Infructescences of *Kasicarpa* gen. nov. (Hamamelidales) from the late Cretaceous (Turonian) of the Chulym-Yenisey depression, western Siberia, Russia[*]

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ABSTRACT. *Kasicarpa* gen. nov. is erected for pistillate heads from the Turonian deposits of the Chulym-Yenisey depression, western Siberia, Russia. The heads consist of about 30–40 oral units at different development stages. Flowers of the new described genus have a well-developed perianth and monocarpous gynoecium. The fruit has a single orthotropous seed. The well-preserved seed has a single integument (one single cell layer) and thick endosperm. The new genus combines characters of the families Platanaceae and Hamamelidaceae. The leaves of a platanoid morphology associating with these heads have been previously described as *Populites pseudoplatanoides* I. Lebedev, 1955.

KEY WORDS: fossil, reproductive structures, microstructure, Hamamelidales, late Cretaceous, Russia

INTRODUCTION

The evolutionary history of the Platanaceae and Hamamelidaceae are entirely different. Currently, the Platanaceae is a monotypic family: the genus *Platanus* is the single remnant of a once extensive and diverse plant group. In contrast, the Hamamelidaceae comprises four subfamilies (Endress 1989a) and about 30 genera (Zhang & Lu 1995). The extant members of the Hamamelidaceae are fairly diverse in their vegetative and reproductive morphology.

To date, fifteen extinct genera of the Platanaceae are described on the basis of their reproductive morphology. Among them, are pistillate heads *Macginicarpa* (Manchester 1986), *Platanocarpus* (Friis et al. 1988), *Tanyoplatanus* (Manchester 1994), and *Oreocarpa* (Maslova & Krassilov 2002), staminate heads *Tricolpopollianthus* (Krassilov 1973), *Platananthus* (Manchester 1986), *Aquia* (Crane et al. 1993), *Hamatia* (Pedersen et al. 1994), *Sarbaya* (Krassilov & Shilin 1995), *Chemurnautia* (Maslova 2002), and *Archaranthus* (Maslova & Kodrul 2003), staminate clusters of *Macginistemon* (Manchester 1986), seeds of *Carinalaspermum* (Krassilov 1976), pistillate and staminate heads of *Quadriplatanus* (Magallón-Puebla et al. 1997), and *Platanites,* originally based on leaves, with the later added pistillate and staminate in orescences (Crane et al. 1988).

The Cretaceous Hamamelidaceae comprises nine genera, among which *Evacarpa* (Maslova & Krassilov 1997), *Lindacarpa* (Maslova & Golovneva 2000a), *Microaltingia* (Zhou et al. 2001), and *Anadyricarpa* (Maslova & Herman

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2004) are close to the subfamily Altingioideae. *Archamamelis* (Endress & Friis 1991), *Allonia* (Magallón-Puebla et al. 1996), *Androdecidua* (Magallón-Puebla et al. 2001), and *Fortunearites* (Manchester 1994) are included in the subfamily Hamamelidoideae. *Viltyungia* (Maslova & Golovneva 2000a) combined characters of the subfamilies Exbucklandioideae, Altingioideae, and Hamamelidoideae.

In the present work the systematics after Cronquist (1981) and Takhtajan (1987, 1991) was followed. There are disagreements between morphological and molecular systematics, in particular concerning the position of the Platanaceae and Hamamelidaceae. According to Cronquist (1981) and Takhtajan (1987, 1991) these families are included in the order Hamamamelidales, while recent molecular studies (e.g. Angiosperm Phylogeny Group 2003) place them in two different orders, the Platanaceae in the Protealeas, and the Hamamelidaceae in the Saxifragales. At the moment it is impossible to resolve the problem for fossil material sa far, for which no molecular data exist, and the question is still pending and need further information accumulated.

The finding of fossil reproductive structures that combined characters of Platanaceae and Hamamelidaceae imply that these families were closely related (Crepet et al. 1992, Maslova & Krassilov 1997, Maslova 2003, and others). Although extant members of the families have distinct reproductive morphologies, fossil platanoids and hamamelids are often similar at the macromorphological level being distinguishable micromorphologically (Maslova & Krassilov 1997, Maslova & Golovneva 2000a, b, Maslova & Herman 2004, and others). The finding of fossil leaves, combining the features of both Platanaceae and Hamamelidaceae, also indicate that these two families are closely related (Golovneva 1994, Maslova 2002).

Kasicarpa gen. nov. is one of such synthetic genera showing a peculiar assemblage of characters diagnostic for the Platanaceae and Hamamelidaceae (subfamilies Altingioideae and Hamamelidoideae). Such an eclectic combination prevents us form assigning it to any of the families. However, the new genus can be safely considered as representing the order Hamamelidales.

MATERIAL AND METHODS

The fossils described here come from the Upper Cretaceous deposits of the Chulym-Yenisey depression (Fig. 1) exposed at the banks of the Kas river, a left tributary of the Yenisey river in its middle course. Plants remains occur in the upper part of the Simonovskaya Formation comprising loose light-gray sandstones with clayey interbeds. The plant-bearing clay lens about 3–4 m wide, 12 m long on the right bank of Kas river 69 km upstream from the mouth was discovered and explored by Lebedev who described the
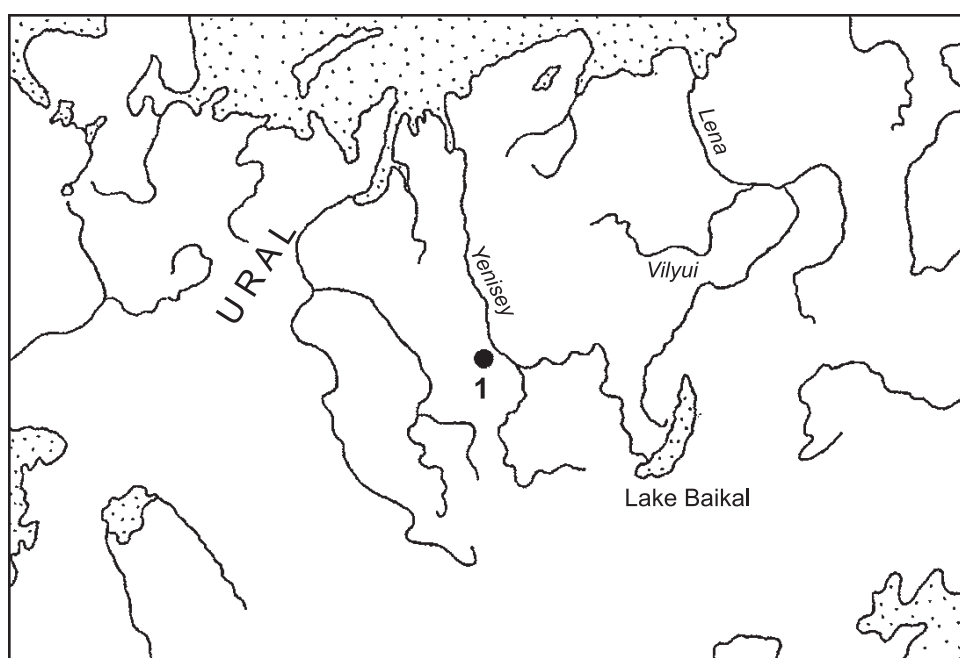

Fig. 1. Localization of the site with fossil plant remains

numerically dominant platanoid remains (Lebedev 1954) and some other plants (Lebedev 1955, 1962) including gymnosperms *Ginkgo*, *Podozamites* sp., "*Taxodium*" sp., and *Sequoia* sp., and angiosperms *Pseudoprotophyllum*, *Platanophyllum*, *Cissites*, *Menispermites*, *Magnoliaephyllum*, *Trochodendroides*, *Cinnamomophyllum*, and *Araliaephyllum*. His collections are currently deposited at the Museum of Tomsk Politechnical Institute (TPI) in Tomsk and Museum of Tumen Oil and Gas Institute (TOGI) in Tumen. Golovneva visited the locality in 2003 and collected additional material, mostly of the same taxa (The Komarov's Botanical Institute in Sankt-Petersburg, Collection 1194). The leaves of a typical platanaceous aspect, described as *Populites pseudoplatanoides* I. Lebed. (Lebedev 1955), prevail among the platanoid remains. They are accompanied by the pistillate heads that are the subject of this paper.

The heads are preserved as compressions, parts of which can be easily removed from the rock. We found that standard maceration with concentrated nitric acid and alkali destroyed the compression. We therefore modified the procedure applying diluted nitric acid for a longer than usual time up to 24 hours. This way we succeeded in extracting a perfectly preserved three-dimensional ovule, that was cleared and studied in transmitted light under dissecting microscope Axioplan 2 (Carl Zeiss, Jena). Several fragments of compression and macerated cuticles were mounted on standard stubs and studied under scanning electron microscope CamScan. Pollen grains, stuck to the surface of the gynoecium, were studied with SEM and TEM. Those prepared for TEM were treated with tetraoxide of osmium before sectioning and the sections were stained after Reynolds (Gayer 1974). The procedure is fully described in Meyer-Melikyan & Telnova (1991).

SYSTEMATIC PALEOBOTANY

Order Hamamelidales Wettstein

Genus *Kasicarpa* N. Maslova, Golovneva & Tekleva, **gen. nov**.

D e r i v a t i o n   o f   t h e   n a m e. From the Kas river and "*carpus*" (Latin) fruit.

T y p e   s p e c i e s. *Kasicarpa melikianii* N. Maslova, Golovneva & Tekleva, sp. nov.

D i a g n o s i s. Compound infructescences with several sessile pistillate heads. Head 5 mm in diameter, with massive receptacle and about 30–40 oral units at different developmental stages. Flowers radially spreading, tightly adpressed, monocarpellate, with a well-developed perianth approximately equal to or somewhat longer than gynoecium in immature owers, about 2/3 of length of ripe fruit. Outer tepals thicker than inner tepals. Ripe fruits obconical, lacking a stylodium, thickly cutinized, hairless, distally with numerous anomocytic stomata. Seed solitary, orthotropous, narrowly ovate, with unitegmic integument, with a single cell layer, slender sclereids and thick endosperm with a distinct aleurone layer.

C o m p o s i t i o n. Type species only.

C o m p a r i s o n. The new genus combines characters of recent and fossil Platanaceae and Hamamelidaceae. The features shared with the Platanaceae are the capitate in orescence, orthotropous ovules, and the structure of spermoderm. Species of extant *Platanus* differ from the new genus in a much greater number of owers per in orescence (up to 300), vestigial perianths, gynoecia of 5–9 carpels, hairy fruits, and simultaneous ripening of fruits. The extinct genera are similar in having well-developed perianths, but differ in several carpels per ower: five in *Platanocarpus* and *Macginicarpa* (Friis et al. 1988, Manchester 1986) and four in *Quadriplatanus* (Magallón-Puebla et al. 1997).

Among the fossil Platanaceae, only *Oreocarpa* (Maslova & Krassilov 2002) has capitate infructescences, in which only one fruit ripens, surrounded by carpellodia. In contrast, in *Kasicarpa* all the owers produce ripe fruits.

When compared to the Hamamelidaceae, *Kasicarpa* shows the closest affinities to the subfamilies Altingioideae and Hamamelidoideae. The altingioid genera *Liquidambar, Altingia* and *Semiliquidambar* are similar in the general architecture of compound unisexual in orescence, ower numbers per head and the non-simultaneously ripening. Their major distinctions are the bicarpellate gynoecia, syncarpous semiinferior ovary and several seeds per fruit. Yet, although the typical gynoecial structure is bicarpellate, monocarpellate gynoecia are occasionally reported in the Altingioideae (Bogle 1986).

Distinct perianths are lacking in the extant genera, but present in such fossil representatives as *Lindacarpa* from the Turonian-Coniacian of the western Siberia (Maslova & Golovneva 2000a). This latter genus has capitate in orescences, as in *Kasicarpa*, and well-developed perianths. The two genera are similar also in the number of owers per

head. However, *Lindacarpa* has bicarpellate gynoecium typical of the Hamamelidaceae.

In the structure of capitate infructescences, *Kasicarpa* resembles *Anadyricarpa* N. Maslova & Herman (Maslova & Herman 2004) from the late Albian – early Cenomanian of northeastern Russia, assigned to the subfamily Altingioideae. The similarities include the number of owers per head, monocarpellate gynoecia, and a well-developed perianth. However, the heads of *Anadyricarpa* are nearly twice larger; the perianth completely envelops the gynoecium, and the ripe fruit is narrowly elliptical.

Among the extant Hamamelidoideae, *Kasicarpa* resembles such genera as *Sycopsis* and *Parrotia* in having a well-developed perianth. Some genera (*Parrotiopsis*) have a monocarpellate gynoecium (Kapil & Kaul 1972). Solitary seed is also typical of this subfamily. The significant distinctions of *Kasicarpa* from all representatives of Hamamelidoideae are the superior ovary, dense capitate infructescences with numerous owers and non-synchronously maturation of fruits.

R e m a r k s. The infructescences of *Kasicarpa* are found in association with the leaves of platanoid aspect previously described as *Populites pseudoplatanoides* I. Lebed. (Lebedev 1955). The reproductive structures and leaves are not in organic connection, but their joint occurrence suggests that they might have been produced by one and the same species.

Kasicarpa melikianii N. Maslova, Golovneva & Tekleva, **sp. nov.**

Figs 2, 3; Pls 1–4

H o l o t y p e. Tomsk Polytechnical Institute, collection no. 29/8b, compound infructescence (Fig. 3).

T y p e   l o c a l i t y. Chulym-Yenisey depression, Kas river.

T y p e   h o r i z o n. The upper part of the Simonovskaya Formation; Turonian.

M a t e r i a l. Two fragments of the compound infructescences with several heads from the type locality (collection no. 29, samples nos. 8, 21).

D e r i v a t i o n   o f   t h e   n a m e. In honour of Professor A.P. Melikyan from the Lomonosov Moscow State University, Russia.

D i a g n o s i s. As for the genus.

D e s c r i p t i o n. Compound infructescence consists of a ribbed axis, 2 mm thick, bearing several alternate heads of about 5 mm in diameter. Up to six heads are preserved on one axis. The heads are sessile, irregularly distributed along the axis at a distance of 2 to 8 mm, more densely crowded towards the apex.

The head consists of a central rounded receptacle 1 mm in diameter and owers/fruits of various developmental stages, from immature carpels to nearly ripe fruits, attached radially to the axis and tightly adpressed to each other. There are rounded scars of various diameters left by the shed fruits. The larger scars obviously mark ripe fruits. The approximate number of owers per head is 30–40. The length of the owers is 0.9–1.1 mm, the width ranges from 0.4 to 0.7 mm depending on their ripeness. The mature fruits are obconical, widening towards the top, attened (Pl. 1, fig. 2). Carpels at the earlier stages of development are cylindrical, of nearly equal width throughout (Pl. 1, fig. 4).

The ower consists of a well-developed perianth and a single carpel. The perianth is roughly equal or somewhat longer than young carpel and about 2/3 of the ripe fruit, with different inner and outer tepals. The cuticle of the outer tepals shows strongly cutinized rectangular or wedge-shaped cells 20–35 µm long,
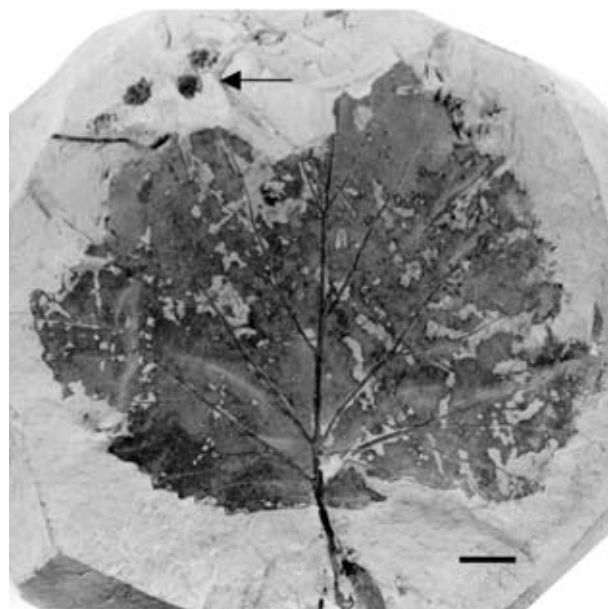
Fig. 2. Compound in orescence (arrow) of *Kasicarpa melikianii* N. Maslova, Golovneva & Tekleva, gen. et sp. nov. (specimen no. 29/8b) and associated *Platanus*–like leaf (specimen no. 29/8a). Scale bar 1 cm
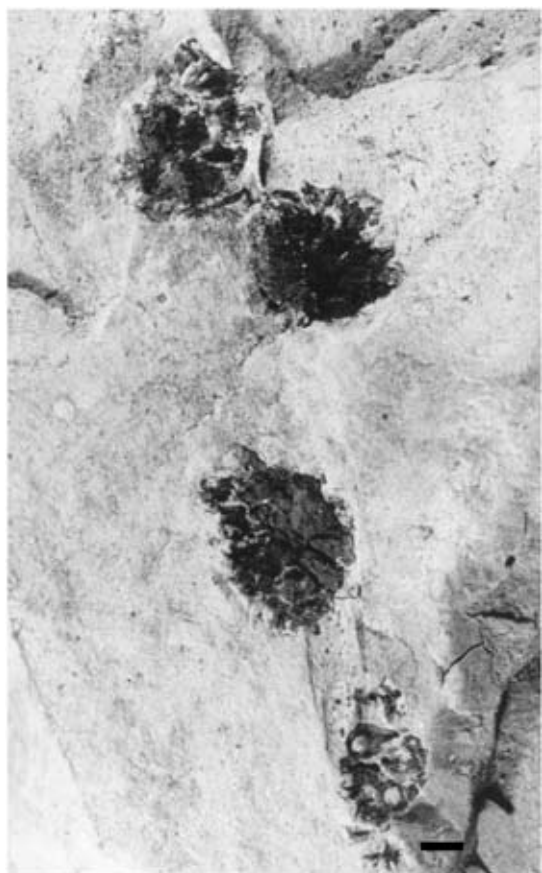
Fig. 3. *Kasicarpa melikianii* N. Maslova, Golovneva & Tekleva, gen. et sp. nov. Sessile spherical heads attached to in o-rescence axis. Specimen no. 29/8b. Scale bar 0.25 cm

8–10 µm wide, arranged in more or less regular rows (Pl. 2, fig. 2). Surface cells of the inner tepals are thinly cutinized, showing slightly undulate anticlinal walls (Pl. 2, fig. 3).

The ripe fruits are obconical, lacking stylodia. The cuticle of exocarp is folded, formed of strongly cutinized polygonal cells varying in outlines and dimensions, about 13–18 µm long, with undulate anticlinal walls. Basal part of fruit is devoid of stomata (Pl. 2, fig. 4), that are rather numerous distally (Pl. 2, fig. 5). The stomata are anomocytic, with 5–6 irregular subsidiary cells. The inner cuticle (of endocarp wall) shows nearly squar to rectangular cells, occasionally triangular or polygonal, arranged in longitudinal rows. The anticlinal and periclinal cell walls are equally heavily cutinized; the plaques of epicuticular wax are clearly seen (Pl. 2, fig. 8).

The fruit contains a solitary and orthotropous seed, with hilum and micropyle on the opposite ends, elongate-ovate, 0.9 mm long, 0.35 mm wide shortly above the base, tapering gradually to the micropylar end and more abruptly to the chalazal end (Pl. 3, fig. 1). The

micropyle is morphologically distinct as a slender beak shortly protruding from beneath the epidermis. The chalaza is relatively massive and darker stained. The hilum is truncate, at.

The seed is transparent, showing at least three cell layers over most of the body (Pl. 3, fig. 2). The epidermis is a colorless single-cell layer of uniform thickness over most of the body, decreasing over chalaza and toward the micropyle, where it is interrupted by the apical beak. The epidermal cells are swollen, hemispherical to nearly spherical, apparently mucilaginous. The evidence of a cuticle is not clear. Over the hilum facet, the epidermis is reduced and the outer layer consists of the radial elongate columnar cells that are discernible over the chalaza, vanishing above. A thin transparent single-cell layer beneath the epidermis consists of slender helically thickened sclereids that are arranged parallel to the long axis of the seed (Pl. 3, fig. 4). The darker inner layer shows longitudinal rows of elongate to fusiform cells about 20–30 µm long, 3–5 µm wide, containing small spherical granules, which correspond to aleurone grains of endosperm in many angiosperm seeds (Pl. 3, fig. 5). Accordingly, the innermost visible layer is interpreted as the starch-storing aleurone layer of a thick endosperm.

The pollen grains adhering to the surface of the carpels are tricolpate, elliptical, the polar axis is 9.0–11.0 µm, the equatorial diameter 14.0–17.5 µm (Pl. 4, fig. 1). The colpi are very long, nearly reaching to the poles. Some pollen have colpi varying in length, with two longer and one shorter, from 3.0 to 7.0 µm (Pl. 4, fig. 2). The exine is reticulate. The lumina vary in shape (rounded to elongate) and size, but not differentiated between the mesocolpia and the margins of colpi, which are indistinctly marked (Pl. 4, fig. 3–4).

In the TEM, the sectioned pollen wall is 1.29 µm thick all over the mesocolpia, showing a perforated tectum of uniform thickness about 0.36 µm (Pl. 4, fig. 5). The infratectal layer is columellate. The columellae are nearly cylindrical, 0.33 µm high, 0.14 µm wide. The foot layer is distinct all over the non-apertural region, 0.36 µm thick (Pl. 4, fig. 6). Under it, there is an electronically less dense, homogenous layer, which probably represents the endexine. This layer is about 0.24 µm. The ectexine decreases sharply towards the colpi

and wedges out at their margin. The apertural region consists of the supposed endexine alone (Pl. 4, fig. 7).

DISCUSSION

General architecture of the inflorescence. Both extinct and extant members of the Platanaceae are characterized by dense capitate in orescences and infructescences. The variations in the head dimensions, number of owers, and oral morphology are diagnostic of the genera in this family. A simple or compound spike is the basic type of in orescence in the extant Hamamelidaceae (Endress 1977). Several genera have simple or compound racemes of variously adpressed elements, or sparse heads. Three extant genera of subfamily Altingioideae, *Altingia*, *Liquidambar*, and *Semiliquidambar*, produce dense capitate in orescences. Microstructure of their reproductive organs is comprehensively studied (Flint 1959, Schmitt 1965, Wisniewski & Bogle 1982, Bogle 1986). In some representatives of the Hamamelidoideae and Exbucklandioideae, the in orescences appear as heads due to a strong compression of the owers.

As noted above, the reproductive structures of recent Platanaceae and Hamamelidaceae are clearly differentiated at the macromorphological level; however, fossil members of these families are very similar in the macromorphology of their fruiting heads, which hinders recognition at the generic and even familial levels (Maslova & Krassilov 1997, Maslova & Golovneva 2000a, b). Among the fossil hamamelidaceous plants, heads occur in the early Cretaceous genus *Anadyricarpa*, late Cretaceous *Lindacarpa* and *Microaltingia*, late Palaeocene – early Eocene *Evacarpa* (subfamily Altingioideae), as well as in the late Cretaceous *Viltyungia*, which is characterized by microstructural characters shared by the subfamilies Exbucklandioideae, Altingioideae and Hamamelidoideae. Also the late Cretaceous genus *Steinhauera* Presl., related to *Liquidambar*, includes morphologically similar heads (Kirchheimer 1943, 1957, Tiffney 1986, Ferguson 1989, Krassilov 1989, 1997).

Manchester (1994) described staminate heads containing in situ pollen in association with racemose infructescences of *Fortunearites*

endressii Manchester. The infructescences are comparable to those of extant *Fortunearia* and *Sinowilsonia*, whereas the staminate in orescences resemble *Hamamelis* and *Corylopsis*. According to Manchester (1994) they must have been produced by different hamamelidaceous plants.

In the general architecture, the in orescences of *Kasicarpa* gen. et sp. nov. resemble extant and extinct members of subfamily Altingioideae, as well as the Platanaceae. There are up to 40 owers per head in extant *Liquidambar* and approximately 35 owers per head in fossil *Anadyricarpa*. The heads of platanaceous genera usually contain a greater number of owers (about 100 in the late Cretaceous *Platanocarpus* and *Platananthus*, up to 300 in extant *Platanus*).

Non-synchronous maturation of fruits in *Kasicarpa* is a feature shared with *Altingia* and *Liquidambar*. Pistillate heads with carpels at different stages of development are known in fossil *Anadyricarpa, Lindacarpa,* and *Evacarpa*. In contrast, heads of platanaceous plants are characterized by simultaneous maturation.

Perianth. In *Kasicarpa* the perianth forms a persistent oral tube reaching up to 2/3 of the carpel length. In this respect the new genus differs from extant *Platanus*, but resembles the extinct genera *Platanocarpus*, *Macginicarpa*, *Platananthus*, *Quadriplatanus*, *Hamatia*, *Tanyoplatanus*, and *Archaranthus* having well-developed perianth.

Flowers with and without perianth are known among the extant hamamelidaceous genera. As a rule, in the Hamamelidoideae, the owers have double tetra- or pentamerous perianth with variously developed calyx and corolla. The tepals are distinct or variously fused. Occasionally, they are fused to the ovary (Bogle 1970, Endress 1989b). The calyx can be distinct in early development only. The owers of extant Altingioideae are naked.

The recent findings confirm that extinct hamamelids had a well-developed perianth. Thus, in *Lindacarpa* (Altingioideae) the perianth was attached slightly above the base of the gynoecium and enveloped nearly entire length of the ower. The petals of *Anadyricarpa* formed a persistent oral tube enveloping the carpel.

Variously developed perianths were found in the extinct Hamamelidoideae. In *Andro-*

decidua, the petals were fusiform, constricted both at the base and apex and partly fused to the outer circle of stamens. In *Archamamelis*, the supposedly differentiated perianth consisted of six to seven triangular basally expanded members. *Allonia* is peculiar in having a differentiated corolla with narrow parallel-margined petals and irregularly developed sepals. *Viltyungia* had a well-developed perianth of broad hairy outer tepals and the narrower inner ones.

As was previously noted (Maslova & Golovneva 2000a, Maslova & Herman 2004), the finds of fossil hamamelidaceous plants with well-developed oral tubes indicate that this structure might have been lost in the perianthless genera of this family in parallel with the Platanaceae.

Gynoecium. *Kasicarpa* is one of a few hamamelids with monomerous gynoecium. Among the fossil Platanaceae, only *Oreocarpa* had heads with one maturing fruit, while the other carpels remained underdeveloped. In the extant *Platanus*, the number of carpels is variable (3–9), whereas it is constantly five in *Platanocarpus* and *Macginicarpa,* four in *Quadriplatanus* and probably in *Platanus hirticarpa* Manchester, three to four in *Tanyoplatanus*.

A syncarpous semiinferior ovary of two carpels is typical of the Hamamelidaceae. However, deviant numbers of one to five carpels occur in *Exbucklandia*, Exbucklandioideae (Kaul & Kapil 1974), one to three in *Parrotiopsis*, Hamamelidoideae (Kapil & Kaul 1972). Monocarpellate gynoecia are occasionally found in species with normally bicarpellate ovaries (Wisniewski & Bogle 1982, Bogle 1986). *Anadyricarpa* from the late Albian-Cenomanian of northeastern Russia (Maslova & Herman 2004) is another monocarpellate hamamelid, differing from *Kasicarpa* in the details of perianth and ripe fruit.

Seed. In *Kasicarpa*, a solitary orthotropous seed is adpressed to, but not coalescent with the walls of the locule. The extant *Platanus* and extinct *Platanocarpus* and *Macginicarpa* also have a solitary orthotropous ovule. The mucous epidermal cells of *Platanus* are fairly similar to those shown in Plate 3, figures 1, 2, 4, 5. In *Liquidambar* and *Altingia* (Altingioideae) the structure of spermoderm is similar to that in the Platanaceae (Melikyan 1973a, b), but the ovules are anatropous, of several dozens per ovary. Solitary ovules are typical of the Hamamelidoideae, although *Parrotiopsis* occasionally produces two ovules per ovary (Kapil & Kaul 1972). After Endress (1989b) in the other subfamilies, the typical numbers are 5–8 (*Disanthus, Exbucklandia, Mytilaria, Chunia*), 10–20 (*Rhodoleia*), 20–30 (*Liquidambar*), and 28–47 (*Altingia*).

Pollen grains. In *Kasicarpa*, the pollen grains adhering to the carpels are tricolpate, reticulate, columellate, as in the other fossil platanoids and hamamelids (Friis et al. 1988, Kvaček & Manchester 2004, Magallón-Puebla et al. 1996, 2001, Pigg & Stockey 1991, Tekleva 2004a, b, Tekleva & Maslova 2004 and others). The extant platanaceous species are more or less uniform in their pollen morphology (Zavada & Dilcher 1986). On the other hand, the extant Hamamelidaceae show a broad spectrum of pollen dimensions (20.0–60.0 μm), shape, apertural type, and sculpture varying from coarsely reticulate to fossulate (Bogle & Philbrick 1980). Among the fossil representatives, *Archamamelis bivalves* had a finer surface reticulum (Endress & Friis 1991). *Allonia decandra* produced much larger coarsely reticulate pollen (Magallón-Puebla et al. 1996). Ultrastucturally, the investigated pollen grains are like in the Platanaceae and some of the Hamamelidaceae except for a thinner foot layer, about one third of the entire ectexine against about one half in the Platanaceae. The layer described as endexine is similarly developed in *Kasicarpa* and extant pollen of the Hamamelidaceae and Platanaceae (Zavada & Dilcher 1986), but differs from the structurally homologous layer in the pollen of fossil forms.

CONCLUSIONS

1. In *Kasicarpa melikianii* gen. et sp. nov. from the Turonian of western Siberia we found monocarpellate gynoecia, an exceedingly rare phenomenon among the extant members of Hamamelidales, implicating a wider range of morphological diversity in the Cretaceous.

2. The new genus shares with both the Platanaceae and Hamamelidaceae such features as the complex capitate in orescence (Platanaceae, Altingioideae), a well-developed perianth forming oral tube (fossil Platanaceae and Hamamelidaceae), solitary ovule (Platanaceae, Hamamelidoideae), and the

structure of spermoderm (*Platanus*, *Liquidambar*, *Altingia*). At the same time, orthotropous ovules occur in the Platanaceae alone, whereas the non-synchronous maturation of owers is a hamamelidaceous feature (Altingioideae) and monocarpellate gynoecia occasionally occur in the Altingioideae and Hamamelidoideae. Using the pollen structure associated with *Kasicarpa* gen. et sp. nov., it is impossible to determine unambiguously the newly described taxon as a member either of the Platanaceae or Hamamelidaceae because of similar pollen structure in these groups; and deficient information about pollen structure of the fossil hamamelids and sporoderm ultrastructure of the modern ones.

3. The combination of characters found in *Kasicarpa* suggests that phylogenetic separation of the Platanaceae and Hamamelidaceae might have not yet been accomplished, while intermediate forms still persisted in the mid-Cretaceous.

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PLATES

Plate 1

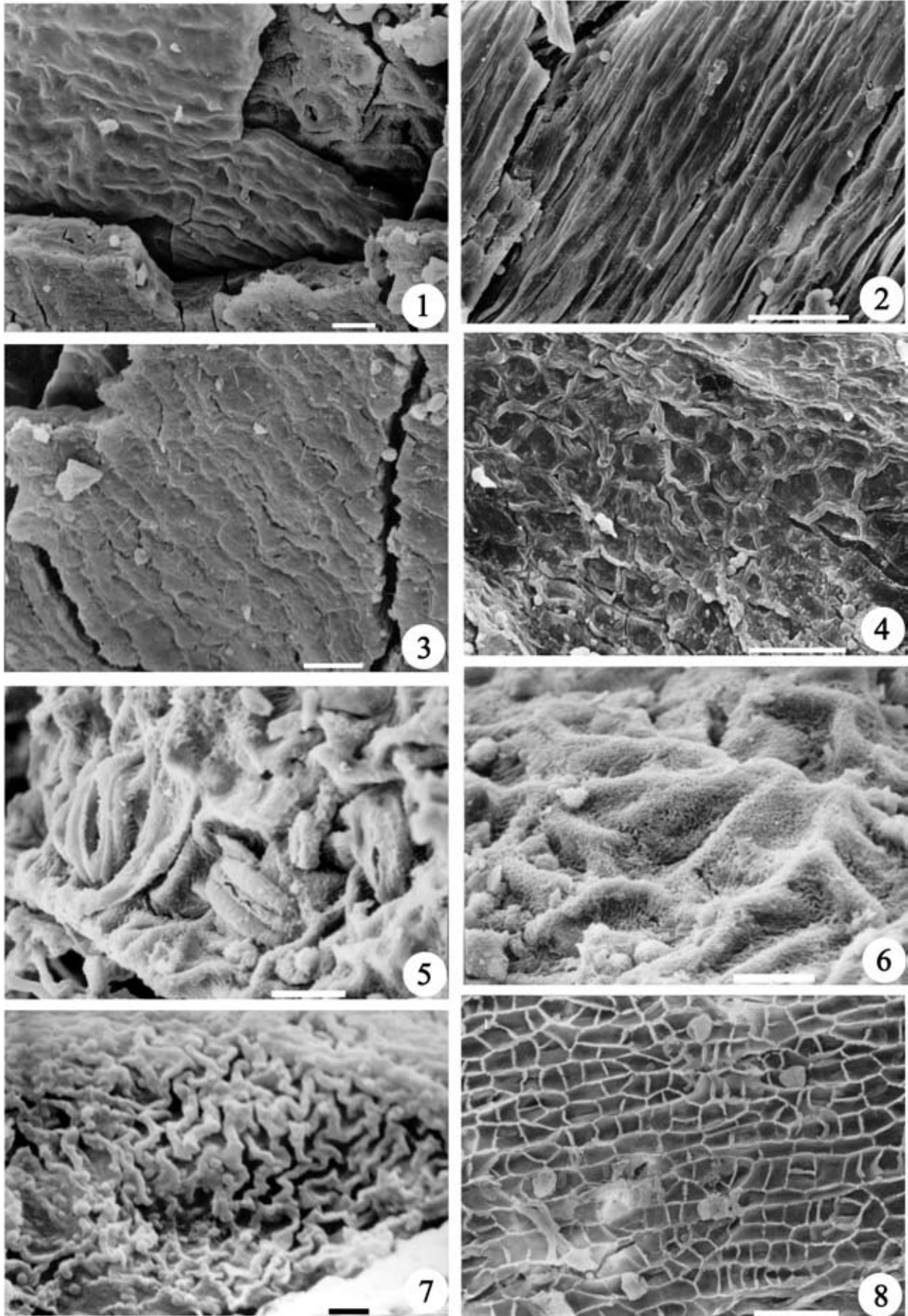*Kasicarpa melikianii* N. Maslova, Golovneva & Tekleva, gen. et sp. nov. Specimen no. 29/8b (SEM)

1. Fragment of an in orescence showing several owers with a well-developed perianth. Scale bar 300 μm
2. Flower in lateral view. Scale bar 300 μm
3. Basal part of two owers. Scale bar 300 μm
4. Undeveloped cylindrical carpel and perianth elements. Scale bar 100 μm
5. Apical view of two mature fruits. Scale bar 100 μm
6. Fragment of in orescence in apical view. Scale bar 100 μm

Plate 1 131
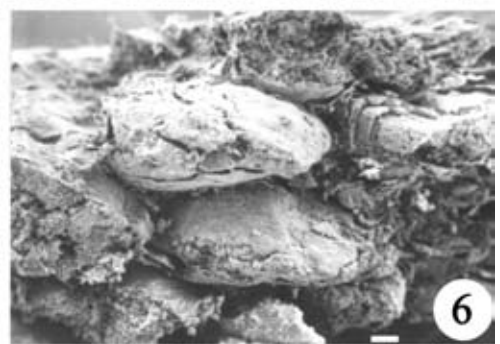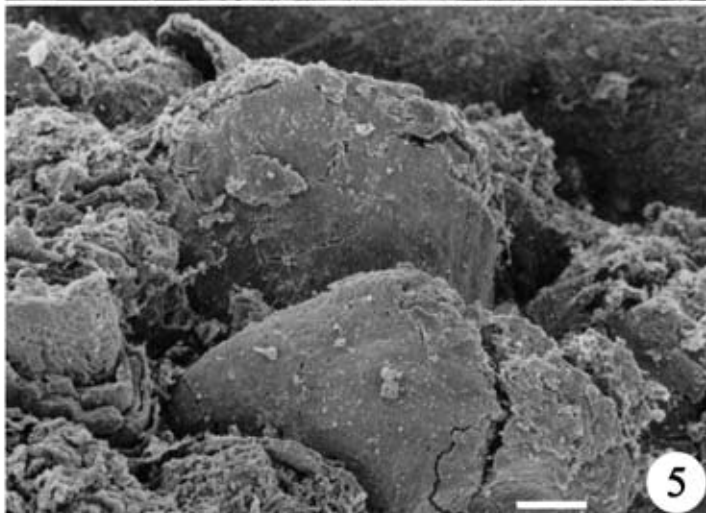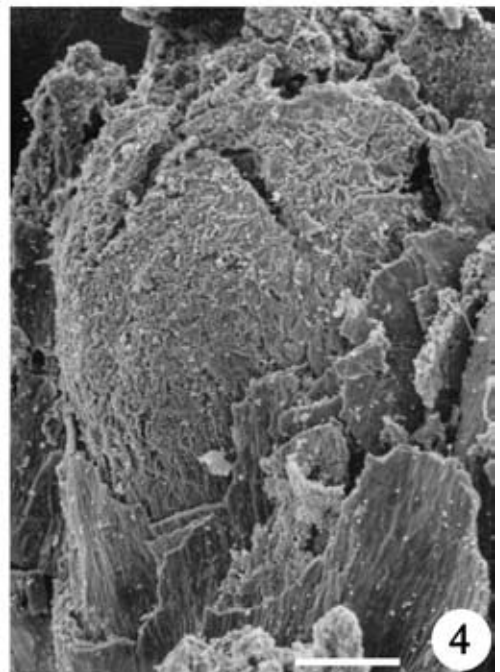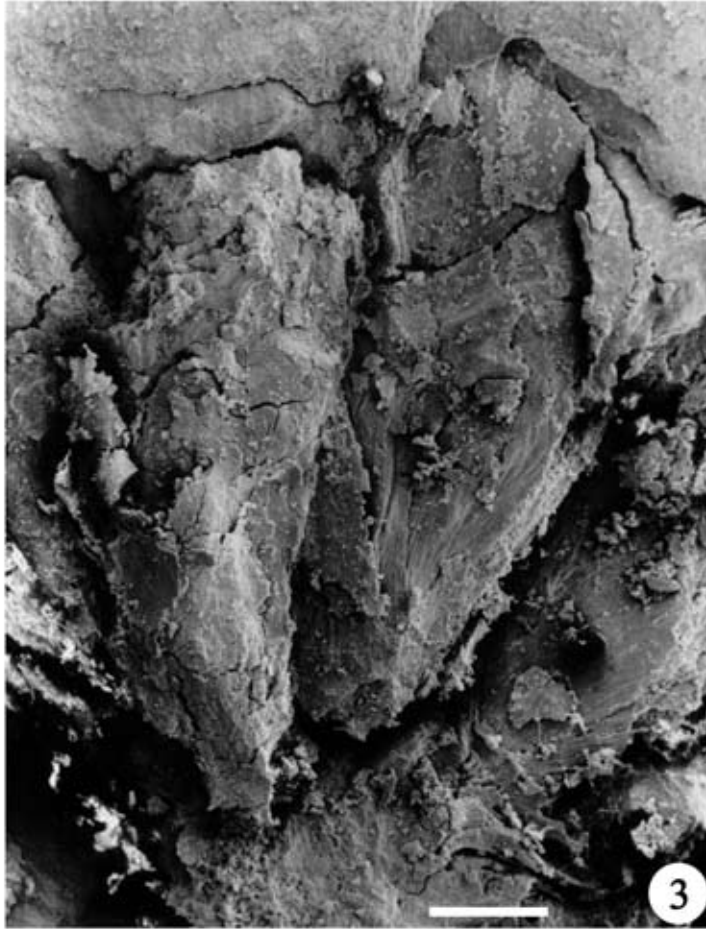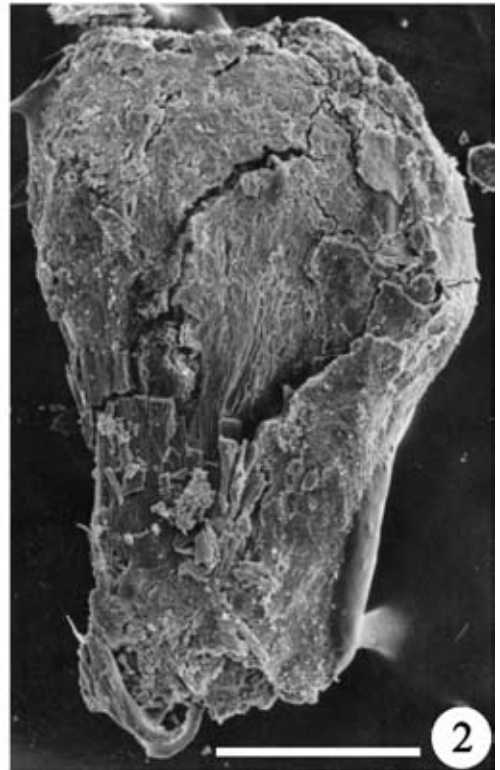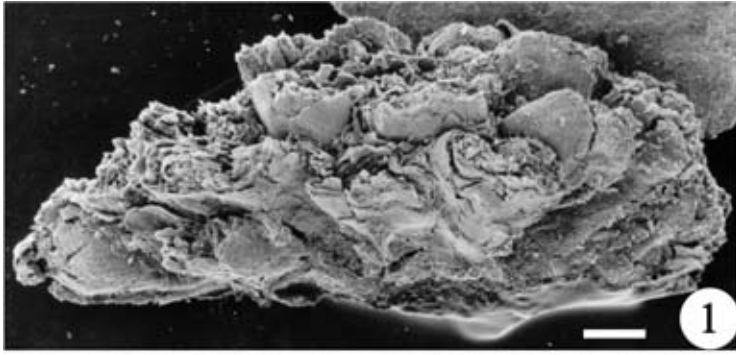
Plate 2

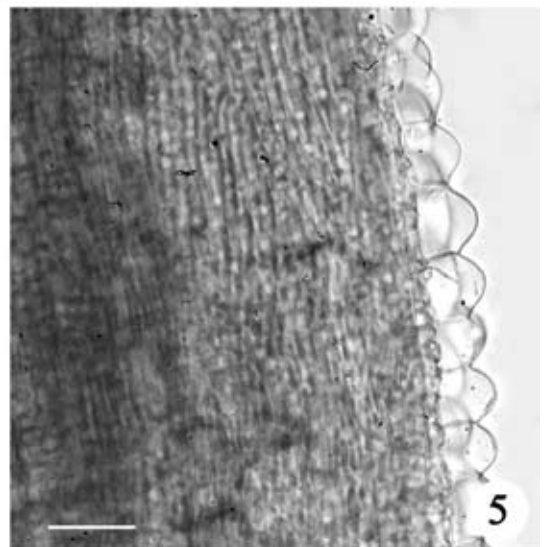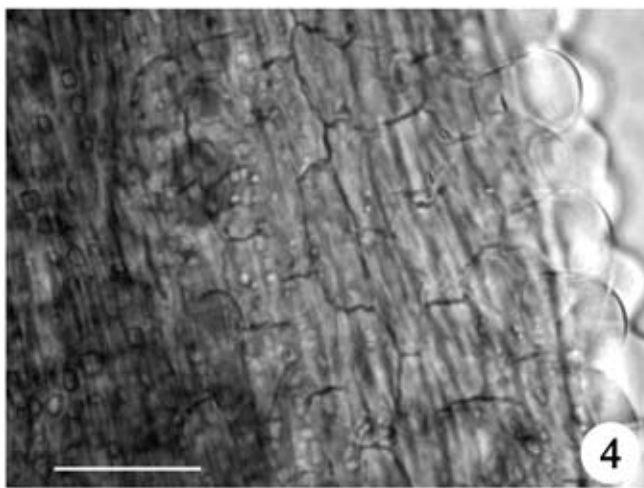*Kasicarpa melikianii* N. Maslova, Golovneva & Tekleva, gen. et sp. nov. Specimen no. 29/8b (SEM)

1. Surface of outer tepals (OT), inner tepals (IT), and carpel (C). Scale bar 10 µm
2. Cuticle of outer tepals showing strongly cutinized cells in regular rows. Scale bar 30 µm
3. Cuticle of inner tepals showing slightly undulate anticlinal walls. Scale bar 10 µm
4. Cuticle of basal part of fruit showing polygonal cells varying in outlines and dimensions. Scale bar 30 µm
5. Cuticle of apical part of fruit with numerous stomata. Scale bar 10 µm
6. Epidermal cells of apical part of fruit. Cuticular fine striation is seen. Scale bar 10 µm
7. Cuticular fine striation of epidermal cells, apical part of fruit. Scale bar 1 µm
8. Cuticle of endocarp wall showing triangular or polygonal cells, arranged in longitudinal rows. Plaques of epicuticular wax are seen. Scale bar 30 µm

Plate 2   133

Plate 3

Kasicarpa melikianii N. Maslova, Golovneva & Tekleva, gen. et sp. nov. Specimen no. 29/8b (LM)

1. Solitary orthotropous seed. Scale bar 100 μm
2. Part of seed showing hemispherical epidermal cells. Scale bar 20 μm
3. Polygonal outlines of epidermal cells showing polygonal outline. Lower focus, than in fig. 2. Scale bar 20 μm
4. Unicellular layer of slender helically thickened sclereids. Lower focus than in fig. 3. Scale bar 20 μm
5. Inner layer showing longitudinal rows of elongate to fusiform cells, which contain spherical granules. The lowest focus. Scale bar 20 μm

Plate 3   135
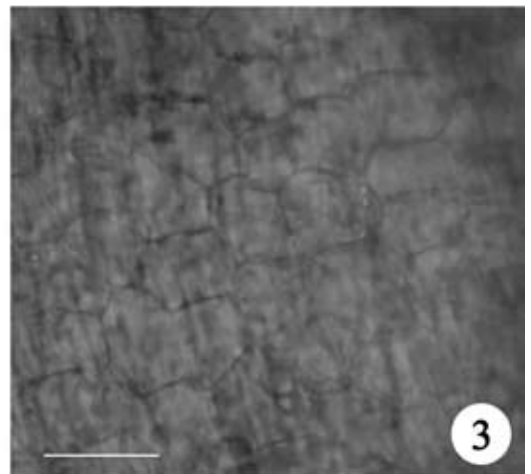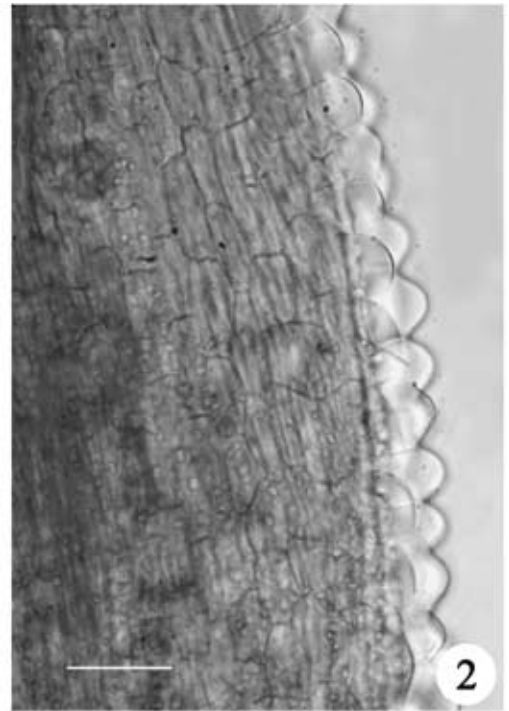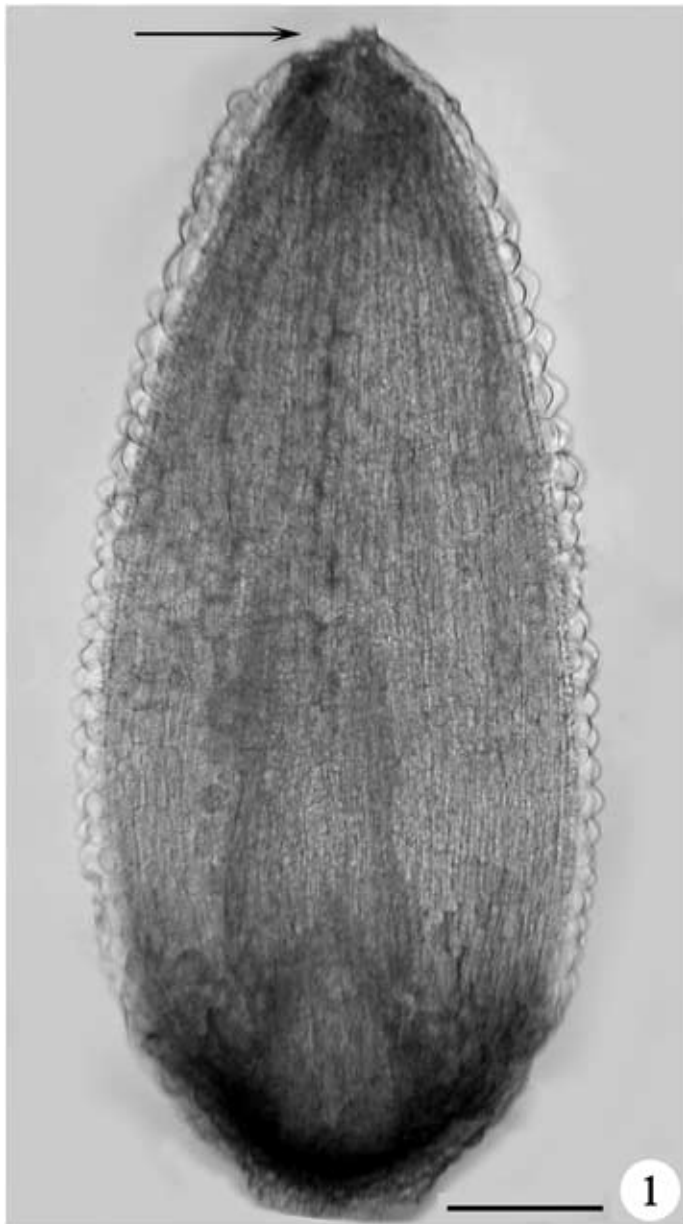
Plate 4

Kasicarpa melikianii N. Maslova, Golovneva & Tekleva, gen. et sp. nov. Specimen no. 29/8b

1. Pollen grains adhering to the surface of the carpels (SEM). Scale bar 10 μm
2–3. Pollen grain, equatorial view (SEM). Scale bar 1 μm
4. Pollen grain, equatorial view showing an occurrence of short colpi (SEM). Scale bar 3 μm
5. The section of pollen grain (TEM). Scale bar 3 μm
6. Pollen grain, nonapertural region (TEM). Scale bar 1 μm
7. Pollen grain, apertural region. (TEM). Scale bar 0.3 μm

Plate 4   137