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Modern pollen deposition in relation to vegetation and climate of Balpakram valley, Meghalaya, northeast India: Implications for Indo-Burma palaeoecological contexts

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ABSTRACT

Balpakram valley, the sacred grove of the Garo tribe in Meghalaya, is world famous for its tropical unique biodiversity, physiography, seismically active zone, and proximity to Cherrapunjee. The area was not previously approached for palynological study due to its remoteness, impenetrable forest and wildlife. A modern pollen database of 120 surface samples from Balpakram valley indicates a good correlation of modern pollen, extant vegetation, and climate. Five pollen zones (forest types) have been recorded based on the regional pollen marker taxa corresponding to the ratio of evergreen and deciduous forest elements (>30% signifies the forest type). The present vegetation is similar to the Indo-Burmese vegetation except for a unique *Duabanga–Schima–Nepenthes* assemblage due to high monsoonal activity with a strong perennial river and streamlet system. The evergreen woody taxa in abundance along with *Dendropthoe*, Piperaceae and *Impatiens* in the assemblage are significant and suggestive of dense forest with high monsoonal activity. The abundance of Poaceae along with an *Artemisia*–Chenopodiaceae assemblage shows a savanna forest type, attributed to seasonal dryness and a poor water system in a restricted region. The absence of Dipterocarpaceae pollen, a characteristic taxon of the Indo-Malayan forest, is indicative of a regional effect. The poor representation of bamboo pollen may be attributed due to low pollen production (one-time flowering) and preservation. Pollen of *Nepenthes khasiana* in sediment signifies high precipitation, and is also indicative of this high pollen producer with good preservation status. No medicinal plants, specifically *Costus speciosus* and *Swertia chirata*, are observed despite their luxuriant growth in the region, which may be due to poor pollen production. Abundance of *Cyathea* (tree fern) along with *Lycopodium* and *Pyrrosia* signifies high rainfall and humid climate. The presence of coprophilous fungi including *Sordaria* and *Cercophora* is indicative of wildlife habitation in the area. The unique forest vegetation of Balpakram valley is mainly controlled by annual precipitation with perennial rivers and streamlets, moisture availability, and altitudinal variation in the region. This study will be helpful to generate palaeoecological data for surrounding ecozones including eastern Himalaya and Indo-Malayan regions, to trace migratory routes for flora and fauna in the Indo-Burma ranges.

1. Introduction

Northeastern India, along with the Himalayan region, is a unique transitional zone among the Indian, the Indo-Malayan and the Indo-Chinese biogeographical zones and is the meeting point of the Himalayan region with peninsular India (Takhtajan, 1988; Mittermeier et al., 2004). However, Meghalaya is globally known for its rich biodiversity and region receiving the highest rainfall on the earth. The flora of the region has close affinities with southeast Asia and southern China (Hooker, 1905). This region of the world is considered by botanists and geographers as one of the nuclear areas of early plant domestication (Vivilov, 1949; Sauer, 1952; Harris, 1972). The Balpakram valley of Meghalaya whose literal meaning is “land of perpetual winds”, and a sacred grove of the Garo tribe, who believed the spirit of dead dwell temporarily before embarking on the final journey. The valley was declared as a national park in February, 1986, and is contiguous with Siju wildlife sanctuary, established in 1979. The valley is also considered to be the homeland of *Elephas maximus* and has recorded one of the highest densities of the Asian elephant in the world (Choudhury,

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1999; Kunte et al., 2012), along with *Nepenthes khasiana* (endemic and state plant of Meghalaya).

Some preliminary research works have been carried out on the flora and fauna of the Balpakram valley (Kumar and Rao, 1985; Marak, 1998; Kumar et al., 2006; Marcot et al., 2011). Limited palynological work has been carried out in the Khasi hills and east and west Garo hills of the Meghalaya (Gupta and Sharma, 1985; Basumatary and Bera, 2007, 2010, 2012; Basumatary et al., 2013). The modern pollen spectra could be employed as a background database for better representation of fossil palynoassemblages, to reconstruct palaeovegetation and climate (Bent and Wright, 1963; Janssen, 1967; Wright, 1967; Overpeck et al., 1985; Prentice, 1985; Bunting et al., 2004; Wilmshurst and Mcglone, 2005; Xu et al., 2005; Gosling et al., 2009; Chen et al., 2010). The present paper is the first surface pollen study considering a total of 120 sites in Balpakram valley of south Garo hills, with a view to characterize vegetation types and climate in the region to correlate with the Indo-Burma range.

2. Regional setting

The Balpakram valley of northeast India lies between 25°10′–25°30′ N, 90°40′–90°50′ E, with an average elevation of 1485 ft. asl (Fig. 1), between the Arabella and Tura ranges running parallel east-west. Geomorphologically the valley consists of undulating hills and is about 220 km^2 in area, drained by several perennial river streams, mainly the Mahadeo, Rongra, Maheshkola and Rongkai. The valley is situated about 90 km northeast of Baghmara (district headquarters) and about 200 km from Shillong (state capital) via Mawsynram–Ranikor along the border road near Bangladesh. Cherrapunjee, the wettest place on earth and lying on the Tropic of Cancer is very close to the Balpakram valley. It covers the south-eastern part of the Garo hills. The valley is an important spot in southeast Asia adjoining the eastern Himalaya in the north and Indo-Burmese region in the east. Geologically the region includes stratigraphic formations from Archaean to recent (Momin, 1984). It is one of the most seismically active regions of the world and has been included in the severe seismic zone V (Bureau of Indian Standards, BIS code). Therefore, the region has a key role in the study of the affect earthquake activity on the behavioral pattern of regional vegetation, using high resolution palynodata (Neumann et al., 2009).

2.1. Climate and soil

The climate of the region is directly controlled by the southwest monsoon originating from the Bay of Bengal and the Arabian Sea. The climatic conditions vary substantially from place to place due to altitudinal variation. The Balpakram valley experiences a tropical climate with heavy rainfall, high temperature, and high humidity. The average annual rainfall in the district is 2023 mm as recorded by district Agriculture Office 2012, Baghmara, Government of Meghalaya. The district receives fairly high rainfall throughout the year, although particular areas receive less due to seasonal variation (rain shadow area). The maximum temperature reaches 33 °C during summer, with a minimum of 4 °C during winter. The relative humidity reaches 98% during summer and 55% during winter season. The forest soil is mainly red loamy, pH varies from 5.6 to 6.2, with about 10% organic content (Kumar and Rao, 1985; Singh and Mudgal, 1998, 2000).

3. Material and methods

3.1. Field work

Though it is difficult to procure palynological samples from the Balpakram valley due to its remoteness, impenetrable thickets, wildlife and the sacred grove, sample collection has been made to assess modern pollen rain in relation to vegetation composition and climate in the region. A large number of samples were procured for a pollen database (120 sample sites) from different vegetation types. The polleniferous materials were procured for preparing pollen reference slides for proper identification of taxa. The location of each sample site was recorded by GPS. Out of total 120 surface samples, 30 (B 1–30) were collected from the evergreen forest, 30 (B 31–60) from semievergreen forest, 30 (B 61–90) from

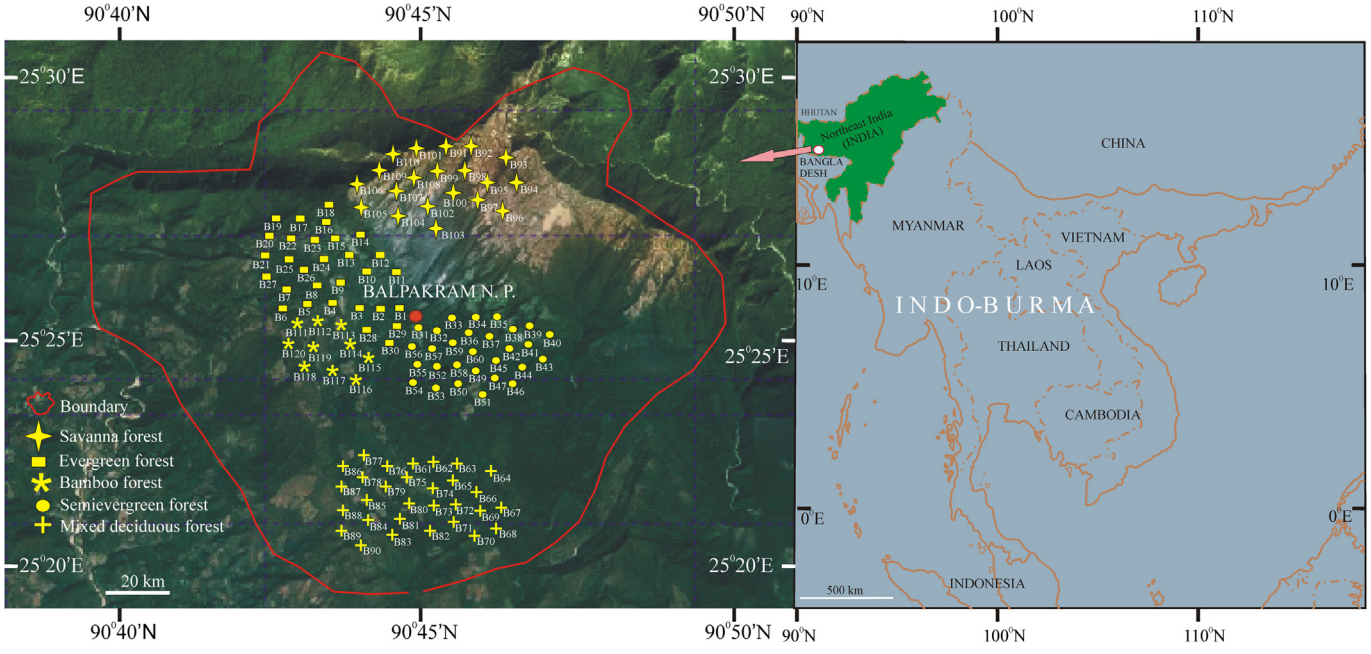

Fig. 1. Location map showing the sampling sites.