BIOMARKER AND POLLEN APPROACH TO RECONSTRUCT LATE HOLOCENE CLIMATE AND ENVIRONMENTAL HISTORY IN WESTERN SRI LNKA

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Introduction

Climate, environment, and agriculture of Sri Lanka are extremely sensitive for the fluctuation of Indian ocean monsoon intensity. The unique geographical location in the Inter-Tropical Convergence Zone (ITCZ) and the morphology of the island make Sri Lanka an excellent location to track Indian ocean monsoon variability through reconstructing paleoenvironmental and paleoclimate conditions. Combined analysis of organic geochemical proxies together with biological proxies (i.e. pollen) can generate robust evidence about the past climate and its influence on terrestrial ecosystems.

A 4.1 m long sediment core retrieved from the coastal Lake Bolgoda in southwestern Sri Lanka revealed ca. 3000 yrs BP depositional history. Salinity in this coastal lake is mainly controlled by seawater intrusion due to the fluctuation of the freshwater inflow via stream (Ratnayake et al., 2018). The core was analyzed for various biomarkers (n-alkane, alkanol, alkanoic acids, and sterols) together with compound specific carbon isotopic signatures of n-alkane. In addition, a pollen analysis was conducted in selected depth intervals in the core to confirm the biomarker and stable isotope changes. Biomarkers revealed changes of organic matter sources into the Bolgoda Lake, whereas the pollen data provided more specific information about the vegetation that is dominant and less dominant species that were in the catchment and in the lake itself.

Results

As revealed by the variation of mangrove specific triterpenols (eg; taraxerol, **β**-amyrin, germinacol) lacustrine salinity changed rapidly with seawater intrusion to the lake system. High salinity triggered dense mangrove vegetation (Versteegh et al., 2004). Poaceae grass was the major source of organic matter into the watershed throughout the whole period. In addition, mangrove vegetation around the lake, mainly Rhizophoraceae and Avicenniaceae contributed significantly to the input of organic matter. However, the dominance varied coinciding with lacustrine salinity. The catchment was dominant with woody plants/trees belonging to *Mallotus*, *Macaranga*, *Phoenix*, *Syzygium*, and *Areaca* but shrubs and small trees of *Randia* and *Ixora* dominated during dryer/arid conditions. δ^{13}C values of n-C$_{33}$ and n-C$_{31}$ alkanes which are dominant in grasses (Sinninghe Damsté et al., 2011) showed a positive correlation with taraxerol. In addition, they showed more positive values during high salinity in the lake induced by low precipitation or dry climatic conditions in the catchment.

Conclusions

The overall climatic condition during the last 3000 yrs can be identified as wet but it was interrupted by a dry phase from ca. 2400 – 2050 cal yr BP. The lacustrine salinity and catchment vegetation indicated two distinct periods in monsoon output extending from ca. 3000 to 2400 cal yr BP when rainfall increased and strengthened. However, there were short periods of weak rainfall with abrupt changes between from 2400 – 1800 cal yr BP. Between 2400 – 2050 cal yr BP drier period is strongly evident. This event has good correlation with the Roman Warm Period. The rainfall again intensified and stabilized ca. 1800 – 1300 cal yr BP. After that, the monsoons again showed a weakening trend until the present. This study illustrates the effectiveness of using different types of proxies and combining their results to unravel high-resolution information about past environmental and climatic changes.
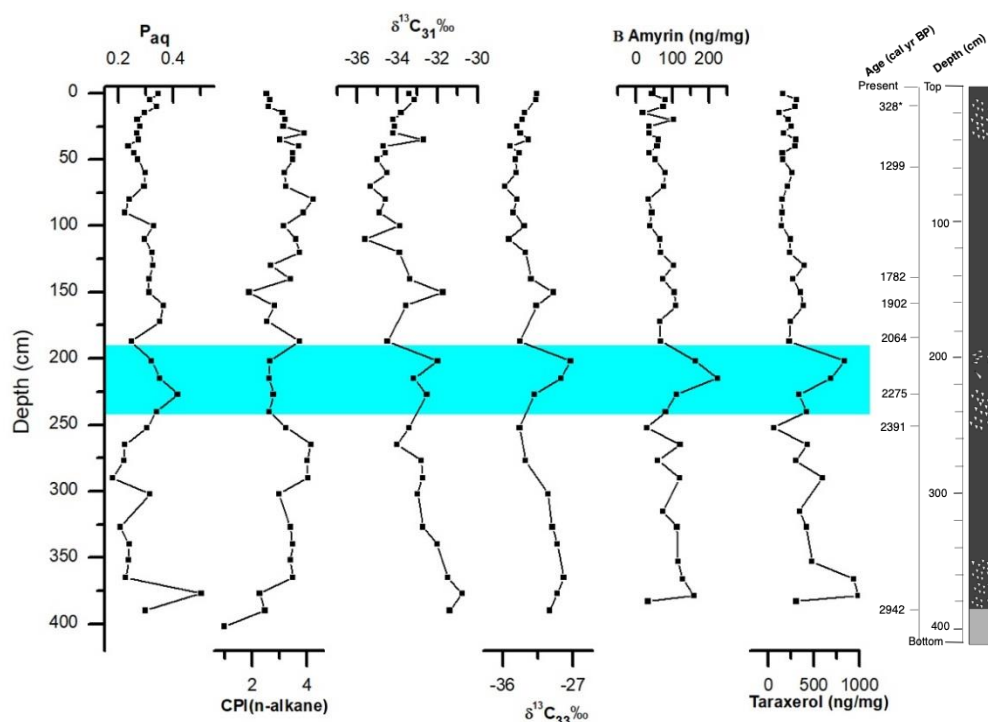
Figure 1. Biomarker trends in Bolgoda Lake used to infer environmental changes: Aquatic plant index (P_{aq}), CPI (n-alkane), $\delta^{13}C_{31}$ and $\delta^{13}C_{33}$ of n-alkane, **β**-amyrin and taraxerol

References

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