Based on the observation of a thin smooth inner layer of the wall in some specimens of *Carpatella rossica* sp. nov., and given some morphological features of other species described after 1988, a new emendation of the genus *Carpatella* (Grigorovich 1969) Damassa 1988 is proposed here.

KEYWORDS: dinoflagellate cysts, systematics, Late Paleocene–Eocene, European Russia, Ukraine

INTRODUCTION

The genus *Carpatella* and its type species *Carpatella cornuta* were originally introduced and described by Grigorovich (1969). A decade later, Stover and Evitt (1978: 144, 145) modified the original description of the genus *Carpatella* Grigorovich 1969. According to them, the archeopyle was precingular and not apical. Subsequently, Fechner & Mohr (1986) revised the description of *Carpatella* based on their Eocene material from southern Marocco. The most recent emendation of the genus was given by Damassa (1988). The author considered the identification of specimens by Fechner and Mohr (1986) as uncertain (Damassa 1988: 169) and designated a neotype species for *Carpatella cornuta* Grigorovich 1969.

Currently there are nine species assigned to the genus *Carpatella*:

– *Carpatella circularis* (He Chengquan 1991) Lentin and Williams 1993;
– *Carpatella cornuta* (Grigorovich 1969) Damassa 1988;
– *Carpatella fusiformis* (He Chengquan 1991) Lentin and Williams 1993;
– *Carpatella humera* He Chengquan 1991;
– *Carpatella lamprota* (He Chengquan 1991) Lentin and Williams 1993;
– *Carpatella scabrota* (He Chengquan 1991) Lentin and Williams 1993;
– *Carpatella septata* Willumsen 2004;
– *Carpatella sinensis* (He Chengquan 1984) Chen et al. 1988; and
– *Carpatella truncata* Willumsen 2004.

The stratigraphical ranges of *Carpatella* species in Europe and New Zealand are well defined; their ranges described from China are less precise. The type species *Carpatella cornuta* Grigorovich 1969, the nominative species of the *C. cornuta* Zone in several dinoflagellate cyst zonation schemes, is considered to be an excellent stratigraphic marker for the base of the Paleocene (Danian) in both the Northern Hemisphere (Hansen 1977, Hansen 1979, Hultberg 1986, Brinkhuis & Leereveld 1988,

Brinkhuis & Zachariasse 1988, Andreeva-Grigorovich 1991, Habib et al. 1996, Vellekoop et al. 2015, Sánchez-Pellicer et al. 2017) and Southern Hemisphere (Willumsen 2000, 2004). *Carpatella septata* and *Carpatella truncata* described by Willumsen (2004) from New Zealand are important uppermost Maastrichtian to lowest Paleocene stratigraphical markers in the Southern Hemisphere. With regard to the six species described by He Chengquan in China, their stratigraphical age is estimated primarily from the presumed age of the local formations, as given in He Chengquan (1991): *C. circularis*, *C. scabrota* and *C. humera* – Paleocene; *C. sinensis* – Paleocene–Eocene; *C. lamprota* – early Eocene; and *C. fusiformis* – middle Eocene.

As a part of a palynological study of two Paleogene core sections from the Voronezh anticline (SW Russia) and an outcrop section in Ukraine, the new species *Carpatella rossica* sp. nov. was recorded from upper Paleocene–middle Eocene sediments. A few morphological features of this new species were not previously observed and hence were not considered in the emendation of the then-monospecific genus *Carpatella* by Damassa (1988). The aims of the present study are to formally describe a new dinocyst taxon, *Carpatella rossica* sp. nov., briefly discuss its affinities with the other genera from the "Aptiana–Ventriosum complex" of Helenes (1986) and, based on morphological features of *Carpatella rossica* and other species described after 1988, propose a new emendation of the genus *Carpatella*.

MATERIAL AND METHODS

Sediment samples used in the present study were collected from two boreholes drilled in the Central and Southern Federal Districts of Russia and from the Kostianets sand quarry in central Ukraine (Fig. 1). Borehole No. 5/93 (~230 km SSE of Voronezh, Voronezh Region) and borehole No. 1238 (~287 km SSE of Voronezh, Rostov Region) were sampled in 1994 and 2018 respectively, under the auspices of the Geological Institute of the Russian Academy of Sciences (Moscow). The sample material from the Kostianets industrial sand quarry, located in the suburbs of Kanev city, ~140 km SSE of Kiev, was collected by E.P. Radionova (Geological Institute of the Russian Academy of Sciences, Moscow) in 2017 during the jubilee meeting and excursion of the Palaeontological Society of Ukraine. Both boreholes are situated within the Don–Donetsk structural-facial zone (Voronezh anticline area). The Kostianets sand quarry, representing the stratotype of the middle Eocene Buchak Formation, is situated on the Ukrainian Shield. All these sections are located in the north-central part of the former Peri-Tethys.

Palynomorphs were concentrated according to the standard palynological techniques of the Russian Academy of Sciences. Samples were processed with 10% hydrochloric acid until the calcium carbonate was dissolved, then processed with 10% tetrasodium pyrophosphate ($Na_4P_2O_7 \times 10H_2O$) to disperse the clay, washed several times to eliminate argillaceous compounds, centrifuged with a heavy liquid (K_2CdJ_4) with specific gravity of 2.25, washed in water and then treated with 10% hydrofluoric acid until the siliceous matter was dissolved, and then boiled with 10% hydrochloric acid to remove fluoro-silicate compounds. The material was not sieved. The residues were mounted on glass slides using glycerine jelly.

All type material is stored in the palynological collection of the Geological Institute, Russian Academy of Sciences, Moscow.

STRATIGRAPHICAL OCCURRENCE

For palynostratigraphical study of the Paleogene sediments, 28 samples from borehole 5/93, 40 samples from borehole 1238, and 6 samples from the Kostianets sand quarry were analysed. Because the detailed litho- and biostratigraphical results from these sections will be presented elsewhere (Oreshkina et al. submitted; Iakovleva & Aleksandrova submitted), the present paper provides only brief information needed to define the precise stratigraphical interval in which the new species *Carpatella rossica* occurs.

Borehole 5/93 penetrates a Paleocene to Eocene succession ~69 m thick. The lowermost part of the core, ~5 m of Paleocene gaizes, is unconformably overlain by ~60 m of Eocene deposits (Veshenska, Buchak, Kiev and Kharkov formations from base to top). The quantitatively rich dinocyst assemblage was found only in the lowermost part of the Eocene succession, that is, in the Veshenska Formation, composed by light grey gaizes with phosphorite nodules at the base, intercalated with sandstones (6 m thick). The presence of the stratigraphically important taxa *Axiodinium lunare* (Gocht 1969) Williams et al. 2015, *Deflandrea phosphoritica* Eisenack 1938, *Homotryblium tenuispinosum* Davey & Williams 1966, *Homotryblium tasmaniense* Cookson & Eisenack 1967 and *Membranilarnacia* sp. cf. *Eatonicysta* sensu De Coninck 1996 places this dinocyst assemblage from the present part of the Veshenska Formation in the lower Ypresian *Stenodinium meckelfeldense* Zone of the Peri-Tethys dinocyst zonation (Iakovleva

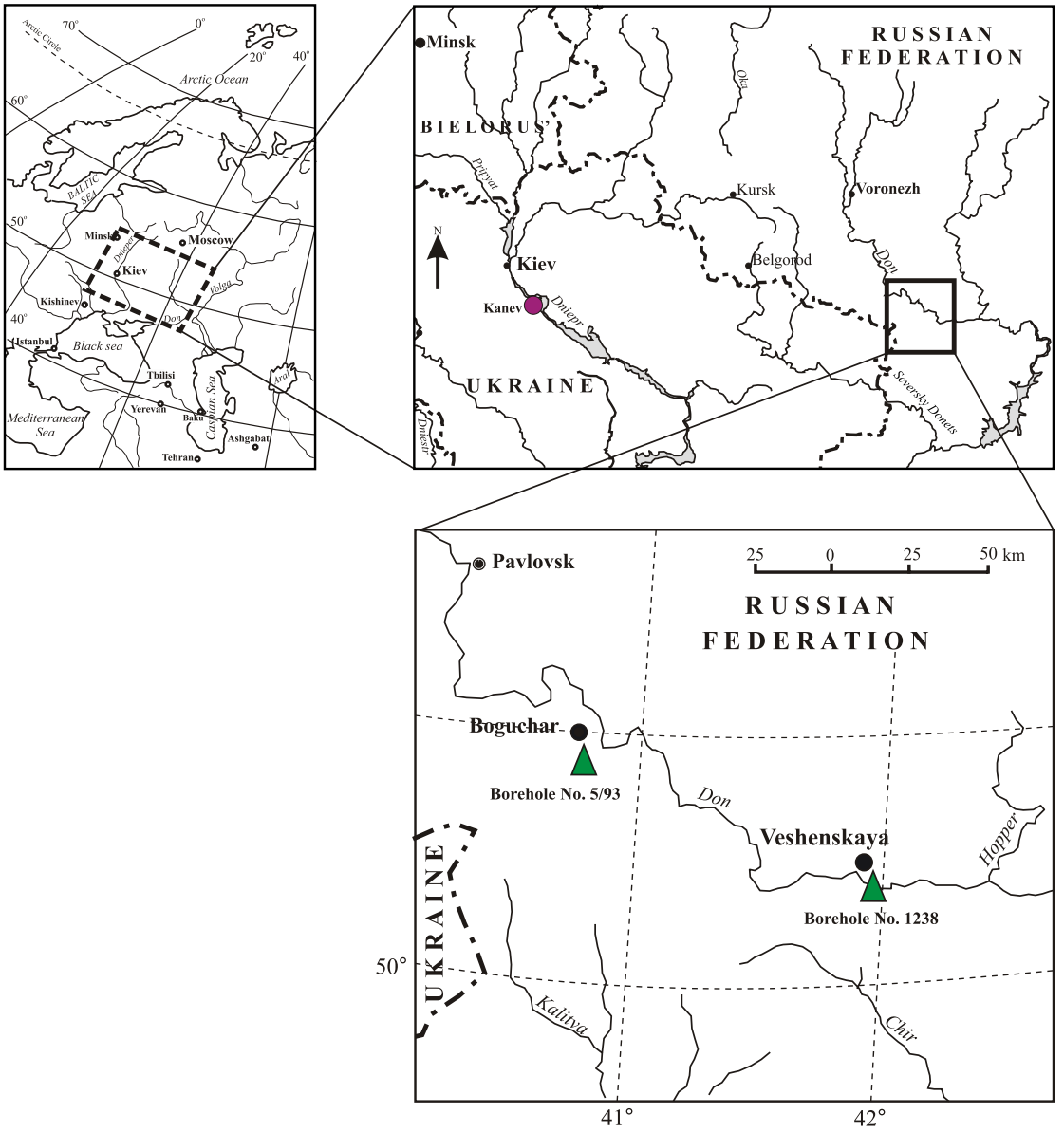

Fig. 1. Location of borehole 5/93, borehole 1238 and the Kostianets sand quarry

2017). The new species *Carpatella rossica* sp. nov. was found in all productive samples at 63.4, 62.1, 61.8 and 60.1 m depth. Going from 63.4 to 60.1 m depth, this new taxon shows relative abundance of ~13%, 18%, 1% and 26% of the total assemblage.

Borehole 1238 revealed a succession of Paleocene–Eocene sediments ~70 m thick, unconformably overlying Cretaceous rocks. *Carpatella rossica* sp. nov. was recognised here in the majority of productive samples of the lower Veshenska Formation, attributed to the Thanetian *Apectodinium hyperacanthum* Zone of the Peri-Tethys dinocyst zonation (Iakovleva 2017) at 81.4 m (41% of assemblage), 80.4 m (17.5%), 79.4 m (7.5%) and 77.4 m (21%) depth. The lower Ypresian part of the Veshenska Formation in this core was devoid of palynomorphs, while the mid Ypresian dinocyst assemblage of the upper Veshenska Formation did not reveal any specimen of *Carpatella rossica* sp. nov.

The Kostianets sand quarry, situated in the Kiev Region (central Ukraine), represents the stratotype of the middle Eocene Buchak Formation. In total, six samples from this quarry were analysed palynologically; only three of them revealed quantitatively and taxonomically rich dinocyst associations. The dinocyst assemblage from the stratotype of the Buchak Formation is characterised by the presence of the stratigraphically important species *Costacysta bucina* Heilmann-Clausen & Van Simayes 2005, *Enneadocysta arcuata* (Eaton 1971) Stover & Williams 1995 and *Enneadocysta harrisii* Stover & Williams 1995, suggesting placement in the mid Lutetian *Costacysta*

bucina Zone of the Peri-Tethys dinocyst zonation (Iakovleva 2017). The new species *Carpatella rossica* is present in each productive sample and forms between ~3% and ~10% of the total assemblage.

SYSTEMATIC PALAEONTOLOGY

Division: DINOFLAGELLATA (Bütschli 1885) Fensome et al. 1993

Subdivision: DINOKARYOTA Fensome et al. 1993

Class: DINOPHYCEAE Pascher 1914

Subclass: PERIDINIPHYCIDAE Fensome et al. 1993

Order: GONYAULACALES Taylor 1980

Suborder: GONYAULACINEAE Norris 1978 (autonym)

Family: GONYAULACACEAE Lindemann 1928

Subfamily: CRIBROPERIDINIOIDEAE Fensome et al. 1993

Genus ***Carpatella*** (Grigorovich 1969) emend.

Emended diagnosis. Subspherical to ellispoidal proximate cysts, having a short horn at apex and antapex. Sexiform gonyaulacacean paratabulation is expressed to varying degrees in different species and indicated by parasutural features. Ventral organisation L-type. Archeopyle precingular, Type P, comprising precingular paraplate 3" only, with rounded pentagonal margin; operculum free or in place. Wall consisting of two layers: pedium, mostly invisible, extremely thin and smooth; luxuria solid, densely fibrous or spongy. Surface of outer layer may be smooth, with features of low relief or ornamented by intratabular processes and penitabular septa.

Emended description.

Shape. Cysts subspherical to ellipsoidal in ventro-dorsal or lateral view, with single and very short to intermediate horns at apex and antapex; approximately circular in polar view; slight indentation in sulcal region is observed in the type species. Horns are solid structures formed from densely fibrous, spongy wall material.

Size. Intermediate to large. Length of cysts ~69–130 µm, including horns (length of horns ~4–20 µm); equatorial diameter ~68–100 µm.

Wall structure. Cyst proximate, acavate, wall consisting of two layers: pedium extremely thin and smooth, very rarely observed only in antapical area. Inner and outer layers so tightly compressed that the pedium is not visible in most cases. Inner surface smooth. Outer surface texture densely fibrous or spongy.

Archeopyle. Precingular archeopyle, Type P, comprising paraplate 3" only; rounded pentagonal in shape. Operculum free or in place. Wall thinner at margins of archeopyle and operculum.

Surface features. Surface features of various species appear to be quite different. Surface may be smooth or with features of low relief such as granula, rugae and fibrous ridges. Paratabulation of the type species is indicated by narrow parasutural "furrows" flanked by somewhat broader raised bands. Intratabular ornament of the type species consists of parallel rows of small "pits" visible only with SEM (see Damassa 1988: 170). Surface of outer wall may contain numerous solid rods, forming a complex tegillum which is developed as simulate septal complexes indicating the paratabulation of the cyst (see Willumsen 2004: 121). Paratabulation may be also reflected by short fibrous processes rising from each paraplate (see Willumsen 2004: 124).

Paratabulation. Various species included in the genus *Carpatella* demonstrate different degrees of paratabulation development. Complete sexiform gonyaulacoid paratabulation of the "Aptiana–Ventriosum complex" of Helenes (1986), indicated by parasutural features, is manifested in the type species *Carpatella cornuta* (see Damassa 1988: 170–173). Parasutural features define the following paraplates: 1 preapical (pr), 4 apical (1'–4'), 6 precingular (1"–6"), 6 cingulars (1c–6c), 6 sulcals (as, ras, rs, ls, 1"', ps), 5 postcingulars (2"'–6"'), 1 posterior intercalary (1p) and 1 antapical (1""). The paratabulation formula is 1pr, 4', 6", 6c, 6s, 5"', 1p, 1"". The paratabulation pattern is characterised by an L-type ventral configuration.

Stratigraphic age. Latest Maastrichtian–mid Lutetian.

Remarks. Species in this genus significantly differ from one another by the degree of development of the paratabulation features, by manifestation of the parasutural and intratabular ornamentation, by the size of the body and apical and antapical horns, and by the visibility (presence?) of the pedium. Some species have no indication of paratabulation (visible under LM), except for the paraplate 3" (operculum) and a shallowly furrowed cingulum; their attribution to the genus *Carpatella* is based on the presence of single apical and antapical horns.

Type species. *Carpatella cornuta* (Grigorovich 1969) Damassa 1988

Carpatella rossica sp. nov.

Pl. 1, figs 1–12; Pl. 2, figs 1–12; Pl. 3, figs 1–12; Pl. 4, figs 1–12; Fig. 2

Holotype. Plate 1, figs 1–5; Slide M-60.1-2. England Finder reference M47/3.

Paratype 1. Plate 2, figs 1, 4, 7; Slide M-60.1-1. England Finder reference L33/2-L34/1.

Paratype 2. Plate 2, figs 3, 6, 9, 12; Slide M-60.1-1. England Finder reference J42/3.

Type strata. Sample M-60.1; 60.1 m depth; Veshenska Formation (63.4–60.1 m depth); Voronezh anticline.

Type locality. No.5/93 borehole, Voronezh region, SW Russia.

Derivatio nominis. *rossica* (Latin) – Russian: the holotype comes from Russia.

Diagnosis. An ovodial to spheroidal, proximate, acavate gonyaulacoidean cyst with single, very short apical and antapical horns. Wall relatively thick (~5 µm). Archeopyle precingular 3", operculum may be free or in place. Tabulation expressed mostly by the archeopyle and (quite faintly) by the cingulum that has a strong overhang, and only rarely by plates 2", 2"" and 3""; single intratabular boundaries very rarely observed.

Description. A gonyaulacoidean dinoflagellate cyst of intermediate size, ovoidal to spheroidal, circular in equatorial section, possessing single and very short solid subtriangular apical and antapical horns with a nipple-like tip. Depending on the orientation of the specimen in the preparation, the antapical horn sometimes appears to be almost invisible. Horns distinctly thinner than the general cyst wall. Cyst wall consists of two layers: pedium extremely thin and smooth; luxuria quite thick (~5–7 µm) and spongy. Inner and outer layers tightly compressed. Nevertheless, occasionally the presence of a thin inner layer may be inferred when the inner layer is visually pressed into the luxuria in the antapical area (Plate 2, fig. 10). Paratabulation is mostly indicated by the precingular archeopyle (Type P) comprising paraplate 3" only, and by a shallowly furrowed cingulum flanked by low smooth ridges on the anterior and posterior sides; only very rarely plates 2", 2"" and 3"" and single intratabular boundaries may be observed. Operculum rounded pentagonal; may be free or in place.

Dimensions. Holotype: total length 72 µm; total width 70 µm; length of apical horn 6.4 µm; length of antapical horn 6 µm; thickness of wall 5 µm. Paratype 1: total length 80 µm; total width 77 µm; length of apical horn 6 µm; length of antapical horn 6 µm; thickness of wall 5.5 µm. Paratype 2: total length 83 µm; total width 73 µm; length of apical horn 6 µm; antapical horn not visible; thickness of wall 7 µm. Dimensions of measured specimens: total length 69–83 µm (mean 75 µm); total width 68–77 µm (mean 72 µm); length of apical horn 4–7 µm (mean 6 µm); length of antapical horn 5–9 µm (mean 6.5 µm); thickness of wall 5–7 µm (mean 6 µm). Thirteen specimens measured.

Comparison. *Carpatella rossica* sp. nov. differs from the type-species *Carpatella cornuta* by its smaller cyst, smaller apical and antapical horns, and faint paratabulation expressed mainly (under LM) by the archeopyle, cingulum and parasutures (e.g. Plate 2, fig. 1); single intratabular linear features are very rarely observed. *Carpatella rossica* sp. nov. differs from *Carpatella septata* and *Carpatella truncata* by its short horns, the absence of reticulate surface ornamentation and intratabular truncate processes. It is more difficult to compare *Carpatella rossica* sp. nov. with species described by He Chengquan (1984, 1991) in China, because their descriptions are not given in English, except for the description of *Carpatella sinensis*. Based only on the illustrations of *C. circularis*, *C. scabrota*, *C. humera*, *C. sinensis*, *C. lamprota* and *C. fusiformis* provided by He Chengquan (1984, 1991), *Carpatella rossica* sp. nov. differs by the absence of any parasutural

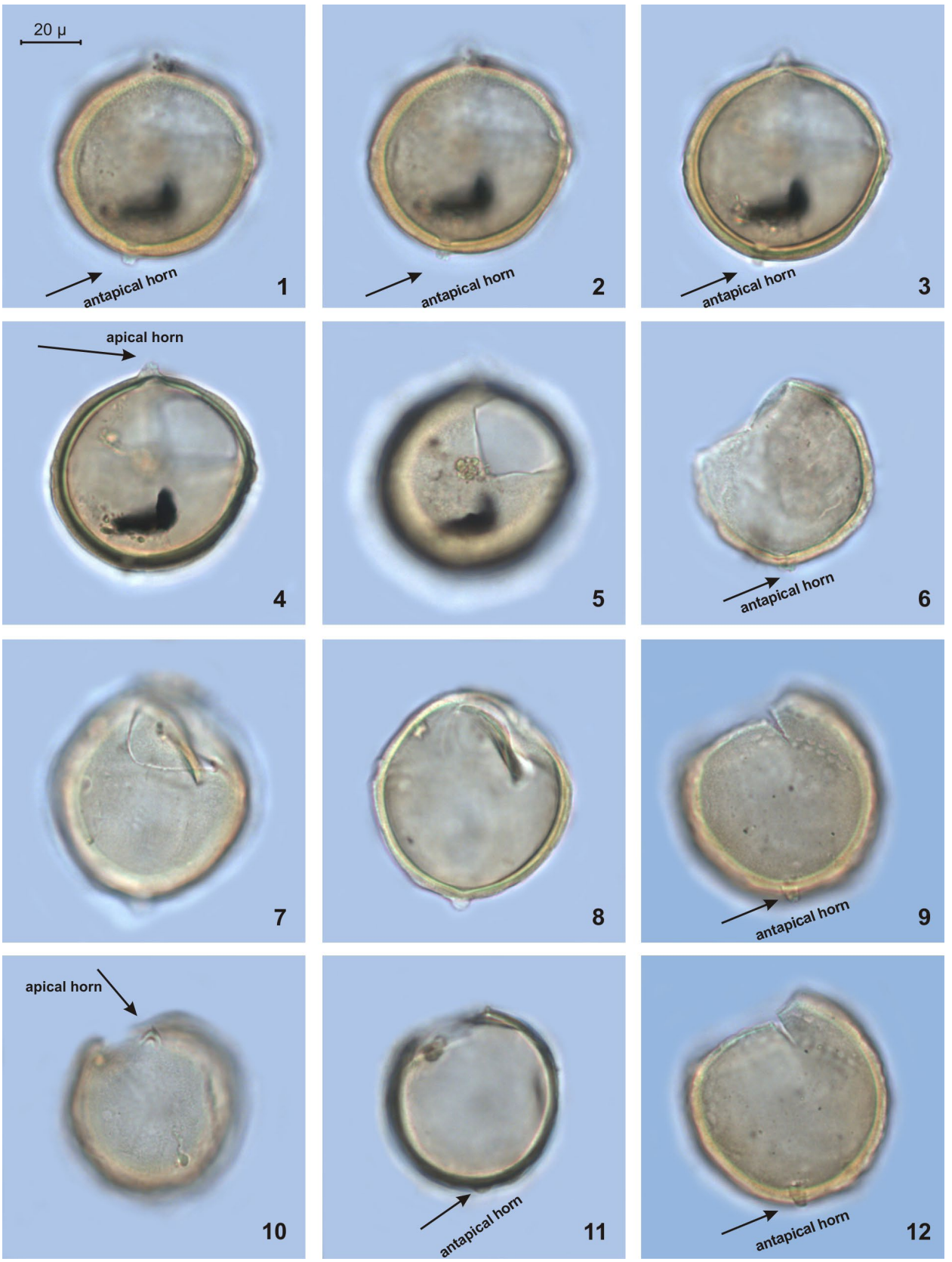

Plate 1. 1–12. *Carpatella rossica* sp. nov. **1–5**. Holotype: **1–3** – three slightly different mid-ventral views with foci on the apical and antapical horns; **4** – mid-dorsal view with focus on the luxuria; **5** – mid-dorsal view with the archeopyle free. Slide 60.1 m – No.2.; **6**. Specimen in lateral view with focus on the antapical horn. Slide 60.1 m – No.1.; **7**, **8**. Specimen in dorsal view with attached opercular plate and focus on the antapical horn. Slide 60.1 m – No.1; **9**, **12**. Specimen in right lateral view showing the spongy character of the luxuria and the antapical horn. Slide 60.1 m – No.2; **10**, **11**. Specimen in lateral view showing the apical and antapical horns. Slide 60.1 m – No.2

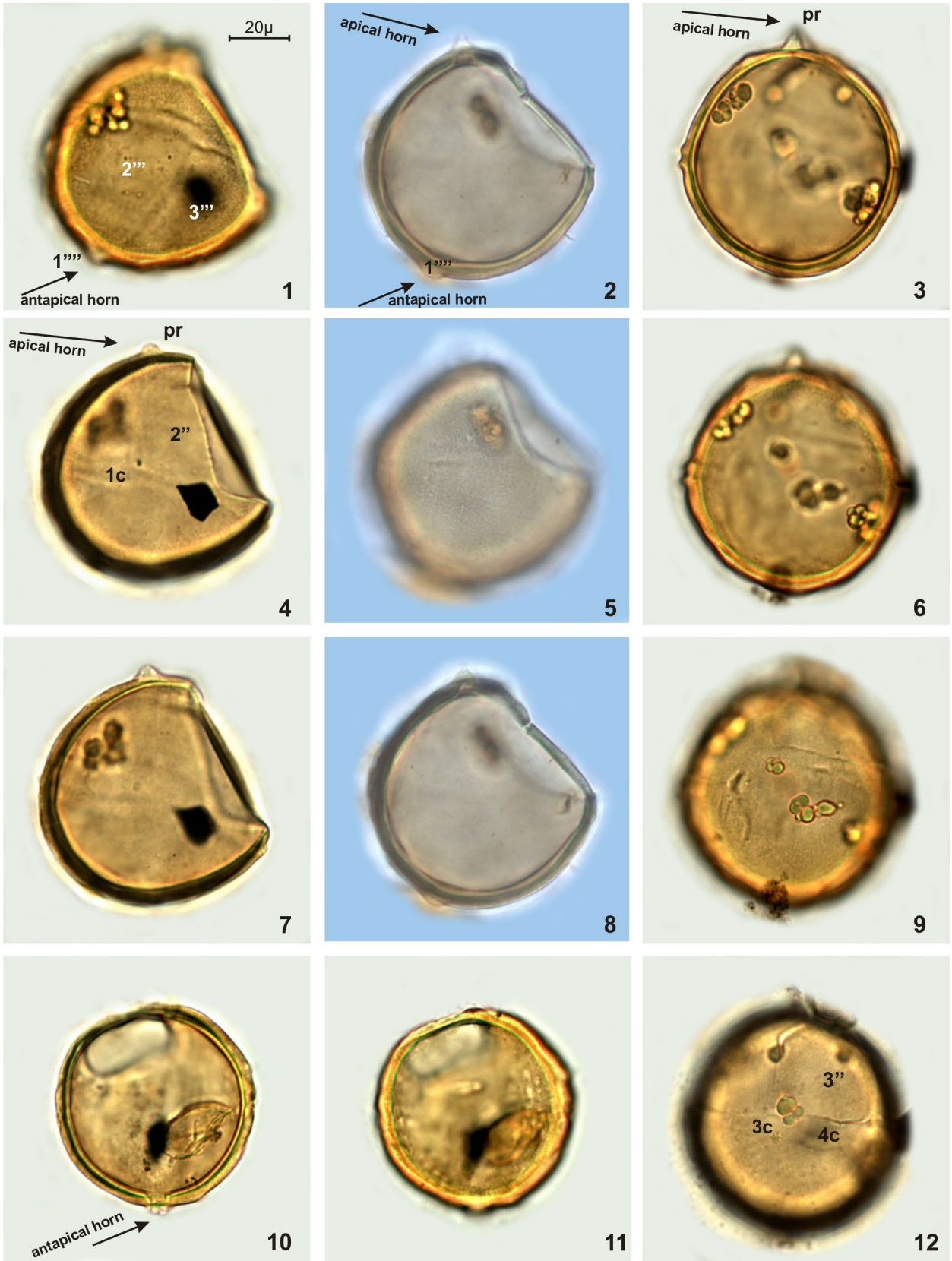

Plate 2. 1–12. *Carpatella rossica* sp. nov. **1**, **4**, **7**. Paratype 1; left lateral view in three foci: **1** – high focus on the antapical horn, cingulum and plates 2''' and 3'''; **4** – optical section focusing on apical horn and plates 2'' and 1c; **7** – high focus on the apical horn and wall structure. Slide 60.1 m – No.1; **2**, **5**, **8**. Specimen in left lateral view; three slightly different foci on the free precingular archeopyle, apical and antapical horns. Slide 60.1 m – No.2; **3**, **6**, **9**, **12**. Paratype 2 in dorsal view: **3** – high focus on the whole structure and antapical horn; **6**, **9** – slightly different foci on dorsal surface; **12** – high focus on the attached opercular plate 3'' and plates 3c and 4c. Slide 60.1 m – No.2; **10**, **11**. Specimen in dorsal view: **10** – high focus on the spongy wall structure and antapical horn; the presence of two layers is seen in the antapical zone; **11** – focus on the wall structure. Slide 60.1 m – No.2

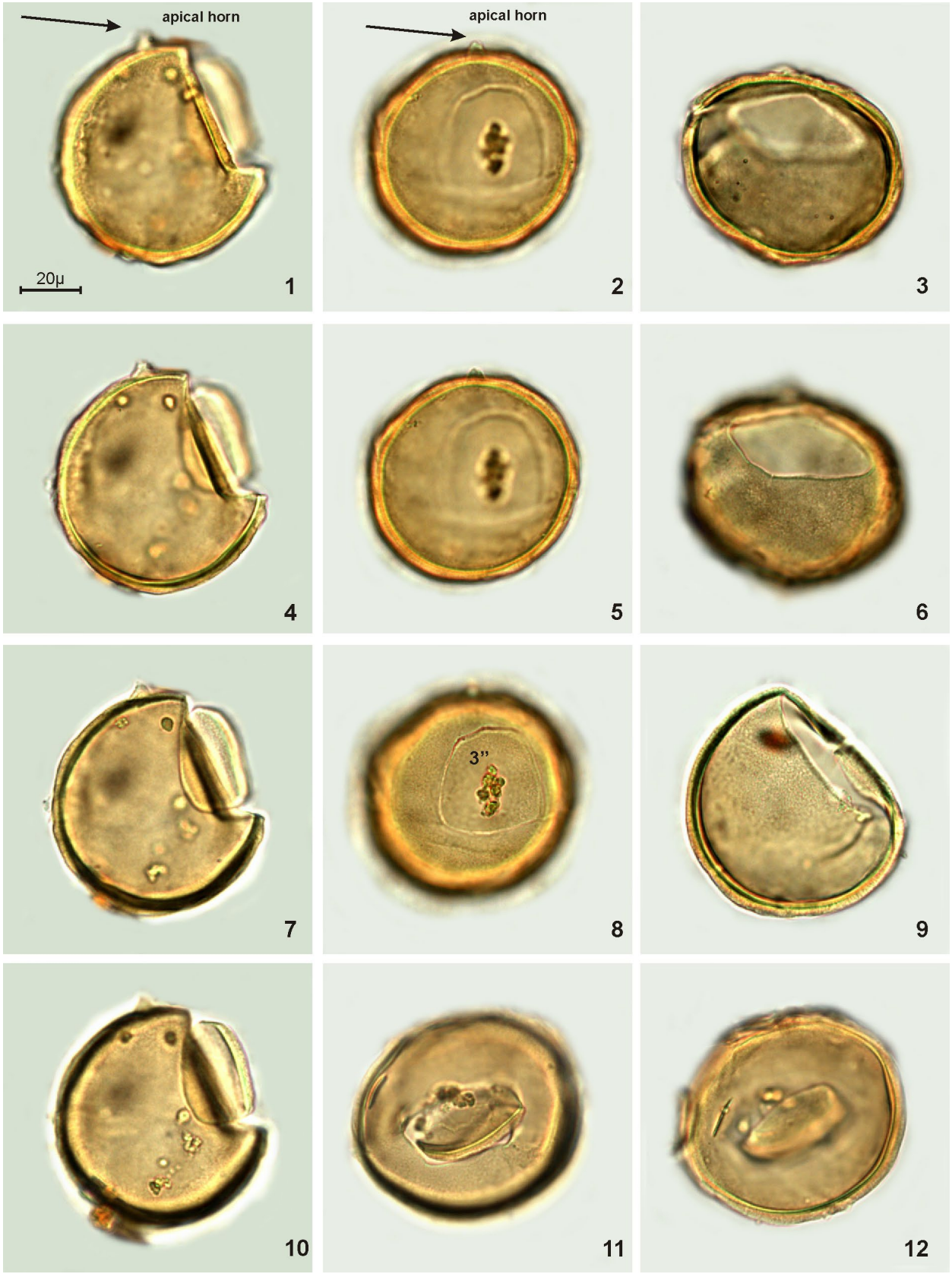

Plate 3. 1–12. *Carpatella rossica* sp. nov. **1**, **4**, **7**, **10**. Specimen in left lateral view; four different foci showing the mid-dorsal surface, apical horn and partially attached opercular plate. Slide 60.1 m – No.2; **2**, **5**, **8**. Specimen in dorsal view; three different foci showing the attached archeopyle, the spongy luxuria and the apical horn. Slide 60.1 m – No.2; **3**, **6**. Specimen in dorsal view; two foci showing the free operculum. Slide 60.1 m – No.2; **9**. Specimen in right lateral view; high focus on the precingular archeopyle and spongy luxuria. Slide 60.1 m – No.2; **11**, **12**. Specimen showing the luxuria. Slide 60.1 m – No.2

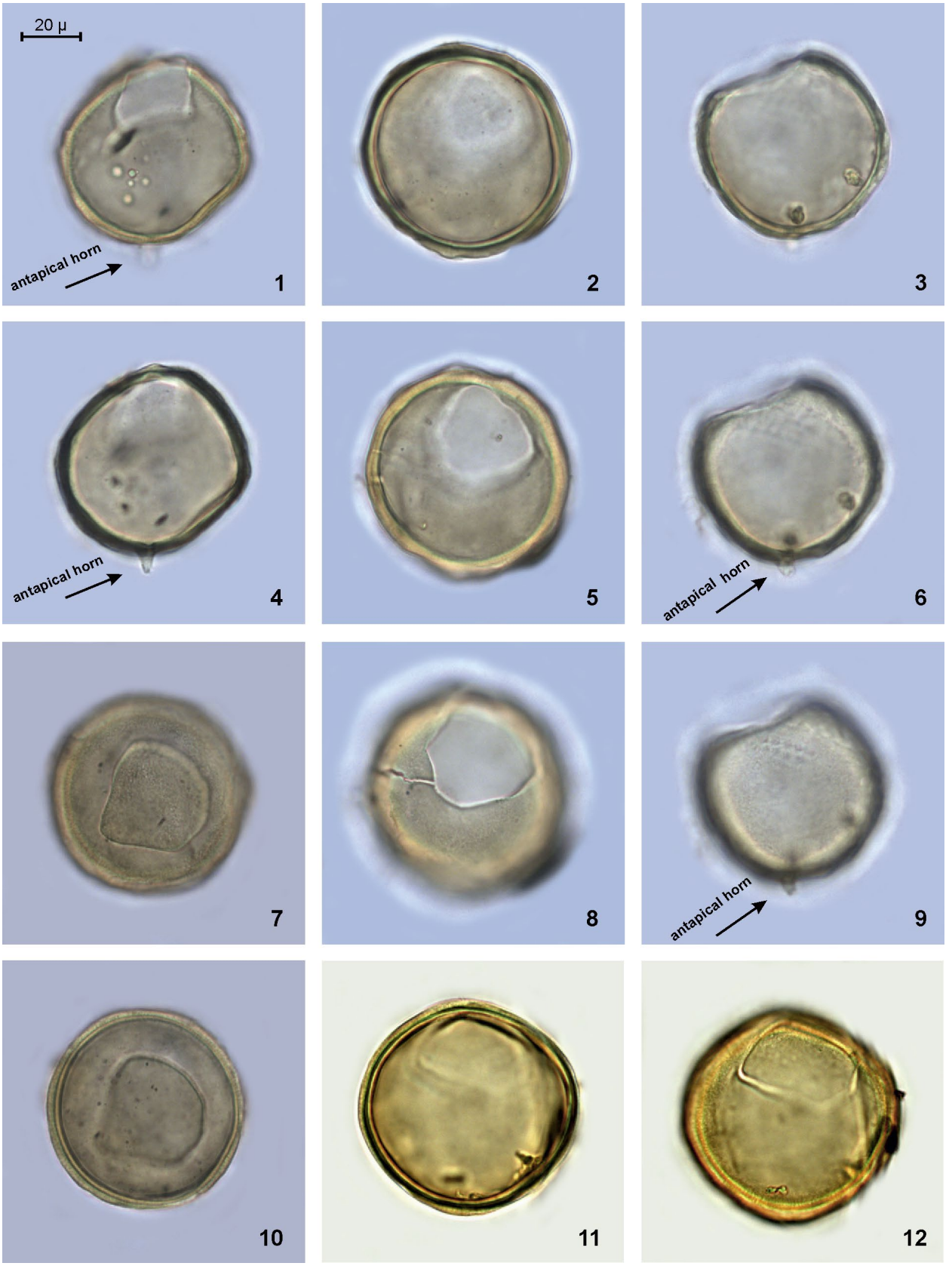

Plate 4. 1–12. *Carpatella rossica* sp. nov. **1**, **4**. Specimen in dorsal view: 1 – focus on the free precingular archeopyle; **4** – focus on the quite long and narrow antapical horn. Slide 60.1 m – No.2; **2**, **5**, **8**. Specimen showing the spongy luxuria and the free archeopyle. Slide 60.1 m – No.2; **3**, **6**, **9**. Specimen showing quite narrow antapical horn; Slide 60.1 m – No.2; **7**, **10**. Specimen in equatorial view in two slightly different foci on the luxuria and opercular plate. Slide 60.1 m – No.2; **11**, **12**. Specimen in dorsal view showing the luxuria and attached opercular plate; horns are almost not visible. Slide 60.1 m – No.2

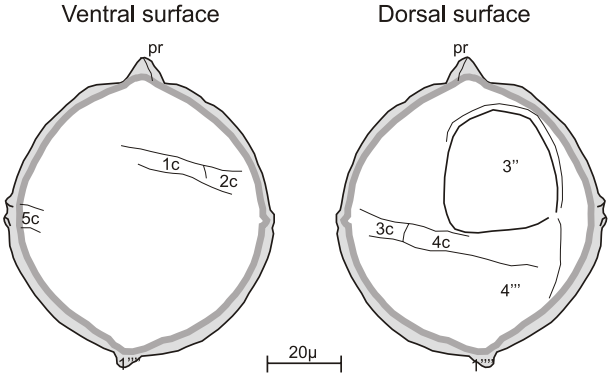

Fig. 2. Line drawing of *Carpatella rossica* sp. nov.; pr – preapical plate; 2" and 3" – precingular plates; 3c and 4c – cingular plates; 2''' and 3''' – postcingular plates; 1'''' – antapical plate

ornamentation and by its more spherical shape, smaller horns and smoother wall surface.

Carpatella rossica sp. nov. bears a resemblance to *Apteodinium crassum* Slimani & Louwye 2013, which is also a subspherical cyst of intermediate size and has a finely spongeous outer layer and a small subtriangular and bulbous apical horn with a nipple-like tip. *Carpatella rossica* sp. nov. is clearly distinguished from *Apteodinium crassum* by the presence of the antapical horn and thinner outer layer.

Stratigraphic age. Late Paleocene–middle Eocene.

Geographical distribution. *Carpatella rossica* sp. nov. is currently known from the Voronezh and Rostov Regions (SW Russia) and central Ukraine.

DISCUSSION AND SUMMARY

As was emphasised by Damassa (1988: 167), the genus *Carpatella* has paratabulation that is nearly identical in all respects to that of other dinoflagellate cysts of the "Aptiana–Ventriosum complex" of Helenes (1986). Damassa (1988: 174) also pointed out that *Carpatella* is distinguished from *Apteodinium* on the basis of the presence of both apical and antapical horns. Otherwise, the two genera are similar in overall appearance (i.e. shape, wall texture, size). According to Stover and Evitt (1978), *Apteodinium* tends to lack clear evidence of a paratabulation. However, Lucas-Clark (1987) demonstrated for *Apteodinium* a partial Aptiana–Ventriosum paratabulation scheme. Additionally, Damassa (1988: 174) noted that the paratabulation, the archeopyle type and the wall structure of *Carpatella* are nearly identical to those of *Cribroperidinium* (Helenes 1984). These two genera may be distinguished primarily on the basis of the development of an antapical horn in *Carpatella* and also a few differences in paratabulation (i.e. configuration of the as/2'''–1'''/1c contacts).

The dinoflagellate cyst species *Carpatella rossica* sp. nov. described here demonstrates some features transitional between the three genera *Carpatella*, *Cribroperidinium* and *Apteodinium*. *Carpatella rossica* sp. nov. possesses both apical and antapical horns, which justifies its attribution to the genus *Carpatella*. At the same time, using only LM imagery it can be seen that this new species has, besides the precingular archeopyle, more suppressed paratabulation: only a slightly depressed cingulum (often without internal paratabulation) is indicated by low anterior and posterior ridges. These weak paratabulation features place the morphology of *Carpatella rossica* sp. nov. between *Apteodinium* and *Cribroperidinium*. Moreover, several observed specimens of *Carpatella rossica* sp. nov. (Pl. 2, figs 3, 6, 9, 12; Pl. 3, figs 1, 4, 7, 10; Pl. 4, figs 11, 12) demonstrate that, depending on the orientation of the specimen in the preparation, the antapical horn appears to be compressed and almost invisible and may be detected only by mechanical pressure in liquid glycerine macerate. If the macerate is not liquid (glycerine jelly), specimens with this morphology may be erroneously referred to the genus *Apteodinium*. It is also obvious that *Carpatella rossica* sp. nov. and the species previously described by He Chengquan (1991: Pl. 8, figs 6–8, 13–20; *C. circularis*, *C. fusiformis*, *C. lamprota*, *C. scabrata*, *C. sinensis*; observations of published photographs only), which are characterised by very faint indication of paratabulation, cannot demonstrate the configuration of the as/2'''–1'''/1c contacts (at least under LM, Fig. 2), suggested by Damassa (1988) as a distinctive generic feature.

Another question that arises from this study of specimens of *Carpatella rossica* sp. nov. is the number of wall layers. In all existing literature dealing with the genus *Carpatella* (Grigorovich 1969, Stover & Evitt 1978, He Chengquan 1984, Damassa 1988, Willumsen 2004) it was presumed that the genus has only one wall layer – the autophragm. However, my observation of specimens of *Carpatella rossica* sp. nov. calls this assumption into question. I observed

that some specimens (Plate 2, figs 10, 11) demonstrate evident extrusion of the thin, smooth inner layer (pedium) into the outer thick layer (luxuria) in the antapical zone. Unfortunately, based only on my LM observation it is not clear if the extrusion occurs at both apex and antapex, nor if it occurs through a pornichnion or intratabular pit as present in Damassa's (1988) description of *Carpatella cornuta*.

Other known *Carpatella* species described from Europe and New Zealand – *C. cornuta*, *C. septata* and *C. truncata* – are important uppermost Maastrichtian–lowermost Paleocene stratigraphical markers with a short stratigraphic distribution (earliest Paleocene). Three species given by He Chengquan from China (*Carpatella sinensis*, *Carpatella lamprota*, *Carpatella fusiformis*) seem to be from the Eocene but their exact stratigraphic age is quite unclear. *Carpatella rossica* sp. nov. is known from Thanetian to middle Lutetian sediments, which places the stratigraphical age of *Carpatella* at latest Maastrichtian to mid Lutetian.

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