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Note

Microplastics in the sediments of Terra Nova Bay (Ross Sea, Antarctica)

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ABSTRACT

This is the first survey to investigate the occurrence and extent of plastic contamination in sediments collected in Terra Nova Bay (Ross Sea, Antarctica). Plastic debris extracted from 31 samples of sediments were counted, weighted and identified by Fourier-transform infrared spectroscopy (FT-IR). All sediment samples contained plastics: a total of 1661 items of debris (3.14 g) were recorded from the 31 samples of sediment. Plastic particles in the samples ranged from 0.3 to 22 mm in length. Fibres were the most frequent type of small plastics debris detected. In terms of abundance, microplastics (< 5 mm) accounted for 78.4% of debris. 9 polymer types were found: the most common material (94.13% by weight) was styrene-butadiene-styrene copolymer (SBS), widely used in pneumatic tires, etc. A decreasing concentration of plastic debris at increasing distances from the Mario Zucchelli Base was evidenced.

We use > 320 million tonnes of plastic each year (Plastic Europe, 2016), and discarded "end-of-life" plastic accumulates particularly in marine habitats. There is a heightened awareness of the amount of plastic in the sea, it's spread to even remote localities and the multiple influences of this on organisms, especially for what concerns small fragments and microplastics (plastic particulates < 5 mm; Ivar do Sul and Costa, 2014). Plastic pollution is ubiquitous throughout the marine environment, yet estimates of the abundance and weight of "end-of-life" plastics have lacked data, particularly from the Southern Hemisphere and remote regions. Antarctica is extremely remote and not connected by any land mass, so it could be used as a "reference" for global plastic pollution. The Ross Sea, which comprises 2% of the Southern Ocean, is located between Victoria Land and Marie Byrd Land and is the largest continental shelf ecosystem south of the Antarctic Polar Front. There, the Mario Zucchelli Base is located on a promontory in Terra Nova Bay. It is a scientific research center and a strategic logistics node for other bases in Antarctica. From 1985, when it was built, until now the station hosted 33 scientific expeditions, with an average of 300 researchers a year. Taking into account the early stages of studies dealing with plastic deposition in Antarctic marine sediments, with the present study we wanted to assess, for the first time in Terra Nova Bay (Ross Sea), the quality and quantity of small plastic debris occurring in sediments to address the gap in knowledge and to serve as a baseline for future comparisons.

In the austral summer 2015, during the 30th Antarctic Expedition (PNRA, Italian Research Program in Antarctica), sediment samples were taken from Terra Nova Bay, Ross Sea (Fig. 1). The sampling program was carried out aboard the MS "Malippo" in January 2015, and sediment samples were taken with a Van Veen grab (surface 0.18 m^2). A total of 11 stations were sampled at increasing distance from the Mario Zucchelli Base: 3 stations at Adelie Cove (10 km south of the base), at 25, 70 and 140 m depth (Stns AC25, AC70, AC140), 1 station at Central Bay (7 km south of the base; Stn CB25), 3 stations at Camp Icarus (4 km south of the base; Stns CI25, CI70, CI140), 3 stations at Rod Bay (2 km south of the base; Stns RB25, RB70, RB140), and finally 1 station in front of the Mario Zucchelli Base (Stn SMZ25). Each station was sampled in triplicate, except for SMZ25 and CB25, where adverse weather conditions allowed collecting only 2 replicates. Sampling stations coordinates are reported in Table 1.

At our laboratories, the plastic debris in sediment samples were removed under a dissection microscope (Nikon SMZ45T, magnification 3.35–300 ×), counted and weighted to the nearest 0.0001 g. The identified plastics were measured at their largest cross-section using calipers and classified into three groups: micro (≤ 5 mm), meso (> 5–20 mm), and macro (> 20 mm) (Jayasiri et al., 2013). Plastic debris were also categorized according to shape (i.e., fibre, film,

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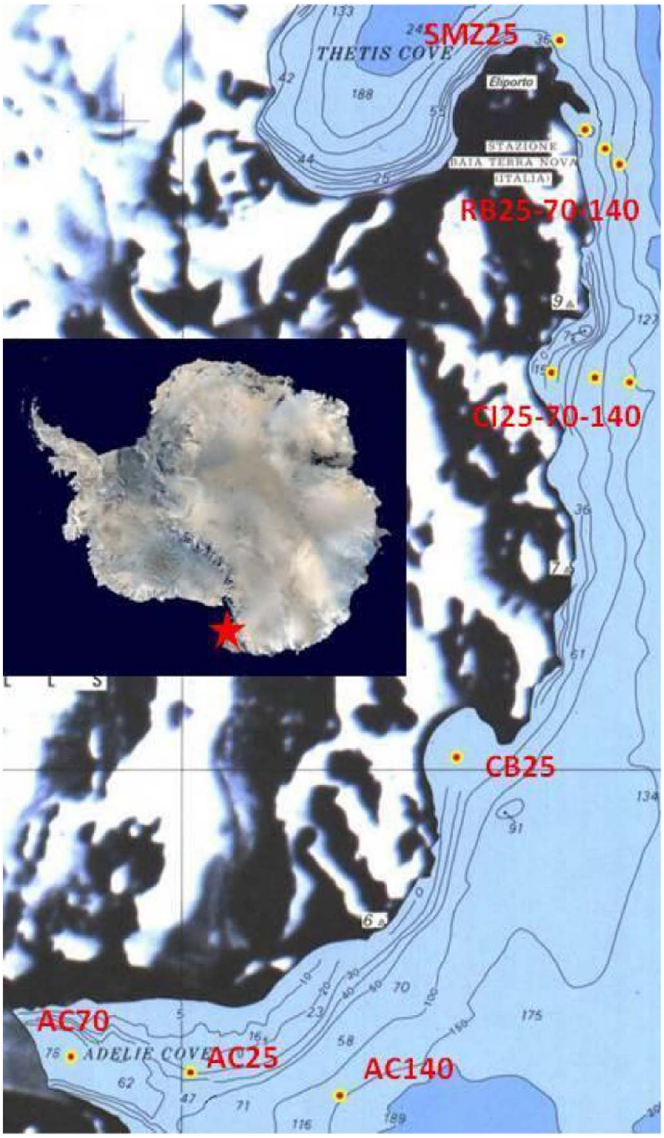

Fig. 1. Map of study sites.

Table 1
Sampling stations coordinates and depth (MZS: M. Zucchelli Base; RB: Rod Bay; CI: Camp Icarus; CB: Central Bay; AC: Adelie Cove).

Station	Latitude S	Longitude E	Depth (m)
SMZ25	74°41.335	164°07.098	25
RB25	74°41.831	164°07.532	25
RB70	74°41.918	164°07.896	70
RB140	74°41.972	164°08.208	140
CI25	74°43.037	164°06.908	25
CI70	74°43.078	164°07.757	70
CI140	74°43.101	164°08.399	140
CB25	74°44.925	164°05.243	25
AC25	74°46.390	163°57.977	25
AC70	74°46.467	164°00.266	70
AC140	74°46.617	164°02.798	140

fragment). Plastic debris composition at the 11 stations was investigated by means of ordination analysis (nMDS) based on the Bray-Curtis similarity index calculated on untransformed quantity data. Plastic categories contributing to dissimilarity between stations were investigated using the similarity percentages (SIMPER) analysis (Clarke, 1993). Differences in plastic debris composition and quantity between stations were analyzed through PERMANOVA (Anderson et al., 2008) according to a one-way experimental design. For the one-way case, an exact P-value was provided using unrestricted permutation of raw data. When low unique values in the permutation distribution were available, asymptotical Monte Carlo P-values were used instead of

Fig. 2. Examples of the collected plastic debris (from station RB70).

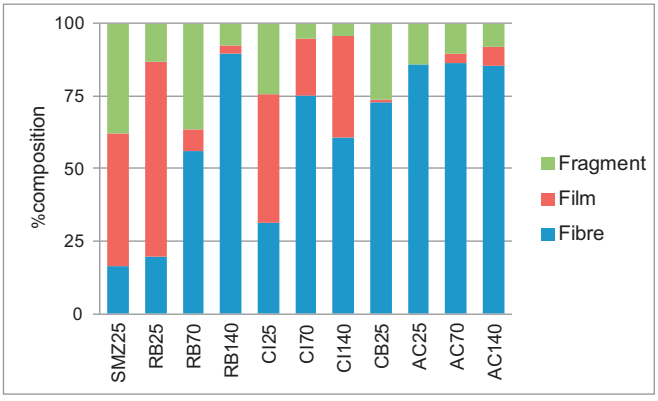

Fig. 3. Composition of plastic debris collected according to shape type.

Table 2
Shape type of plastics collected. Values represent average abundance (number of items *per* square meter) and standard deviation (in italics).

Location	Site	Fibre	Film	Fragment
M. Zucchelli Base	SMZ25	19.50	55.50	45.50
		4.95	*44.55*	*9.19*
Rod Bay	RB25	24.33	82.67	16.00
		15.31	*69.92*	*15.39*
	RB70	31.67	4.33	20.67
		23.50	*4.04*	*27.30*
	RB140	34.67	1.00	3.00
		19.63	*1.73*	*1.73*
Camp Icarus	CI25	38.00	53.00	29.67
		42.79	*90.93*	*46.20*
	CI70	5.00	1.33	0.33
		2.65	*2.31*	*0.58*
	CI140	23.00	13.33	1.67
		20.42	*21.39*	*2.08*
Central Bay	CB25	39.00	0.50	14.00
		0.00	*0.71*	*14.14*
Adelie Cove	AC25	2.00	0.00	0.33
		1.00	*0.00*	*0.58*
	AC70	19.33	0.67	2.33
		11.59	*1.15*	*3.21*
	AC140	25.00	2.00	2.33
		8.66	*2.65*	*3.21*