



Review paper

Implications of *Pinus* L. pollen abundance for reconstructing the Holocene palaeoclimate from the Himalayas, India

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ABSTRACT

Pinus L. is a genus of coniferous trees, belonging to the class Pinopsida and the family Pinaceae of the division Gymnosperms (naked-seeded plants). Being anemophilous (wind pollinated), *Pinus* produces huge quantities of pollen grains, which often completely overwhelm the other pollen taxa in the palynological assemblages. This, coupled with its efficient transport by wind (due to its excellent buoyancy) and good preservation potential in the sediments, makes it abundant in the pollen assemblages. This over-representation of *Pinus* pollen creates an ambiguity in both the modern and fossil pollen records. Moreover, the over-representation of *Pinus* pollen often hampers in the understanding of modern pollen–vegetation relationship, as well as in the interpretation of fossil pollen records, for the reconstruction of past vegetation dynamics and contemporary climate (change). In the present article, the bountiful abundance of *Pinus* pollen in the palynological assemblages is assessed, and the implications of its over-representation in reconstructing the fossil pollen records and interpreting the past climatic changes are reviewed from the Indian Himalayas.

1. Introduction

Pinus L. is the sole genus in the Pinoideae sub-family and the largest genus of the pine family: Pinaceae of the division Gymnosperms; it is mostly monoecious, having the male and female cones on the same tree. It first appeared in the Jurassic Period (200 million to 145 million years ago). The male cones (small, typically 1–2 cm long, only appear for a short period, and fall just after shedding their pollen) of *Pinus* have many fertile scales and each scale has two pollen-sacs, arranged abaxially. The pollen grains of *Pinus* are bisaccate, having one central body (corpus) and two sacchi (wings or bladders), which aid in its long distance transport by providing buoyancy to the grain (Mirov, 1967; Maberley, 1987). The genus is currently divided into two sub-genera (modern classification) - 1) *Pinus* (yellow or hard pines), and 2) *Strobus* (white or soft pines). According to the older classification, the other sub-genus: *Ducampopinus* (Pinyon, bristlecone and lacebark) was based on its cone, seed and leaf characteristics (Michael, 2002; Gemandt et al., 2005). However, DNA phylogeny has shown that the species in the sub-genus *Ducampopinus* are, in fact, the members of the sub-genus *Strobus*, and, therefore, *Ducampopinus* no longer exists (Gemandt et al., 2005). All these sub-genera, as a matter of fact, constitute “the pines”. Moreover,

pines with two fibrovascular bundles per leaf (needle) are known as diploxylon pines (hard pines; sub-genus *Pinus*), whereas pines with one fibro-vascular bundle per leaf (needle) are known as haploxylon pines (soft pines; sub-genus *Strobus* [and also the earlier sub-genus *Ducampopinus*]). Diploxylon pines have harder timber and large amount of resin, compared to the haploxylon pines (Little and Critchfield, 1969; <http://en.wikipedia.org/wiki/pine>; searched on 28/09/2022).

Pinus is a genus of about 115 species of evergreen conifers, distributed throughout the world, but is native primarily to the northern temperate regions (Mirov, 1967; Kral, 1993). In India, the species of *Pinus* grow naturally in the Himalaya, owing to the sub-tropical–temperate climate, because of the higher altitude. Among the different species, *Pinus roxburghii* Sargent (synonym: *Pinus longifolia*: Binomial name- *Pulmonaria longifolia* Boreau; Chirpine), *Pinus gerardiana* Wall. ex D. Don (Chilgoza pine), *Pinus wallichiana* A.B. Jackson (synonym: *Pinus griffithii* McClelland, *Pinus excelsa* Wall., *Pinus chylla* Lodd.; Blue pine), *Pinus keyisia* or *Pinus khasiana* Royle ex Gordon (Khasi pine, Benguet pine or three-needled pine), *Pinus merkussi* Jungh. & de Vriese (Merkus pine/ Sumatran pine/ Teriasserian pine), *Pinus densata* Mast. (Sikang pine) and *Pinus sylvestris* L. (Scots pine/Scotch pine/ Baltic pine) are the most common. Out of these, five species, such as *Pinus roxburghii*, *Pinus*

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