

## HIGH-ALTITUDE ENVIRONMENTS AND GLACIERS FLUCTUATIONS IN THE WESTERN SECTOR OF THE AOSTA VALLEY DURING THE HOLOCENE

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ABSTRACT: Pini R. *et al.*, *High-altitude environments and glaciers fluctuations in the western sector of the Aosta Valley during the Holocene* (IT ISSN 0394-3356, 2011)

Palaeobotanical and chronological data from high-altitude mire successions in the western Alps (Aosta Valley) are here compared with geomorphological evidences of glacier oscillations, to describe the history of glacial systems and the occurrence of phases of climatic optimum during the first half of the Holocene. These phases are marked by periods of glacier recession, rise of the forest limit up to altitudes above 2400 m and widespread tufa deposition at 2000 m altitude. These data are in good agreement with available information from the Central Italian, the Swiss and the Austrian Alps.

RIASSUNTO: R. Pini *et al.*, *Ambienti d'alta quota e oscillazioni glaciali nel settore occidentale della Valle d'Aosta durante l'Olocene* (IT ISSN 0394-3356, 2011)

*L'analisi integrata di dati paleobotanici e cronologici da successioni di torbiera d'alta quota nel settore occidentale della Valle d'Aosta e di evidenze geomorfologiche in aree interessate da avanzate glaciali oloceniche fornisce indicazioni sulla storia degli apparati glaciali e sull'esistenza di più fasi di optimum climatico durante la prima metà dell'Olocene. Queste fasi sono testimoniate da periodi di evidente recessione glaciale, innalzamento del limite delle foreste a quote superiori ai 2400 m e alla deposizione diffusa di travertini a 2000 m di quota. I dati ottenuti sono in accordo con quanto noto per le Alpi Centrali italiane, le Alpi svizzere e austriache.*

Key words: Holocene, Aosta Valley, mires, glaciers, tufa, prehistoric archaeology

Parole chiave: Olocene, Valle d'Aosta, torbiera, ghiacciai, travertini, archeologia preistorica

Among the stratigraphical archives yielding information on the structure of ancient natural and anthropic landscapes, mires are of particular interest. These habitats, widespread on the Alpine chain, develop well on crystalline bedrock along wide altitudinal transects, extending from the colline to the high-alpine belt. Detailed geological and geomorphological surveys in former glacialized areas nowadays occupied by mires provide interesting data on past glacier extent and fluctuations and help reconciling the chronology of local glacial history, trees immigration and forest development.

This contribution focuses on recent investigations carried out by the authors on high-altitude mires and glacial systems in the western sector of the Aosta Valley. Relevant sites are:

- the **foreland of the Rutor Glacier** (2510 m asl, La Thuile Valley: Fig. 1). Here a succession of compressed peat, <sup>14</sup>C dated to 7600 – 9200 cal years BP and intercalated within minerogenic deposits, outcrops along the proglacial stream and provides information on former phases of glacial recession during the first half of the Holocene and

on the history of vegetation development, both at local and regional scale (OROMBELLI, 1998; ACETI, 2006);

- the **Crotte Basse mire** (2365 m asl, southern slope of Mont Fallère, Aosta: Fig. 2). This stratigraphical sequence was cored in summer 2009 and 2010, retrieving multiple cores along the succession of lacustrine – palustrine deposits. Pollen and geochemical analysis and <sup>14</sup>C determinations are still in progress: available data testify to an early stage of vegetation development (before the Holocene onset) and the subsequent expansion of forests growing well above their present day altitudinal ranges. This forest displacement interacted with Mesolithic hunters and gatherers and Eneolithic farmers seasonally settling on nearby high-altitude areas for subsistence purposes (GUERRESCHI *et al.*, 2010).

- a **4m - thick tufa bank**, outcropping at 1950 m asl on Mont Fallère. This deposit, rich in wood, charcoal, needles and cone imprints, testifies to the local development of *Pinus sylvestris* woodlands during the Holocene climatic optimum

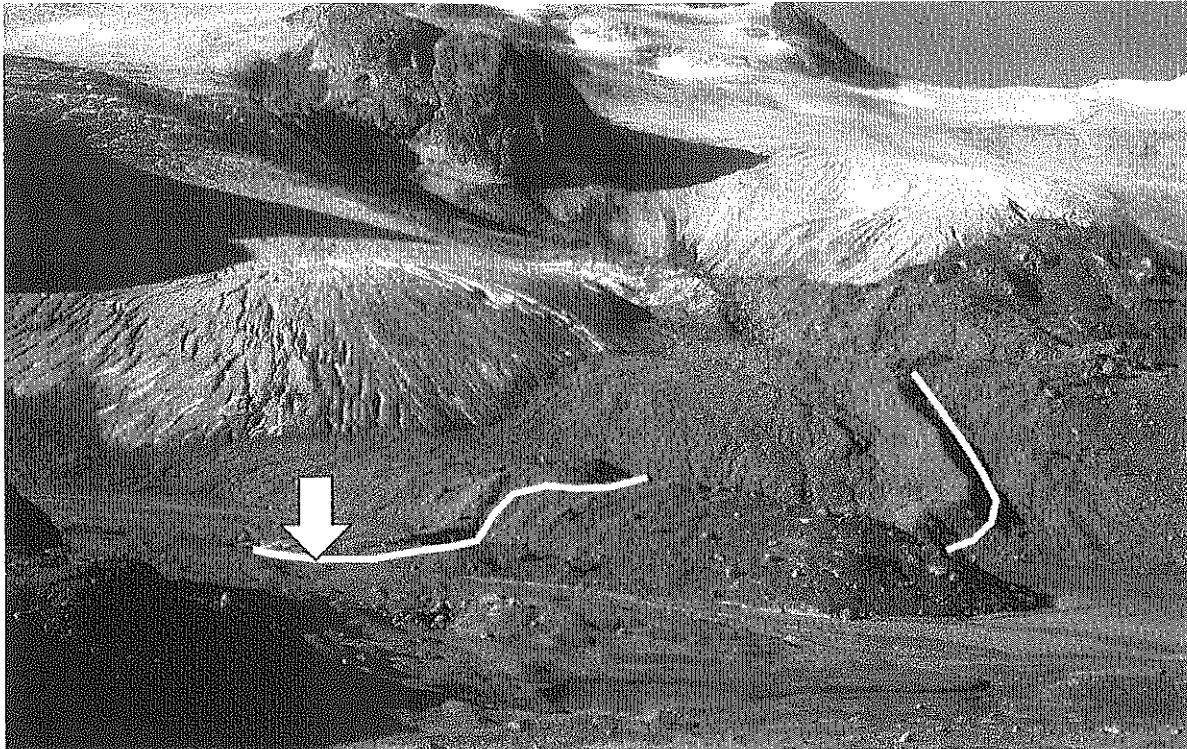


Fig. 1, Panoramic view of the western and central lobes of the Rutor Glacier. The white line indicates the position of the moraine related to the 1980's advance; an arrow shows the outcrop of compressed peat discussed in the text (photo: Amelia Aceti, summer 2005).

*Panorama dei lobi occidentale e centrale del Ghiacciaio del Rutor. La linea bianca indica la posizione della moraine deposta dopo l'avanzata degli anni '80; la freccia mostra la posizione dell'affioramento di torbe compresse discusse nel testo (foto: Amelia Aceti, estate 2005).*

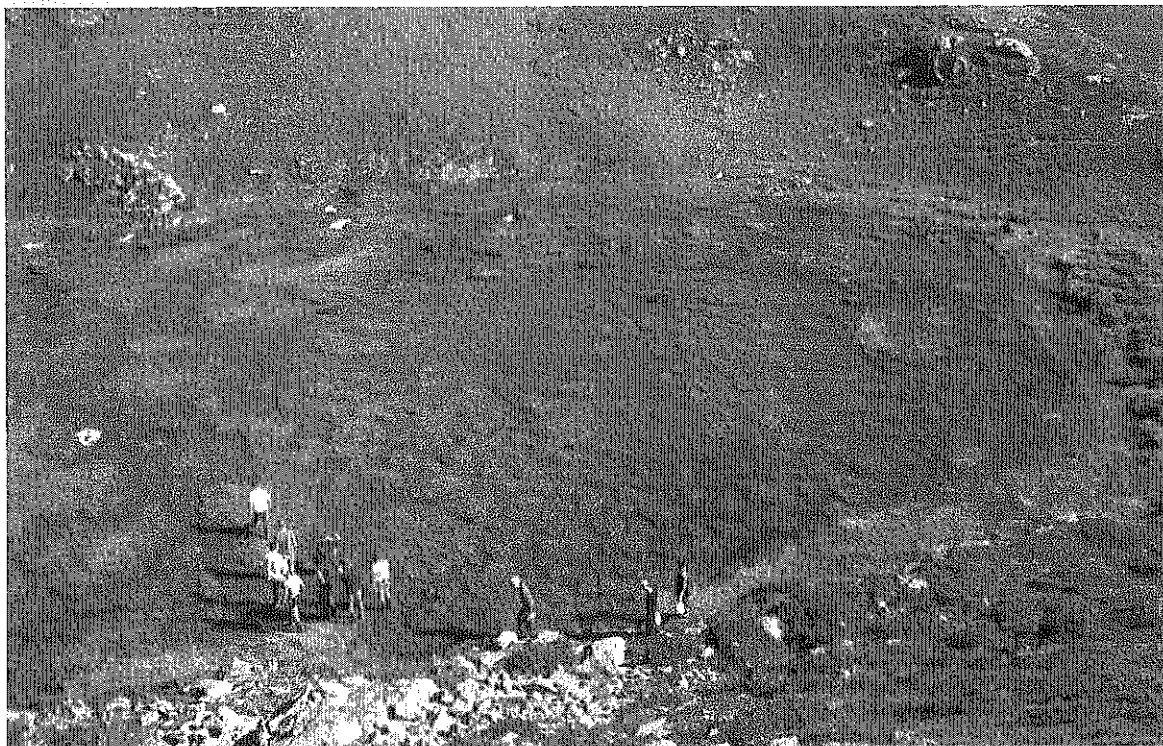


Fig. 2, The Crotte Basse mire: this stratigraphic sequence provides information for the reconstruction of the vegetation and climate history of the area from the last part of the Late Glacial to the present (photo: Diego De Nisi, summer 2009).

*La torbiera delle Crotte Basse: questa sequenza stratigrafica illustra la storia della vegetazione e del clima dell'area in esame a partire dalla fine del Tardoglaciale fino ai giorni nostri (foto: Diego De Nisi, estate 2009).*

and allows for comparisons with the palaeobotanical information obtained from the Crotte Basse mire. Interestingly, this is not the only tufa deposit found on Mont Fallère: the slopes actually host several tufa layers, displaying massive to porous texture and varying in thickness from a few centimeters to several decimeters.

## DISCUSSION

The stratigraphic section at the foreland of the Rutor Glacier testifies to prolonged phases of glacier recession framed between the early and the middle Holocene. Deposition of fine-grained material (lacustrine silt overlaid by peat) above glacial sediments can be related to a phase of sudden glacier retreat dated to ca. 9500 years cal BP. The glacier maintained a reduced extent at least up to ca. 6500 years cal BP, possibly up to 4900 years cal BP (considering the age of other peat layers found dislocated nearby the studied section). Forests never reached the proglacial Rutor area; palaeobotanical data indeed suggest that *Abies alba* was widespread along the valley slopes possibly up to an altitude of ca. 2000 – 2200 m asl, while *Pinus cembra* developed at higher altitudes.

The same chronological interval is testified at the Crotte Basse mire. Palaeobotanical and chronological data indicate the local occurrence of dense conifer forests dominated by *Pinus cembra* as early as ca. 8800 years cal BP, accompanied by *Abies alba* starting at ca. 8600 years cal BP. The full sun aspect enabled the growth of dense conifer forests up to an exceptional altitude (at least up to 2365 m asl). The widespread deposition of tufa at an unusual altitude (1900 - 2150 m asl) on Mont Fallère may represent an evidence for phases of climatic optimum. In particular, radiocarbon dating of the huge carbonatic bank found on the southern mountain slope established that tufa accumulated quickly between 5800 –

9100 years cal BP.

Generally speaking, glaciological and palaeobotanical data from the western Alps are in good agreement with those from the Central Italian, the Swiss (HORMES *et al.*, 2001) and the Austrian Alps (NICOLUSSI & PATZELT, 2000) and speak for several phases of climatic optimum during the first half of the Holocene, characterized by recessional glacier phases and development of woody vegetation well above the modern treeline. Further studies are needed to understand and characterize such phases and for a better definition of their timing and extent: are they short-lived, centennial phases or longer periods of climatic optimum?

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