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Integrating the EMPD with an Alpine altitudinal training set to reconstruct climate variables in Holocene pollen records from high-altitude peat bogs

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Temperatures and precipitation are the main environmental factors influencing vegetation and pollen production. Knowing the modern climate optima and tolerances of those plants represented in fossil assemblages and assuming that the relationships between plants and climate in the past are not dissimilar from the modern ones, fossil pollen records offer many descriptors to reconstruct past climate variables. The aim of our work is to investigate the potential of high-altitude pollen records from an Alpine peat bog (TBValter, close to the Ruitor Glacier, Western Italian Alps) for quantitative paleoclimate estimates. The idea behind is that high-altitude ecosystems are more sensitive to climate changes, especially to changes in July temperatures that severely affect the timberline ecotone. Meantime, we met with difficulties when considering the factors involved in pollen dispersal over a complex altitudinal mountain pattern, such as the Alps.

We used the EMPD-European Modern Pollen Database (Davis et al., 2013) as modern training set to be compared with our high-altitude fossil site. The EMPD dataset is valuable in that it provides a large geographic coverage of main ecological and climate gradients (at sub-continental scale) but lacks in sampling of altitudinal gradients and high-altitude sites in the Alps. We therefore designed an independent altitudinal training set for the alpine valley hosting our fossil site. 27 sampling plots were selected along a 1700m-elevational transect. In a first step, each plot was provided with **(i)** 3 moss polsters collected following the guidelines provided by Cañellas-Boltà et al. (2009) and analyzed separately to account for differences in pollen deposition at small scale, **(ii)** morphometrical parameters obtained through a high-resolution DEM, and **(iii)** temperature and precipitation were estimated by means of weighted linear regression of the meteorological variable versus elevation, locally evaluated for each site (Brunetti et al., 2014), starting from a dense and quality-controlled observational dataset. In the most advanced step, we designed calibration functions using modern pollen and climate data stored in the EMPD and integrated with the 27 samples from the altitudinal training set. Regression and calibration method (LWWA) and MAT (Modern Analogue Technique) were used to reconstruct temperatures and precipitation. We applied the models to our fossil site to infer temperatures of the coldest (T_{jan}) and warmest (T_{jul}) months and the mean annual precipitation (P_{ann}). Finally we compared our results with established climate proxy records (oxygen isotope records from ice cores, records of Alpine Glaciers fluctuations, stalagmites).

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Brunetti et al., 2014. *International Journal of Climatology* 34, 1278-1296.

Cañellas-Boltà et al., 2009. *The Holocene* 19(8), 1185-1200.

Davis et al., 2013. *Vegetation History and Archaeobotany* 22, 521-530.