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Palaeoecological evidence for Mesolithic to Medieval climatic change and anthropogenic impact on the Alpine flora and vegetation of the Silvretta Massif (Switzerland/Austria)

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ABSTRACT

In a high altitude region such as the Silvretta Alps (Switzerland/Austria), past and extant settlement activities are known to have had large influences on the alpine flora and vegetation. The Silvretta Massif harbors more than 230 archaeological sites above 2000 m a.s.l. on a total area of 550 km^2, from the Mesolithic period to Modern Times, but received little attention in these matters up to recently. The Fimba Valley within the Silvretta area – with 47 known archaeological sites (6 prehistoric, 21 from the Medieval and/or Modern Times, 20 undated) located over an area of 62 km^2 – provides evidence of a broad range of former human presence, as well as peat records allowing the reconstruction of Holocene climatic change and anthropogenic impact on past vegetation. Here, we present a high resolution, multi-proxy study (including pollen, cryptogam spores, and non-pollen palynomorphs) on a 177-cm-long radiocarbon dated peat core from the Las Gondas Bog in the Fimba Valley (2363 m a.s.l.). Palynological evidence adds and confirms previous dendrochronological results, revealing extensive high *Pinus cembra* (Arolla pine) stands around the bog at 10,400 cal BP and between *ca.* 8600–6700 cal. BP, more than 300 altitudinal meters above today's timberline, and belonging therefore to the highest population known for Central Europe. In addition, our palaeoecological results correlate well with the archaeologically known human impact during the Neolithic, Iron Age and Medieval periods. The exploitation of alpine landscape resources (cultivation of cereals in the valleys) and livestock grazing (in the subalpine and alpine areas) has therefore a long tradition going back at least for 6200 years in the Silvretta region.

1. Introduction

Understanding today's climate change and its impact on human societies is dependent on the accurate knowledge of historical and prehistorical interactions between humans and their environment. However, few environmental archaeological studies have explored palaeoecological proxies in the context of archaeological settlements at subalpine and alpine altitudes so far (Ejarque et al., 2010). The impact of past climatic change remains less investigated in alpine than in pre-alpine environments (Kofler et al., 2005). The Silvretta Massif with its passes is one of the possible (pre-)historical exchange routes through the Eastern Alps (Reitmaier, 2012; Reitmaier et al., 2013). Silex flints from the Lake Garda area (Northern Italy) were found in several archaeological sites north of the Alps, notably in the Neolithic pile dwelling village of Arbon Bleiche-3, Lake Constance, Switzerland (Jacomet, 2008), implying their long-range transport. In addition, mountainous regions such as the Silvretta Alps are highly sensitive to microclimatic alterations. Such perturbations, even if small, may have had a large effect on subalpine settlement activities and the former use of natural resources (for instance, timberline lowering due to high alpine climatic change and/or pastoral activities). Climatic fluctuations may also have influenced anthropogenic activities above the former timberline in several regions of the Alps as reflected in the numerous archaeological sites dating from the Mesolithic to Medieval Times. Until 2007, the Silvretta archaeological potential

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received little attention, but since then more than 230 archaeological sites (*e.g.* settlement structures, abris, and livestock enclosures) were discovered above 2000 m a.s.l., inventoried, and excavated on this 550 km^2 area, from which 47 sites (including 6 prehistoric, 21 from the Medieval and/or Modern Times) are located in the Fimba Valley (Reitmaier, 2012; Reitmaier et al., 2013).

Alpine palynological studies are of prime importance to reconstruct past vegetation as well as to reveal human presence and its impact due to the exploitation and management of natural landscape resources (Thiébault, 2010). It is well acknowledged that all types of vegetation assemblage are significantly impacted by human presence, livestock grazing and landscape management. There is global consensus that pollen and spores are of invaluable interest to reconstruct past vegetation composition and its evolution and to reveal the impact of climatic change and human presence on natural resources (Behre, 1981, 1988; Berglund et al., 1991; Latałowa, 1992; van Geel et al., 2003; Graf and Chmura, 2006; Brun, 2011). Furthermore, non-pollen palynomorphs (NPPs, such as algal cysts, fungal spores, zoological microfossils) help to interpret general pollen data, especially because of the good knowledge of their ecological requirements and their local dispersion (van Geel et al., 2003; Graf and Chmura, 2006; van Geel and Aptroot, 2006). Moreover, local scale palaeoecological studies are most likely to reveal human–environment relationships, especially regarding coprophilous fungi, which can be considered as indicators for livestock grazing pressure (Blackford and Innes, 2006; Davis and Shafer, 2006; Dearing et al., 2006; Gauthier et al., 2010; Laine et al., 2010; Dietre et al., 2012). NPPs therefore help as proxies to interpret results obtained by environmental archaeology (van Geel et al., 2003).

Here, we present the palaeoecological study of the Las Gondas Bog, Fimba Valley, Switzerland, performed on a peat core from the central, deepest part of this bog, which was built up after the retreat of the Late Glacial ice masses around 11,000 cal BP (Hertl and Kerschner, 2001). The bog area has formerly been studied on a nearby 148-cm-long peat core in a first overview work (Pott et al., 1995; Bauerochse and Katenhusen, 1997) for pollen and cryptogam spores. In the present new study, a high-resolution dated multi-proxy palaeoecological approach was adopted, combining the analysis of plant pollen and cryptogam spores, as well as NPPs and macrofossils, on a 177-cm-long peat core from the Las Gondas Bog, more than 300 altitudinal meters above today's timberline.

2. Regional setting

The Silvretta mountain range (Switzerland/Austria, Fig. 1) is a 771-km^2 massif located in the center of the Alps, within the Central Eastern Alps (Brachmann, 1979). Geologically, the Silvretta Massif is mainly composed of gneiss, marble, and quartzite due to high metamorphism (Frei et al., 1995). The highest mountain peak is Piz Linard (3411 m a.s.l.) on the Swiss side of the massif. The mean annual precipitation is 900 mm on the northern side, and 695 mm on the southern side of the Silvretta Alpine ridge, and the annual mean temperatures are equal to 3 °C and 5 °C, as recorded by the nearby weather stations located at Galtür (Austria, 1589 m a.s.l.) and Scuol (Switzerland, 1253 m a.s.l.), respectively (Bauerochse and Katenhusen, 1997). The Fimba Valley is located north of the Silvretta Alpine ridge and joins the lower lying Paznaun Valley at the village of Ischgl (Austria). Because of historical land-use and legacy reasons, the northern and lower parts of the Fimba Valley belong to

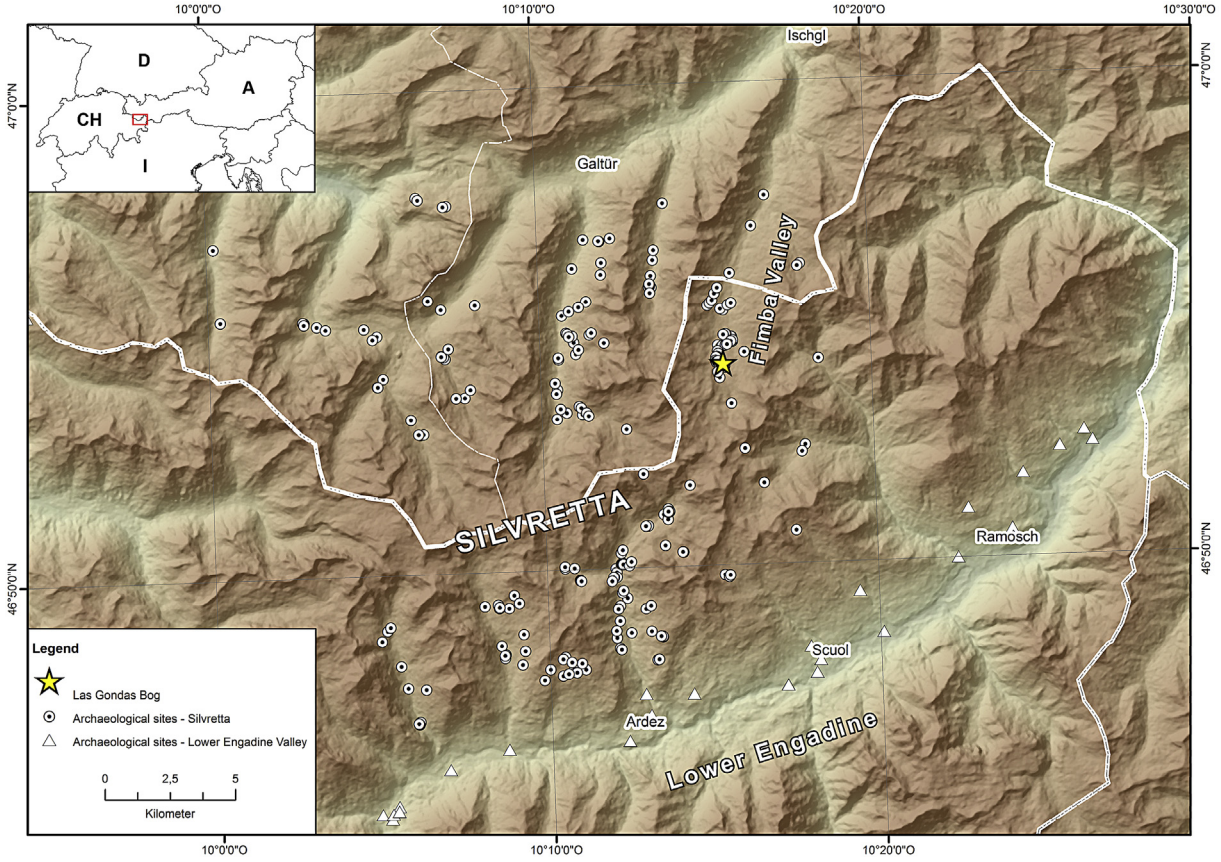

Fig. 1. Location of the Silvretta Massif and Fimba Valley in the Eastern Alps (Switzerland/Austria) and location of known archaeological sites of the Silvretta Massif (above 1500 m a.s.l., circles) and of the Lower Engadine (below 1500 m a.s.l., triangles). The star marks the location of the Las Gondas Bog. Source Digital Terrain Model: ASTER GDEM (ASTER GDEM is a product of METI and NASA). Source country-borders: http://diva-gis.org/gdata.