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Research paper

The Middle Jurassic flora of South Mongolia: Composition, age and phytogeographic position

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ABSTRACT

The Nariin-Sukhait Flora from the terrigenous, coal-bearing deposits of the Orgilokhbulag Formation in the Nariin-Sukhait Coalfield, southernmost Mongolia, is documented for the first time. The Nariin-Sukhait Flora contains 57 fossil plant species belonging to liverworts, horsetails, ferns, cycadaleans, bennettitaleans, ginkgoaleans, leptostrobaleans, conifers and plants of an unknown affinity. Its floristic composition allows us to date the Orgilokhbulag Formation as Middle Jurassic. This flora is typical of the West Siberian Province of the Siberian Region. The boundary between this province and the North Chinese Province of the same region should be positioned further south than its previous placement, and the Nariin-Sukhait Flora existed close to this boundary. The parent plants grew in an alluvial plain characterised by rivers, oxbow lakes and swamps. The flora reflects a wet, most probably warm-temperate climate with some seasonality in temperature and/or precipitation. Two new fern species of the Nariin-Sukhait Flora are described: *Coniopteris gurvantesensis* Kostina et Herman and *Sphenopteris gobiensis* Kostina et Herman.

1. Introduction

Non-marine Jurassic deposits are widespread in Mongolia. Their biostratigraphy is based mainly on plant remains, which are numerous and diverse in some localities. Application of phytostratigraphy is economically important, because many of the Jurassic deposits in Mongolia host commercial quantities of coal. A detailed study of the composition and age of Mongolian Jurassic floras is also crucial for a better understanding of Mesozoic phytogeography, the boundaries of the main phytochoria (regions and provinces) in Asia, and palaeoclimatic reconstructions.

Although Jurassic floras have been known from Mongolia for several decades, comprehensive analyses of their composition and age are lacking. Plant fossils were first found in this region at the end of the 19th century (Potanin, 1881, 1893) and subsequently collected by the Soviet-Mongolian geological and palaeontological expeditions during geological mapping and stratigraphic research in the region. Plant fossils were studied by Vakhrameev (1983, 1991; Vakhrameev et al., 1970), Markovich, Neiburg, and Vladimirovich (their identifications of fossil plants are in: Marinov et al., 1973), Krassilov (1985), Sodov (1990, 1993), Lebedev and Doludenko (Sodov, 1993), and Kostina et al. (2010). Data from the earlier studies contributed to later phytostratigraphic and phytogeographic interpretations of the region (Sodov, 1990). However, most individual assemblages are known from preliminary lists of fossil plants and have not described and illustrated in detail. Moreover, only the Jurassic floras of Western and Central Mongolia have been studied extensively, whereas those of South Mongolia were completely unknown until recently (Sodov, 1990; Vakhrameev, 1991; Durante and Makulbekov, 2009).

During our fieldwork in 2007–2009, Jurassic non-marine deposits were studied in the western and central parts of the Lake Valley District and Eligen-Gobi Depression in Central Mongolia and fossil charophytes, palynological samples and plant megafossils were collected (Kostina et al., 2008, 2010). Our preliminary identification of fossil plants shows their close similarity to the Jurassic plants of the West Siberian Province belonging to the Siberian Phytogeographic Region (Vakhrameev, 1991). This indicates that the boundary between the West Siberian Province and the North Chinese Province of the same region should be placed further south than its position designated by Kiritchkova et al. (2005), who considered that, in the Early–Middle Jurassic, Central and South Mongolia belonged to the North Chinese Province.

To corroborate this conclusion and clarify the precise position of the boundary between these provinces, we continued our study in the Nariin-Sukhait Coalfield in Omnogovi Aimag (Omnogovi District), southernmost Mongolia (Fig. 1A, B) in 2011. Numerous and diverse plant megafossils and palynological samples were collected from several fossiliferous localities within the coalfield. Some preliminary results of our study were published by Kodrul et al. (2012) and Baatarkhuyag et al. (2011, 2012). The present paper focuses on the composition, age and phytogeographic relationship of the Middle Jurassic Nariin-Sukhait Flora of South Mongolia. We use a system of suprageneric

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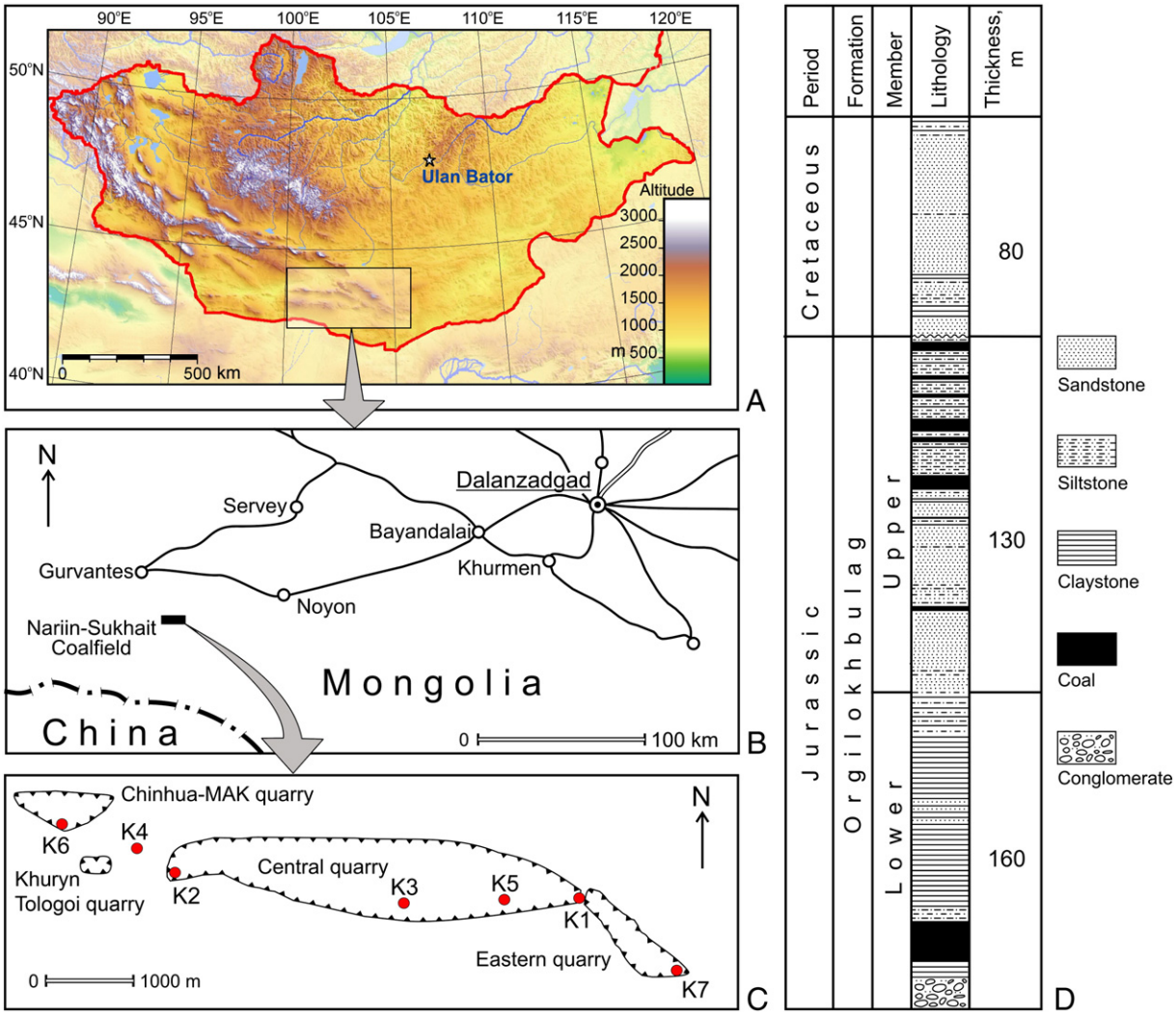

Fig. 1. A, B — position of the Nariin-Sukhait Coalfield in southernmost Mongolia; geographic map (A) from (www.200stran.ru, modified), map of the southernmost Mongolia (B) from (www.legendtour.ru); C — position of plant fossil localities within the Nariin-Sukhait Coalfield; and D — section of the Jurassic and Cretaceous deposits in the Nariin-Sukhait Coalfield (modified from Baatarkhuyag et al., 2011).

plant taxa devised by Meyen (1987) and phytogeographic terminology employed by Vakhrameev (1991) and Kiritchkova et al. (2005).

2. Geological setting of the Nariin-Sukhait Coalfield and plant fossil localities

The Nariin-Sukhait Coalfield is situated in the South Trough of the Noyon Depression, southernmost Mongolia (Fig. 1A, B). The coal-bearing strata constitute an upper part of the upper Paleozoic–lower Mesozoic folded molassic deposits. The regional geological structure and lithostratigraphy have been documented by Baatarkhuyag et al. (2010, 2011, 2012). They assigned the terrigenous coal-bearing deposits of the Nariin-Sukhait Syncline to the Orgilokhbulag Formation (190 m thick) that underlies the Tserd Formation (80 m thick). The Orgilokhbulag Formation consists of sandstones, siltstones, mudstones, conglomerates and coals. It is subdivided into two members: the lower member was named by the Mongolian coal geologists the Nariin-Sukhait Member and the upper — the MAK[1] Member (Baatarkhuyag et al., 2011). The latter, however, is named after the commercial corporation and therefore the member name does not abide by the guidelines of the International Stratigraphic Guide and is not a valid stratigraphical name. To avoid this we use the following names for the members: Lower Member (160 m thick) and Upper Member (130 m thick) (Fig. 1D). These deposits crop out in several quarries (Central, Ovoot Tolgoi (Eastern), Khuryn Tologoi and Chinhua-MAK quarries) within the Nariin-Sukhait Coalfield (Fig. 1C). The Orgilokhbulag Formation is overlain by poorly cemented conglomerates and sandstones provisionally dated as Cretaceous (Baatarkhuyag et al., 2011).

The depositional environment of the Orgilokhbulag Formation is interpreted to have been an alluvial plain with meandering rivers, oxbow lakes and swamps where an extensive accumulation of organic matter took place.

The vast majority of plant fossils were collected at eight localities listed below (Fig. 1C).

Locality K1 — 43°00′16.0″N, 101°15′17.1″E, junction of the Central quarry and Ovoot Tolgoi (Eastern) quarry, south wall. Interbedded fine-grained sandstones, siltstones and clays overlying a thick coal seam. Upper Member.

Locality K2 — 43°00′30.2″N, 101°11′50.7″E, western part of the Central quarry. Pyritized sandstones and siltstones. Upper Member.

[1] Abbreviation for the Mongolyn Alt (Mongolian Gold) Corporation, Ulan Bator, Mongolia.