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# Infructescences of *Friisicarpus sarbaensis* sp. nov. (Platanaceae) from the Cenomanian–Turonian of Western Kazakhstan

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**Abstract**—Platanoid capitate infructescences are described as a new species *Friisicarpus sarbaensis*. Infructescences of *Friisicarpus* N. Maslova et Herman have been first found in the Cretaceous of Kazakhstan. A joint burial of *Friisicarpus* infructescences and other platanoid reproductive structures as well as *Platanus*-like leaves are discussed. This indicates a considerable role of the group in the Cretaceous flora of Kazakhstan.

*Keywords*: reproductive structures, *Friisicarpus*, Platanaceae, Cenomanian–Turonian, western Kazakhstan.
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## INTRODUCTION

The genus *Friisicarpus* N. Maslova et Herman (Maslova and Herman, 2006) has capitate infructescences composed of 50–100 densely pressed pentamerous flowers with well-developed perianth. Six species of the genus are known: *F. brookensis* (Crane, Pedersen, Friis et Drinnan) N. Maslova et Herman, Early–Middle Albian (Crane et al., 1993); *F. marylandensis* (Friis, Crane et Pedersen) N. Maslova et Herman, Late Albian (Friis, Crane, and Pedersen, 1988); *F. elkneckensis* (Pedersen, Friis, Crane et Drinnan) N. Maslova et Herman, Late Albian (Crane et al., 1993); *F. dakotensis* Wang, Dilcher, Schwarzwalder et Kvaček, Albian (Wang et al., 2011); *F. kubaensis* N. Maslova, Tekleva et Sokolova, Albian–Cenomanian (Maslova et al., 2011); *F. carolinensis* (Friis, Crane et Pedersen) N. Maslova et Herman, Santonian–Campanian (Friis, Crane, and Pedersen, 1988). The earliest record of *Friisicarpus* is dated by Early–Middle Albian (*F. brookensis*), the latest is Santonian–Campanian *F. carolinensis.*

The genus is widespread. Four species are known from the USA: *F. brookensis* from Virginia, *F. marylandensis* and *F. elkneckensis* from Maryland, *F. carolinensis* from North Carolina, and *F. dakotensis* from Kansas; one species was described from West Siberia, Russia (*F. kubaensis*). The infructescences from Kansas, USA (Wang, 2008), Sweden (Friis, Crane, and Pedersen, 1988), and West Siberia, Russia (Maslova and Herman, 2006) were determined up to genus.

The infructescences of *Sarbaicarpa* N. Maslova (Maslova, 2009) and staminate inflorescences of *Sarbaya* Krassilov et Shilin (Krassilov and Shilin, 1995) have been described from the Sarbay locality in western Kazakhstan; other staminate inflorescences are currently studied and will be distinguished as a new genus based on the complex of diagnostic features that are typical for the families Platanaceae and Hamamelidaceae. The purpose of the present paper is to determine the taxonomic position of capitate infructescences, which are very similar externally to the previously described infructescences from this locality.

The new species *F. sarbaensis* sp. nov. from western Kazakhstan widens considerably our knowledge on the genus areal in Cretaceous and supplements data on morphology of these infructescences.

## MATERIAL AND METHODS

Structurally preserved infructescences were found in the Cenomanian–Turonian strata of gray clays in the Sarbay quarry near the town of Rudnyi (western Kazakhstan). The material studied in the paper was collected by P.V. Shilin in 1978. Initially *Asplenium dicksonianum* Heer, *Gleichenia* sp., *Sphenopteris* sp., *Sequoia heterophylla* Velen., *Cedrus* sp., *Platanus pseudoguillelmae* Krass., *P. cuneiformis* Krass., *Dalbergites simplex* (Newb.) Sew., and *Ilex* sp. were distinguished within this floral assemblage (Shilin, 1986). Later data on the flora from Sarbay locality were considerably widened and partly revised. The angiosperms of Ranunculales, Urticales, Rosales, Myrtales, Celastrales, Platanaceae, Illiciaceae, and Magnoliaceae were determined (Frumin and Friis, 1996, 1999).

Separate heads were placed on the lacquer film by dissolution of rocks in the hydrofluoric acid. The rock was removed from infructescence fragments by hydrofluoric acid, and then the heads were mounted on the stubs for studying under scanning electron microscope (SEM). Fruit elements after maceration in the concentrated nitric acid and alkali were also

studied with SEM. The figures of inflorescences were made with digital camera Nikon Coolpix 8700 and camera Leica DFC420. The microphotographs were made with SEM CamScan.

The studied specimens from the collections nos. 417 and 419 are stored at the Borissiak Paleontological Institute of the Russian Academy of Sciences (PIN), Moscow.

## SYSTEMATIC PALEOBOTANY

### Family Platanaceae Lestiboudois, 1826

### Genus *Friisicarpus* N. Maslova et Herman, 2006

#### *Friisicarpus sarbaensis* N. Maslova et Tekleva, sp. nov.

Plate 19, figs. 1–10; Plate 20, figs. 1–8

Etymology. From the Sarbay locality.

Holotype. PIN, no. 417/101; capitate infructescence; western Kazakhstan, Sarbay quarry near the town of Rudnyi; Zhirkindek Formation; Cenomanian–Turonian (Pl. 19, figs. 3, 6), designated here.

Diagnosis. Compound infructescence with longitudinally striate axis bearing sessile heads. Each head consists of more than 60 fruits. Fruits are enclosed in distinct perianth, nearly reaching fruit top. Perianth elements are in three or four whorls. Epidermal cells of outer elements are strongly extended longitudinally. Epidermal cells of inner elements vary from square to longitudinally extended. Carpel with trichomes. Fruits pentamerous, carpel apices bear bilobate and triangular-conical extension; stylodium lacking. Epidermal cells of carpels vary from longitudinally extended to square, apically with median papillae.

Description (Figs. 1–3). The compound infructescence consists of longitudinally striate, up to 2 mm in diameter axis and several alternately arranged sessile capitate infructescences (Pl. 19, figs. 5, 6). The maximum number of preserved heads on the axis is nine; the head diameter is 8–10 mm.

The longitudinal striation of axis is accentuated by the well-pronounced cuticular folds (Fig. 1a). The ordinary epidermal cells of the axis are longitudinally extended or almost square, from 15 to 30 μm long and from 10 to 15 μm wide, and arranged in longitudinal rows (Fig. 1b). The surface of infructescence axis is strongly hairy. The trichomes develop on one epidermal cell; their base is barrel-shaped, oval in outline, strongly cutinized, from 10 to 18 μm in diameter (Fig. 1a); their apex is at least up to 5 μm long.

The head consists of central rounded core 1–2 mm in diameter surrounded by densely pressed fruits (Pl. 19, figs. 1–4). Detached fruits leave rounded or oval scars, which are well-marked by preserved fragments of perianth elements (Fig. 1c).

There are over 60 fruits in one head. Within one head the fruits are almost equal in size. The fruits are enclosed in well-developed perianth, whose elements are arranged in three or four whorls (Figs. 1d, 2a). The perianth almost completely covers the gynoecium and only the carpel apices remain free (Pl. 19, fig. 8). Outer and inner perianth elements are equally long. Outer perianth elements are more cutinized than the inner. The epidermis of outer and inner perianth elements is different. The epidermis of elements of outer whorls is formed by strongly longitudinally extended, from 40 to 70 μm long and from 5 to 10 μm wide cells (Figs. 1e, 1f). The epidermis of inner elements is composed of variously shaped and sized cells: from almost square to rectangular; from 20 to 40 μm long and from 5 to 15 μm wide (Figs. 2b, 2c).

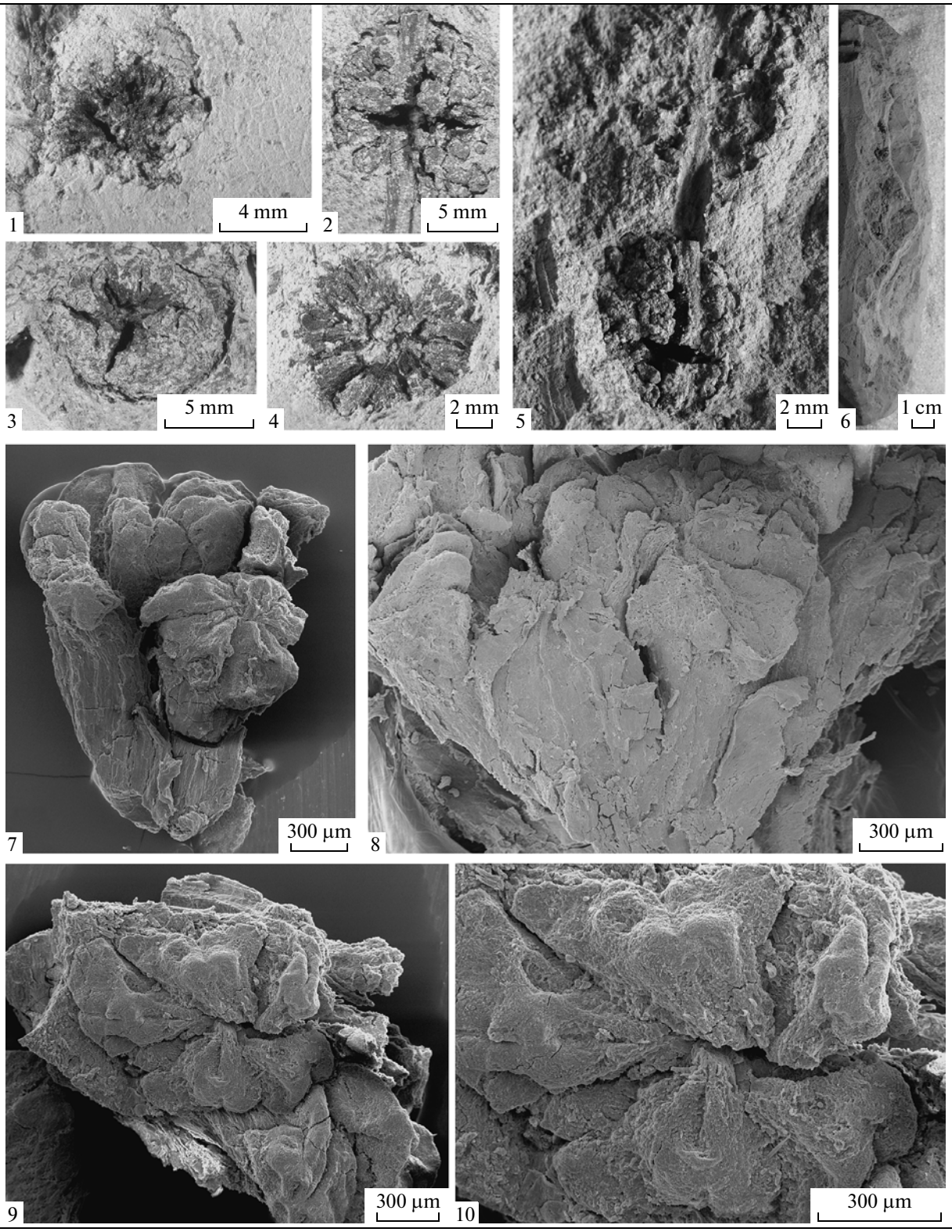
The fruits are pentamerous (Pl. 19, figs. 7–10), triangular in outline, about 1200 μm long and about 400 μm wide in the middle. The carpel apex bears bilobate triangular conical extension (Pl. 19, figs. 9, 10; Fig. 2d). The stylodia are absent. The epidermal cells are from longitudinally extended to square, from 20 to 60 μm long and from 5 to 15 μm wide (Pl. 20, fig. 4). The trichomes are developed in the carpel central region (Figs. 2e, 2f). Most of the epidermal cells in the carpel apices bear median papillae (Pl. 20, figs. 1–6). The papillae are up to 10 μm long. The epidermis of carpel apex also contains trichomes (Pl. 20, figs. 1–6). Apices of trichomes and papillae are usually broken.

Accumulations and numerous individual pollen grains were found on the surface of carpel apices (Figs. 3a–3e); pollen grains belong at least to three morphological types and probably to three or more taxa.

Comparison. *F. sarbaensis* sp. nov. is the most similar to the Albian–Cenomanian *F. kubaensis* (Maslova et al., 2011) differing in a number of features. Three different types of trichomes and lenticel-like structures were described for the *F. kubaensis* infructescence axis while the species under study has trichomes developing on one epidermal cell of the axis. Unlike *F. kubaensis* with linear perianth elements free from the base and almost parallel margins, in *F. sarbaensis* sp. nov. perianth elements are densely adjoined resulting in their uncertain shape. Numerous trichomes and papillous cells in the epidermis of carpel apex and absence of stylodium also distinguish the new species from *F. kubaensis*. *F. sarbaensis* sp. nov. differs from all other species of the genus in the presence of median papillae on the epidermal cells of carpel apex.

Remarks. The pollen grains found on the surface of carpel apices are small and have granular aperture membrane. They differ in some features and were divided into three types based on these differences. The pollen grains were measured by photographs received with SEM; 12 specimens of the first type, 18 specimens of the second type and 4 of the third type

Plate 19




Explanation of Plate 19

**Figs. 1–10.** *Friisicarpus sarbaensis* sp. nov.: (1)–(4) general view of a head: (1) specimen PIN, no. 417/89; (2) specimen PIN, no. 417/95; (3) holotype PIN, no. 417/88, separate head from the axis in fig. 6; (4) specimen PIN, no. 417/98; (5), (6) axis fragment with capitate infructescences: (5) specimen PIN, no. 419/59; (6) holotype PIN, no. 417/88; (7)–(10), SEM: (7), (8) specimen PIN, no. 417/10, infructescence fragments; (9), (10) specimen PIN, no. 417/10, upper view of a fruit.

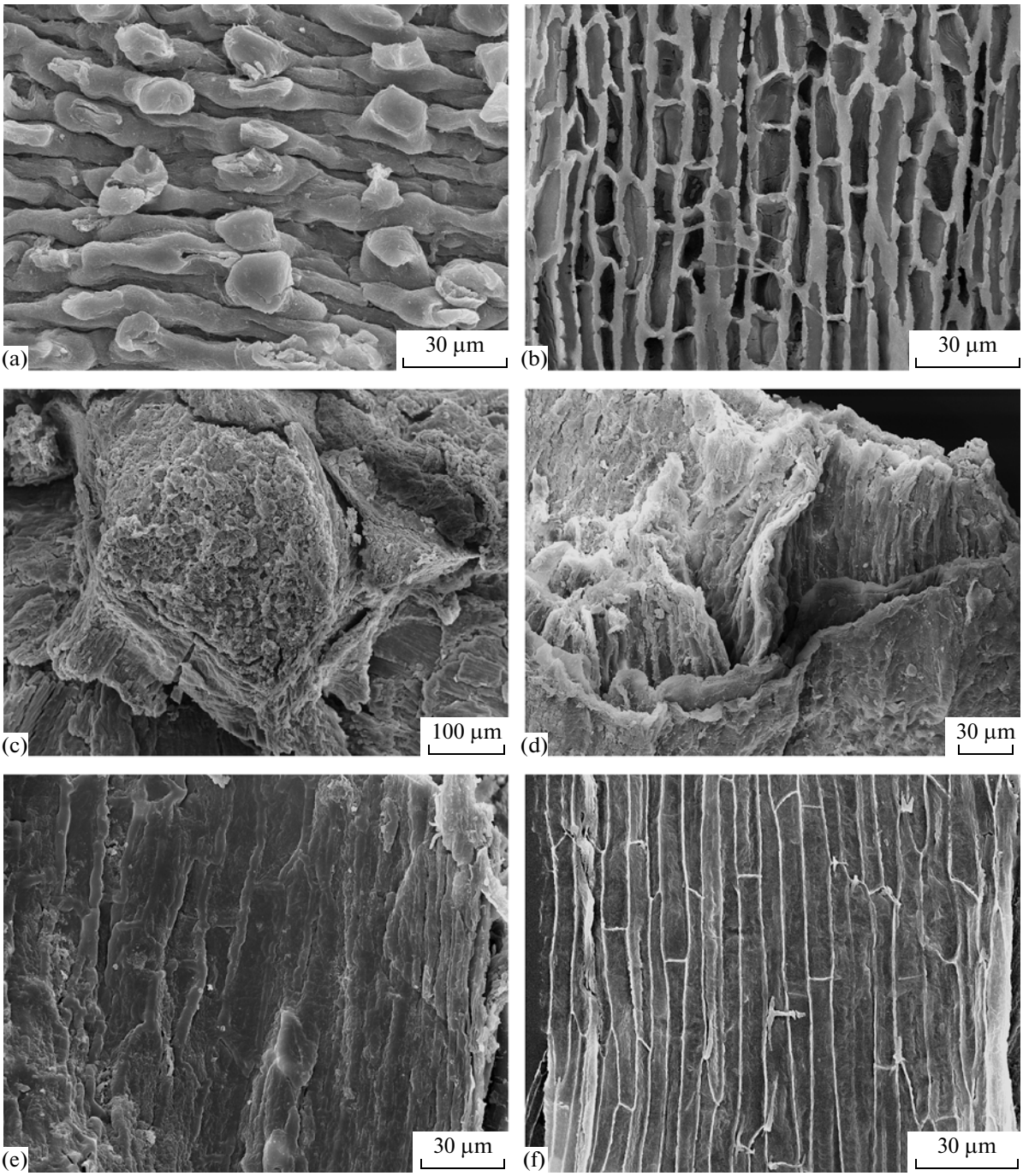



**Fig. 1.** *Friisicarpus sarbaensis* sp. nov., SEM: (a) specimen PIN, no. 417/95, cuticle of infructescence axis with trichomes; (b) specimen PIN, no. 417/95, inner surface of axis cuticle; (c) holotype PIN, no. 417/88, scar of the detached fruit with remains of perianth; (d) specimen PIN, no. 417/10, perianth elements arranged in several whorls; (e) specimen PIN, no. 417/10, cuticle of outer perianth elements, outer surface; (f) specimen PIN, no. 417/10, cuticle of outer perianth elements, inner surface.

were measured. The pollen grains of the first type are distinctly tricolporate with finely reticulate sculpture (Figs. 3f, 3g), the polar axis is 14.69 (11.6–18.2) μm, the equatorial diameter is 12.16 (9.2–14.4) μm, the colpus length is 8.59 (5.8–11.5) μm. The os diameter is about 2.0 (1.85–2.2) μm; muri are about 0.14–0.15 μm thick, triangular in cross section; there are is six to nine lumina within 3 μm. The pollen grains of the second type (Figs. 3b–3d) with finely reticulate sculpture are possibly also tricolporate though it cannot be determined with confidence as on the SEM photograph the colpi are closed. The polar axis is 12.6

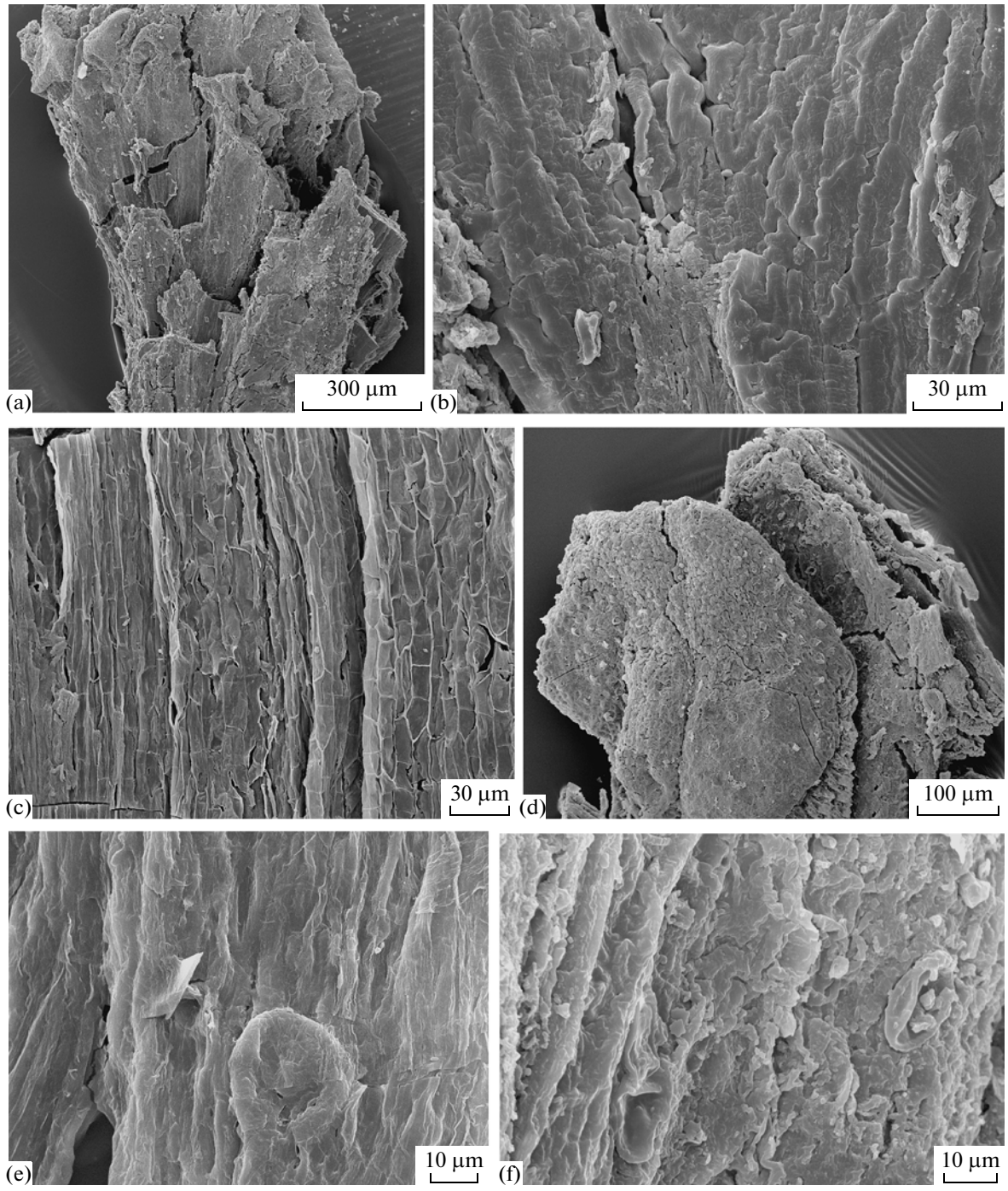



**Fig. 2.** *Friisicarpus sarbaensis* sp. nov., SEM: (a) specimen PIN, no. 417/10, fruit fragment with remains of several whorls of perianth; (b) specimen PIN, no. 417/10, cuticle of inner perianth elements, outer surface; (c) specimen PIN, no. 417/10, cuticle of inner perianth elements, inner surface; (d) holotype PIN, no. 417/88, apices of two carpels; (e), (f) specimen PIN, no. 417/10, cuticle of central carpel region with rare trichomes.

(9.4–14.1) μm; the equatorial diameter is 10.08 (8.6–11.7) μm; the colpus length is 8.76 (6–12.1) μm; the muri are about 0.3 μm thick, rounded triangular in cross section; there are five to eight lumina within 3 μm. Four pollen grains of the third type were found. They are tricolporate, with coarsely reticulate sculpture (Figs. 3d, 3e). The polar axis is about 13.1 (10.93–15.25) μm; the equatorial diameter is about 11.75 (8.6–13.6) μm; the colpus length is about 9.92 (7.93–11.9) μm; the muri are from 0.2 to 0.7, mainly 0.4–0.6 μm thick, rounded triangular in cross section; there are three lumina within 3 μm.

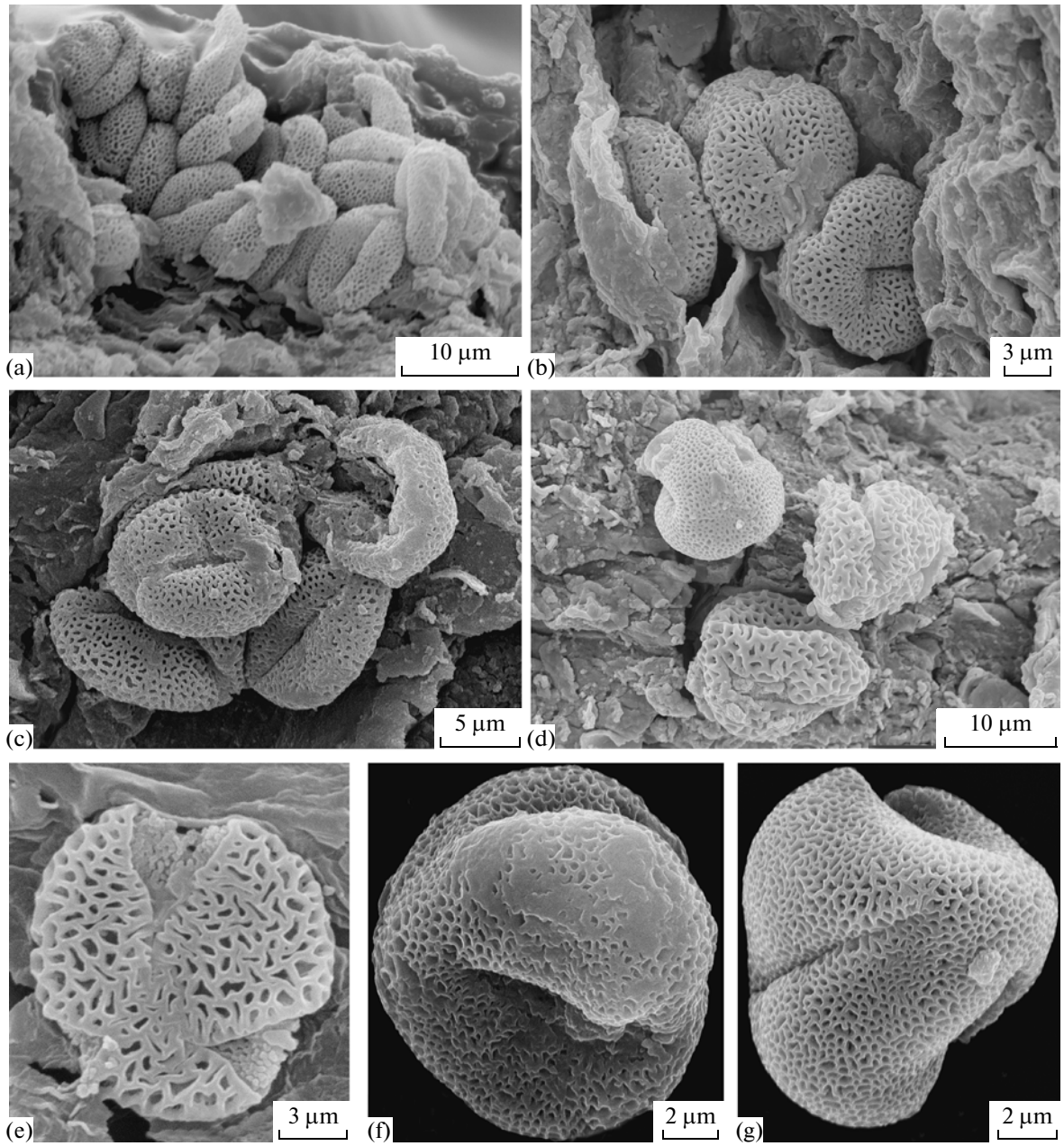
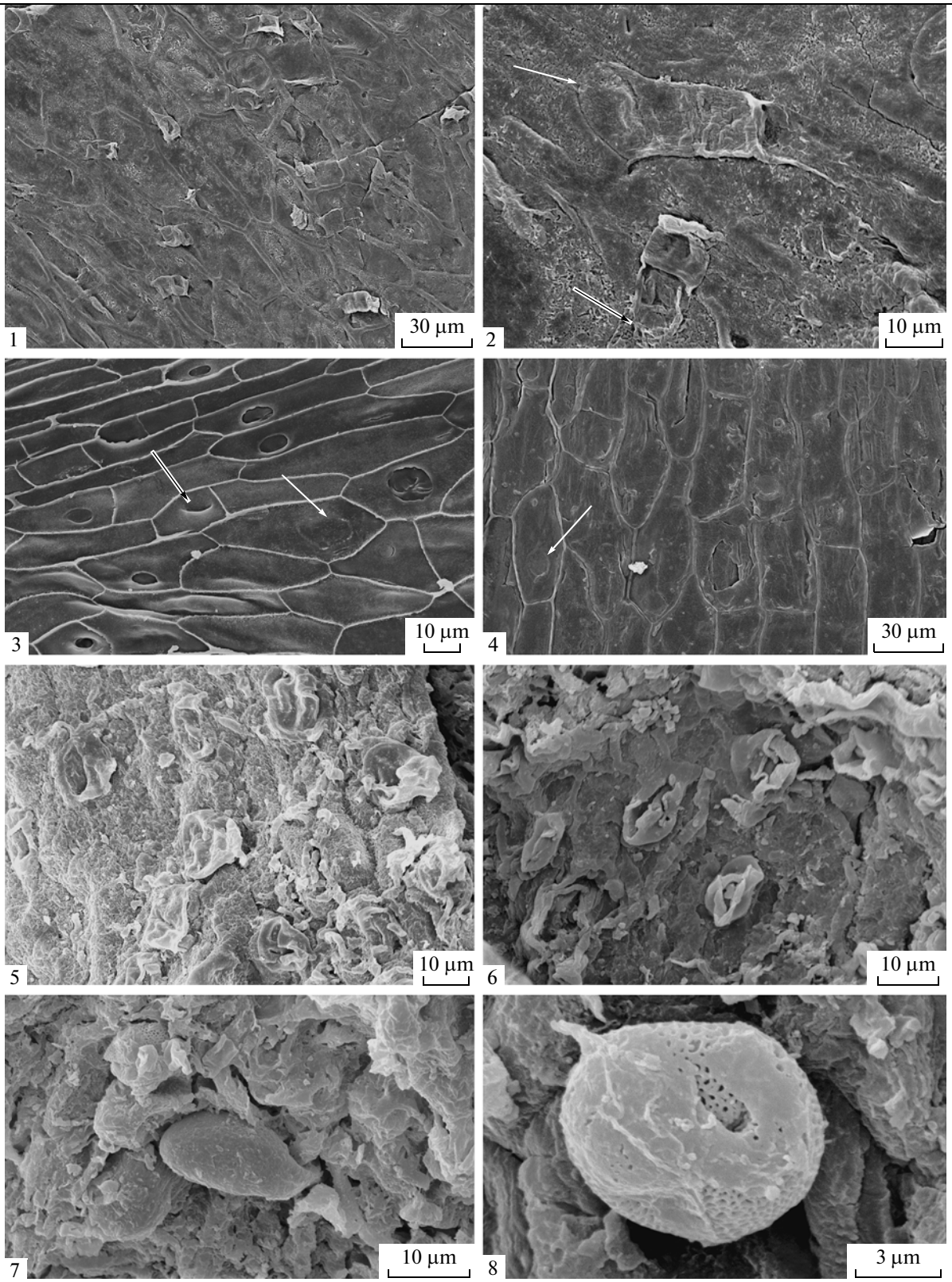



**Fig. 3.** Pollen grains found on the carpel surface of *Friisicarpus sarbaensis* sp. nov., holotype PIN, no. 417/88, SEM: (a) accumulation of pollen grains; (b) several pollen grains of the second type, polar view; (c) accumulation of pollen grains of the second type, equatorial view; (d) one pollen grain of the second type, polar view (upper left), two pollen grains of the third type, polar view (right middle) and equatorial view (lower); (e) pollen grain of the third type, polar view, granular membrane of a colpus is well seen; (f) pollen grain of the first type, equatorial view, os is well seen; (g) pollen grain of the first type, polar view.

Explanation of Plate 20

**Figs. 1–8.** *Friisicarpus sarbaensis* sp. nov., SEM: (1)–(6), holotype PIN, no. 417/88: cuticle of carpel apex after maceration (1–4) and not macerated cuticle (5–8): (1), (2) outer surface, papillae and trichomes, white arrow points to the trichome base, black arrow points to the cell with papillae; (3), (4) inner surface, white arrow points to the trichome base, black arrow points to the cell with papillae; (5), (6) cuticle of carpel apex with trichomes and cells with papillae; (7), (8) specimen PIN, no. 417/10, pollen grains stuck to the carpel surface and covered with mucus; mucus was probably secreted by the trichomes and epidermal cells with papillae.

Plate 20



M a t e r i a l. Two specimens of infructescences on the axis and 6 specimens of heads from the type locality.

## DISCUSSION

**General architecture of infructescence.** Compound infructescence of *F. sarbaensis* sp. nov. consists of axis with numerous sessile heads (the maximal number of preserved heads on the axis is nine). The axial epidermis bears frequently distributed trichomes developed on one cell. The trichomes in the epidermis of inflorescence and infructescences axes are known for the recent plane tree and some Proteaceae (Carpenter, Hill, and Jordan, 2005), and also were found in the extinct genera *Bogutchanthus* N. Maslova, Kodrul et Tekleva, family Bogutchanthaceae, Hamamelidales (Maslova, Kodrul, and Tekleva, 2007) and *Sarbaicarpa*, Sarbaicarpaceae, Sarbaicarpales (Maslova, 2009), which mosaically combine features of the families Platanaceae and Hamamelidaceae. The new species resembles Albian–Cenomanian *Friisicarpus kubaensis* (Maslova et al., 2011) in numerous trichomes developed on one epidermal cell of infructescence axis but the latter has trichomes of three types (except type described for *F. sarbaensis* sp. nov., it has also trichomes developed on the contact of two or more cells and trichomes developed in the epidermis and surrounded by 8–10 smaller cells (in comparison with the most of ordinary epidermal cells). *F. kubaensis* also differs in the presence in epidermis of lenticel-like structures, which are morphologically similar to the lenticels of recent plane tree.

The heads of recent plane tree, as well as of the most extinct platanoid genera consist of relatively massive central core surrounded by variously pressed flowers. The borders of separate flowers are almost indistinguishable in recent plane tree as the flowers lack developed perianth and are densely pressed to each other. In extinct platanoids, particularly in *Friisicarpus*, the perianth is well developed and often consists of several whorls, in consequence of this the borders between the flowers are well-pronounced.

Species of *Friisicarpus* differ in the number of fruits per head: *F. marylandensis* and *F. carolinensis* have about 100 fruits (Friis, Crane, and Pedersen, 1988), *F. brookensis* (Crane et al., 1993) has more than 50, and 50 flowers were also mentioned for *Friisicarpus* sp. (Maslova and Herman, 2006). Number of flowers in inflorescences of *F. elkneckensis* (Crane et al., 1993) was not indicated. The heads of *F. sarbaensis* sp. nov. are composed of more than 60 fruits. The heads of *F. kubaensis* also comprise more than 60 (up to 100) fruits. It was pointed out that *F. dakotensis* had 20 flowers in the infructescence (Wang et al., 2011), but this number was established by scars on the central core left by detached fruits with visible imprint surface and therefore is only a part of total number of fruits in infructescence.

The Late Cretaceous *Quadriplatanus* Magallón-Puebla, Herendeen et Crane, Bogutchanthaceae (Magallón-Puebla, Herendeen, and Crane, 1997) has about 40 flowers in a head, the infructescences of Eocene *Macginicarpa* Manchester, Platanaceae comprise up to 60 flowers (Manchester, 1986).

**Perianth.** The perianth of *Friisicarpus sarbaensis* sp. nov. almost completely envelopes fruit, only the gynoecium apex remains free. The perianth elements are arranged in several (probably three or four) whorls. Outer and inner perianth elements are almost equally long. *F. brookensis* and *F. marylandensis* have well-developed, almost as long as a fruit perianth but they differ in the length of inner and outer elements: outer perianth elements are slightly shorter than the inner. The shape of perianth elements of a new species is unknown as they are densely pressed to each other and envelope gynoecium like a flower tube. Unlike *F. sarbaensis* sp. nov., *F. brookensis* and *F. elkneckensis* have spade-shaped, wider in the central region perianth elements; perianth elements of *F. kubaensis* are free from the base, linear, with almost parallel margins. The perianth of *F. carolinensis* is one-third of a fruit length; its elements are shorter and wider. The perianth of *F. dakotensis* was not described.

As with *F. kubaensis*, the cuticle of outer perianth elements of *F. sarbaensis* sp. nov. is stronger and elements of its inner whorls are less cutinized.

**Gynoecium.** Recent *Platanus* L. has apocarpous gynoecium composed of inconstant number of elements (five to eight, rarely three to nine carpels), which are arranged in two or three whorls, with developed stylodia. Extinct Platanaceae have constant number of carpels: *Friisicarpus* and *Macginicarpa* had five carpels per fruit.

All species of *Friisicarpus* have narrowly triangular fruits; they may differ in the presence or absence of stylodia, variously developed fruit apices, and epidermal peculiarities of fruit walls. *F. sarbaensis* sp. nov. lacks stylodia. Short stylodia are known only for Albian *F. dakotensis*, Albian–Cenomanian *F. kubaensis* and Santonian–Campanian *Friisicarpus* sp. (Friis, Crane, and Pedersen, 1988). Of extinct platanoids, pentamerous infructescences of *Macginicarpa* have well-developed stylodia (Manchester, 1986).

The new species is most similar to *Friisicarpus elkneckensis*, *F. kubaensis*, *Friisicarpus* sp. from the Cenomanian of West Siberia (Maslova and Herman, 2006) and *Friisicarpus* sp. 2 from the Albian–Cenomanian of North America, Kansas (Wang, 2008) in the shape of apical fruit extension but differs from them in the presence of numerous median papillae on the epidermal cells of apical fruit extension.

Peculiarities of epidermal structure of the fruit wall were described for *F. carolinensis* (Friis, Crane, and Pedersen, 1988) and *F. kubaensis*. The ordinary epidermal cells of *F. carolinensis* are longitudinally extended, with straight anticlinal walls, and arranged

in well-pronounced longitudinal rows. Various regions of the fruit wall of *F. kubaensis* differ in the epidermal structure. In *F. kubaensis* the epidermal cells of carpels in the fruit base are longitudinally extended and have straight anticlinal walls that resembles the epidermis morphology of *F. carolinensis*. However, in the central region of the fruit of *F. kubaensis* the epidermis cells are more or less square or rhombic, with straight thickened anticlinal walls, and some of them bear median papillae. Dome-shaped, probably, glandular trichomes with rounded cutinized base may also occur. The apical part of fruits of *F. kubaensis* bear frequent anomocytic stomata and oval or rounded trichome bases. The epidermal cells of fruit wall of *F. sarbaensis* sp. nov., as well as of *F. kubaensis* bear median papillae; the trichomes were also found in the carpel epidermis of a new species. The trichomes and papillae on the epidermal cells look almost identical on the outer surface of the carpel epidermis in *F. sarbaensis*. They can be distinguished by studying the inner cuticle surface. In the case of trichomes developed on one epidermal cell, periclinal walls with rounded or oval, from 15 to 30 μm in diameter trichome bases are observed (Pl. 20, figs. 3, 4, white arrow). Meanwhile the periclinal walls with median papillae are not continuous but perforated by circular or oval apertures up to 10 μm in diameter, which correspond to the papillae bases (Pl. 20, figs. 2, 3, black arrow).

Large median papillae are also known for the epidermal cells of seeds of *F. kubaensis*. Unfortunately, the seeds of *F. sarbaensis* sp. nov. are unknown.

The fruit walls of Coniacian–Santonian *Quadriplatanus georgianus* Magallón-Puebla, Herendeen et Crane, Bogutchanthaceae (Magallón-Puebla, Herendeen, and Crane, 1997) and Cenomanian–Turonian *Sarbaicarpa shilinii* N. Maslova, Sarbaicarpaceae (Maslova, 2009) bear peltate trichomes, which probably performed the glandular function.

The trichomes with probable glandular function on the carpel surface were first described for *Friisicarpus kubaensis* (Maslova et al., 2011); the fruits of all previously known species of this genus are not hairy. The carpels of recent *Platanus* are variously covered with hairs.

Presence of mucus on the carpel apices was mentioned for *Friisicarpus* sp. 1 (Wang, 2008). Data on the epidermis structure of *Friisicarpus* sp. 1 were not adduced (Wang, 2008). The carpel apices of *F. sarbaensis* sp. nov. also bear traces of mucus, which was possibly secreted by trichomes and epidermal cells with median papillae. Some pollen grains, which stuck to the carpel surface of *F. sarbaensis* sp. nov., are completely covered with mucus and the reticulate sculpture of their surface is not discernible (Pl. 20, figs. 7, 8). This mucus and substance secreted by glandular trichomes of *F. kubaensis, Quadriplatanus* and *Sarbaicarpa* possibly could attract insects and hold pollen together during pollination.

**Pollen grains.** The morphological types of pollen grains found on the carpel surface of *F. sarbaensis* sp. nov. are known for many dicotyledons, including platanoids and hamamelids. The pollen grains of the first type are most similar in the external sculpture to the Late Cretaceous and Paleocene platanoids (*Quadriplatanus*, *Platanus quedlinburgensis* Pacltova emend. Tschan, Denk et von Balthazar (Tschan, Denk, and von Balthazar, 2008), *Platananthus spersae* Pigg et Stockey (Pigg and Stockey, 1991), and pollen grains on the surface of *Friisicarpus kubaensis*). The pollen grains of the second type are similar to that of *Hamatia* Pedersen, Friis, Crane et Drinnan (Pedersen et al., 1994), *Sarbaya* (Krassilov and Shilin, 1995) and *Platananthus potomacensis* Friis, Crane et Pedersen (Friis, Crane, and Pedersen, 1988). The pollen grains of the third type may be compared to that of *Platananthus hueberi* Friis, Crane et Pedersen (Friis, Crane, and Pedersen, 1988). This is the only known extinct platanoid species, whose pollen grains have coarsely reticulate sculpture. *Hamatia, Sarbaya*, and material under study have tricolporate pollen grains. Considering the morphological differences of studied pollen types, it is rather the association of infructescences of *F. sarbaensis* sp. nov. and pollen grains of several taxa than variability of pollen characters within one species. In the following we plan to study in detail the pollen grains of revealed morphotypes with light (LM), scanning electron (SEM) and transmission (TEM) microscopes. The consistent study of pollen grains with LM, SEM and TEM will reveal their systematic position and diversity.

**The assemblage of similar to Platanaceae and Hamamelidaceae fossils from the Sarbay locality.** Several taxa related to Platanaceae are known from Sarbay locality: *Platanus*-like leaves of *Ettingshausenia sarbaensis* (Maslova and Shilin, 2011), infructescences of *Sarbaicarpa* (Maslova, 2009), and staminate inflorescences of *Sarbaya* (Krassilov and Shilin, 1995). Although finds of reproductive structures are very similar in their macromorphology, the morphological and anatomical features imply their referring to the genera from different families.

In addition to the infructescences of *Friisicarpus sarbaensis* sp. nov., infructescences of *Sarbaicarpa* were also described from this locality (Maslova, 2009). The infructescences of both genera have very similar heads; however micromorphological studies revealed considerable differences in their structure. The infructescence of *Sarbaicarpa* is composed of approximately 30 fruits, which are irregularly arranged, widely wedge-shaped, monocarpellate, and lack stylodium. The bundle of hairs is located at the fruit base. The ovule is single, anatropous. Two types of sterile structures are developed: hemispherical, comparable to the fruits in size, covered with frequent rounded trichomes, and narrow, linear, longer than half of the fruit length. Based on the unique mosaic combination of features of the families Platanaceae and Hamamel-

idaceae this genus was referred to the extinct family Sarbaicarpaceae, Sarbaicarpales (Maslova, 2010).

The staminate inflorescences found in the Sarbay locality are externally similar to the heads of recent *Platanus* but differ in the micromorphology. The flowers in staminate inflorescences of *Sarbaya*, Bogutchanthaceae (Krassilov and Shilin, 1995) are tetramerous, have strongly reduced, shorter than one-third of a stamen length perianth, tetrasporangiate stamens, and tricolporate pollen grains. In addition to *Sarbaya*, other staminate inflorescences were also found in the Sarbay locality, which have distemonous flowers with a well-developed perianth, which is considerably longer than androecium, bisporangiate stamens, and tricolporate pollen grains with peculiar reticulum (study in progress).

The *Platanus*-like leaves were also found in this locality. Initially in Shilin's monograph (1986) these leaves were referred to two species of *Platanus*, *P. pseudoguillelmae* and *P. cuneiformis* based on the general morphology and without consideration of cuticular-epidermal features. Later (Maslova and Shilin, 2011) two types of the leaf blades have been distinguished based on the analysis of the morphological and cuticular-epidermal features of the Sarbay leaves. These types correspond to the species *P. pseudoguillelmae* (morphotype 1) and *P. cuneiformis* (morphotype 2) and are united by transitional forms into one variational row. The unique epidermis structure was first reveled for the fossil *Platanus*-like leaves: combination of encyclocytic, laterocytic, and paracytic types of stomata and presence of trichomes developing on one or from two to seven epidermal cells. Common for both morphotypes cuticular-epidermal features are quite specific and allow to unite these finds into one species. Two morphotypes (*P. pseudoguillelmae* and *P. cuneiformis* sensu Shilin, 1986) are considered as a group of sun and shade leaves of *Ettingshausenia sarbaensis* based on variations of morphological and epidermal features.

The pollen grains found on the carpel surface of *F. sarbaensis* sp. nov. and pollen grains extracted from the staminate inflorescences of *Sarbaya* are small, have finely reticulate sculpture and tricolporate apertures. In spite of their general similarity, they probably belong at least to three taxa as they have a number of features, by which they can be distinguished in dispersed state. Four pollen grains with coarsely reticulate surface, which were also found on the carpel surface of *F. sarbaensis* sp. nov., considerably differ from all known recent and fossil platanoids except for *Platananthus hueberi*. The results of more detail study and analysis of pollen grains associating the infructescences of *F. sarbaensis* sp. nov. will be published in a separate paper.

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