

NOMENCLATURE ARTICLE

The problematic genus *Problematospermum*Patrick S. Herendeen,¹  Maya A. Bickner,¹  Eugenia Bugdaeva,²  Serge Naugolnykh³  & Elena Kostina³¹ *Chicago Botanic Garden, 1000 Lake Cook Road, Glencoe, Illinois 60022, U.S.A.*² *Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far East Branch, Russian Academy of Sciences, 159 Prosp. 100-letiya, 690022 Vladivostok, Russia*³ *Geological Institute, Russian Academy of Sciences, 7 Pyzhevsky per., 119017 Moscow, Russia*Address for correspondence: Patrick S. Herendeen, pherendeen@chicagobotanic.orgDOI <https://doi.org/10.1002/tax.12722>

Abstract The name *Problematospermum* has been used for Mesozoic age fossil seeds with a tuft of hairs at one end, the systematic affinity of which is uncertain. The generic name and names of two species were introduced by Turutanova-Ketova but not validated in her 1930 publication. Paleobotanists have evidently been unaware of this because Turutanova-Ketova is consistently cited as the authority for the names. Krassilov inadvertently validated the generic name *Problematospermum* and species name *P. ovale* in 1973, so the authority should be cited as “Turut.-Ket. ex Krassilov”. This paper clarifies the nomenclatural problems surrounding these names. An additional problem is that the type specimen indicated by Krassilov is missing. A neotype is designated here to replace the missing type for *P. ovale*. The generic diagnosis for *Problematospermum* is amended to clarify contradictory interpretations in the literature.

Keywords Bennettitales; Karatau; Krassilov; *Problematospermum*; Turutanova-Ketova

■ INTRODUCTION

The Mesozoic fossil seeds of the genus *Problematospermum* are aptly named for multiple reasons. For one, the name hints at the challenge in understanding the relationships of these unusual seeds. However, the problem we address in this paper is nomenclatural. Turutanova-Ketova (1930) described two species of enigmatic fossil seeds from the Late Jurassic dolomitic shales of Karatau Ridge (South Kazakhstan). The two species were treated as representing a new, unknown group of gymnospermous seed plants. Turutanova-Ketova described these fossil seeds as a new genus that she called *Problematospermum*. Although descriptions were provided for the two new species, *P. ovale* and “*P. elongatum*”, the author failed to provide a diagnosis or description for the new genus, which is required by Art. 38.1 of the *International Code of Nomenclature for algae, fungi, and plants (ICN)* (Turland & al., 2018). As a consequence, the new genus and species names presented by Turutanova-Ketova (1930) were not validly published. This error appears to have been overlooked by subsequent authors because Turutanova-Ketova (1930) is universally cited as the validating publication for these names (see list of publications below), and no explicit attempts to correct the problem have been published. However, in 1973, Krassilov inadvertently validated the genus name and one of Turutanova-Ketova’s two species names when he described fossil seeds provided to him by Maya Doludenko from the same Late Jurassic shales of Karatau that were the source for Turutanova-Ketova’s material. Krassilov ascribed these fossils to the species “*Problematospermum ovale* Turutanova-

Ketova” and made no mention of the other species described by Turutanova-Ketova. Krassilov (1973a) stated that the Late Jurassic age of the fossil locality “was established on the evidence of fairly abundant invertebrate as well as vertebrate (fishes, reptiles, etc.) fossils. The fossil flora of Karatau was rich in the bennettites and conifers of *Brachyphyllum-Pagiophyllum* group and comprised no leaf remains of the angiosperm type.”

Although Krassilov (1973a) provided a detailed description of *Problematospermum ovale*, which he attributed to Turutanova-Ketova, he did not cite details for any of the specimens figured in his paper. However, he did cite the original description and a single illustrated specimen from Turutanova-Ketova: “1930 *Problematospermum ovale* Turutanova-Ketova, p. 160, pl. 4, fig. 30, 30a”. This citation of a single specimen from Turutanova-Ketova can be accepted as the type designation for *P. ovale* Turut.-Ket. ex Krassilov. Thus, Krassilov (1973a) satisfied the requirements of Art. 38.5 and 38.6 of the *ICN* for a descriptio generico-specifica, and as a consequence validly published the genus name *Problematospermum* and species name *P. ovale*. Ascribing the names to Turutanova-Ketova is appropriate since Krassilov clearly believed that the genus and species names had already been validly published.

Until recently it has been presumed that the specimens of Turutanova-Ketova (1930) and Krassilov (1973a) had been lost. However, in a recent (Nov., 2021) search of the collections of the Geological Institute, Russian Academy of Sciences in Moscow, Russia, some specimens from Turutanova-Ketova (1930) have been found. Unfortunately,

the specimen corresponding to plate 4, figures 30 and 30a is not among them and its location remains unknown. As a consequence, it is necessary to designate a neotype for *P. ovale* because a figure cannot serve as type in place of a specimen for fossil taxa (ICN Art. 8.5). Fortunately, the only other specimen of *Problematospermum* figured by Turutanova-Ketova, the specimen that corresponds to pl. 4, fig. 29, 29a has been located. This specimen was referred to as “*Problematospermum elongatum*” by Turutanova-Ketova, but as noted above that species name was not validly published, and as a consequence that specimen has no nomenclatural standing as the type of “*P. elongatum*”. Turutanova-Ketova distinguished *P. ovale* and “*P. elongatum*” based on differences in seed size and shape, but subsequent workers have treated them as taxonomic synonyms. While it is unfortunate that the specimen designated as type by Krassilov (1973a) is missing, this is mitigated by the fact that the only other specimen of *Problematospermum* cited by Turutanova-Ketova (1930) is available in the collections of the Geological Institute, Russian Academy of Sciences, Moscow, Russia, to serve as the neotype for *P. ovale* Turut.-Ket. ex Krassilov. This specimen has been selected as the neotype because it exhibits all of the characteristic features of *Problematospermum* and it is from the Karatau locality, which is the source for the

specimens described and illustrated by Turutanova-Ketova and Krassilov.

■ TYPIIFICATION

Problematospermum Turut.-Ket. ex Krassilov in Geophytology 3: 1. 1973 – Type *Problematospermum ovale* Turut.-Ket. ex Krassilov.

= *Typhaera* Krassilov in Palaeontographica, Abt. B, Palaeophytol. 181: 35–36. 1982.

Problematospermum ovale Turut.-Ket. ex Krassilov in Geophytology 3: 1. 1973 – Type: Turutanova-Ketova in Trudy Geol. Muz. Akad. Nauk S.S.S.R. 6: 160, t. 4, fig. 30, 30a. 1930, specimen lost – **Neotype (designated here)**: specimen referred to as “*P. elongatum*” by Turutanova-Ketova in Trudy Geol. Muz. Akad. Nauk S.S.S.R. 6: 160, t. 4, fig. 29, 29a. 1930 (Geological Institute, Russian Academy of Sciences, Moscow, Russia, specimen number 1848/154). [Neotype illustrated in Fig. 1]

= *Typhaera fusiformis* Krassilov in Palaeontographica, Abt. B, Palaeophytol. 181: 35–36, t. 19, fig. 247–251. 1982.



Fig. 1. Fossil seed described as “*Problematospermum elongatum*” by Turutanova-Ketova (1930), although the name was not validly published. Specimen designated here as neotype for *Problematospermum ovale* Turut.-Ket. ex Krassilov, Geological Institute, Russian Academy of Sciences, Moscow, Russia, specimen number 1848/154. Photographs by Elena Kostina.

= *Carpolithus longicilius* Zijin Liu in Bull. Xi'an Inst. Geol. Miner. Resources 24: 97, t. 1, fig. 22. 1988.

■ GENUS DIAGNOSIS

The diagnosis for *Problematospermum* has become confused due to differing interpretations of the structure of the fossil seeds. Therefore, we take this opportunity to clarify the structure of these distinctive seeds through an amended diagnosis. Additional details on the genus, including newly discovered fossil seeds from the Early Cretaceous of Mongolia will be presented in a subsequent publication (Bickner, work in progress).

Genus diagnosis, amended here. — Seeds small and orthotopous. Seed body elliptical with an acute apical micropyle

and a rounded to truncate base with a long slender basal stalk that may become detached from the seed body. Seed enclosed by a thin, membranous integument and a two-layered seed envelope. The surface of the seed is covered with short blunt ridges arranged in rows. Seed bears long, delicate filamentous appendages that are directed away from the micropyle and toward the seed base and the long slender stalk; filamentous appendages are readily detached and may be absent.

■ DISCUSSION

Fossil seeds identified as *Problematospermum* have been reported from Jurassic and Cretaceous age sediments from Kazakhstan, Mongolia and China (Table 1). Most reports use the species name *P. ovale*. Although the name was not validly

Table 1. List of occurrences of *Problematospermum* in the fossil record.

Taxon	Publication	Location	Age	Notes
<i>Problematospermum ovale</i> Turut.-Ket.	Turutanova-Ketova, 1930 (pl. 4, figs. 30, 30a)	Karatau, Kazakhstan	Late Jurassic	Name not validly published
<i>Problematospermum elongatum</i> Turut.-Ket.	Turutanova-Ketova, 1930 (pl. 4, figs. 29, 29a)	Karatau, Kazakhstan	Late Jurassic	Name not validly published
<i>Problematospermum ovale</i> Turut.-Ket. ex Krassilov	Krassilov, 1973a (pl. 1, figs. 1–12; pl. 2, figs. 13–22)	Karatau, Kazakhstan	Late Jurassic	Genus and species names inadvertently validated by Krassilov
<i>Problematospermum ovale</i>	Krassilov, 1973b (pl. 170, figs. 4A–4D)	Karatau, Kazakhstan	Late Jurassic	Discusses same material as in Krassilov (1973a)
<i>Problematospermum</i> sp.	Krassilov, 1982 (pl. 19, fig. 252)	Gurvan-Eren Mountain, Mongolia	Early Cretaceous	Seed “pappus” only
<i>Typhaera fusiformis</i> Krassilov	Krassilov, 1982 (pl. 19, figs. 247, 248, 250, 251)	Gurvan-Eren Mountain, Mongolia	Early Cretaceous	Taxonomic synonym of <i>P. ovale</i>
<i>Carpolithus longicilius</i> Zijin Liu	Liu, 1988 (pl. 1, fig. 22)	Niuposigou, Shenyu, and Wangjiagou, China	Early Cretaceous	Treated as synonym of <i>P. ovale</i> by Wang & al. (2010)
<i>Typhaera fusiformis</i>	Wu, 1999 (pl. 16, figs. 3, 3a, 6, 6a)	Huangbanjigou, Beipiao, Liaoning, China	Early Cretaceous	
<i>Problematospermum beipiaoense</i> G.Sun & S.Zheng	Sun & al., 2001 (pl. 25, figs. 1, 2; pl. 66, figs. 1, 2; pl. 75, figs. 1–6)	Huangbanjigou, Beipiao, Liaoning, China	Early Cretaceous	Recognized as a distinct species mainly because basal stalk is absent
<i>Problematospermum ovale</i>	Sun & al., 2001 (pl. 25, figs. 3–4; pl. 66, figs. 3–11)	Huangbanjigou, Beipiao, Liaoning, China	Early Cretaceous	
<i>Problematospermum ovale</i>	Wang & al., 2010 (pl. 1–3)	Daohugou, Inner Mongolia; Sanjiaocheng, China	Middle Jurassic	Authors interpret seed orientation differently from others and emend diagnosis
<i>Problematospermum ovale</i>	Na & al., 2017 (pl. 4, figs. 11, 12)	Daohugou, Inner Mongolia, China	Middle Jurassic	
<i>Problematospermum</i> sp.	Pott & Jiang, 2017 (pl. 5, figs. 7, 8)	Daohugou, Inner Mongolia, China	Middle and Late Jurassic	Seed “pappus” only
<i>Problematospermum ovale</i>	McLoughlin & Pott, 2019 (pl. 4, figs. B–E)	Jehol Group, Inner Mongolia, China	Early Cretaceous	
<i>Problematospermum beipiaoense</i>	McLoughlin & Pott, 2019 (pl. 4, fig. A)	Jehol Group, Inner Mongolia, China	Early Cretaceous	
<i>Problematospermum</i> sp.	Bickner & al., unpub. data	Tevshiin Govi, Mongolia	Early Cretaceous	

published, Turutanova-Ketova's "*Problematospermum elongatum*" is usually listed as a taxonomic synonym of *P. ovale*. In addition, *Typhaera fusiformis* Krassilov and *Carpolithus longicilius* Zijin Liu have been treated as taxonomic synonyms of *P. ovale*. One other species of *Problematospermum* has also been described, *P. beipiaoense* G.Sun & S.Zheng (Table 1).

The name *Problematospermum* was established for these fossil seeds by Turutanova-Ketova because of the unusual structure of the seeds with a "pappus-like" tuft of hairs at one end of the seed. Krassilov (1973a,b) compared them with the pappus of Compositae fruits. The systematic relationships and possible evolutionary significance of *Problematospermum* have been addressed by a number of authors (e.g., Krassilov, 1973a,b; Wang & al., 2010; Friis & al., 2011) but their relationships remain "problematic". Ongoing research on fossil seeds from Mongolia and Inner Mongolia, China will hopefully help to resolve these questions (Bickner, 2021, unpub. data).

This case with *Problematospermum* is a useful demonstration of how an inadvertent validation of a taxonomic name can occur. It is clear in reading Krassilov (1973a) that the author thought the names *Problematospermum* and *P. ovale* had been validly published by Turutanova-Ketova in 1930. However, by adopting only one of Turutanova-Ketova's species and citing only a single specimen, Krassilov solved a nomenclatural problem that he was unaware existed. Had he not done this, nomenclatural priority would require the use of the genus name *Typhaera* Krassilov for these fossil seeds.

■ AUTHOR CONTRIBUTIONS

PSH and MAB researched taxonomic and nomenclatural literature and prepared the initial draft; EB, SN and EK researched the possible locations of type material; EK found and photographed the illustrated specimen from Turutanova-Ketova (1930); all authors contributed to editing the manuscript. — PSH, <https://orcid.org/0000-0003-2657-8671>; MAB, <https://orcid.org/0000-0002-1974-5593>; EB, <https://orcid.org/0000-0001-6919-9722>; SN, <https://orcid.org/0000-0001-6506-7319>

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