Reaffirming *Pinus mundayi* as the oldest known pine fossil

Howard J. Falcon-Lang¹, Viola Mages¹, and Margaret Collinson¹

¹Department of Earth Sciences, Royal Holloway, University of London, Egham, Surrey TW20 0EX, UK

Hilton et al. (2016) assert that our identification and dating of *Pinus mundayi* from the Cretaceous (Valanginian, 140–133 Ma) of Nova Scotia (Falcon-Lang et al., 2016) is unreliable, and argue that *P. yorkshirensis*, a species that they earlier described (Ryberg et al., 2012) is actually the oldest pine fossil. In their paper, the age of *P. yorkshirensis* is given as Early Cretaceous, and close to the Barremian–Hauterivian boundary (ca. 131–129 Ma). However, in Ryberg et al.’s figure 1, the fossil is shown straddling the Hauterivian–Valanginian boundary (ca. 133 Ma). In their abstract (Ryberg et al., 2012) the fossil is said to derive from the Wealden Formation of Yorkshire, UK, although this stratigraphic unit is absent in that region. The reasons for these inconsistencies relate to uncertain provenance. Ryberg et al. found the specimen in the Lapworth Museum, Birmingham, UK, in six pieces, with a label reading ‘Yorkshire Jurassic cone,’ but without any other accession information.

To determine the age of *P. yorkshirensis*, Ryberg et al. obtained a ‘poor to fair’ assemblage of dinoflagellate (not illustrated) from one fragment, including *Callatothoea asymmetricum, ?Cribroperidinium confossum, and Odontochitina operculata*. As biozones can be diachronous, they assumed correct locality data on the specimen label (Yorkshire). Compared to Yorkshire reference sections, the assemblage was considered indicative of an Early Cretaceous, Barremian–Hauterivian boundary age. However, this inference required that the age data on the specimen label (Jurassic) was incorrect. A Barremian–Hauterivian boundary age in Yorkshire indicates an origin in the Speeton Clay Formation (SCF), a unit that is time-equivalent to the Wealden Formation of the southern UK; hence, presumably, the incorrect use of that unit in the abstract. Only one seed cone has been, hitherto, reported from the SCF (Pearce, 1982). Crucially, this cone is pyritized, as is almost all SCF fossil plant material, whereas *P. yorkshirensis* is sideritized. While an origin in the SCF cannot be excluded, the absence of fossil plant material with similar preservation to *P. yorkshirensis* is concerning.

If the age is incorrect, so also may be the locality on the specimen label (Yorkshire). The dinoflagellate assemblage could be indicative of a wider age range. Globally, *C. asymmetricum* and *O. operculata* have a Cretaceous (Valanginian) to early Paleogene (Eocene) range; *C. confossum* is the only taxon with a narrower Hauterivian–Barremian range (Dinoflagellate Database; www.paleobotany.ru). However, Ryberg et al. note that the identification of *?Cribroperidinium confossum* is uncertain. A Hauterivian–Barremian boundary age for *P. yorkshirensis* is one scenario assuming a Yorkshire provenance and correct identification of *C. confossum*; the alternative scenario is a Cretaceous (Valanginian) to early Paleogene (140–34 Ma) age. In spite of the approaches employed by Ryberg et al., we consider that their claim that *P. yorkshirensis* is the oldest known pine fossil is unreliable. Specimens discovered in museum drawers without accession history have led to paleobotanical errors in the past. Stopes (1913) described an unaccessioned specimen in the Natural History Museum, London, as *Woburnia*, and argued that it was, then, the oldest *Pinaceae* (Aptian) angiosperm. Stopes’ findings were criticized, and analogous techniques to those of Ryberg et al. were employed to better constrain age and provenance, and *Woburnia* is now considered as being from the Neogene of Indonesia (Casey, 1961).

Turning to the disputed identity and age of our own fossils of *P. mundayi*, an interesting anomaly, to which Hilton et al. draw attention, is the absence, in *P. mundayi*, of ray tracheids, a feature common to all extant *Pinus*. We are uncertain if this is a genuine absence or an apparent absence due to limited options for observing rays; if the former, this suggests that, in its early evolution, *Pinus* had not yet acquired all the apomorph characters of the modern genus. As Hilton et al. point out, this raises questions regarding how we distinguish between *Pinus* and *Pinus*-like taxa in the fossil record, be they long-shoots, seed cones, or some other organ. Multiple non-diagnostic characters are listed by Hilton et al. (their supplemental table), but *P. mundayi* does have characters diagnostic of *Pinus*. The occurrence of normal resin ducts in the secondary xylem and phloem that show thin-walled epithelial cell walls is highly characteristic of *Pinus*, but also found occasionally in some juvenile *Picea*. Hilton et al. state that this feature is also present in *Larix* and *Pseudotsuga*, but they do not provide any evidence, and their view contradicts other sources (e.g., Esteban et al., 2004). Further, they failed to comment on the occurrence of axial ducts in the phloem of *P. mundayi*, a feature that excludes *Cathaya, Picea*, and *Pseudotsuga* (Lin et al., 2002). Our material also shows fenestriform and pinoid cross-field pitting, a character that is diagnostic of *Pinus* (Esteban et al., 2004). Taphonomic studies do show that the shape of cross-field pits may significantly change during charring but, as we stated, we had allowed for this, and in other taxa from the same assemblage, different (e.g., cupressoid) original pit structure is faithfully preserved. A third diagnostic character is the presence of short-shoots that distally diverge into two separate bundles. We interpreted these features as evidence that *P. mundayi* was a two-needle pine. Hilton et al. state that we have “structurally misinterpreted” these features; however, the bundles show very close anatomical comparison with the short-shoots of two-needle pines at the periphery of the wood (Dörken et al., 2010), supporting our interpretation.

A final issue that Hilton et al. raise is the age of *P. mundayi*. As with all biostatigraphic interpretations, age is a question of likelihood. The most parsimonious interpretation is a Valanginian (140–133 Ma) age based on palynological assemblage comparison with proximal basins of the nascent Atlantic Ocean. A Valanginian–Hauterivian (140–129 Ma) age is possible, if comparison with more distal western Canadian sites is included. Least likely, due to lack of angiosperm pollen, is a Valanginian–Barremian (140–125 Ma) range, though this is Hilton et al.’s preference. In our opinion, the age of *P. mundayi* is known with greater certainty than that of *P. yorkshirensis*, which Hilton et al. argue is the oldest known pine. Therefore, we reaffirm *Pinus mundayi* as the oldest known pine, and emphasize its preservation as charcoal, which may suggest that fire played a key role in the early evolution of the genus.

REFERENCES CITED


© 2016 Geological Society of America. For permission to copy, contact Copyright Permissions, GSA, or editing@geosociety.org.