Glaciation and human colonization of the high valleys of NW Bhutan (Eastern Himalaya)

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The Higher Himalayas and the Tibetan Plateau represent extreme environments for habitation, challenging modern man as well as prehistoric hunter-gatherers and nomadic herders [1]. During Late Pleistocene and early Holocene times, cold desert and more humid climatic conditions alternated on the Tibetan Plateau, whereas rapidly fluctuating glacier systems occupied the high valleys of the Himalaya chain. Palaeo-environmental changes in both regions were mainly controlled by variations in the intensity of the Indian and Asian summer monsoon. Despite complexities encountered in some regions, caused by, for example, the prevailing influence of the westerlies or regional precipitation gradients [2], the following general picture can be drawn: Strengthening of the monsoon circulation caused both more humid climatic conditions on the Tibetan plateau [3, 4] and the advance of glaciers in the Himalayas in response to enhanced precipitation and thus positive glacier mass balances [5, 6]. For periods of weak summer monsoons converse trends can be observed; drier climatic conditions in most of Tibet [7] and shrinking valley glaciers in the Himalayas, respectively [5]. Such environmental and climatic upheavals must have presented severe problems to prehistoric hunter-gatherers although little is known about the adaptation and migration of these populations during Late Pleistocene and Holocene climate changes [8].

We constrain the Late Pleistocene and Holocene glacial history of a key site in the Bhutan Himalaya, the Pho Valley, by a combination of OSL and ^{14}C dating and Quaternary geological mapping. During the local last glacial maximum, at ca. 30 000 BP (OSL data on glacial outwash fan), the Pho Valley was characterized by highly restricted glacier positions. Despite severe cooling and extensive glaciation in the northern hemisphere at ca. 18 000–24 000 BP, glaciers in the Bhutan Himalaya only advanced 5 km from their present positions. The valley glaciers re-advanced during the middle Holocene (at ca. 6700 BP) and finally decayed just prior to 4700 BP. This is in agreement with data from monsoon influenced glacier systems in the Western Himalaya [4, 5].

The high valleys in NW Bhutan are presently occupied by nomadic-herders who managed to cross the glacier-passes as they migrated southwards from Tibet. Our data demonstrate that migration into these Himalayan valleys occurred as early as 4700 BP (^{14}C ages on charcoal horizons and palynological drill cores) and thus immediately after glacial retreat in the middle Holocene. Yak pastoralism was an integral part of this early phase of colonization and impacted severely on the local environment and biotic community. Weakening of the monsoon circulation system led to drier conditions on the Tibetan plateau and ice-free conditions in the high-valleys of NW Bhutan at ca. 4700 BP, thus enabling nomadic-herders to cross the Himalaya in search of more habitable places.

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