

Fossil gastropods from the Indian Upper Siwaliks and their stable carbon and oxygen isotope values indicate presence of cold climatic conditions in the Early Pleistocene.

Simran Singh Kotla

Fossil gastropods from the Indian Upper Siwaliks and their stable carbon and oxygen isotope values indicate presence of cold climatic conditions in the Early Pleistocene

Simran Singh Kotla^{a*}, Rajeev Patnaika, Ramesh Kumar Sehgal, Aditya Kharyab.

^a C.A.S in Geology Panjab University, Chandigarh, India 160014. ^bWadia Institute of Himalyan Geology, Dehradun 248001. *corresponding author

The Early Pleistocene in general is characterized by widespread glaciations in the Northern Hemisphere. Early to Middle Pleistocene freshwater Pinjor Formation (Upper Siwalik) exposed all along the Himalayan Foothills preserves a diverse faunal and floral assemblage. We carried out paleontological (gastropods) and stable isotope (carbon and oxygen isotope) studies of a 6 m thick swamp/pond deposit (that represents $\sim 12,000$ yrs) of Pinjor Formation, exposed near the Village Nadah, Panchkula (Haryana) and dated to ~ 1.8 Ma (Azzaroli and Napoleon, 1982). We have identified four gastropod species in the assemblage, *Lymnae* sp., *Gyraulus* sp., *Viviparus bengalensis* and *Hippeutis complantus*. The first two are widespread throughout the globe. *Lymnae* can exist in temperature range of 19 to 24 [U+0366] C and occur in Palearctic and Neoartic regions (animalbase.org). *Gyraulus* occur in Holarctic region with temperature ranging from 17.8 to 30 [U+0366] C (animalbase.org, theaquariumwiki.com), whereas *Viviparus bengalensis* typically exists in the Oriental region suggesting an overall warm and humid condition (Moore, 1997). *Hippeutis complantus* on the other hand exists in palearctic regions upto 63 [U+0366] N (Aplinarska and Cisewka 2006) under cold (6 [U+0366] to 23.3 [U+0366] C) and dry climatic conditions (Spyra., 2014). The powdered gastropod shell samples were analyzed using Continues Flow Isotope Ratio Mass Spectrometer (CF-IRMS) at the Wadia Institute of Himalayan Geology, Dehradun, India. The $\delta^{13}\text{C}$ values of gastropod shells fall between -2.56‰ and 6.14‰ VPDB and suggest the dominance of C4 vegetation. The $\delta^{18}\text{O}$ value of gastropod shell fall between -0.64‰ and -7.80‰ VPDB, suggesting fluctuation of climate between warm and cold conditions. Presence of *Hippeutis complantus* may suggest the extension of palearctic region up to Panchkula (Haryana, India) in the Early Pleistocene which presently lies in the Oriental Province. Therefore, our results indicate that the overall climatic condition during ~ 12000 years in the Early Pleistocene were warm and humid with some excursion towards cold and dry conditions for short time spans, supported by the occurrence of palearctic gastropod *Hippeutis complantus* and $\delta^{18}\text{O}$ values (-0.64‰ VPDB).