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A New Genus of Platanaceae from the Paleocene of the Amur Region

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Abstract—Pistillate heads with a single ripening fruit and peltate carpellodia from the Tsagayan (Early Paleocene) deposits of the Amur Region are assigned to a new genus of the Platanaceae, *Oreocarpa* N. Maslova et Krassilov gen. nov. The heads associate with the seeds of *Carinalaspermum bureicum* Krassilov, staminate heads of *Tricolpopollianthus burejensis* Krassilov, and polymorphous leaves of *"Platanus" raynoldsii* Newberry emend. Brown, which apparently belong to the same plant. The significance of this find for the evolutionary morphology of the family is discussed.

INTRODUCTION

A wide morphological diversity of the Cretaceous and Paleocene members of the family Platanaceae, which now comprises a single genus, *Platanus* L., has been recently revealed. Abundant in the localities of this age, the leaves of the Platanaceae have been scrutinized by paleobotanists for a long time. However, their considerable variability makes the differentiation of species and genera on the basis of leaf macromorphology problematic. The micromorphological characters of leaves are known for few Platanaceae fossils that belong either to the modern genus *Platanus* or to more or less provisionally differentiated leaf genera.

A detailed investigation of the fossil reproductive organs of the Platanaceae proved to be more useful for systematics. Until recently, however, the fructifications have remained poorly studied. Thus, pollen grains were first extracted from the staminate heads of fossil Platanaceae in 1973 (Krassilov, 1973, 1976). In subsequent years, such data were obtained for fructifications from the North American, European, and Asian localities (Friis, 1985; Manchester, 1986, Crane *et al.*, 1988; Friis *et al.*, 1988; Pigg and Stockey, 1991; Crane *et al.*, 1993; Manchester, 1994; Pedersen *et al.*, 1994; Krassilov and Shilin, 1995, Madallon-Puebla *et al.*, 1997; Maslova, 1997). At least thirteen fossil genera of the Platanaceae were established, thus significantly changing the state of knowledge of the evolution of the Platanaceae.

However, the available materials suggest that our current knowledge of the taxonomic diversity of fossil Platanaceae may be substantially improved. Recent finds extended the composition of the family Platanaceae, and, therefore, the fossils that were earlier referred to other families may actually belong to the Platanaceae. Thus, several leaf morphotypes presumably assignable to the Platanaceae were described from the Tsagayan (Lower Paleocene) deposits of the Amur Region (Krishtofovich and Baikovskaya, 1966) and united by Krassilov (1976) in *"Platanus" raynoldsii* Newberry emend. Brown (Fig. 1a). The synonymy of this species includes four more species of *Platanus* described from the same locality as well as the leaf morphotypes assigned by earlier investigators to *Alnus, Quercus, Pterospermites*, and others. Such a taxonomic decision was substantiated by the polymorphism of leaves, the extreme variants of which may simulate leaves of other genera. However, the cuticular features are relatively constant and comparable with those of modern planes (Figs. 1b, 1c).

Nevertheless, the species from the Tsagayan deposits was only provisionally assigned to the modern genus, as the associated reproductive organs do not demonstrate close similarity to those of modern planes. Small staminate heads of *Tricolpopollianthus burejensis* Krassilov were found together with *"Platanus" raynoldsii.* These heads are small (7–8 mm) with relatively massive stamens, peltate apical extension of the connective, and tricolpate pollen grains (Figs. 1d, 1e). Their winged seed organs are assigned to *Carinalaspermum bureicum* Krassilov (Fig. 1h), the species, which was compared to the winged seeds of fossil and modern species of *Liquidambar* of the family Hamamelidaceae. The similarity between the latter genus and the members of the Platanaceae in the leaf and head macromorphology causes frequent misinterpretations of fossil material.

In 1999, Akhmetiev studied type localities of the Tsagayan flora near the piedmont of Belaya Mountain on the Lower Bureya River and in the mouth of its tributary Darmakan. New finds significantly emended the systematics position of the Tsagayan Platanaceae and extended the knowledge of the morphological diversity of the Platanaceae.

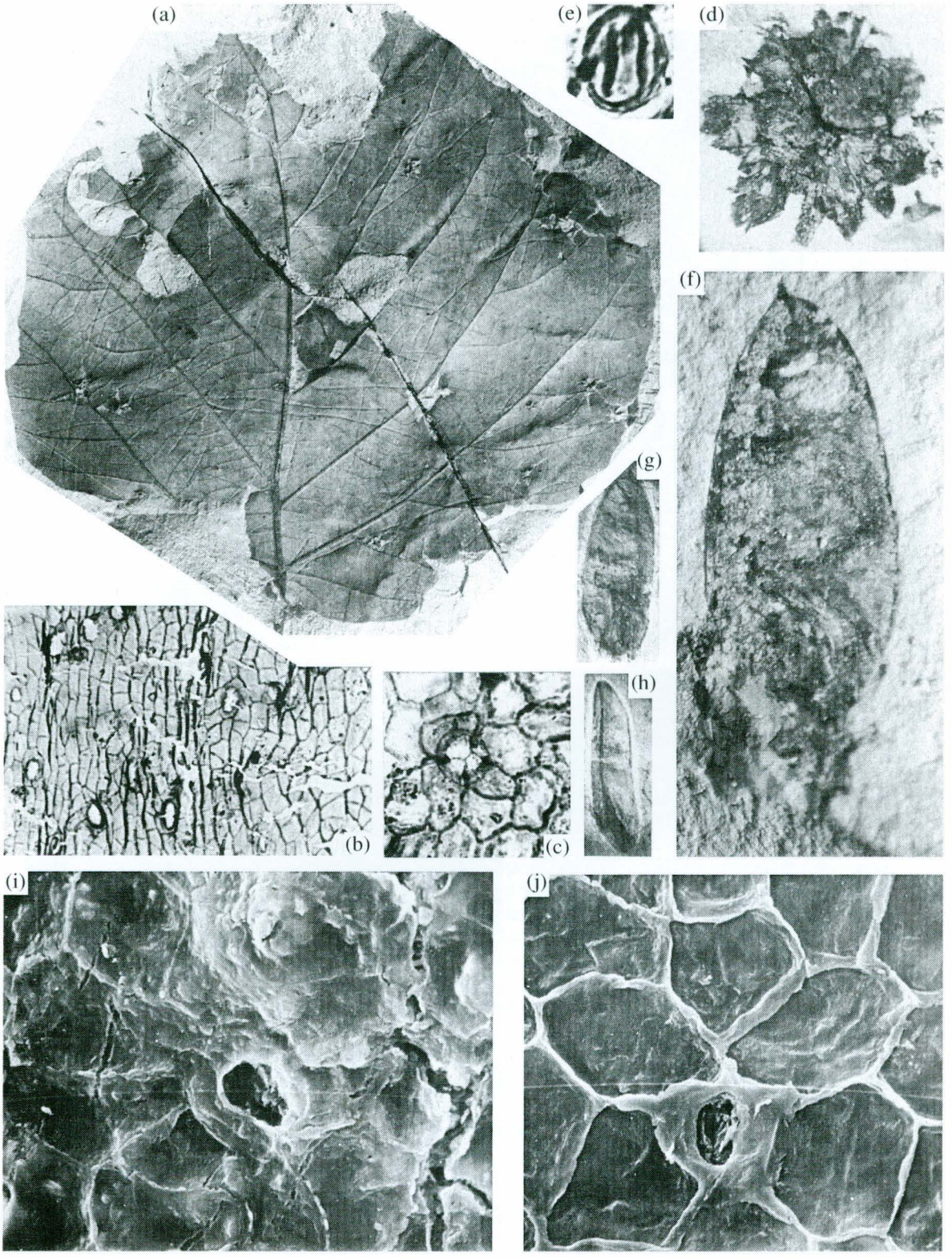
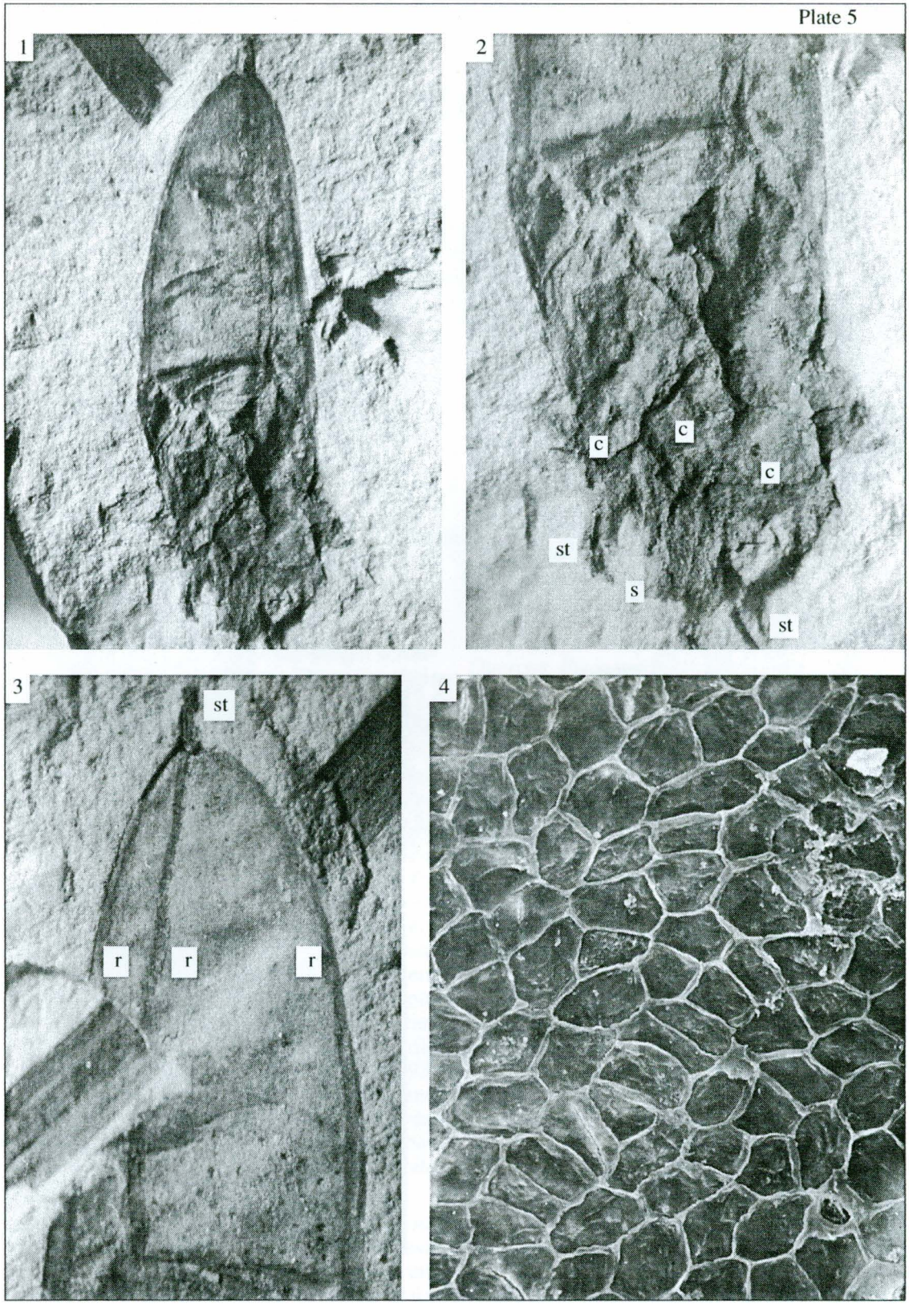


Fig. 1. *Oreocarpa bureica* gen. et sp. nov. and associated organs supposedly belonging to the same plant from the Tsagayan deposits (Lower Paleocene), Amur Region: (a)–(c) *"Platanus" raynoldsii*, leaf, Institute of Biology and Soil Sciences, Far East Division of the Russian Academy of Sciences (IBSS), no. 575-390 and cuticle with hair bases: (a) ×1; (b) ×146, and (c) ×395; (d) and (e) *Tricolpopollianthus burejensis*: (d) staminate head, IBSS, no. 575-149, ×7; (e) pollen grain extracted from the anther, ×1000; (f), (g), (i), and (j) *Oreocarpa bureica* sp. nov.: (f) fruit with a partly destroyed head near the base, GIN, no. BG-43, ×10; (g) identical fruit from the collection of Krassilov, IBSS, no. 571-361, ×3; (i) and (j) hair base morphology, SEM: (i) ×1500 and (j) ×1100; (h) seed of *Carinalaspermum bureicum*, IBSS, no. 571-333, ×3.



Explanation of Plate 5

Figs. 1–4. *Oreocarpa bureica* sp. nov., Tsagayan deposits (Lower Paleocene), Amur Region, GIN, no. BG-42: (1) head with a single ripe fruit, ×10; (2) preserved part of a head with a (s) stalk; (c) peltate apices of carpellodia and (st) stylodes curved downward, ×17; (3) winged appendage of the fruit with three (r) ribs and (st) a style base, ×17; (4) cuticle of the carpellodia apex with the hair bases, SEM, ×430.

MATERIAL

The material for the present investigation was kindly provided by Akhmetiev and is housed in the collection of the Geological Museum of the Russian Academy of Sciences (GIN).

SYSTEMATIC PALEOBOTANY

Order Hamamelidales

Family Platanaceae Dumortier, 1829

Genus *Oreocarpa* N. Maslova et Krassilov, gen. nov.

Etymology. Greek *oros* (mountain) [after Belaya Gora (White Mountain) locality] and Greek *carpus* (fruit).

Type species. *Oreocarpa bureica* sp. nov.

Diagnosis. Pistillate heads small, with single ripening fruit and persistent carpellodia. Fruit elongate, with short stylode on its apex, larger than the head, consisting of basal locule and winglike distal appendage with three longitudinal ribs. Carpellodia small, peltate, with reflexed stylodes. Disperse seeds of *Carinalaspermum* type.

Species content. Type species.

Comparison. The genus differs from capitate infructescences of the Platanaceae and other Hamamelidales in having very small heads and few carpels, only one of which ripens to exceed the head in size. The differentiation of the fruit in a locule and winged appendage with three ribs is a distinctive feature unknown in other members of the Platanaceae. The fruit most likely dehisced to shed a solitary seed. However, this unusual for the Platanaceae dissemination remains hypothetical and is not indicated as a distinctive feature in the generic diagnosis.

***Oreocarpa bureica* N. Maslova et Krassilov, sp. nov.**

Plate 5, figs. 1–4

Carinalaspermum bureicum: Krassilov, 1976, part., pl. 33, figs. 3 and 4.

Etymology. After the Bureya River.

Holotype. GIN, no. BG-42, the Bureya River, Bureinskii Tsagayan, Tsagayan Formation, Lower Paleocene.

Diagnosis. As for the genus.

Description (Fig. 1). The holotype and its counterpart (GIN, no. BG-43) are impressions of a pistillate head with a single ripe fruit. Underdeveloped carpellodia are preserved near the fruit base (Pl. 5, figs. 1–3).

The spheroid head (4 mm in diameter) is attached to a short longitudinally striate stalk (1 mm long). There are about ten densely apressed and partly overlapping carpellodia on the impression surface. The carpellodia have peltate apophyses about 1 mm in diameter. Short reflexed stylodes are preserved only in the lower carpellodia (Pl. 5, fig. 2).

The single ripening fruit completely covers the head, which is level its locule. The elongated distal appendage of the fruit rises above the head by 6 mm and ends by a short stylode (0.8 mm long). The locule is rounded-ovate, oriented a little obliquely the midline of the fruit, and is fringed by a broad arched fold on the surface. Three longitudinally striate ribs, which most likely correspond to vascular bundles, are distinguishable distally (Pl. 5, fig. 3). The midrib extends from the locule apex to the stylode base; the two other ribs embrace the locule laterally. The stylode emerges from in the apical depression of the fruit. The stylode is straight, with small pits on its surface, probably reflecting hair bases.

The material is preserved as a ferruferous incrustation with small fragments of compression. The cuticle was macerated from these fragments. The epidermis of the ripe fruit and carpellodia consists of irregular polygonal cells, which have thick slightly sinuous anticlinal walls. The cells are irregularly arranged and, occasionally, form short longitudinal rows. The cells of the rows are irregularly rectangular, relatively narrow, and elongated across the row (Pl. 5, fig. 4). The hair bases are scattered on the whole surface. They are elliptical and have a thick cuticular rim. The cells surrounding trichomes are almost isodiametric, arranged radially, forming an irregular ring of five to six cells (Figs. 1i and 1g).

The main features of other specimens from the collection of Krassilov and Akhmetiev agree with those of the holotype. These are the position of the ripened fruit with reference to the head, a short prominent stylode, and longitudinal ribs (Figs. 1f and 1g).

Remarks. Among isolated winged seeds of *Carinalaspermum bureicum* (the holotype may be seen in Fig. h), fruits having carpellodia persisting near their bases were included into this species in its first description (Krassilov, 1976, pl. 33, figs. 3 and 4; one of these specimens, namely, specimen no. 571–361 may be seen in Fig. 3i). These specimens should be excluded from the protologue of this species and transferred to the species *Oreocarpa bureica* sp. nov. Newly obtained data on the epidermal morphology of the fruit and carpellodia corroborate the hypothesis by Krassilov that these seed organs should be assigned to the plant with *"Platanus" raynoldsii* leaves having identical morphology of the hair bases and the configuration of surrounding cells.

Material. Holotype and its counterpart and two additional impressions from the type locality.

DISCUSSION

The available material allows us to make a relatively complete reconstruction of this Paleocene species of the Platanaceae. Due to abundance of its remains, the species can be considered as a dominant of the riparian vegetation of the Tsagayan time. This species had entire or lobed platanoid leaves with more or less distinctly peltate leaf bases. The morphology of the leaf margin significantly varies from grossly dentate to serrate, with or without marginal glands. The preserved epidermal

features of these leaves are comparable with those of modern Platanaceae.

The staminate and pistillate heads are nearly of the same size. The pistillate heads are substantially smaller than those in the Platanaceae and Hamamelidaceae known to date. Single flowers are undistinguishable both in the pistillate and staminate heads; however, they are not numerous: the number of carpels is about ten and the number of stamens is about twenty per head. The stamen morphology is typical for the Platanaceae. Small tricolpate pollen is usually treated as an ancestral type for all Hamamelidales.

The pistillate heads have the most peculiar morphology, a single carpel developed in a fruit while others remain underdeveloped. The head most likely abscised after the ripening of the single fruit with the carpellodes persisting near the fruit base.

Although the shed heads with only few ripe fruit are known in the fossil species of the Platanaceae *Macginicarpa glabra* Manchester (Manchester, 1986, figs. 31, 32), the Tsagayan plant significantly differs from it, in showing abscissed heads with a single fruit that completely dominates over the deminutive carpellodia persisting at its base. It is interesting to note that inflorescences with a single ripened ovary of the terminal flower are characteristic of *Distylium racemosum* Sieb. et Zucc. and, perhaps, of *Sycopsis dunnii* Hemsl. and *S. laurifolia* Hemsl. of the family Hamamelidaceae (Bogle, 1970). Although, morphologically, these plants completely differ from the plant under study, the type of pistillate organ development can be parallel.

The fruit of the new genus significantly differs from that of other members of the Platanaceae in having a basal locule and three distinct ribs, because of which the fruit resembles a follicle. Dehisced fruits have not been preserved, and one can only guess that they opened as follicles releasing a single seed with one-sided wing (*Carinalaspermum*).

Fruits of the Platanaceae are usually described as achenes or nutlets. Fruits of Hamamelidaceae are, as a rule, loculicidal or septicidal capsules dehiscing by two valves and releasing seeds, which are often winged. Within the order Hamamelidales, only fruits of *Myrothamnus* (Myrothamnaceae) are sometimes interpreted as follicles. Hence, the new genus combines features of the Platanaceae and Hamamelidaceae. On the basis of gynoecid morphology, the new genus is closer to the former family, because the members of the Hamamelidaceae have paracarpous ovary with two styles.

The find of the fruits resembling typical follicles with three vascular bundles in ancient Platanaceae indicates a wider occurrence of this structure within the order Hamamelidales. Although fruits of more ancient Cretaceous Platanaceae have been conventionally described as achenes, we do not exclude the priority of follicle as a primitive type for the whole order. We suppose that this structure underwent cardinal transformations in general evolutionary lines, being preserved as an archaic feature in some fossil and modern members of different families. Anyway, the new genus demonstrates a combination of archaic and derived features, distinguishing it from other Platanaceae.

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