Microplastics in the snow of the north-western Italian Alps: analysis of distribution and typology

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Microplastic pollution (hereinafter referred to as MP) is an increasingly topical and debated topic, but while their presence in marine environments and fauna has been studied for years, that in other contexts is less so. Recently, several studies have aimed at evaluating the origin, presence and danger of MPs in the air, fresh water and snow. This thesis, thanks to the collaboration with the project "A⅃Ч-Stop the ALPs becoming Plastic Mountains" and taking advantage of the particular situation generated by the health emergency, aims to investigate and explain the presence of MPs (in the form of particles and fibers) in the snow collected during the 2020-2021 winter season in Piedmont.

The samplings take place between December 2020 and April 2021, at different times and places in the Piedmont Alps In figure 1 you can see the sampling map and in table 1 the list of collected samples. The subdivision of the periods is indicated with the letters A, B and C while the duplicates are indicated with the words "bis" and "ter". The snow is collected with steel tools and stored in glass jars at room temperature and, during the collection phase, it is recommended to wear cotton and natural fiber clothes to avoid contamination.

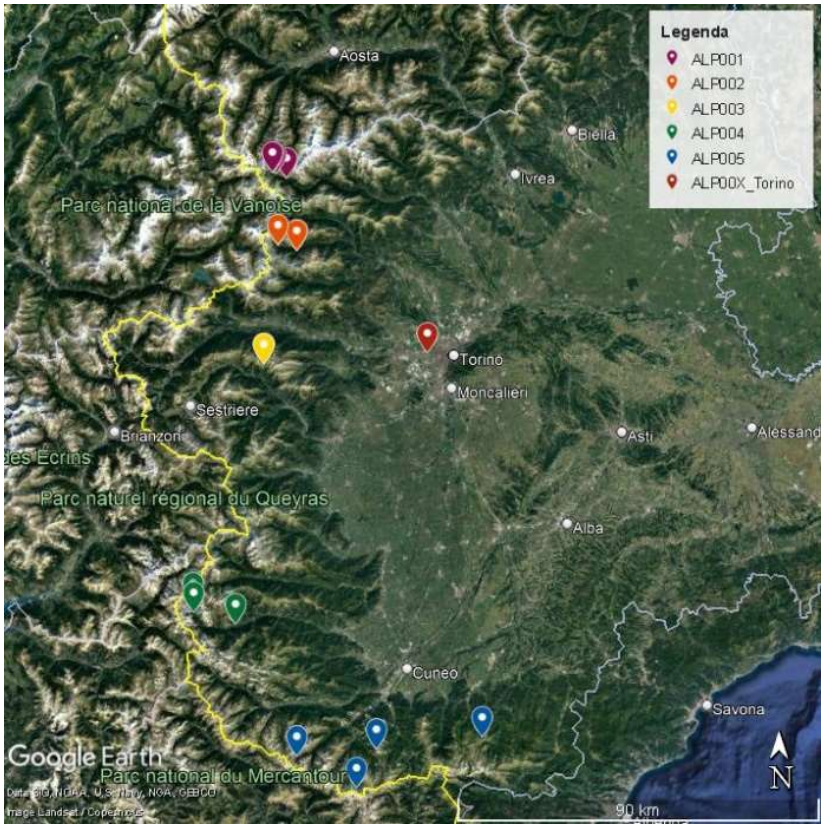

Fig. 1: sampling map

Table 1: list of collected samples

ALP001_A	ALP002_B_bis	ALP003_C
ALP001_B	ALP002_C	ALP004_A
ALP001_B bianco	ALP003_A	ALP004_B
ALP001_B_ter	ALP003_A_bis	ALP004_B bianco
ALP001_C	ALP003_A_bis bianco	ALP004_C
ALP002_A	ALP003_B	ALP005_A
ALP002_B	ALP003_B_bis	ALP005_B

The subsequent phase of preparation of the samples consists of four steps: first a separation by density of the suspension is carried out, solubilizing NaCl up to saturation (1.2 g/cm3); therefore, after having suitably discarded the heavier precipitate, one proceeds with the digestion of the organic fraction by means of hydrogen peroxide at 30% in a proportion of 1:1; subsequently, the residual suspension is filtered by gravity and finally the filters are left to dry, then covered with aluminum foil and stored in Petri dishes.

The analyzes carried out are divided into optical and spectroscopic, both performed using a micro-FT-IR spectroscope. The optical analyzes allow to perform a quantitative count of particles and fibers present in the samples while the spectroscopic analysis has the purpose of identifying the polymeric species found. Since the optically analyzed filtrate is often too small for an accurate spectroscopic analysis, it was decided to deepen the analysis with FE-SEM enlargements of some selected samples.

Only 18 of the 356 spectroscopies carried out are attributable to polymers, despite the library search recognizing 80 polymers, and this is probably due to the problems encountered due to the small size and the significant quantity of sand arrived with the perturbations of early February 2021 from the Sahara and remained despite the separation phase. Below are some spectra of the samples correctly identified as polymers, reporting in figure 2 (A and B) samples with a high correspondence and in figure 3 a sample with a less clear correspondence.

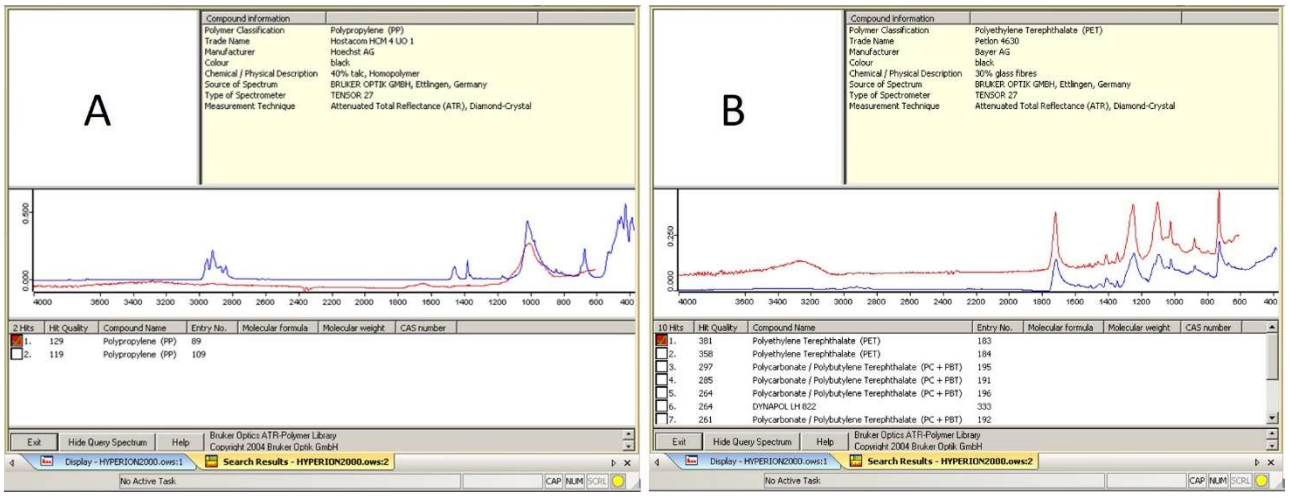

Fig. 2: Fibers coming from sample ALP002_B (A) and ALP004_A (B)

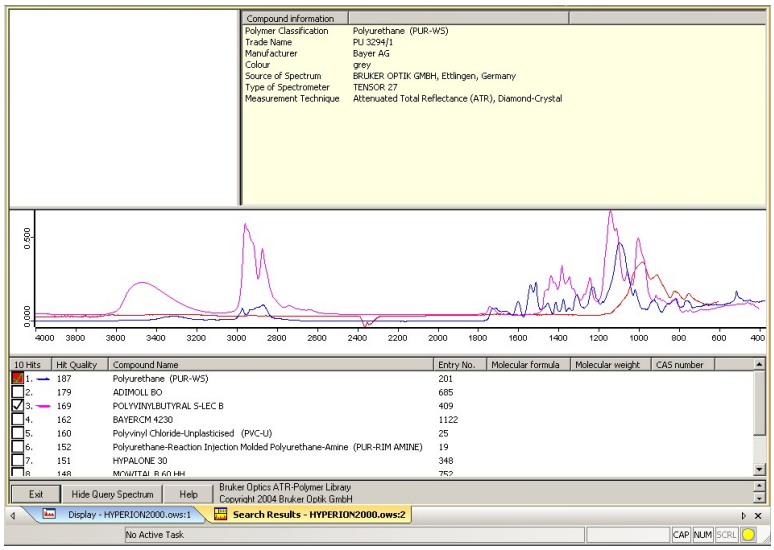

Fig. 3: Gray particle from sample ALP001_C

The FE-SEM analyzes confirm the sandy nature of the particles observed and also identify organic remains, such as the wooden particle in figure 4 or parts of insects. The fibers observed through optical magnification are both natural (figure 5A) and synthetic (figure 5B) and spectroscopy does not always return an accurate analysis but the images obtained with the FE-SEM confirm this double presence.

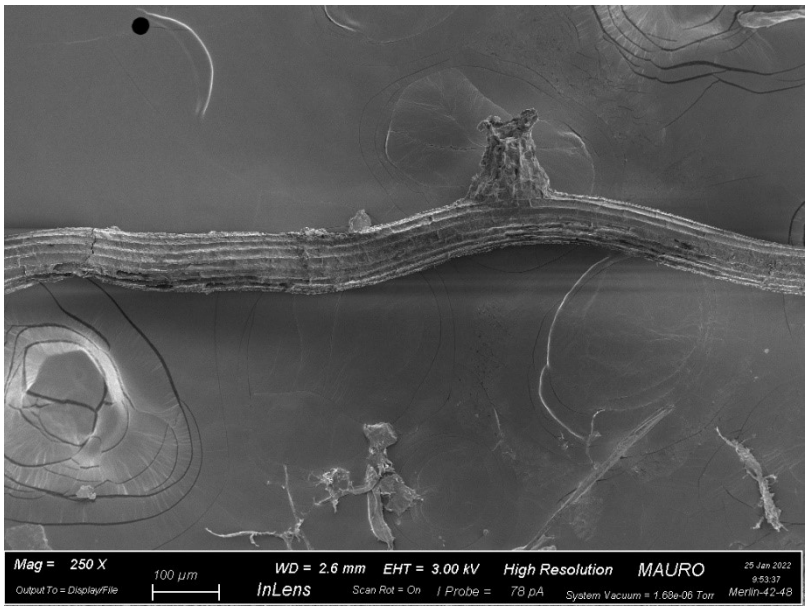

Fig. 4: Wood particle from sample ALP002_B

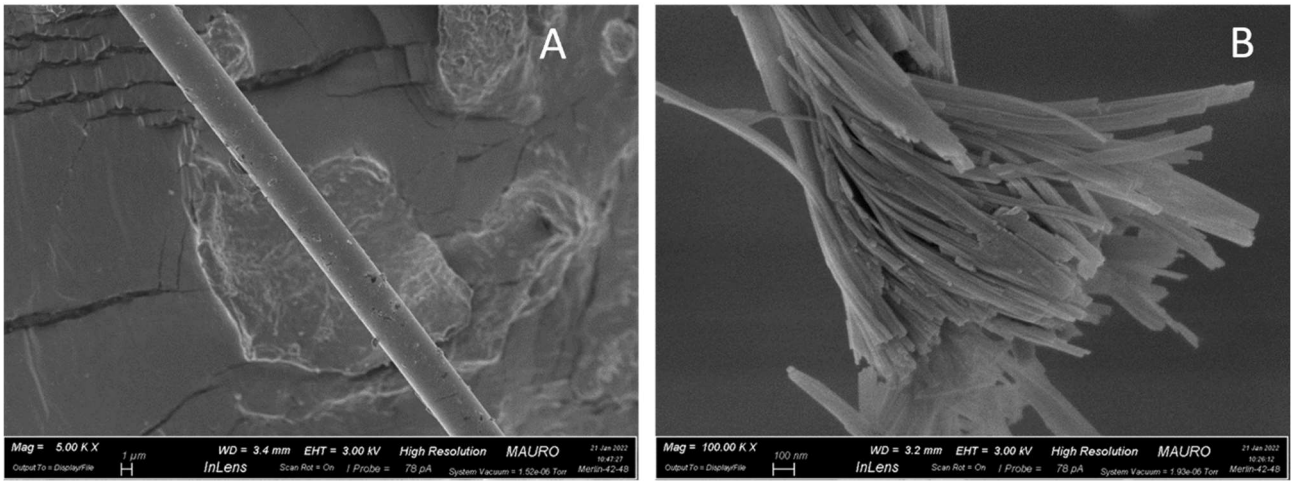

Fig. 5: Natural fiber from sample ALP002_C (A) and Synthetic fiber from sample ALP005_B (B)

As regards the quantitative aspect of the research, a chemometric analysis of the distribution of the filtrate was opted for using the MATLAB software. This analysis, however, is not explanatory of the distribution but confirms that it is almost homogeneous in all the sampling sites.

The quantities of particles and fibers are normalized on the volume of filtered sample and the figure 6 shows the normalized particle count on the ordinate and the fiber count on the abscissa. The graph shows a homogeneous distribution for the various samples except for the two whose label is shown. In detail: sample ALP001_A corresponds to one of the very first snowfalls of the season which probably cleared the air and sample ALP003_B anticipates the "red snowfall" due to the sand of the Sahara by about a week. In general, the concentration of particles is higher than the concentration of fibers and this is influenced by the sandy perturbations of the period which inevitably contaminated the snow collected.

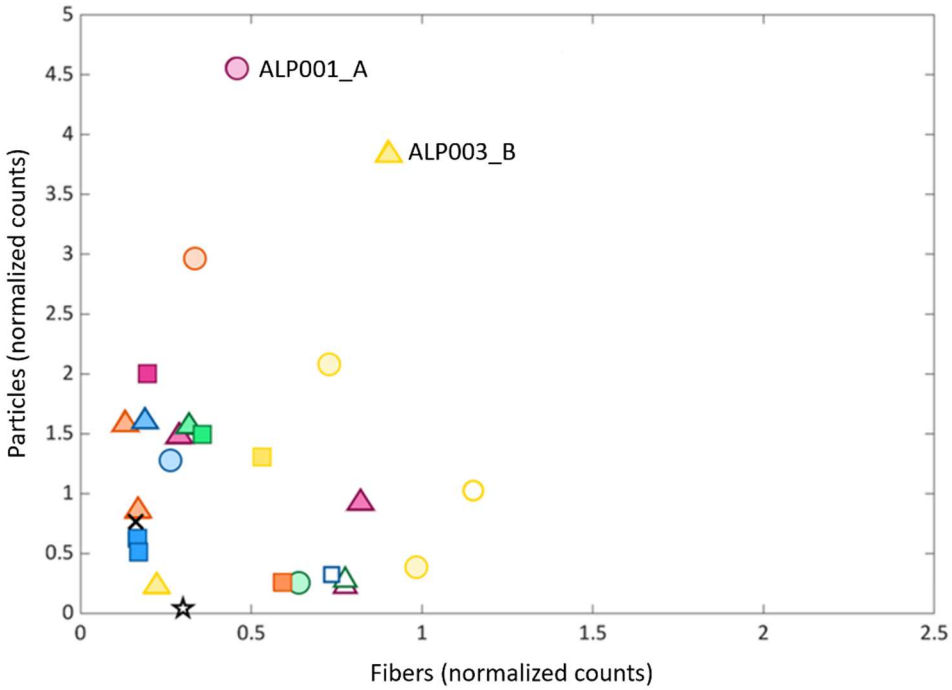

Fig. 6: Distribution graph. The units of measurement of the axes are intended in [number/ml].

In conclusion, it can be said that the quantities and nature of the particles found are in line with the scientific literature concerning MPs in the atmosphere. It can also be stated, if this result is compared with that of the reference article concerning the analyzes of the snow in the Aosta Valley (Parolini et al., 2021), that a greater presence of PM, both in the form of fibers and in form of particle, in the snow is caused by human presence in mountain areas, mainly due to tourism and sporting activities.