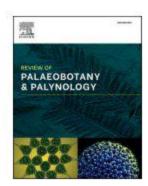


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Review paper



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

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ABSTRACT

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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 sacci (wings or bladders), which aid in its long distance transport by providing buoyancy to the grain (Mirov, 1967; Mabberley, 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 subgenus 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 keysia 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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