The Early Jurassic male ginkgoalean inflorescence *Stachyopitys preslii* Schenk and its *in situ* pollen

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An early Liassic male inflorescence of *Stachyopitys preslii* with *in situ* pollen is described from a clay lens in the sandpit Küfner near Pechgraben, Bavaria, Germany. These male inflorescences have been known since the 19th century and are rather common in the early Liassic floras of Bavaria, but *in situ* pollen was hitherto unknown. *Stachyopitys preslii* is always found in association with the leaves and the female fructifications of *Schmeissneria microstachys*. The *in situ* pollen proved to be monosulcate, a pollen type commonly occurring in the Cycadophyta and Ginkgophyta. This strengthens the possible attribution of the parent plant of *S. preslii* (*Schmeissneria microstachys*) to the Ginkgoales.

Contents

Introduction

Schenk described *Stachyopitys preslii* as a genus and species for associated male and female inflorescences from the early Liassic of Bavaria (Germany) in 1867. The males consist of pedunculate axes with lateral branches. These lateral branches bear a cluster of spreading pollen sacs at their apex. The female fructifications (formerly named *Pinites microstachys* Presl) also consist of a pedunculate main axis, the upper part of which is covered with spirally arranged cupulate ovules, often in pairs. Over time, *Stachyopitys preslii* was re-interpreted as a male fructification only (Schenk, 1890, was the first to do this), probably belonging to the Ginkgoales. In particular, *Baiera muensteriana* was named as its possible parent plant (e.g., Gothan, 1914; Weber, 1968). In 1992 Wcislo-Luraniec described a cupulate axis of *Stachyopitys preslii* indicating that the species was indeed a mixture of male and female fructifications. However, she did not remove the female fructifications from *S. preslii*. In the same year, Kirchner (1992) doubted the attribution of *Stachyopitys preslii* to *Baiera muensteriana* because of the absence of *Baiera* leaves in the type locality Veitlahm (near Kulmbach) of *Stachyopitys preslii*.

Kirchner & van Konijnenburg-van Cittert (1994) separated the female fructifications from the male ones and named the former *Schmeissneria microstachys* (Presl) Kirchner et van Konijnenburg-van Cittert; these had been found attached to short shoots also bearing a tuft of undivided leaves. The attribution of these female fructifications was with the Ginkgoales although the seeds appear to be winged when mature, a feature not occurring in this group. They considered *Stachyopitys preslii* to be the male fructification belonging to *Schmeissneria microstachys*, but, as it was only found in association and not attached, the name *S. preslii* was retained. Although *S. preslii* is not uncommon in Liassic localities especially in Bavaria (Germany), but also in coeval layers in Poland (Wcislo-Luraniec, 1992), *in situ* pollen had previously never been recovered.

This paper describes *in situ* pollen from a male cone of *S. preslii* from the sandpit Küfner near Pechgraben (Bavaria, Germany) for the first time; its monosulcate pollen is in accordance with a possible ginkgoalean affinity.

Materials and methods

The specimen comes from the sandpit Küfner near Pechgraben (Bavaria, Germany). *Stachyopitys preslii* is quite common in some of the clay lenses in the sandpit, and is always found associated with leaves and female fructifications of *Schmeissneria microstachys* (for more details, see Kirchner & van Konijnenburg-van Cittert, 1994). The *in situ* pollen was prepared by macerating a pollen sac in a solution of $KClO_3$ in 30 % HNO_3 and, after thorough rinsing in water, neutralizing it in 5 % KOH. Macerated pollen was mounted on a slide in glycerine jelly and sealed with paraplast. The pollen grains were only studied under light microscopy. The specimen is stored at the Laboratory of Palaeobotany and Palynology, Utrecht, the Netherlands, under number 23116 (pollen slide 200).

Description of the male inflorescence and its *in situ* pollen

Pls. 1, 2.

Description – The specimen (nr. 23116) is an incomplete inflorescence (the base is missing), consisting of a striate main axis, 23 mm long, with irregularly placed branches 1-2 mm long, each ending in a cluster of pollen sacs (Pl. 1, figs. 1, 2). The maximum number of pollen sacs observed in a cluster is eight. Pollen sacs are just over 1.0 mm long and 0.5 mm wide. The pollen was slightly immature as it was yielded in large masses (Pl. 2, figs. 1, 2) and was difficult to separate. Pollen is monosulcate, with a narrow sulcus without a margo (Pl. 2, figs. 3, 4). Mean length of pollen is 49 μm, mean width 26 μm. The wall appears to be granulate (Pl. 2).

Discussion – A couple of specimens in the Utrecht collection (e.g., 10604 A-D, Pl. 1 figs. 3, 4) also yielded a few *in situ* pollen grains, but only 23116 gave a large mass of slightly immature grains. It proved to be impossible to separate individual pollen grains from each other, but the pollen morphology is clear from the grains on the edges of the pollen masses (Pl. 2). As it was the only specimen yielding *in situ* pollen, no SEM or TEM study was undertaken.

General discussion and comparison with other *Stachyopitys* species

Ginkgoalean inflorescences with *in situ* pollen are scarce in the fossil record. The present inflorescence is the oldest male cone with a putative ginkgoalean affinity. The best known male *Ginkgo* with *in situ* pollen is the male catkin attributed to *Ginkgo huttonii* from the Middle Jurassic of Yorkshire (Van Konijnenburg-van Cittert, 1971, 1972; Harris & Millington, 1974). Here, the inflorescence consists of a main axis with loosely arranged short appendages, which bear two pollen sacs at their apex; thus, they differ mainly from *S. preslii* in the number of pollen sacs on each appendage. The pollen grains (29-42 μm in length) are monosulcate, but the pollen wall appears to be less clearly granulate than in *S. preslii*. The Lower Cretaceous *Ginkgo liaoningensis* carried 2-4 pollen sacs on each appendage and the pollen is again monosulcate; however, no details on the pollen wall morphology have been published (Liu *et al*., 2006). The male cones of living *Ginkgo biloba* have two pollen sacs on each appendage in the catkin and the pollen (34-46 μm long) is again monosulcate with a slightly granulate pollen wall (Van Konijnenburg-van Cittert, 1971). Thus, the *in situ* fossil and extant ginkgoalean pollen grains are remarkably similar.

Stachyopitys specimens are rare in the fossil record. Apart from the type species, *S. preslii,* known from Germany and Poland, Turutanova-Ketova (1931) described *Stachyopitys* sp. from the Jurassic of Kyrgyzstan, but no details can be observed from the illustrations other than that it looks like a *Stachyopitys* inflorescence. Ye Meina *et al*. (1986) mentioned *Stachyopitys* sp. from the lowermost Liassic of China, but did not describe or figure it. Schweitzer & Kirchner (1995) described *Stachyopitys venustus* from the Liassic of Iran. The number of pollen sacs at the end of each appendage is 6-10. The length of these pollen sacs is only up to 0.7 mm and thus is distinctly shorter than in *S. preslii*; this is, according to the authors, the only obvious difference between the two species. No pollen was recovered from *S. venustus* and no possible parent plant has been indicated other than a ginkgoalean affinity.

Anderson & Anderson (2003) described six *Stachyopitys* species from the Late Triassic Molteno Formation of South Africa. These species differ mainly in size of the inflorescences, with *S. matatilongus* as the longest (an incomplete inflorescence was almost 140 mm long); number of pollen sacs attached to the appendages (from 3-4 up to >20 for *S. lacrisporangia*); and shape and size of the pollen sacs (*S. rotundisporangia* has spherical pollen sacs, the other species all have elliptical pollen sacs). One specimen of *Stachyopitys lacrisporangia* was found attached to a bulbous short shoot, together with a leaf of *Sphenobaiera africana* (*Sphenobaiera* is a ginkgoalean leaf morphogenus differing from *Schmeissneria* in its dichotomously divided lamina). None of these *Stachyopitys* species yielded any pollen grains and all species had larger pollen sacs than those of *Stachyopitys preslii*. Holmes & Anderson (2007) recorded two of these species (*S. matatilongus* and *S. lacrisporangia*) with a cf. determination from the Middle Triassic Nymboida Coal Measures.

Conclusions

The type of pollen found *in situ* in *S. preslii* (the type species of the genus *Stachyopitys*) is of a general type found in extinct and living Ginkgophyta and Cycadophyta. No

definite taxonomical attribution can be deduced from this type of pollen grains, except that it does not contradict a ginkgoalean affinity of the pollen organ. Pollen organs with a cycadophyte affinity (Cycadales or Bennettitales) are rather different in gross morphology from *Stachyopitys* material. Hence, a ginkgoalean affinity seems the most likely for this type of inflorescences and confirms the suggestions made by all authors describing this genus (Schenk, 1867, 1890; Gothan, 1914; Weber, 1968; Wcislo-Luraniec, 1992; Kirchner, 1992; Kirchner & van Konijnenburg-van Cittert, 1994; Schweitzer & Kirchner, 1995).

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Plate 1

Stachyopitys preslii Schenk
Fig. 1. Male inflorescence; specimen 23116.
Fig. 2. Detail from Figure 1 showing a cluster of eight pollen sacs which yielded *in situ* pollen.
Fig. 3. Male inflorescence; specimen 10604D.
Fig. 4. Detail from Figure 3, showing several clusters of pollen sacs.

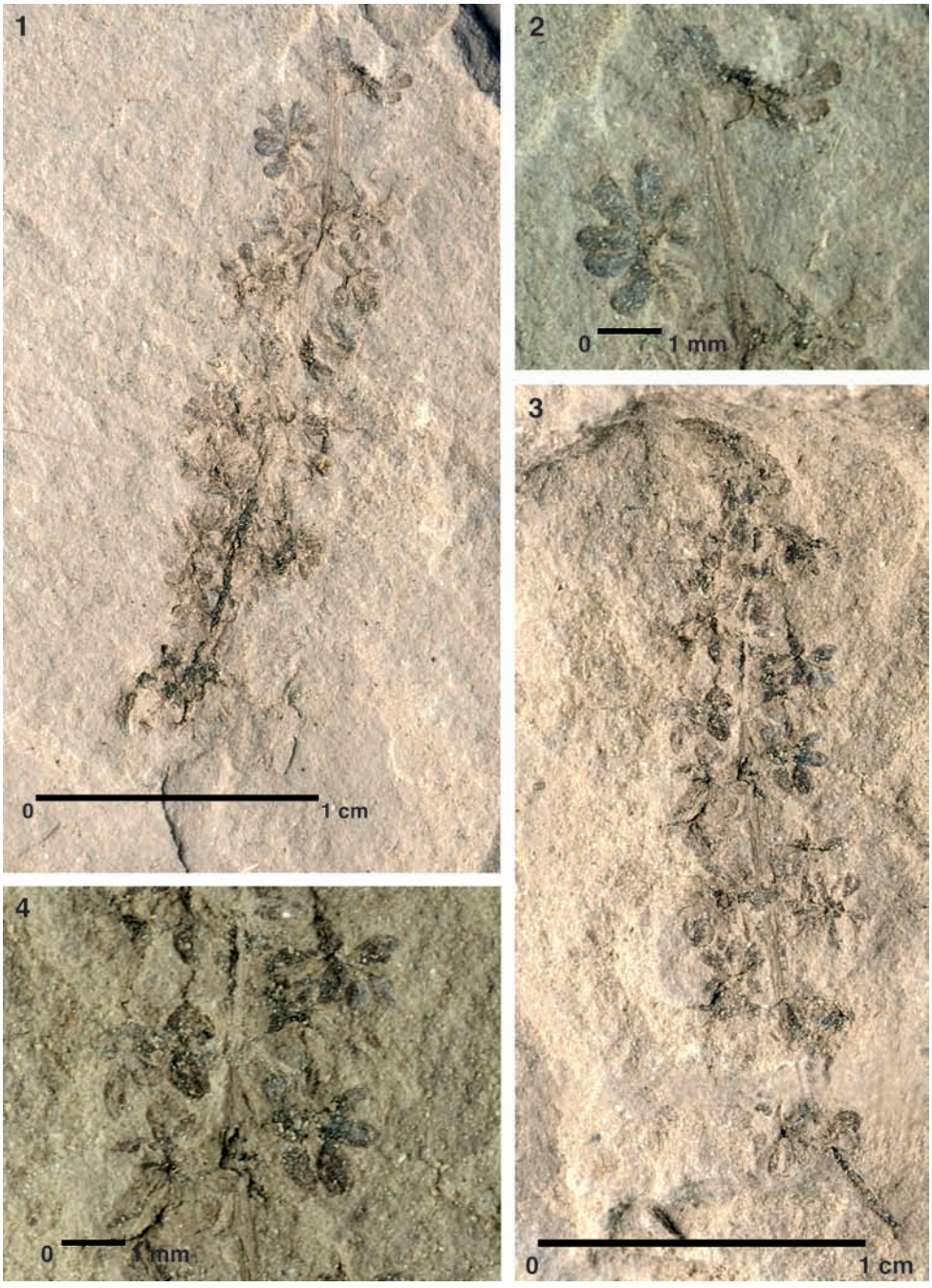
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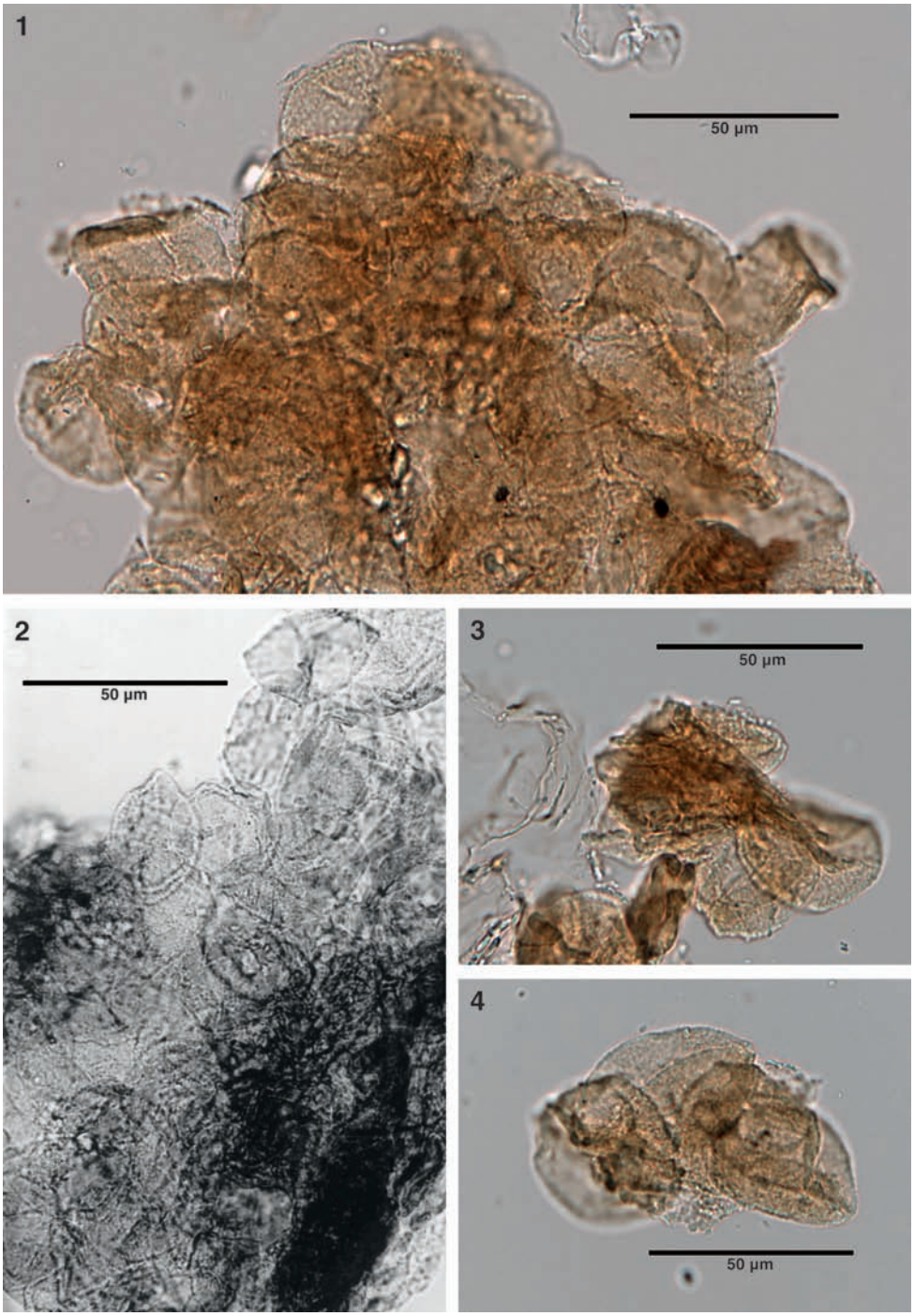
Plate 2

Stachyopitys preslii Schenk
Fig. 1. Part of the content of a pollen sac from specimen 23116, showing monocolpate, granulate pollen grains.
Fig. 2. Part of the content of another pollen sac from specimen 23116.
Fig. 3. Some remains of a pollen sac wall (on the left) and a number of monocolpate, granulate pollen grains.
Fig. 4. A few pollen grains, showing clearly the colpus (upper pollen grain) and the granulate wall.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