The oldest Pinus and its preservation by fire
Howard J. Falcon-Lang et al.

Supplementary discussion: Justification for a new species

Plant fossils are usually preserved in a disarticulated state, and new taxa are described based on individual organs; there are very few taxa reconstructed as ‘whole-plants’. The new Pinus fossils described here comprise remains of partial twigs, with short shoot bases, lacking fertile remains. We note that there is a paucity of anatomically-preserved pinaceous twigs in the Cretaceous fossil record. Prior to this paper, the oldest described twig material is from the Cretaceous (Cenomanian) of the Czech Republic, some 40 million years younger than our new Pinus fossils; however, that material is assigned to family level only, and all other Cretaceous fossils that are similar to modern pines are based on secondary xylem only, and therefore assigned to genera such as Pinuxylon (Peralta-Medina and Falcon-Lang, 2012) rather than Pinus sensu stricto. Based on the antiquity, rarity, good preservation, and genus-level identification of the new material, it is advantageous to apply a binomial name, to allow its discussion in the literature.

As the material is assignable to the extant genus, Pinus, it is also necessary to consider how the fossil differs from the c. 115 extant species. Pinus is subdivided into two subgenera, Pinus and Pinus Strobus (Farjon, 2010). Pinus subgenus Strobus shows, typically, five needles per fascicle, whereas Pinus subgenus Pinus, shows, variably, 1 to 8 needles per fascicle (Farjon 2010). Our new Pinus fossils consistently show two needles per fascicle suggesting an affinity with Pinus subgenus Pinus (Farjon, 2010), and implying that the two subgenera diverged earlier than previously thought (Gernandt et al., 2011).

In Pinus subgenus Pinus, the number of needles per fascicle is species-specific in the range of (1) 2 – 5 (8) needles per fascicle (Farjon 2010). Two needles per fascicle is a stable characteristic of the 19 species of so-called ‘Old World Pines’ only: P. densata, P. densiflora, P. hawnshanensis, P. kesiya, P. latteri, P. luchuensis, P. massoniana, P. merkusii, P. mugo, P. nigra, P. resinosa, P. sylvestris, P. tabuliformis, P. taiwanensis, P. thunbergii, P. tropicalis, P. uncinata, and P. yannanensis (Farjon, 2010). A few additional species may show two needles per fascicle but in these taxa, the number of needles per fascicle is highly variable (1-5), unlike the stable two needle state observed in our material (Farjon, 2010).

Another important character state of the new Pinus fossils is their 3/8 phyllotaxic fraction. The most common phyllotaxic fractions in Pinus subgenus Pinus approximate to 1/3, 2/5, 3/8, and 5/13 (Farjon, 2010). Of the classic ‘Old World Pines’ that show two needles per fascicle, the most common fractions are 2/5 and 5/13 (Farjon, 2010). Only P. sylvestris and P. nigra has a phyllotaxic fraction that commonly and closely approximates to 3/8 (i.e., 135°) (Farjon, 2010). According to the analysis of the wood of 352 conifer species compiled by Esteban et al. (2004), the new fossil Pinus differs from P. sylvestris and P. nigra, and most other ‘Old World Pines’ based on the absence of alternate ray tracheids. Therefore, the fossil material can justifiably be treated as a new species.
**The oldest *Pinus***

Figure DR1

- *Pinus* (c. 115 sp.)
- *Cathaya* (1 sp.)
- *Picea* (c. 38 sp.)
- *Larix*/*Pseudolarix* (12 sp.)

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- normal axial ducts
- thin-walled epithelium pinoid cross-field
- *Pinus mundayi*
- *Pityostrobus*
- *Picea burtonii*

**Axial resin ducts with thin-walled epithelial cells**

**Short-shoots that separate into two needle bases**

**Pinoid and fenestriform cross-field pits**