Correlation of data on loss-on-ignition and palynology for Late Quaternary climate change in southwestern Madhya Pradesh, India

Various proxy signals such as pollen, diatoms, isotopes, macrofossils, etc. are in vogue to reconstruct the palaeoclimate which plays a pivotal role in understanding the natural variability of the climatic system and to simulate the models to understand the trend of future climate changes relevant to society. However, not much attention has been paid to utilize chemical analysis of lacustrine sediments in reconstructing the palaeoclimate, except a few[1–14]. The present study is designed to correlate palaeoclimatic and palaeovegetational changes on the basis of loss-on-ignition (LOI) data with those of the pollen data from Nitaya Lake in Nitaya village, Hoshangabad district, southwestern Madhya Pradesh, India.

The Nitaya Lake is situated about 17 km southeast of Hoshangabad Township between 77°42′E long. and 22°40′N lat., in the close vicinity of Nitaya village in the Itarsi Forest Range (Figure 1). This ancient lake basin, measuring 300 m in length and 250 m at its widest, is subcircular in outline. Topographically, this entire lake basin and the adjoining area is flat and is under agricultural practice by the local inhabitants. The average altitude of the lake and surrounding flat area is about 800 ft amsl. However, the hillocks, southwest of the lake are moderate-sized with the altitudes varying from 1800 to 2000 ft and support diversified tropical deciduous teak (*Tectona grandis*) forests. Geomorphologically, the catchment area is flat-topped, covered with black cotton soil, derived by weathering from Deccan trap as the predominant soil type with patches of loam and sandy loam.

For the present study, 24 samples have been collected at 10 cm intervals each from a 2.4 m thick sediment profile from the Nitaya Lake. Besides, seven bulk samples were also taken up at larger intervals for radiocarbon dating. The lithological details and radiocarbon dates of the sediment profile are given in Table 1.

Five distinct zones (Figure 2) were identified in this profile on the basis of pollen analysis[15]. The palaeoclimatic and palaeovegetational changes inferred from Nitaya Lake around 12,700 yrs BP, based on LOI study are discussed below.

LOI is a widely used method to estimate the total organic carbon (C_{org}) and inorganic carbon (CO_3^{2-}) content of sediments[16]. In Quaternary science, this is used for palaeoenvironmental studies[17–19]. The methodology involves 5 g air-dried samples being heated at 110°C for 12 h, 550°C for 2 h, 950°C for 2 h respectively, in three steps and the weight loss observed after each step represented the moisture present, total organic carbon and the inorganic carbon present in the samples respectively. The LOI in the samples was then calculated by adding all the weight loss and taking out its percentages[20,21]. In the 2.4 m thick sediment profile from Nitaya, moisture percentage varies from 5 to 7, C_{org} from 2 to 5 and CO_3^- from 1 to 5 (Figure 3). In zone NL-I (between 12,700 and 7150 yrs BP), there is uniform moisture content, slightly increase in C_{org} and more or less uniform CO_3^- content depicting cool and dry climate. In zone NL-II (between 7150 and 4657 yrs BP), the increasing trend of moisture, C_{org} and decreasing trend of CO_3^- content show warm and humid climatic conditions. In zone NL-III (between 4657 and 2807 yrs BP), decreasing trend of moisture and C_{org} content and relatively increasing trend of CO_3^- indicate warm and less humid climatic

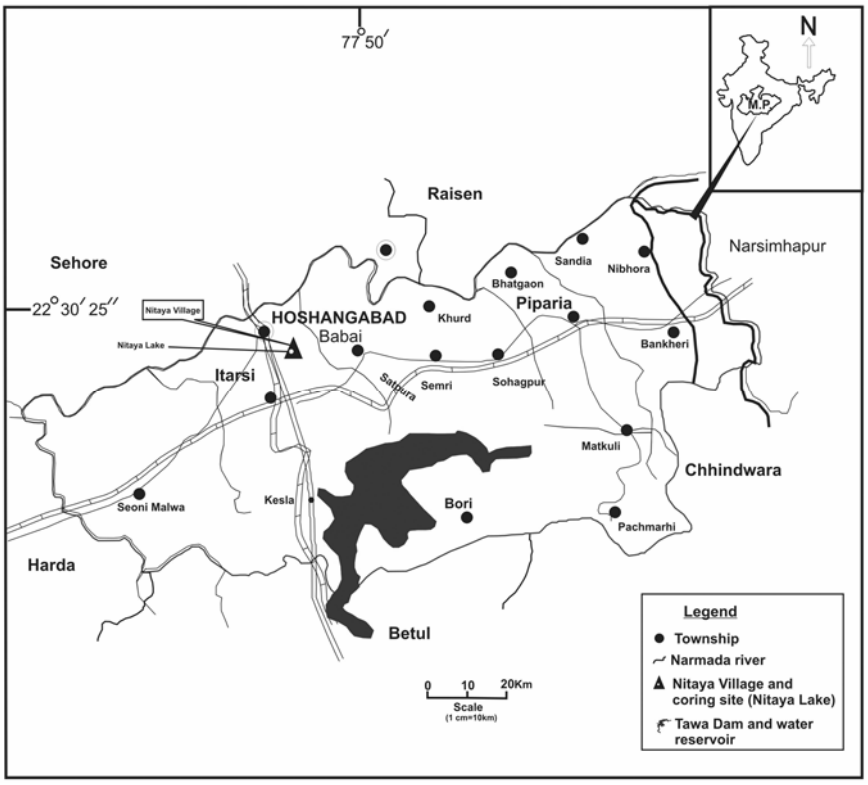

Figure 1. Map showing the study site at Nitaya, Hoshangabad district (after ref. 15).

Table 1. Lithological details and radiocarbon dates from Nitaya Lake profile

Depth (cm)	Nature of samples	Lab. ref. no.	C-14 dates (yrs BP)
60–75	Blackish clay	BS-2984	3030 ± 80
95–110	Blackish clay	BS-3013	3080 ± 90
130–145	Blackish clay	BS-3012	3960 ± 80
160–175	Blackish clay	BS-2983	5490 ± 120
225–240	Brownish clay	BS-2981	11,950 ± 140

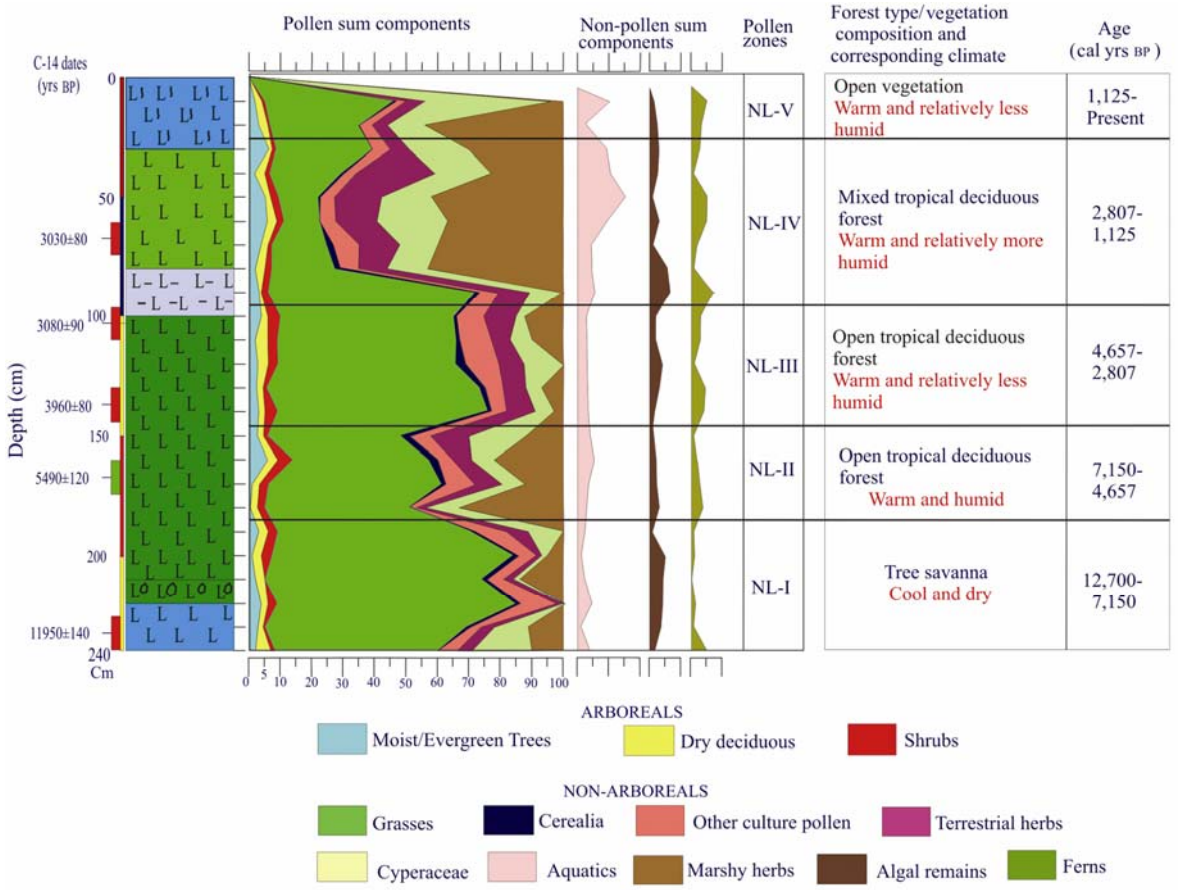

Figure 2. Summary pollen diagram of the Nitaya Lake profile showing the salient features of the present study, based on pollen evidence (after ref. 15).

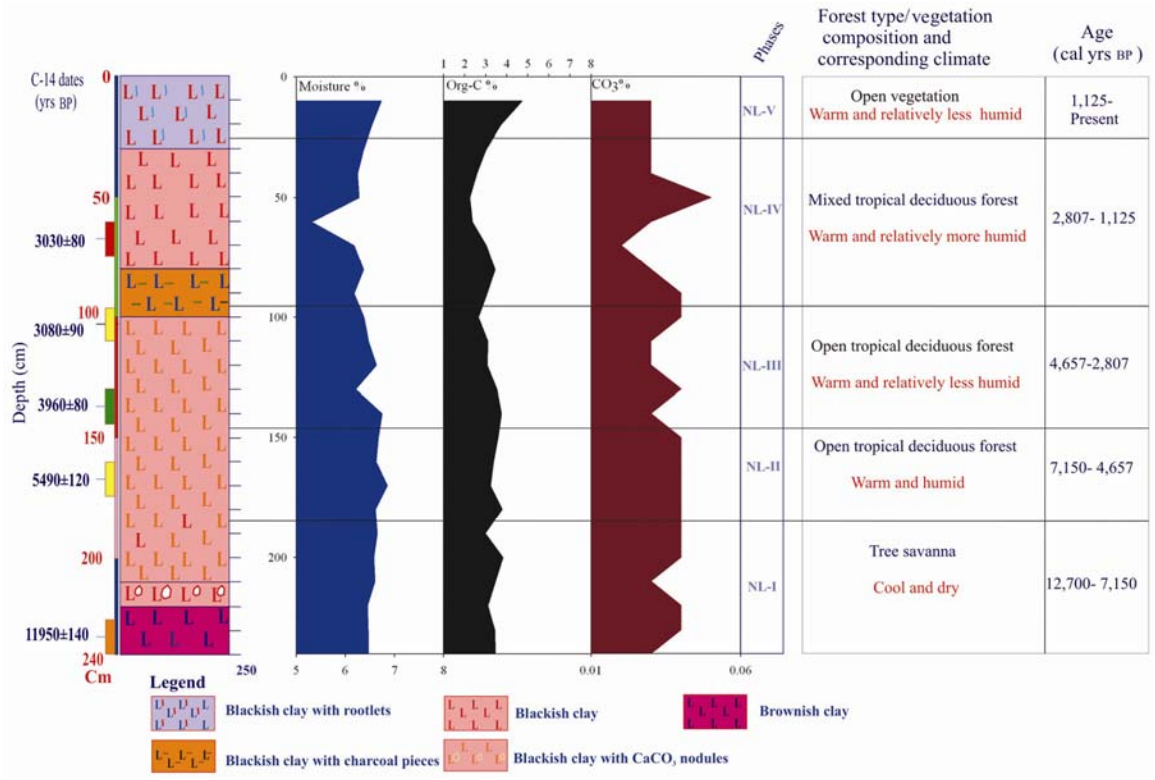

Figure 3. Correlation diagram of the pollen and loss-on-ignition data.

conditions during the time of deposition. In zone NL-IV (between 2807 and 1125 yrs BP) abrupt decrease in moisture and C_{org} content and highest value of CO_3^- content portray that climate was relatively warm and more humid than the preceding zone. In the topmost zone, i.e. NL-V (between 1125 yrs BP and the Present), increasing moisture and C_{org} content and decreasing CO_3^- content point towards a warm and relatively less humid climate equivalent to that existing today. The correlating results of palaeoclimatic changes of pollen analytical studies in the respective corresponding zones are in agreement with those of the present study.

LOI and CO_3^-, thus, play a crucial role by acting as a potential tool in corroborating the findings made by other proxies and will be suitable even for the sites where biota are not preserved. The above study is based on one site. Further studies from various sites would provide a good database of regional climatic scenarios that could be of help in understanding the climatic models for assessing the trends of future climatic changes not only on regional scale, but also at a global level.

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