Airborne pollen biodiversity in Alpine sites: complementing optical microscopy and eDNA

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Alpine protected areas function as key refuges for biodiversity. However, pressures associated with global environmental change increasingly threaten these ecosystems; species may undergo range shifts, and the species composition of communities may change. Regular monitoring can detect those changes and ensure the implementation of proper protection and conservation strategies. Pollen—widely used in palaeoecological studies—represents a valuable proxy for detecting plant biodiversity in modern contexts as well.

As part of the NBFC-Bioalpec, the ALPoll project aimed to investigate pollen and plant biodiversity relationships across different spatial scales in four Alpine protected sites in Trentino, Italy: Rifugio Val di Fumo (1906 m a.s.l.), Rifugio Altissimo (2057 m a.s.l.), Rifugio Rosetta (2577 m a.s.l.), and Rifugio Cevedale (2608 m a.s.l.). Aerobiological samples were collected using Sigma-2 (VDI 2119) gravimetric samplers and analyzed by optical microscopy (OM) and eDNA metabarcoding. Results were compared with vegetation data from field surveys at increasing distances from the samplers (10, 100, 1000 m).

The OM analysis identified 53 pollen taxa, while plant species within 1000 m totaled 306. Pollen and plant richness did not correlate at any of the spatial scales examined; the mean Jaccard similarity index ranged from 0.19 (10 m) to 0.26 (1000 m). Different outcomes are expected from the eDNA analysis, which enhances the taxonomic resolution of pollen. For example, Poaceae pollen (identifiable only at the family level by OM) was found to comprise over 20 species after eDNA analysis of a subset of samples from Rifugio Cevedale.

Improved taxonomic resolution of pollen allows for more accurate detection of changes in plant biodiversity, such as tracking the spread of alien species or the presence of threatened or protected ones. This provides relevant information to support plant conservation plans and management strategies in highly sensitive Alpine ecosystems.