Supporting Information

Wang et al. 10.1073/pnas.1115076109

SI Text

This section provides a comparison of the Wuda tuff flora with similar preserved floras. A fossil flora that is similar in age and appearance and which was similarly preserved in a white volcanic tuff is the flora of the Döhlen Basin in Saxony, Germany (1, 2). There, specimens were collected in underground mines and only qualitative descriptions of plant communities were possible. There are also distinct differences in the composition of the floras (Table S1) that we interpret to be because of the biogeographic differences between the Cathaysian and Euramerican paleophytogeographic realms. Fossil floras in the Czech Republic (3, 4) and Spain (5) show a similar preservation and were studied with a similar approach, but those floras are Carboniferous in age and, therefore, older. The same is true for floras preserved in clastic material above suddenly drowned peat swamps/coal seams (6, 7). A flora of similar early Permian age preserved in a volcanic tuff is being excavated in Chemnitz, Saxony, Germany (8). However, this forest was growing on tuff, not on peat, near a volcano, was embedded in an ash flow, and the plants were preserved by permineralization. The standing forest reported from the Permian of Antarctica (9) represents a totally different climatic belt.

Figs. S2–S6 show selected plant fossils of the floral elements of each group of the peat-forming swamp forest buried in the Early Permian volcanic tuff near Wuda, Inner Mongolia, China. Six groups of plants make up this peat-forming vegetation. They include lycopsids (*Sigillaria* cf. *ichthyolepis*), sphenopsids (*Sphenophyllum* and *Asterophyllites*, a small *Calamites*), marattialean tree ferns (a number species of *Pecopteris*), herbaceous ferns (*Nemejcopteris feminaeformis*, *Cladophlebis*, and *Sphenopteris*), Noeggerathiales (*Tingia* and *Paratingia*), cycadophytes (*Samaropsis*, *Taeniopteris*, and *Pterophyllum*), and coniferophytes (*Cordaites*). Five plates are shown to illustrate the exceptional preservation of the fossil plants of the peat-forming swamp forest. Our reconstructions for all plant individuals are based on the specimens we found, which often include crowns, stems, or branches with attached leaves. Several reconstructions confirm previously published ones. The reconstructions of the noeggerathialean *Tingia* and *Paratingia* are recent and are unique in being shown in the context of their plant community.

1. Barthel M (1976) Die Rotliegendflora Sachsens [Fossil flora of the Rotliegend Group, Lower Permian, of Saxony, Germany]. *Abh Staatl Mus Mineral Geol*, 24:1.190. German.
2. Kunzmann L (2005) *Blumen Gebirge: Ein fossiles Herbarium (Katalog zur Ausstellung)* [*Flowers in the Rocks: A Fossil Herbarium*. *Catalogue of the Exhibit*.] (Druckerei Thieme GnbH and Co. KG, Meissen). (German)
3. Opluštil S, et al. (2009) A middle Pennsylvanian (Bolsovian) peat-forming forest preserved in situ in volcanic ash of the Whetstone Horizon in the Radnice Basin, Czech Republic. *Rev Palaeobot Palynol* 155:234–274.
4. Opluštil S, et al. (2009) Composition and structure of an in situ middle Pennsylvanian peat-forming plant assemblage buried in volcanic ash, Radnice basin (Czech Republic). *Palaios* 24:726–746.
5. Wagner RH (1989) A late Stephanian forest swamp with *Sporangiostrobus* fossilized by volcanic ash fall in the Puertollano Basin, central Spain. *Int J Coal Geol* 12:523–552.
6. DiMichele WA, Falcon-Lang HJ, Nelson WJ, Elrick SD, Ames PR (2007) Ecological gradients within a Pennsylvanian mire forest. *Geology* 35:415–418.
7. Gastaldo RA, Stevanović-Walls IM, Ware WN, Greb SF (2004) Community heterogeneity of early Pennsylvanian peat mires. *Geology* 32:693–696.
8. Rössler R (2006) Two remarkable Permian petrified forests: Correlation, comparison and significance. *Non-Marine Permian Biostratigraphy and Biochronology*, eds Lucas SG, Schneider JW (The Geological Society Publishing House, Bath, UK), Vol 265, pp 39–63.
9. Taylor EL, Taylor TN, Cúneo NR (1992) The present is not the key to the past: A polar forest from the permian of antarctica. *Science* 257:1675–1677.

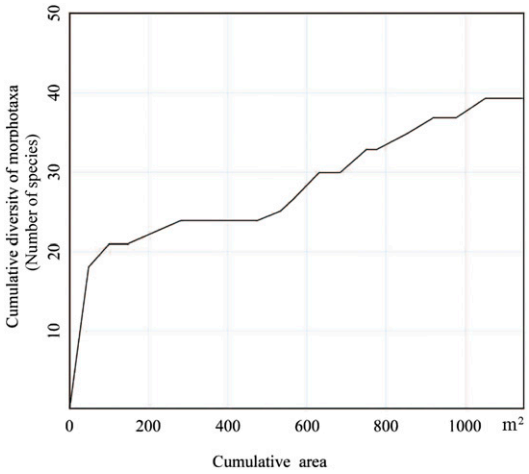

Fig. S1. Incremental increase in the number of new species encountered over an expanding area of the excavation. The first area counted was site 1 in the southern part of the syncline, followed by sites 2 and 3 in the northern part of the syncline. The species-area curve levels off in the census in site 1 (ca. 135 m^2), rises again and levels off after an incorporation of the data of the site 2 (ca. 390 m^2) and site 3 (ca. 592 m^2).

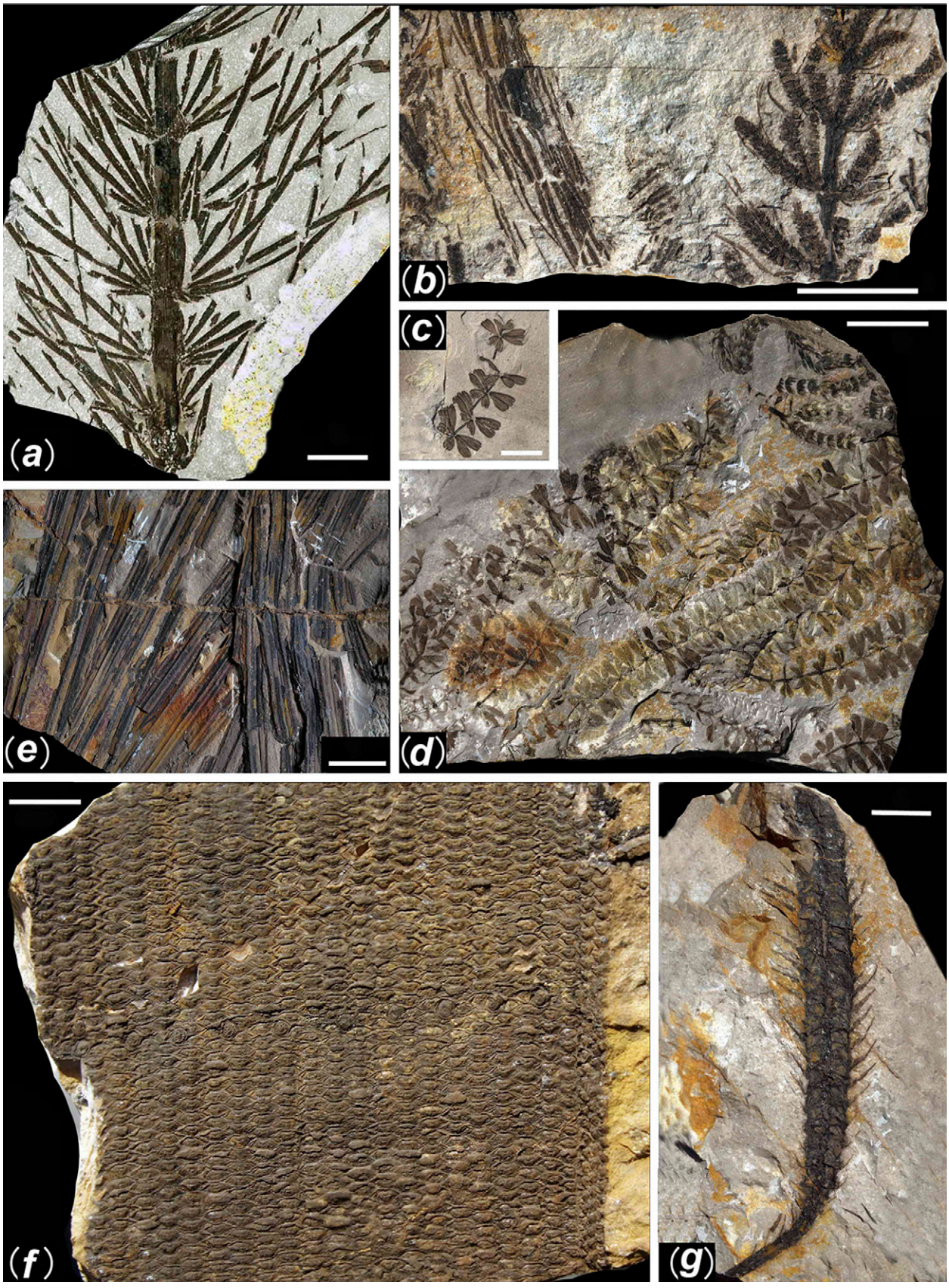

Fig. S2. Sphenopsids and lycopsids: *Asterophyllites longifolius* (*A*) and associated *Paleostachya* type strobili (*B*); *Sphenophyllum oblongifolius* (*C*) and associated strobili (*D*); *Sigillaria* cf. *ichthyolepis* leaf (*E*), stem (*F*), and strobilus (*G*). (Scale bars, 2 cm in *A*, *C*, *D*, *F*, and *G*; 1 cm in *B* and *E*.)

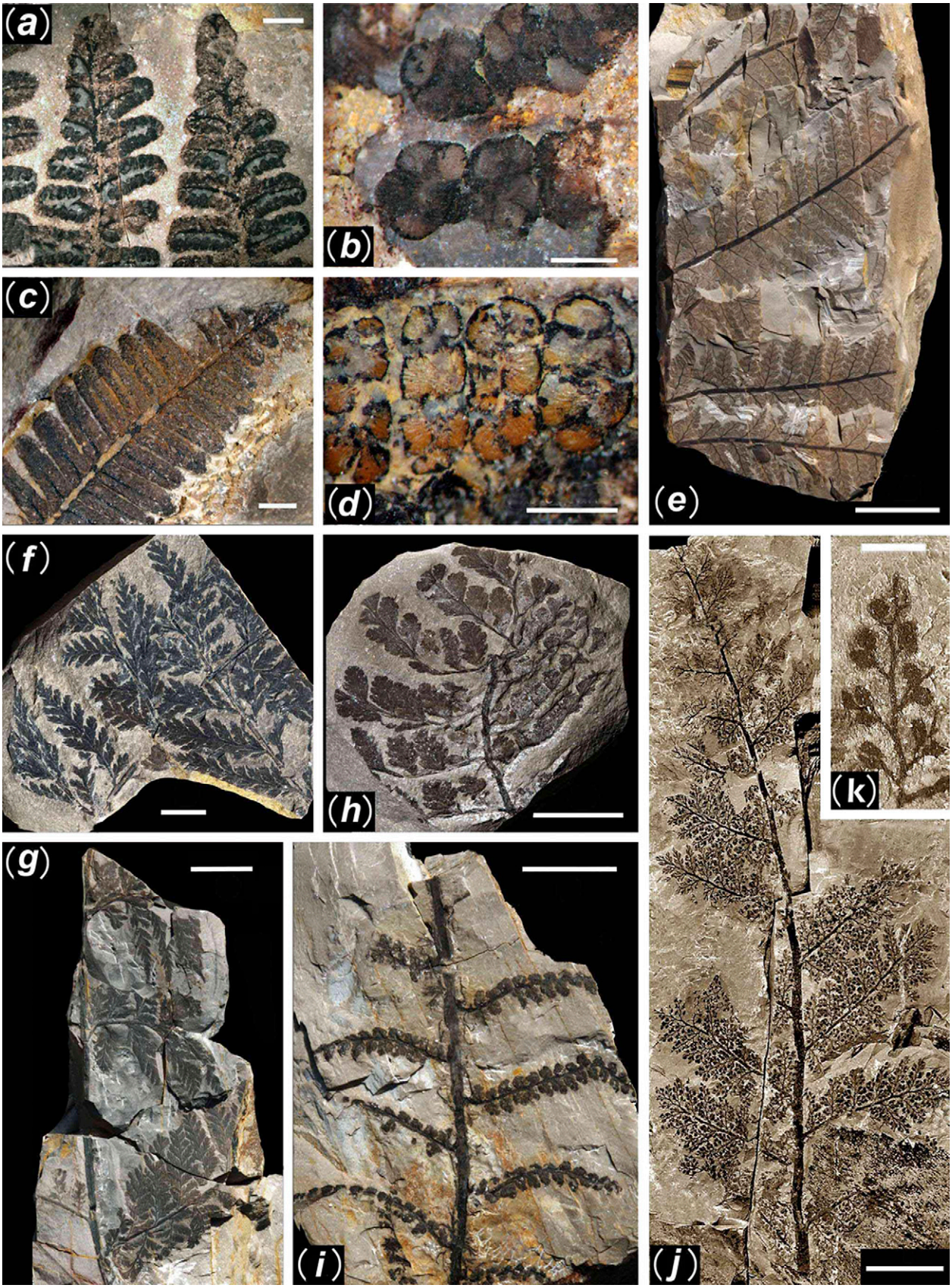

Fig. S3. Ferns. (*A* and *B*) *Pecopteris* sp. with sporangia of *Asterotheca* type; (*C* and *D*) *Pecopteris hemitelioides* with sporangia of *Eoangiopteris* type; (*E* and *J*–*K*) *Sphenopteris* (*Oligocarpia*) *gothanii*; (*F* and *G*) *Sphenopteris* cf. *tenuis*; (*H*) *Sphenopteris* sp. 1; (*I*) *Sphenopteris* sp. 2 with abnormal pinnule (*Aphlebia*) at the very base of each ultimate pinna, indicating the plant may be a liana. (Scale bars, 2 mm in *A* and *C*; 500 μm in *B* and *D*; 1 cm in *E*–*J*; 1 mm in *K*.)

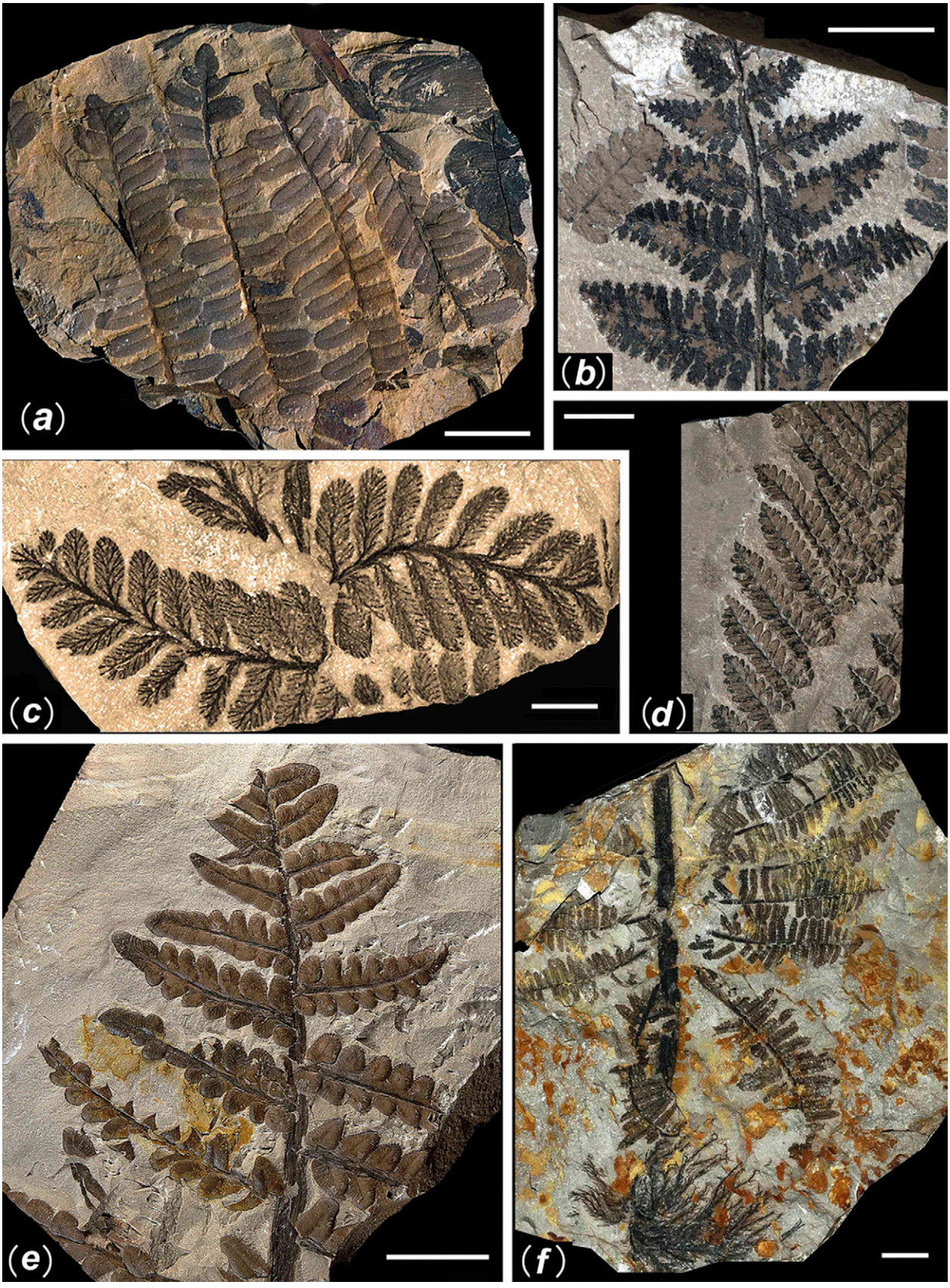

Fig. S4. Ferns. (*A*) *Pecopteris* cf. *candolleana*; (*B*) *Nemejcopteris feminaeformis*; (*C*) *Pecopteris orientalis*; (*D*) *Pecopteris* sp.; (*E*) *Pecopteris lativenosa*; (*F*) *Pecopteris arborescens* with abnormal pinna (*Aphlebia*) at the base. (Scale bars, 2 cm in *A*–*E*; 3 cm in *F*.)

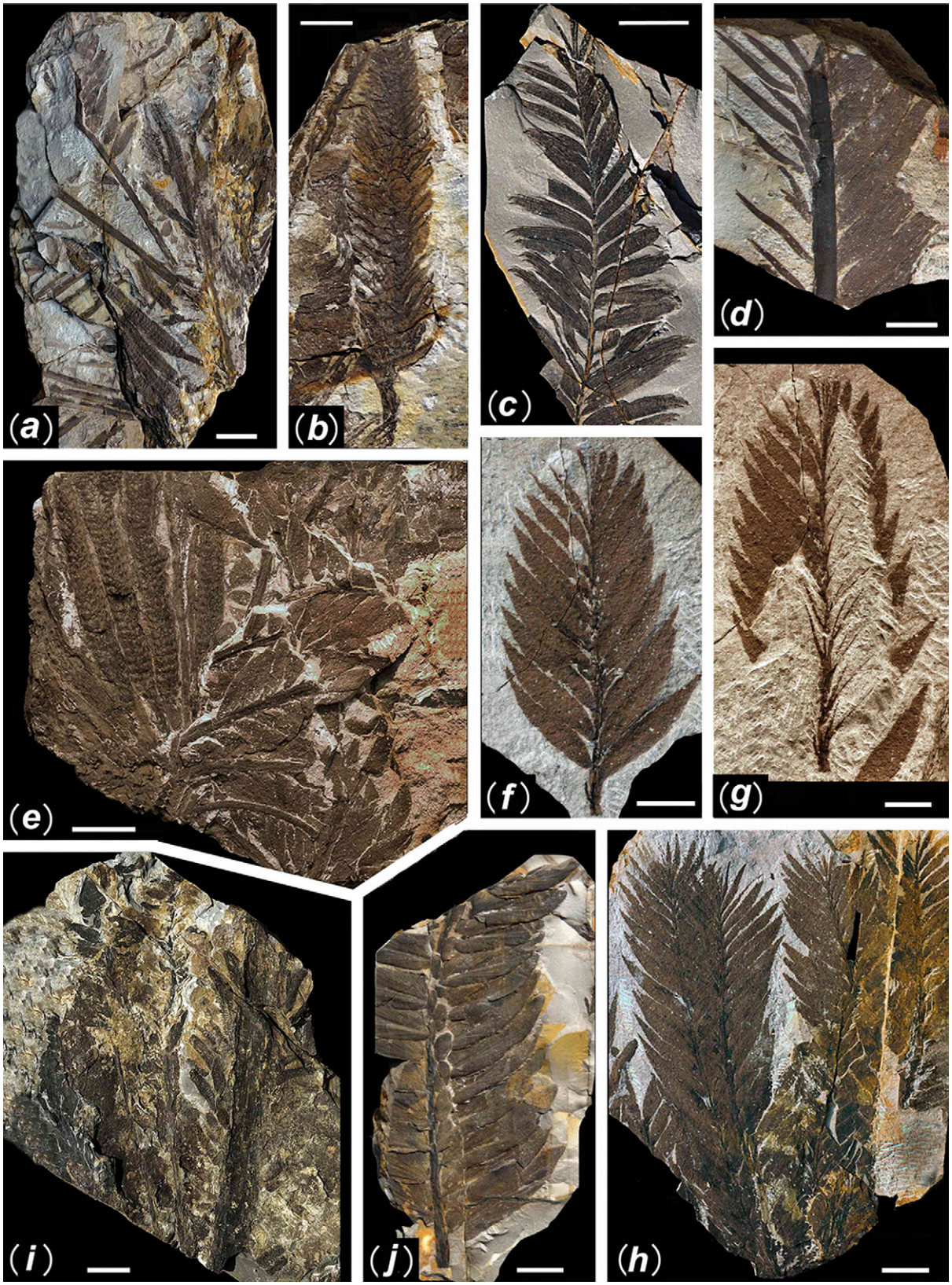

Fig. S5. Noeggerathiales. (*A–D*) *Tingia unita*: (*A*) a crown with strobili and once pinnate compound leaves attached to the stem, (*B*) isolated strobilus, (*C*) leaf with only large pinnules exposed, and (*D*) leaf with both large and small pinnules exposed; (*E–H*) *Paratingia wudensis*: (*E*) a crown with strobili and once pinnate compound leaves attached to the stem, (*F*) leaf with only large pinnules exposed, and (*G*) with small pinnules exposed after degagement, (*H*) a number of leaves likely attached to a common stem; (*I* and *J*) *Paratingia* sp.: (*I*) a crown with strobili and once pinnate compound leaves attached to the stem, (*J*) a leaf with both large and small pinnules visible. (Scale bars, 3 cm in *A* and *H*; 1 cm *B–D*; 2 cm *E–J*.)

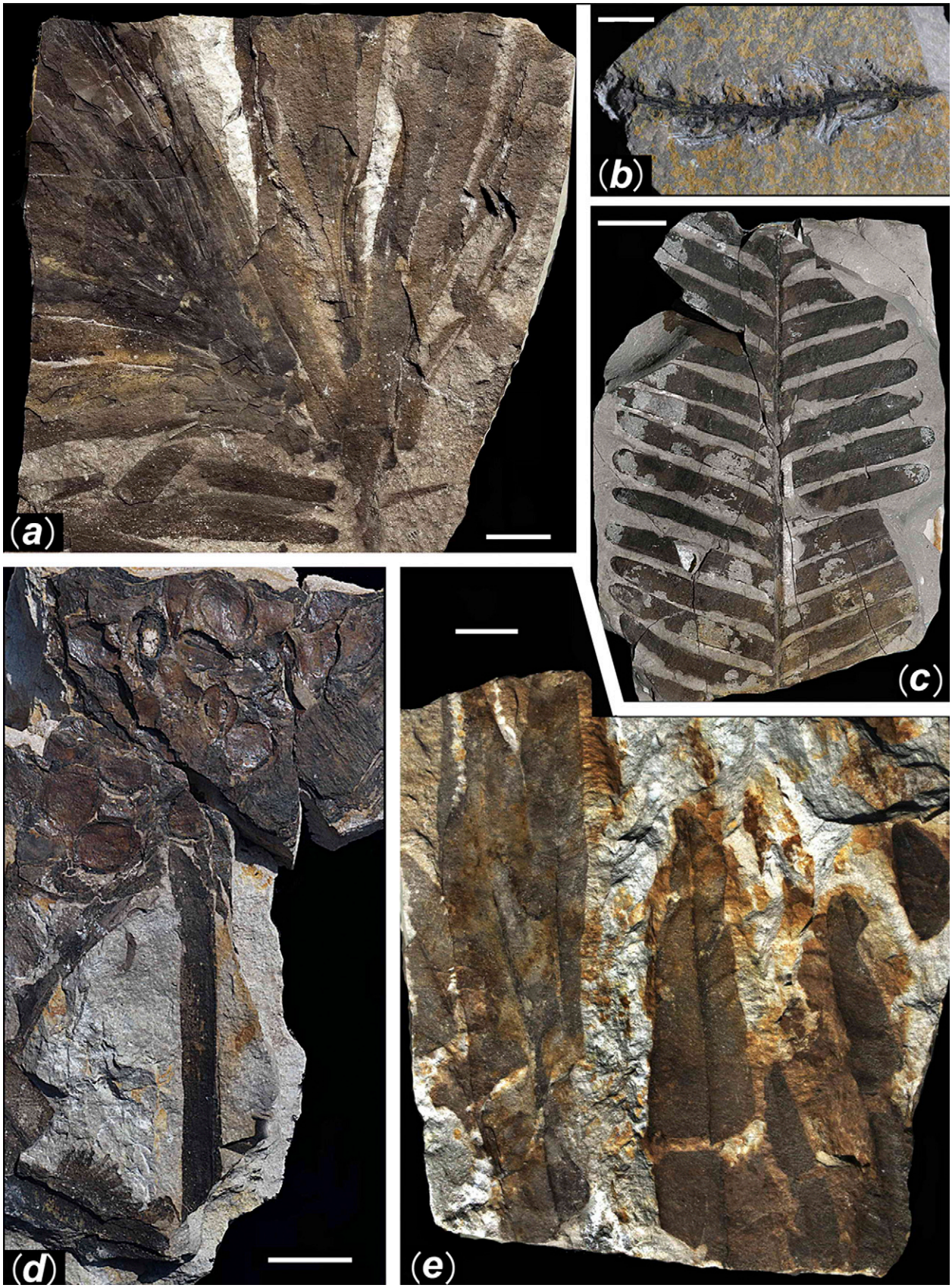

Fig. S6. *Cordaites* and cycadophytes. *Cordaites* sp., (*A*) bunch of leaves and (*B*) reproductive organ; (*C*) *Pterophyllum* sp.; (*D*) a cluster of *Samaropsis* type of seeds; and (*E*) *Taeniopteris* type leaves. (Scale bars, 2 cm in *A* and *C*–*E*; 1 cm in *B*.)

Table S1. Comparison between earliest Permian peat-forming floras from Wuda, Inner Mongolia, China, the Döhlen Basin in Saxony, Germany, and Thuringia, Germany

Trees and scramblers	Wuda	Döhlen (1)	Thuringia (2)
Trees			
Sigillaria	•	—	—
Calamites	—	•	•
Pecopteris	•	•	•
Noeggerathiales	•	—	—
Pteridosperms	—	—	—
Cordaites	•	•	•
Scramblers			
Nemejcopteris	•	•	•
Sphenophyllum	•	•	•

"•" And "—" represent present and absent in the flora, respectively. Wuda data is reported in the present paper. For Döhlen Basin, see ref. 1, p. 54; for Thuringia, see list reported on pages 159–160 of ref. 2.

1. Barthel M (1976) Die Rotliegendflora Sachsens [Fossil flora of the Rotliegend Group, Lower Permian, of Saxony, Germany]. *Abh Staatl Mus Mineral Geol*, 24:1.190. German.
2. Barthel M (2008) Die Rotliegendflora des Thüringer Waldes. Teil 6: Wurzeln und fertile Organe. Algen und Bakterien. Pflanzengesellschaften [Fossil flora of the Rotliegend Group, Lower Permian, of Thüringer Waldes, Germany. Part 6: Roots and fertile organs. Algae and bacteria. Vegetation]. *Veröffentlichungen des Naturhistorischen Museum Schleusingen*, 23:39.62. German.

Other Supporting Information Files

Dataset S1 (XLSX)