First assessment of plastic pollution in juvenile Magellanic penguins (*Spheniscus magellanicus*) from South Atlantic Coasts

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Introduction

Plastic pollution is a global problem and an improve knowledge in this regard is urgent to find solutions. Seabirds have been widely used as sentinels for monitoring plastic pollution in the marine environment. However, data for deep-diving seabirds remain scarce. Penguins are top predators and can reflect perturbations on the marine environment through changes in their population size, health or breeding success.

Magellanic penguin (*Spheniscus magellanicus*) is the most abundant penguin living in temperate regions (distributed between Argentina, Brazil and Chile). The survival through their first migration trip is an important determinant of population recruitment; however, mortality rates are very high. Many anthropogenic impacts can affect them on their migratory route. The aim of this work was to assess, for the first time, the occurrence, types and composition of plastic pollution in juvenile Magellanic penguins (*S. magellanicus*) stranded at different beaches from the southern Buenos Aires Province, Argentina

Materials and method

The content of the gastrointestinal tract (GIT) was digested with 30% H_2O_2, subsequently filtered (0.45 um glass microfiber) and visualized with a stereomicroscope. The particles were classified according to size, shape and color. Finally, a representative subsample was identified using Raman spectrometer and ATR-FTIR

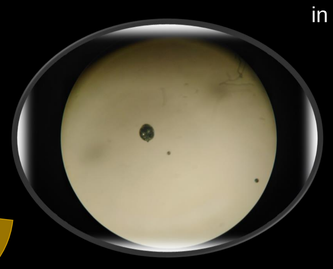
Step 1: Necropsy and extraction of the gastrointestinal tract (GIT)

Step 2: GIT contents were dissolved in 30% H2O2 at 60 °C

Step 3: The digested solution was filtered

Step 4: Filter stored in sterile Petri dishes

Step 6: Subsample was identified



Step 5: Samples were inspected under a stereomicroscope

Results:

Plastic-like particles were found in 100% of the GIT and their abundance ranged between 33-200 items per individual. A total number of 1609 particles were recovered and characterized. According to their size, microplastics represented 91.0% of all particles, followed by 8.8% of mesoplastics and 0.2% of macroplastics.

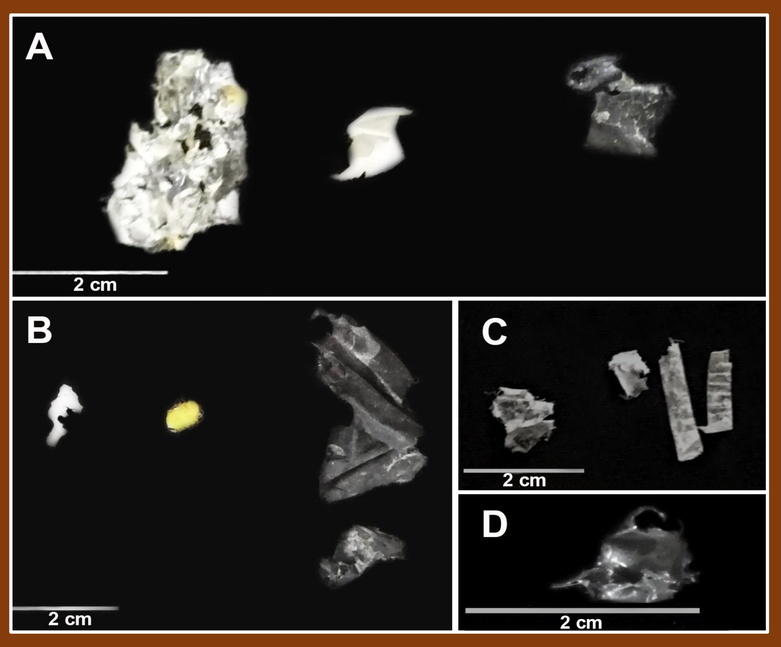


Fig. 1. Macroplastic and mesoplastic particles in juvenile Magellanic penguins. A, C, D: films; B: films and fiber

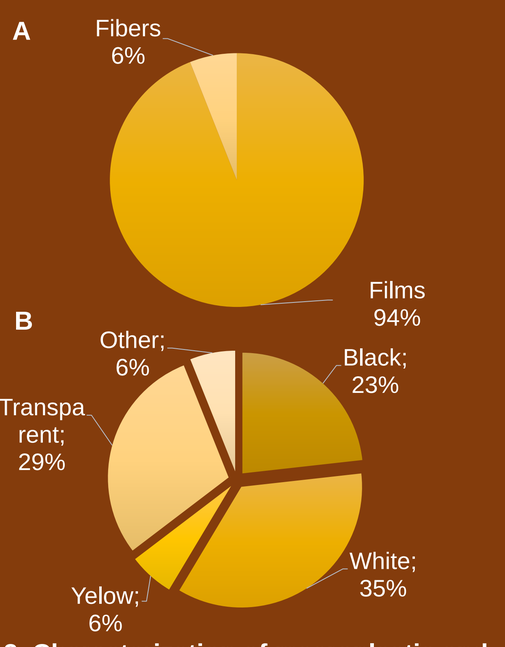


Fig. 2. Characterization of macroplastic and mesoplastics according to their shape (A) and color (B).

Particles visible to the naked eye were found in 23.8% of the penguins. They were classified as meso- and macroplastics. 94% of the particles corresponded to films. Most particles were white (35%) and transparent (29%). According to the ATR-FTIR analysis (n=13), a 62% of particles were identified as polypropylene, low-density polyethylene: 23%; and high-density polyethylene: 15%.

Results: Particles not visible to the naked eye were found in 100% of the GIT and their abundance ranged between 33-196 items per individual. The particles were classified as microplastics (92%) and mesoplastics (8%). The smallest particles (<1 mm) were the most frequent. Particles of 3-5 mm were less abundant. Regarding their shape, fibers had the highest frequency. Black particles were the most abundant (30%), followed by transparent (26%) and blue (14%).

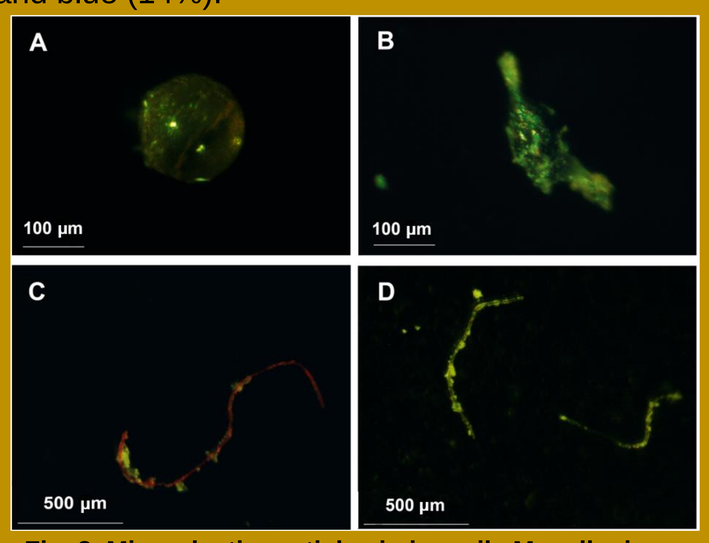
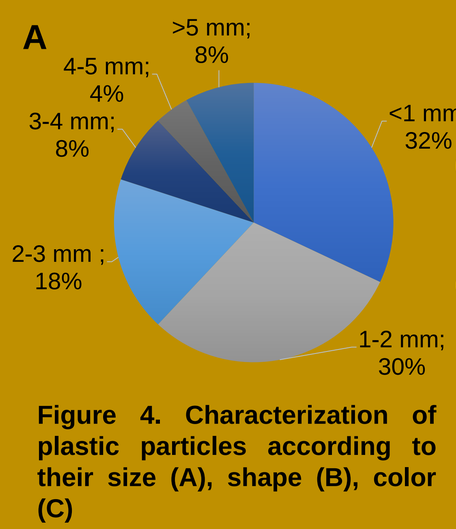


Fig. 3. Microplastic particles in juvenile Magellanic penguins. A: pellet; B: fragment; C and D: fibers



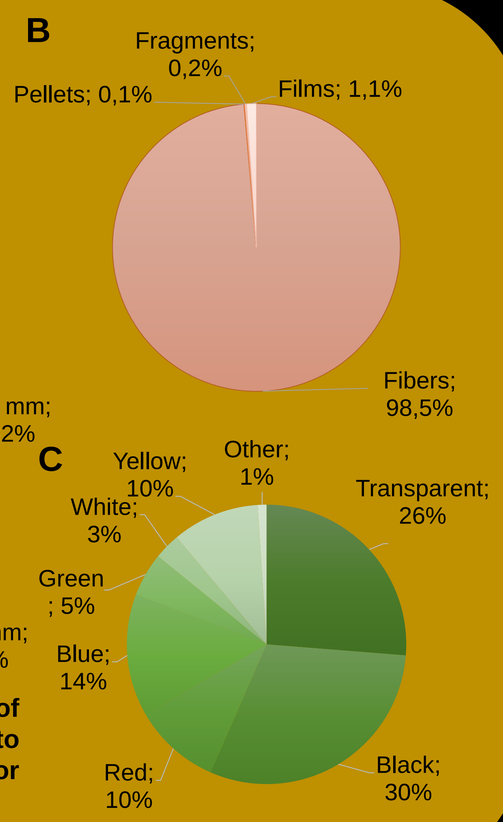


Figure 4. Characterization of plastic particles according to their size (A), shape (B), color (C)

Particles not visible to the naked were examined by u-Raman spectroscopy. The most abundant polymeric composition detected was polyester (28%), followed by anthropogenic cellulosic (22%), polypropylene (PP; 18%), and polyethylene terephthalate (PET; 10%). Pigments were also recognized: Indigo blue pigment (5.3%) and copper phthalocyanine (CuPc;1.3%).

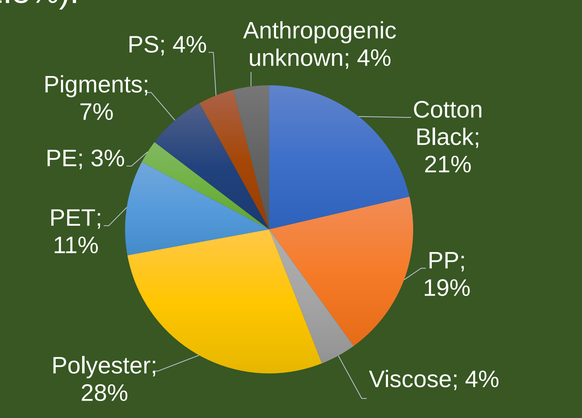


Figure 5. Characterization of plastic particles according to polymeric composition.

Conclusion:

This work reveals the first evidence of vulnerability of the southern Magellanic penguins to the ingestion of marine plastic debris, including macro, meso and microplastics. In addition, other anthropogenic pollutants such as anthropogenic cellulosic fibers and pigments were also found. Our data suggest that juvenile Magellanic penguins may be a promising tool to monitor plastic pollution in the South Atlantic. Further research is needed to improve our knowledge on plastic distribution and impact on Magellanic penguins to further develop policies and specific mitigation measures targeting fishing gear and urban wastewater plastic pollution in the Patagonian coastline.

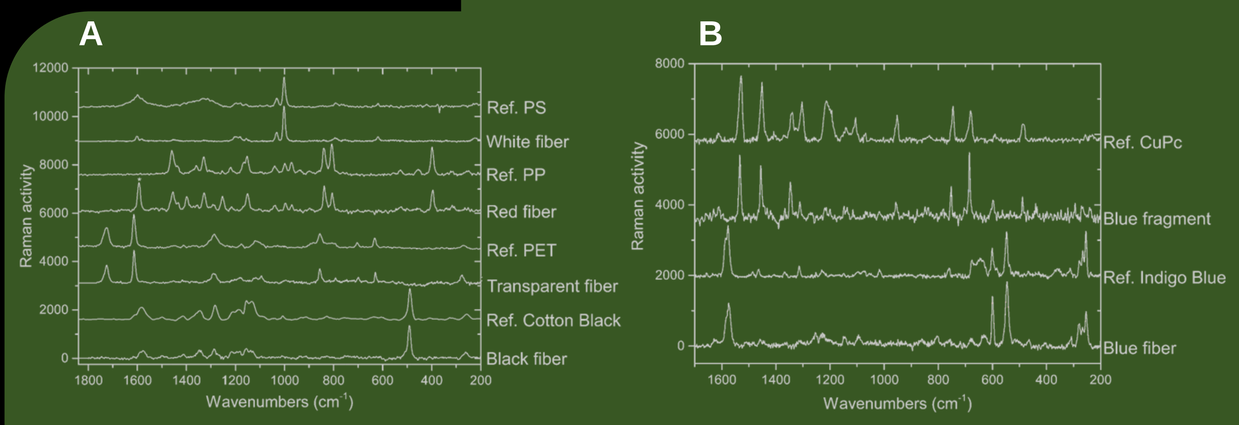


Fig. 6. Raman spectra of selected microparticles detected. A: Raman spectra of MPs with their corresponding polymeric composition; B: Raman spectra of MPs containing anthropogenic pigments.