Monitoring of microfiber pollutants in karst environments

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The problem of anthropogenic microfibers

Recent studies highlighted a preoccupant pollutant which impact natural environments: the anthropogenic microfibres (MFs), fibres <5 mm in length of any composition (natural, regenerated, and synthetic) derived from larger primary textiles manufactured for different human use.

MFs have been detected in different environments, as well as in human and animal organs. Adverse effects on animal health have been studied too.

Non-synthetic MFs have been often considered microplastics because of their colours, and because are extruded and processed industrially. However, natural and regenerated fibres are a source of carbon for organisms, and are not plastic polymers generally considered biodegradable. Despite the general consensus on the biodegradability and reduced dangerousness of the non-synthetic fibres in the environment, little is known about their degradation in ecosystems. Their potential faster degradation could release toxic compounds into the environment, such as resins, dyes, and flame retardants. In addition, natural and regenerated textiles release more fibres than synthetic ones during laundering. All these factors may explain a long-term accumulation of MFs in the environment over time.

Aims

- Understanding if human-sourced MFs are present in the Classical Karst Region;
- Highlighting the extent to which anthropogenic MFs dominate karst environments in both cave and spring environments;
- Characterizing detected MFs by size, shape, colour, fluorescence and typology to facilitate a more critical future consideration of their environmental impact.

In detail, we want to investigate the following questions:

a) is there an accumulation of MFs in submerged sediments or concentration are higher in waters?
b) does the MF amount increase with the decrease in the size considered?
c) are synthetic fibers less abundant than natural and regenerated ones?

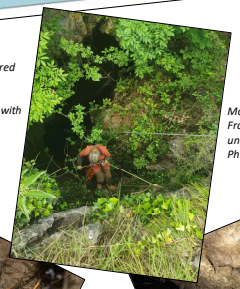
Study area

The Classical Karst Region is a rocky limestone plateau stretching from the NE Italy and the SW Slovenia, for a total 15-20 km wide and 40 km long area in the SW-NW direction, representing important habitats characterized by the presence of dissolution feature in carbonate rock such as caves and sinkholes, which connect surface and subterranean environments. These habitats host different stygobionts, such as obligate groundwater specialized species, including the endemic crustaceans *Troglocaris planinensis* and *Monolistra racovitzai*, and the salamander *Proteus anguinus*, the only troglobiont vertebrate present in Europe.

Underground waters played an important role for the development of the Italian sector of this region, therefore, this area has been heavily exploited and strongly altered by human activities, which irreversibly modified the hydrology of the system.

Italian sector of the Classical Karst Area. Karst area in green, blue stars for monitored springs, red stars for monitored caves. From Balestra et al., 2024. (Maps created with QGIS Desktop 3.12.1 with GRASS 7.8.2 using OpenStreetMap map, modified -openstreetmap.org/copyright)

Study site. Italy in green, Friuli Venezia Giulia Region in red. (Maps created with mapchart.net).



Monitoring in caves. From Balestra et al., under review. Ph M. Galbiati

Proteus anguinus in spring. From Balestra et al., under review. Ph V. Balestra

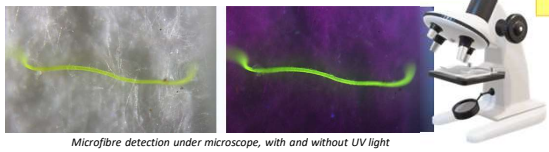
Monitoring in cave. From Balestra et al., under review. Ph V. Balestra

Materials and method

In this preliminary study we collected and investigated several water and submerged sediment samples in different subterranean (caves) and surface (springs) aquatic habitats of the Classical Karst Region.

Water and submerged sediment samples were pre-treated with 1:1 30% H_2O_2.

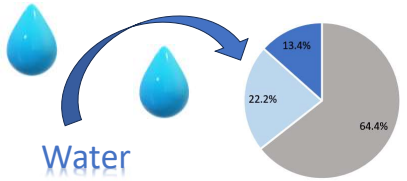
MFs from 0.1 to 5.0 mm were counted and characterized by size, color and shape via visual identification under a microscope, with and without UV light. Spectroscopic analyses with µFTIR-ATR were carried out on 10% MFs.



Microfibre detection under microscope, with and without UV light

Results

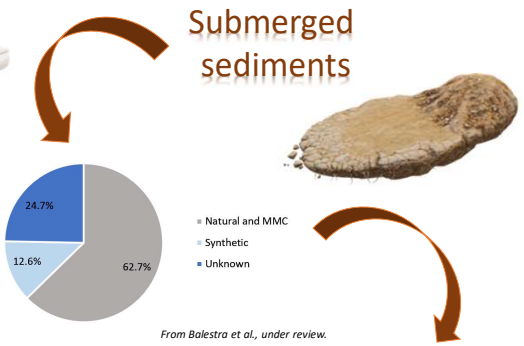
- MFs were found in all samples, highlighting MF pollution in surface and subterranean habitats of the karst system
- There is an accumulation of MFs in submerged sediments
- Most of the analysed MFs were cellulosics
- Only 22% in water and 12.6% in submerged sediments were synthetics
- The size distribution of collected MFs indicated that big MFs (1-5 mm) are less abundant (<22%)
- MF amount increase with the decrease in the size considered
- More than 80% of fibres were fluorescent under UV light
- Of the fluorescent MFs, 91% were transparent; non-fluorescent MFs were mainly black and blue
- Of the synthetic fibres, samples contained especially polyesters and copolymers



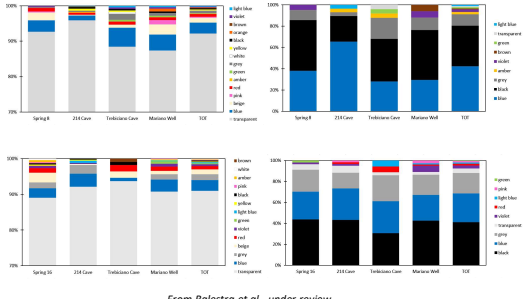
Conclusions

This research provides a baseline for future work related to the anthropogenic microfibres pollution in karst environments, which are under-represented in literature respect to microplastics (MPs), and useful for mitigation and management plans.

MF pollution monitoring in karst areas must become a priority for species protection, habitat conservation, and waters management, improving analyses on a larger number of aquatic environments, taking into account the ecological connections between surface and subterranean habitats.



From Balestra et al., under review.



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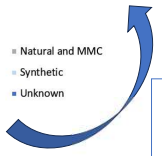

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