The end-Permian mass extinction is the greatest biotic crisis in Earth history. Most marine species (>95%) and many land tetrapods (>70%) disappeared within a very short time interval [1]. Previous studies of this dramatic event mainly have focused on evolutionary patterns in animal groups prior to the extinction, and on their recovery during the Early Triassic [2]. Although some macroevolutionary scenarios have been postulated for the changes in land-plant vegetation through the Permian and Triassic, the severity of extinction and, the timing and radiation pattern in the recovery of plant groups during the Early Triassic are still debated [3]. Hitherto there has been little information about plant life in the wake of the end-Permian extinction event, mainly because of the scarcity of records of earliest Triassic plant-bearing deposits worldwide. Here we report on an Early Triassic flora from Southwest China that provides a rare glimpse into the post-extinction vegetation in the (sub)tropics of Cathaysia.

More than 500 plant fossils were collected from a single bed in the top part of the lowermost Triassic Dongchuan Formation near Lubei village of northern Huize County in Yunnan Province, Southwest China. Direct age assessment of the terrestrial formation itself is difficult due to the lack of index fossils. In the study area, however, the Dongchuan Formation overlies the recently refined uppermost Permian Kayitou Formation, and overlain by the Olenekian Jialingjiang Formation [4]. The Dongchuan Formation is considered to be correlative with the marine Feixianguan Formation [5], it is thus that the inferred Induan (early Early Triassic) age of the formation is resulted from an entirely lithostratigraphic correlation equating terrestrial red beds with fossiliferous marine rocks.

The plant-bearing bed contains mass accumulations of branch fragments of Albertia (Fig. 1a–e), a poorly known genus of Agathis-like conifer foliage defined by broad, obovate to elliptical leaves with longitudinal striae and rounded apex [6]. Albertia had long been exclusively from the Buntsandstein (Lower Triassic) of the Vosges Mountains and the Rhineland until it was reported also from coeval deposits of South and North China [7]. In the present collection, the most common remains are branch and leafy-twig fragments with helically arranged leaves (Fig. 1c), but a few larger, complanate branch fragments have also been found (Fig. 1d). The leaves have a narrowed base, a broad, obovate, concave, multi-veined lamina and an obtuse to mucronate apex (Fig. 1e, f). The material is most similar to Albertia latifolia and A. elliptica based on the broad dimensions and stout appearance of the leaves. Additional plant remains include rare specimens of sphenophyte stems (Paracalamites stenocostatus; Fig. 1g), osmundalean fern foliage (Anomopteris sp. cf. A. mougeotii; Fig. 1h) and a few undetermined seeds. In addition, we recovered a single Lepacyclotes-like sporophyll, characterised by a prominent midrib, free lateral wings flanking the proximal portion, and an elongate acuminate tip (Fig. 1i).

Early Triassic floras are extremely rare worldwide [8]. In South China, a late Early Triassic (Olenekian) plant-fossil assemblage has been reported from the Qionghai District of Hainan Province [9]. The Qionghai flora is also dominated by conifers (Albertia and Voltzia), but is much more diverse with altogether 38 species in 28 genera of sphenophytes, ferns, conifers and cycadophytes [7]. Another comparatively diverse Early Triassic flora from the presumably upper Induan Liujiaogou Formation in Shanxi Province of North China is, by contrast, dominated by the lycopsid Pleuromeia, with additional occurrences of sphenophytes, ferns, peltasperm seed ferns, cycadophytes, and voltzian conifers [10].

Fossil floras through deep geological times provide a better understanding of the evolutionary history of land vegetation [11]. The overwhelming dominance of conifer remains in the current flora is of particular interest, given that the earliest Triassic vegetation is generally thought to have been dominated by lycopsid [8]. Altogether, the disparate compositions of the few
known Early Triassic plant macrofossil assemblages thus highlight that local vegetation types must have been more diverse than previously thought; our current state of knowledge on the earliest Triassic land plants is apparently still too limited to enable straightforward conclusions about patterns in extinction, recovery, and radiation across the Permian–Triassic boundary.

Conflict of interest

The authors declare that they have no conflict of interest.

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