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Research paper

Revision of the genus *Grenana* Samylina from the Middle Jurassic of Angren, Uzbekistan

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ABSTRACT

The revision of the material from the Middle Jurassic sediments of Angren (Uzbekistan), comprising leaves, collar complexes, and seeds originally described together as a new putative pteridosperm genus *Grenana* Samylina (1990), suggests a ginkgoalean affinity of these plant remains. Morphological and epidermal characters of *Grenana* leaves fit the diagnosis of *Sphenobaiera* Florin, on the basis of which a new combination *Sphenobaiera angrenica* comb. nov. is designated, turning the generic name *Grenana* into a younger synonym of *Sphenobaiera*. "*Grenana*" collar complexes, considered by Samylina to represent ultimate leaf segments with terminal cupules, are reinterpreted as compound generative axes consisting of peduncles, pedicels, and collars, and similar to female fructifications of the modern and fossil *Ginkgo* L. A new genus *Nagrenia* gen. nov. and species *Nagrenia samylinae* sp. nov. are erected to accommodate this kind of remains. It is confirmed that leaves and collar complexes share a similar epidermal pattern and thus likely represent parts of the same plant. Seeds of three types, all with characteristic ginkgoalean structure, are discovered in association with the leaves of *S. angrenica* comb. nov. Two kinds of seeds are placed within *Allicospermum* Harris and one in *Ginkgo*; a new species *Allicospermum angrenicum* sp. nov. is described.

1. Introduction

The genus *Grenana* Samylina was described from the Middle Jurassic sediments of the Angren Formation (Angren, Uzbekistan) on the basis of an association of isolated fragments of dichotomizing narrow linear leaves, collar complexes, and seeds (Samylina, 1990). Having combined various structures sharing a similar epidermal pattern under a single name (*Grenana angrenica* Samylina), Samylina chose a leaf fragment as a holotype. The presumably cupular nature of the reproductive structures and the pteridosperm type of the stomatal complexes made Samylina refer *Grenana* to the seed ferns (Lyginopteridopsida). Various researchers, however, subsequently suggested a ginkgoalean affinity for this genus (Zhou, 1997; Wu et al., 2006; Yang et al., 2008; Zhou, 2009).

Samylina regarded the Angren samples as parts of a "monodominant burial of plants of the same species, that formed during their lifetime a pure stand" (Samylina, 1990: 846). Our examination has shown a mixed nature of the original material: in addition to the fragments of narrow linear leaves described by Samylina as *Grenana angrenica*, pieces of wider leaves with a considerably different epidermal pattern were found. We consider the morphological and epidermal characters of the proper *Grenana* leaves to match those in the diagnosis of *Sphenobaiera* Florin (1936), on the basis of which we designate a new combination, *Sphenobaiera angrenica* (Samylina) Nosova, comb. nov., thus regarding the generic name *Grenana* as redundant.

The presumably reproductive structures found in association with the leaves of *Sphenobaiera angrenica* and sharing a similar epidermal pattern were treated by Samylina (1990) as ultimate leaf segments bearing terminal cupules. We believe there is evidence to interpret them as compound reproductive axes composed of peduncles that furcate into 2(−3) pedicels, each extending further into a cup-shaped collar in a manner similar to the female fructifications of the modern and fossil *Ginkgo* L. — a resemblance further supported by the *Ginkgo*-type organization of the stomata. It is the lack of specimens with these structures found in organic connection with the seeds that does not allow to describe them directly as *Ginkgo* and makes us to establish a new genus *Nagrenia* Nosova gen. nov. with the type species *Nagrenia samylinae* Nosova sp. nov.

We also use this genus to accommodate remains of comparable collar complexes reported from the Middle Jurassic of the south-west of East Siberia (Ust-Balej locality in the Irkutsk oblast', Russia) and described as *Ginkgo huttonii* (Sternberg) Heer (Heer, 1876, 1878), *Ginkgo sibirica* Heer (Heer, 1880), or *Ginkgo* sp. (Prynada, 1962). All these findings are treated here under the name *Nagrenia* sp.

Seeds of three species have been found in Samylina's material. Two kinds of seeds belong to *Allicospermum* Harris: *Allicospermum angrenicum* Nosova sp. nov. and *Allicospermum* sp. (as *Allicospermum* sp. 1 in: Nosova, 2012 [only in discussion on the p. 67 and in the tab. 2]), while the seeds of the third kind have been described as *Ginkgo gomolitzkyana* Nosova (Nosova, 2012). Pollen of *Cycadopites* sp. has been discovered in the pollen chamber and the nucellar beak of *A. angrenicum* and *Allicospermum* sp. (Nosova, 2012; Zavialova et al., work in progress).

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2. Occurrence and geological age

The main material described here was collected by L. Yu. Budantsev in 1976 from the Angren coalfield (41°01′ N, 70°08′ E) situated 80 km east of Tashkent, Uzbekistan, Middle Asia (Fig. 1).

Two formations are distinguished in the Jurassic of Angren. The lower, Angren Formation, overlies the residual soil of the Lower Triassic quartz porphyries. Its thickness varies widely and reaches up to 180 m, the typical range being 60–100 m. The formation is made up of variously grained sandstones, siltstones, black to dark gray clays, and coal beds. The floral composition of the Angren Formation suggests the age of the containing sediments to be not older than Middle Jurassic (Sixtel, 1953; Gomolitzky and Lobanova, 1969; Gomolitzky et al., 1981), presumably Aalenian–Bajocian (Troitsky and Gomolitzky, 1996; Nosova, 1998). The Angren Formation is overlain with an erosional unconformity by variegated clays and white quartzose sandstones of the Jigiristan Formation. The thickness of this formation reaches up to 60 m. The age, judging mainly from its stratigraphic position, is estimated as latest Middle Jurassic (Callovian?) (Gomolitzky and Lobanova, 1969; Troitsky and Gomolitzky, 1996). The Jigiristan Formation is unconformably overlain by red sandstones and fine pebble conglomerates of Cretaceous age (Gomolitzky and Lobanova, 1969; Troitsky and Gomolitzky, 1996).

The sediments of the Angren Formation have yielded numerous remains of pteridophytes and gymnosperms. The gymnosperm component is dominated by czekanowskialeans, ginkgoaleans, and conifers, with only a marginal role of cycadophytes (Nosova, 1998). Ginkgoaleans were represented by *Ginkgo* (*Ginkgo asiatica* Nosova, *Ginkgo gomolitzkyana* Nosova, *Ginkgo gromykoi* Nosova, *Ginkgo* aff. *insolita* Samylina [in lists only], *Ginkgo troitzkii* Gomolitzky, and *Ginkgo* ex gr. *sibirica* Heer [in lists only]), *Baiera* Braun (*Baiera ahnertii* Kryshtofovich and *Baiera gracilis* Bunbury [both in lists only]), *Leptotoma* Kiritchkova et Samylina (*Leptotoma borealis* Travina, later listed as *Leptotoma sibirica* Kiritchkova et Batjaeva [in lists only]), *Sphenobaiera* Florin (*Sphenobaiera* sp. [description without illustration]), and *Pseudotorellia* Florin (*Pseudotorellia angrenica* Gomolitzky, *Pseudotorellia vachrameevii* Gomolitzky, and *Pseudotorellia gomolitzkyana* Nosova) (Sixtel, 1953; Gomolitzky and Lobanova, 1969; Gomolitzky et al., 1981; Nosova, 1998, 2009, 2012).

Additional material comes from the locality Ust-Balej (approximately 52°38′ N, 103°59′ E) situated in the Irkutsk oblast', the south-west of East Siberia, Russia. The Mesozoic plant-bearing sediments of this area are represented by outcrops of masses of yellowish block sandstones with interleaving lenses of siltstones, sandstones, and clays, and are regarded as belonging to the upper part of the Cheremkhovo Formation dated as Middle Jurassic (Kiritchkova and Travina, 2000). The gymnosperm component of this rich flora is dominated by czekanowskialeans, ginkgoaleans, and conifers (Kiritchkova and Travina, 2000: Table 2).

3. Materials and methods

The samples from Angren originally studied by Samylina (1990) are housed at the Laboratory of Palaeobotany of the Komarov Botanical Institute of the Russian Academy of Sciences (BIN RAS) as part of collection # 813. The numbering of the previously published specimens respects that in Samylina's work (e.g., spec. 813/1 N 13, and spec. 813/1 N 42). In case of the newly published specimens, the collection number is followed by the simple specimen number after a slash (e.g., spec. 813/80).

The material is represented by a mass of numerous predominantly leaf fragments forming a leaf litter. The whole lamina has not been observed, but the good preservation of the cuticle allowed us to study the epidermal pattern in detail. Besides the leaves, the samples yielded few remains of collar complexes (15 fragments) and three-dimensionally preserved seeds (about 25), all of which were also macerated to examine their fine structure (the epidermal pattern in the collar complexes, the integument, and the nucellus, as well as the organization of the megaspore membrane). Pollen was extracted from the nucellar beak and the pollen chamber of the seeds.

Cuticles were prepared according to the standard procedures outlined by Kerp (1990). The structure of the epidermis was studied with a light microscope (LM) and a scanning electron microscope (SEM) JSM-6390 LA. The description of the megaspore membrane follows the terminology used by Zhou (1993).

The specimens from Ust-Balej studied by Heer (Heer, 1876, 1878, 1880) are partly stored at the Laboratory of Palaeobotany of BIN RAS (collection 6a). We were only able to locate one of the specimens (spec. 6a/31), which most probably does not correspond to any of those figured by Heer. The material described by Prynada (1962) is stored at the Chernyshov Central Geological Survey and Research Museum (CNIGR) in St. Petersburg, Russia, collection 5392. Unfortunately, due to

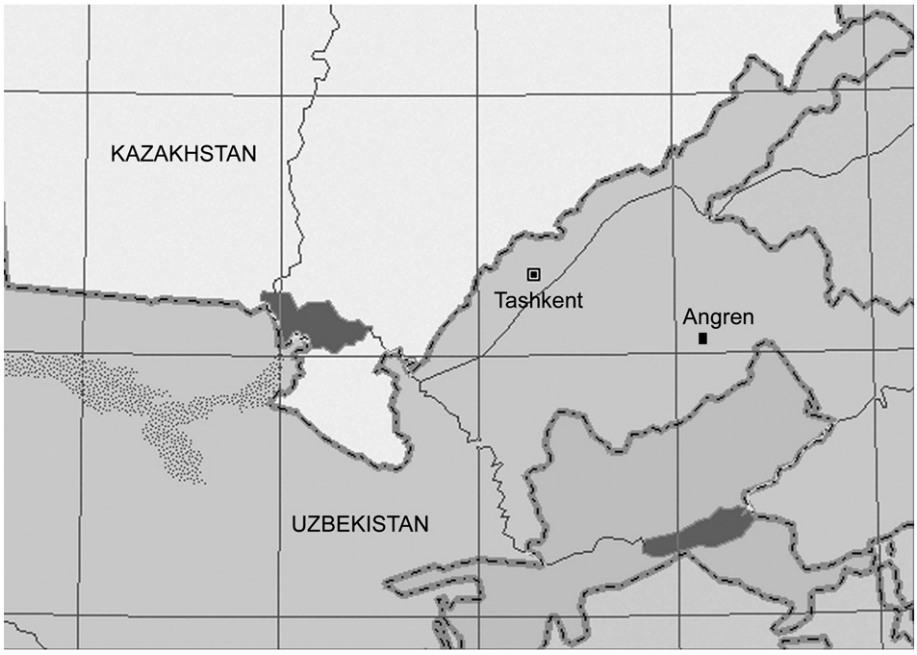

Fig. 1. Sketch map showing the location of the Angren coal mine.