



Research paper

New fossil bryophytes from the Triassic Madygen Lagerstätte (SW Kyrgyzstan)

Philippe Moisan ^{a,*}, Sebastian Voigt ^b, Jörg W. Schneider ^b, Hans Kerp ^a^a Forschungsstelle für Paläobotanik am Institut für Geologie und Paläontologie, Westfälische Wilhelms-Universität Münster, Hindenburgplatz 57, 48143 Münster, Germany^b Geologisches Institut, Technische Universität Bergakademie Freiberg, Bernhard-von-Cotta-Straße 2, 09599 Freiberg, Germany

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ABSTRACT

Bryophytes are found throughout the world in almost all terrestrial habitats. However, the fossil record of bryophytes is generally poor and fragmentary. In this contribution, we present the first unequivocal record of bryophytes from the Middle–Late Triassic Madygen Formation, in southwestern Kyrgyzstan, Central Asia. The bryophyte flora comprises two new species, the thalloid liverwort *Ricciopsis ferganica* and the leafy moss *Muscites brickiae*. In addition, a third form occurs, here described as *Muscites* sp. The dorsiventrally differentiated thallus of *R. ferganica* closely resembles that of the extant liverwort *Riccia fluitans* (Ricciaceae). The Central Asian finds represent the oldest known occurrence of the fossil genus *Ricciopsis*. The relative abundance of bryophytes in the Madygen fossil biota suggests that non-vascular plants played important role in special microhabitats within the Madygen palaeoecosystem and probably fostered the diversity of arthropods by providing favourable microhabitats for a range of aquatic and amphibiotic insects.

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1. Introduction

Bryophytes represent the most diverse group of land plants after the angiosperms. Recent studies estimate a number of about 20,000 bryophyte species worldwide (e.g., Shaw and Renzaglia, 2004; Shaw, 2009; Stech and Quandt, 2010). Bryophytes are non-vascular plants and comprise three separate evolutionary lineages, i.e., mosses (Bryophyta), liverworts (Marchantiophyta) and hornworts (Anthocerotophyta). They are the only land plants with a dominant haploid gametophyte generation and a relatively short-lived diploid sporophyte. Bryophytes are small plants that are important elements of the vegetation in a diverse range of habitats including moist forest, wetland, mountain, and tundra ecosystems (von Konrat et al., 2010) growing on soils, rocks and trees as epiphytes.

Bryophytes have a poor and fragmentary fossil record. Compared to vascular plants their fossilisation potential is often considered to be low (Miller, 1982; Edwards, 2000). Although it has also been suggested that the preservation potential of bryophytes may in fact be similar to that of vascular plants (Hemsley, 2001). The unequivocal oldest liverworts showing cell preservation have been described from the Givetian (Middle Devonian) by Hernick et al. (2008) and the oldest mosses by Hübers and Kerp (2012). The latter authors also discuss the preservation potential of bryophytes in particular. Bryophytes have been reported from Mesozoic floras of Eurasia, including the Rhaetian of Greenland (Harris, 1931) and England (Harris, 1938), the Liassic of Iran (Fakhr, 1977; Schweitzer et al., 1997) and Sweden (Lundblad,

1954), the Middle Jurassic of England (Harris, 1961), the Upper Jurassic of Siberia (Ignatov and Shcherbakov, 2007) and Mongolia (Ignatov, 1992), the Upper Jurassic–Lower Cretaceous of Russia (Krassilov, 1973), and the Lower Cretaceous of China (Wu, 1999), England (Watson, 1969) and Mongolia (Krassilov, 1982). This contribution deals with bryophyte remains from the Ladinian–Carnian Madygen Formation of Kyrgyzstan, Central Asia. The Madygen bryophyte flora comprises mass occurrences of a riccioid liverwort, for which the new species *Ricciopsis ferganica* Moisan et al. sp. nov. is proposed, and a leafy moss that is formally described as *Muscites brickiae* Moisan et al. nov. sp. A third form, *Muscites* sp., is described in open nomenclature. These fossils are important since they represent the first unequivocal evidence of bryophytes from the Madygen Formation.

2. Geological setting

All fossils described herein are from the stratotype area of the Middle–Late Triassic Madygen Formation about 50 km to the west of Batken, the capital of the southwestern-most district of Kyrgyzstan, Central Asia (Fig. 1). The study area is located in the vicinity of Madygen, a small livestock farmer's settlement in the northern foothills of the Turkestan Mountains and close to the southern border of the Fergana Valley. The Madygen Formation comprises a c. 500–600 m thick succession of complexly interbedded conglomerates, sandstones and siltstones representing alluvial fan, alluvial plain and freshwater lake deposits. The fossil biota of Madygen is rich and diverse and considered to be one of the world's most significant Mesozoic Lagerstätten (Voigt et al., 2006; Shcherbakov, 2008; Sues and Fraser, 2010), with plants (Dobruskina, 1995; Moisan et al., 2011), trace fossils, crustaceans, bivalves (Voigt et al., 2006;

* Corresponding author.

E-mail address: f_mois01@uni-muenster.de (P. Moisan).

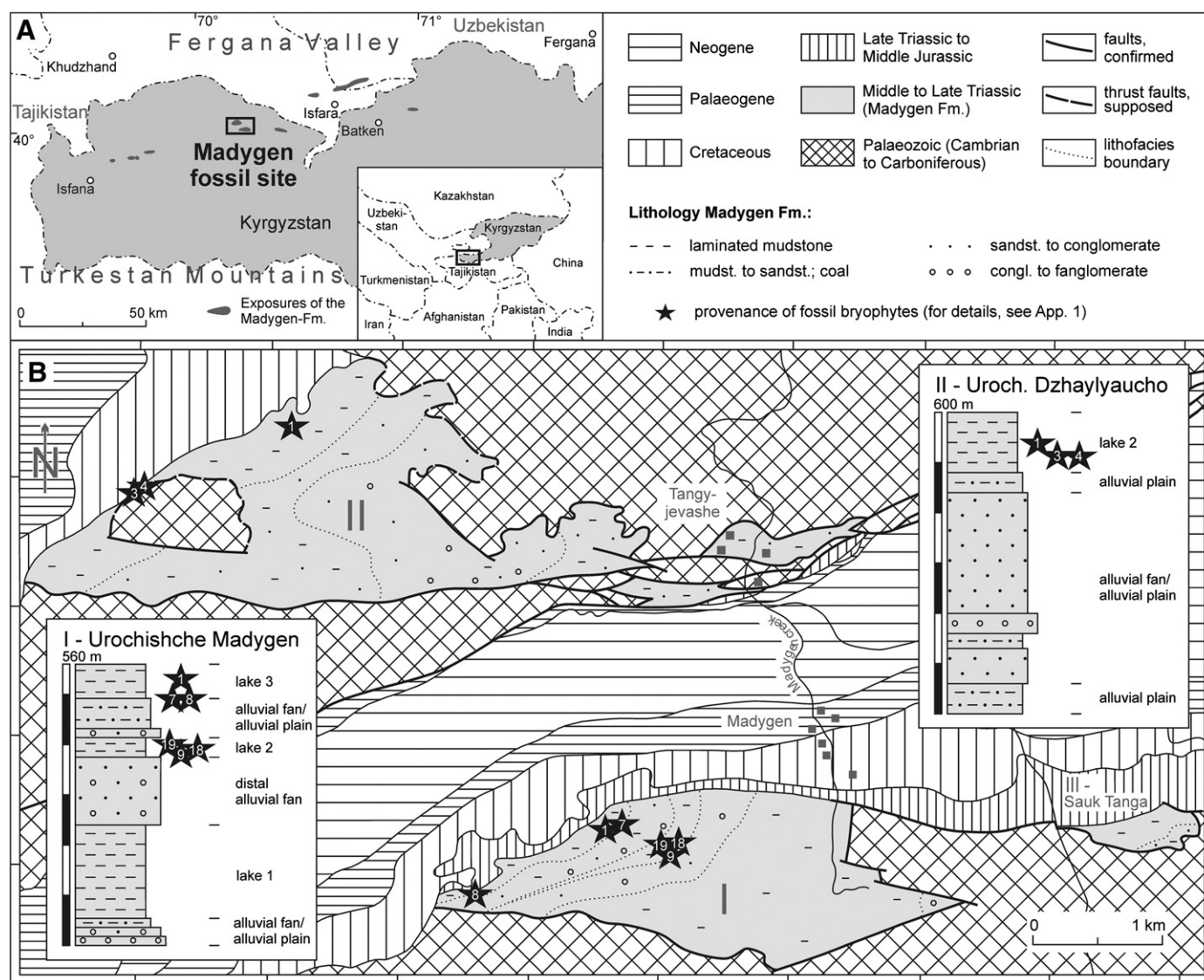


Fig. 1. Map showing exposures of the Madygen Formation in southwestern Kyrgyzstan and geographic and stratigraphic occurrence of the fossil bryophytes.

Voigt and Hoppe, 2010), insects (e.g., Shcherbakov, 2008), various fishes (Sytchevskaya, 1999; Kogan et al., 2009; Fischer et al., 2011), and unusual tetrapods (Sharov, 1970, 1971; Tatarinov, 2005; Buchwitz and Voigt, 2010; Schoch et al., 2010; Alifanov and Kurochkin, 2011).

Fossil bryophytes of the Madygen Formation have only been observed in laminated mudstones interpreted as lacustrine deposits. Some of the fossil-bearing rocks are secondarily limonitized (Plate I, 1–5). The section of the Madygen Formation in the Urochishche Madygen outcrop area shows three distinct horizons of lacustrine deposits ranging 40–190 m in thickness (Fig. 1). The section of the Madygen Formation in the Urochishche Dzhaylyaucho area is less complete and comprises only one, up to 120 m thick lacustrine unit at the top. In accordance with previous workers (e.g., Dobruskina, 1995),

this package is correlated with ‘lake 2’ of Urochishche Madygen. Bryophytes are most common at FG localities 596/I/9, -18, and -19 (Urochishche Madygen) and FG localities 596/II/1, -3, and -4 (Urochishche Dzhaylyaucho), all are referred to the second lacustrine unit (Fig. 1; Appendix 1). A few slabs with fossil bryophytes were found in the lower and middle parts of the uppermost lacustrine unit at Urochishche Madygen (FG localities 596/I/1, -7, and -8; Fig. 1; Appendix 1). No records, however, exist from sediments of lacustrine unit 1.

3. Material and methods

The bryophytes occur as impressions lacking organic matter, however, features of the epidermal surfaces are preserved as imprints in

Plate I. *Ricciopsis ferganica* from the Madygen Formation, Middle–Late Triassic, SW Kyrgyzstan.

1. Mass occurrence of the thalloid liverwort *Ricciopsis ferganica* in dorsal view. FG 596/X/721 (holotype). Scale bar = 1 cm.

2. The same specimen as in Fig. 1 in ventral view. Scale bar = 1 cm.

3–4. Detail of the ventral surfaces of *Ricciopsis ferganica* showing the longitudinal ridge and scales. FG 596/X/721. Scale bar for Fig. 3 = 1 cm; scale bar for Fig. 4 = 5 mm.

5. Detail of the dorsal surface of *Ricciopsis ferganica* showing the longitudinal furrow located in the middle part of the linear segments. FG 596/X/720. Scale bar = 1 cm.

6. Thalli of *Ricciopsis ferganica* showing dichotomies and the longitudinal ridge and scales (arrows). FG 596/X/926b. Scale bar = 5 mm.

7. Isolated specimen of *Ricciopsis ferganica* showing multilobed thalli. FG 596/X/737a. Scale bar = 5 mm.

8. Habitus of the extant crystalwort *Riccia fluitans* which shows a close resemblance to the fossil *Ricciopsis ferganica*. Scale bar = 5 mm.

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