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New platanoid staminate heads from the mid-Cretaceous of Kazakhstan

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Abstract

Staminate heads described from the Late Cretaceous of Kazakhstan as *Sarbaya* Krassilov et Shilin, *gen. nov.* have individual flowers of four stamens and a much reduced perianth. Pollen grains are tricolporate with cingulate endoapertures. Both staminate heads and associated leaves with distinctive stomatal structures add to the morphological diversity of the Cretaceous platanoid complex.

1. Introduction

New evidence of morphological diversity in early angiosperms has been provided by fossil material recovered from Sarbay Quarry near Rudnyj City, northwestern Kazakhstan. The quarry cuts in the Shet-Irgiz Formation which consists of sandstones with siltstones and clay interbeds. A detritic siltstone at a depth of 140 m contains fragmentary plant compressions, mostly conifer needles and cones, platanoid leaves and putative monocotyledonous remains (Shilin, 1986).

The plant-bearing beds are palynologically correlated with adjacent paralic sequences containing *Inoceramus orbicularis* as well as the foraminifera *Quadryina asiatica* and *G. filiformis* indicative of a Cenomanian–Turonian age (Shilin, 1986).

Among the plant debris from this locality, we found three small staminate heads of platanoid aspect, two of which still being attached to a short piece of axis. The heads are preserved as mineralized compressions. Parts of the heads have been detached from the rock matrix, treated with fluoric acid and mounted for SEM while fragments of the anthers have been cleared in nitric acid and prepared for observation in transmitted light. This material was assigned to a new genus described below.

2. Taxonomic description

SARBAYA Krassilov et Shilin, *gen. nov.*

Type: *Sarbaya radiata* Krassilov et Shilin, *sp. nov.*

Diagnosis: Staminate heads sessile on a slender axis, consisting of a globose receptacle and distinct flowers of 4 stamens each, with perianth less than 1/3 stamen length. Stamens with a very short filament, massive apically protruding connective and lateral pollen sacs. Pollen reticulate, tricolporate, endocingulate.
Derivation of name: After locality, Sarbay Quarry.

Sarbaya radiata Krassilov et Shilin, *sp. nov.*

Holotype: Sarbay Quarry, N 27, deposited at the Institute of Zoology, Kazakh Academy of Sciences, Alma-Ata (Plate I, 3).

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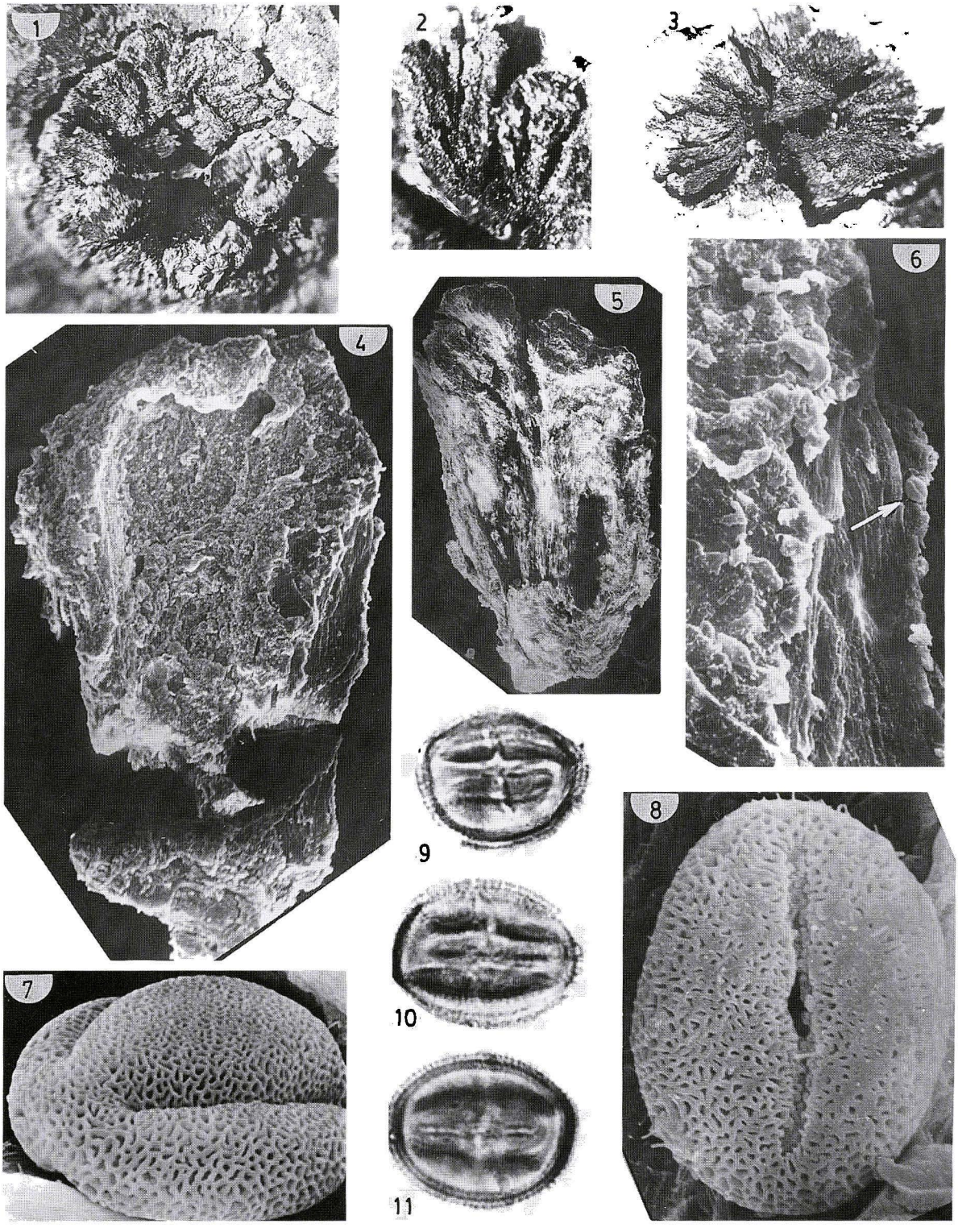
PLATE I



Type locality: Sarbay Quarry near Rudnyj City, north-western Kazakhstan.
Stratigraphic horizon: Shet-Irgiz Formation, Cenomanian–Turonian.
Derivation of name: From *radiatus* (L.) = rayed.
Diagnosis: As for the genus.
Description: The staminate inflorescences are about 5 mm in diameter and divided into distinct clusters of stamens representing individual flowers. One head (Plate I, 3) is attached to an axis 1.5 mm thick. Eight to twelve flowers were observed on the surface and their complete number could be twice as much. Detached flowers (Plate I, 5) consist of four stamens spreading at acute angle and a few delicate tepals, perhaps as many as stamens and opposite to them. Receptacles which shed their flowers show rectanguloid meshes left by perianths.

The stamens are wedge-shaped with a very short stout filament and a massive anther about 1.8 mm long and 0.4 mm wide. The connective is protruding, apically expanded and recurved. The pollen sacs are narrow, decurrent down to filament (Plate I, 4). The connective cuticle is verrucate while that of the pollen sacs is longitudinally striated (Plate I, 6).

Pollen grains trapped in striae of the pollen sacs are elliptical in equatorial view and trilobate in polar view (Plate I, 7, 8). The equatorial diameter of the pollen grain is about 13.5–16.5 μm, their polar axis is about 17.5 μm. The sexine is about 1.5 μm thick, semi-tectate with distinct, widely spaced columellae. The reticulum has thick muri and irregularly rounded-polygonal lumina. The nexine is as thick as the sexine with a distinct foot layer.

The ectocolpi are long, about 4/5 the length of polar axis, blunt or shortly pointed, slit-like with irregular margins, slightly if at all gaping over porous mesoapertures. A colpus membrane is sometimes present, microgranular (Plate I, 8). Mesoapertures were observed in transmitted light at medium focus level as light spots in the middle of the colpi (Plate I, 9–11). They could be indistinct against an equatorial thin zone. The latter feature corresponds to a cingulate endoaperture, or endocingulus described in the pollen grains of some extant rosaceans (cf. Reitsma, 1966; Van Leeuwen et al., 1988).

Associated leaves

The staminate heads are accompanied by abundant leaf compressions of one kind with conspicuous marginal glands, widely spaced branched acrodromous secondary veins and interstitial veins between each pair of the secondaries reaching about halfway to the margin. Tertiary veins are percurrent, branched, forming irregularly-polygonal meshes filled with the forth order venation. Marginal glands are globose supplied by a single vein or two converging ultimate branches of adjacent dichotomies.

The leaves are hypostomatic with the venation pattern reflected in the cuticle topography down to the third-order meshes while the fourth-rank veins are faintly marked by elongate cells on the upper cuticle and a short file of hair bases on the lower cuticle. Intercostal cells are irregularly-polygonal with straight or slightly sinuous anticlinal walls.

On the lower cuticle hair bases are scattered over the costal and intercostal zones, often next

PLATE I

Sarbaya radiata Krassilov et Shilin, *gen. et sp. nov.*
1. Staminate head showing distinct clusters of stamens, individual flowers. × 10.
2. Individual flower. × 20.
3. Head attached to a piece of axis. × 10.
4. Detached stamen with a short filament, massive connective and narrow pollen sacs. SEM, × 50.
5. Detached flower showing two stamens and a stump of the third one in the front; one tepal is distinct on the left side. SEM, × 25.
6. Surface features of connective (left) and pollen sac; arrow on a pollen grain. SEM, × 450.
7. Pollen grain, oblique polar view. SEM, × 4000.
8. Pollen grain, equatorial view, note granular colpus membrane. SEM, × 5000.
9–11. Pollen grains. Equatorial view at different foci showing porous mesoaperture and cingulate endoaperture. × 2000.

to stomata and sometimes over cell junctions. Stomata are closely packed, irregularly oriented but mostly parallel to costal zones when adjacent to them. Guard cells are slightly raised. They are not thickened except around the aperture. Subsidiary cells are narrow, forming a peristomatic cutinized flange, sometimes showing transverse striation (Plate II, 2). Encircling cells form a single irregular, sometimes incomplete, ring. They are not thickened with faintly striated periclinal walls.

Though there is no evidence of affinity other than association, it seems probable that these leaves, being the only type abundant in the locality, belonged to the same plant as the staminate heads.

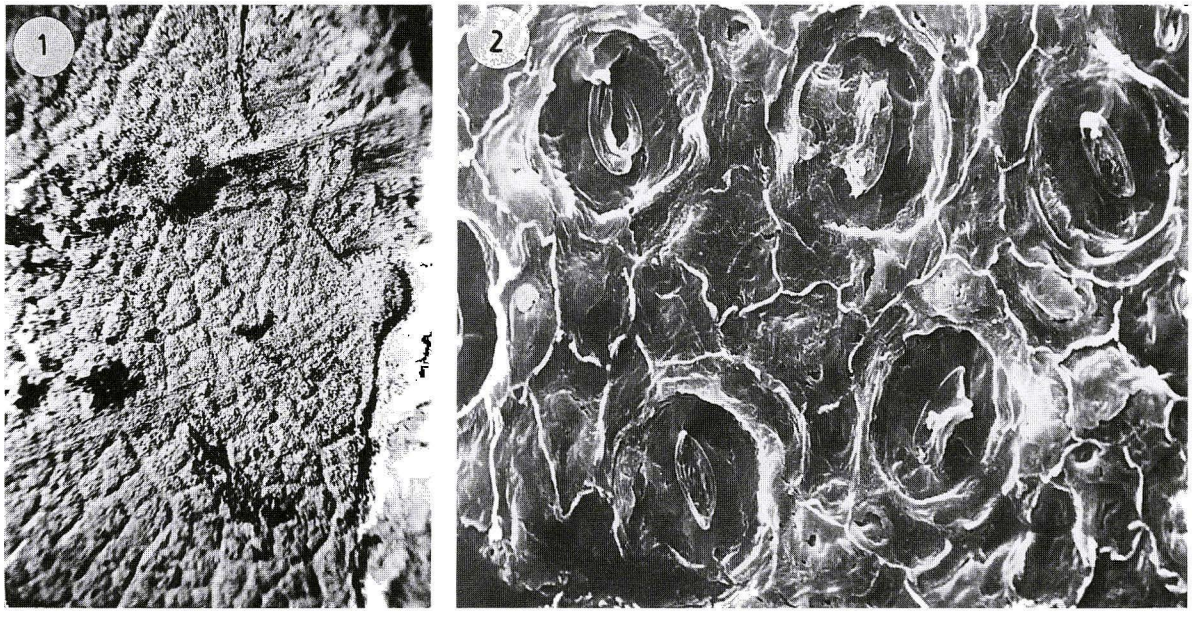
Discussion

The staminate heads described here from Upper Cretaceous deposits of Kazakhstan are obviously platanoid. With the extant *Platanus* they share the general morphology of staminate heads, their dimensions and their attachment to the axis (although, unfortunately, it was not possible to determine the number of heads per axis) as well as the 4-staminate flowers with reduced perianths, and the general aspect of the stamens and pollen grains. They differ, however, in more distinct flowers, less prominently peltate stamens and transversely contiguous endoapertures forming an equatorial thin zone, or endocingulus.

At the same time these pollen heads differ from those previously reported from Asia, Europe and North America. According to Crane (1987) and Friis et al. (1988), the Cretaceous and Early Tertiary platanoid staminate flowers assigned to the organ-genus *Platananthus* are pentamerous and typically with a more prominent perianth, while the pollen grains are smaller and tricolpate (Manchester, 1986).

In *Tricolpopolianthus*, from the lower Paleocene of the Russian Far East, the individual flowers are indistinct while the stamens are strongly peltate (Krassilov, 1973). This organ-genus also has tricolpate pollen grains. In *Platanites hebridicus*, from the Paleocene of Scotland, the stamens have a short capitate connective (Crane et al., 1988). The pollen grains are described as tricolpate although

PLATE II



Leaf associated with *Sarbaya radiata* Krassilov et Shilin, *gen. et sp. nov.*

1. Venation near marginal gland. × 10.
2. Stomata. Note one with a transversely plicate peristomatal flange (top left). SEM, × 1000.

the SEM micrographs suggest gaping of the colpi as if over a porous mesoaperture. This feature could not be ascertained, however, in the absence of any light photographs.

Crane (1987) has suggested that within the platanoid clade there has been a trend toward wind-pollination accompanied by reduction of perianths. In this character *Sarbaya* would seem more advanced than the contemporaneous platanoids from Europe and North America. However, there was an increase in the size of pollen grains (which is rather unusual in the trend to anomophily). *Sarbaya* pollen grains are of the same size as those of the Paleocene platanoids and within the size range of the extant species. The more elaborate pollen apertures of *Sarbaya* resemble those of some rosoid genera. This can be taken as an indication of affinity or parallel development.

The associated leaves have distinctly platanoid venation and epidermal topography similar to *Platanus* and *Credneria* (Ruffle, 1975). The marginal glands, though lacking in *Platanus*, are strongly developed in a number of platanoid leaf types, such as *Protophyllum* (see Krassilov, 1979). At the same time the stomata are distinct in showing plicate peristomatic flanges similar to those of extant *Quercus ilex* L. and some fossil Fagaceae (Alexeenko and Krassilov, 1980).

Thus, both the staminate heads and their associated leaves add to the morphological diversity of the ancient platanoid complex.

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