Underway water system of research vessels: Optimization of a method for microplastic sampling in oceanic waters.

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INTRODUCTION:

Broad scale monitoring efforts and microplastic sampling in open oceanic waters are required to understand distribution, abundance and fate of these particles in the environment. For surface seawaters, towing a neuston net is the most common sampling method; however, the deployment of this infrastructure is not always an opportunity when at sea, and the underway water system of research vessels has been tried for this purpose in several studies to date. Method validation and recovery checks have not been thoroughly applied, which may be resulting in wrong estimations.

AIM:

The aim of this study is to validate the performance and effectiveness of this method, based on the inter-comparability of samples taken through the underway intake system and samples filtered from the Rosetta.

METHODS:

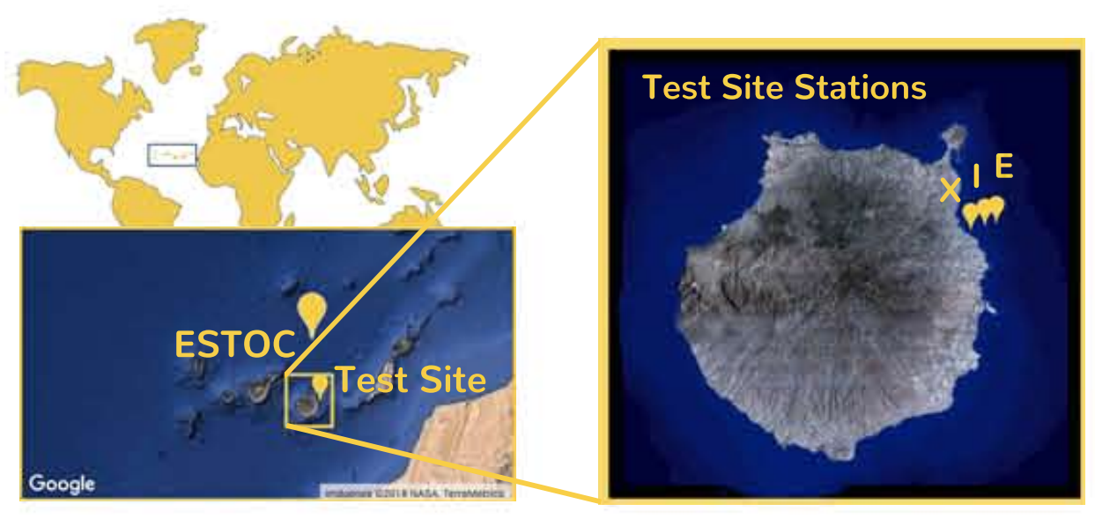


Fig. 1 Geographical location of the experiment.

This experiment was performed onboard the Research Vessel Ángeles Alvariño at four different stations: the European Station for Time series in the Ocean Canary Islands (ESTOC), and the Stations E, I and X from the PLOCAN Test Site, situated to the north-east of the island of Gran Canaria, in the Canary Islands Archipielago (Spain). [Fig.1].

We tested the method for its calibration and investigated abundance, distribution and type of small microplastics sampled from subsurface waters.

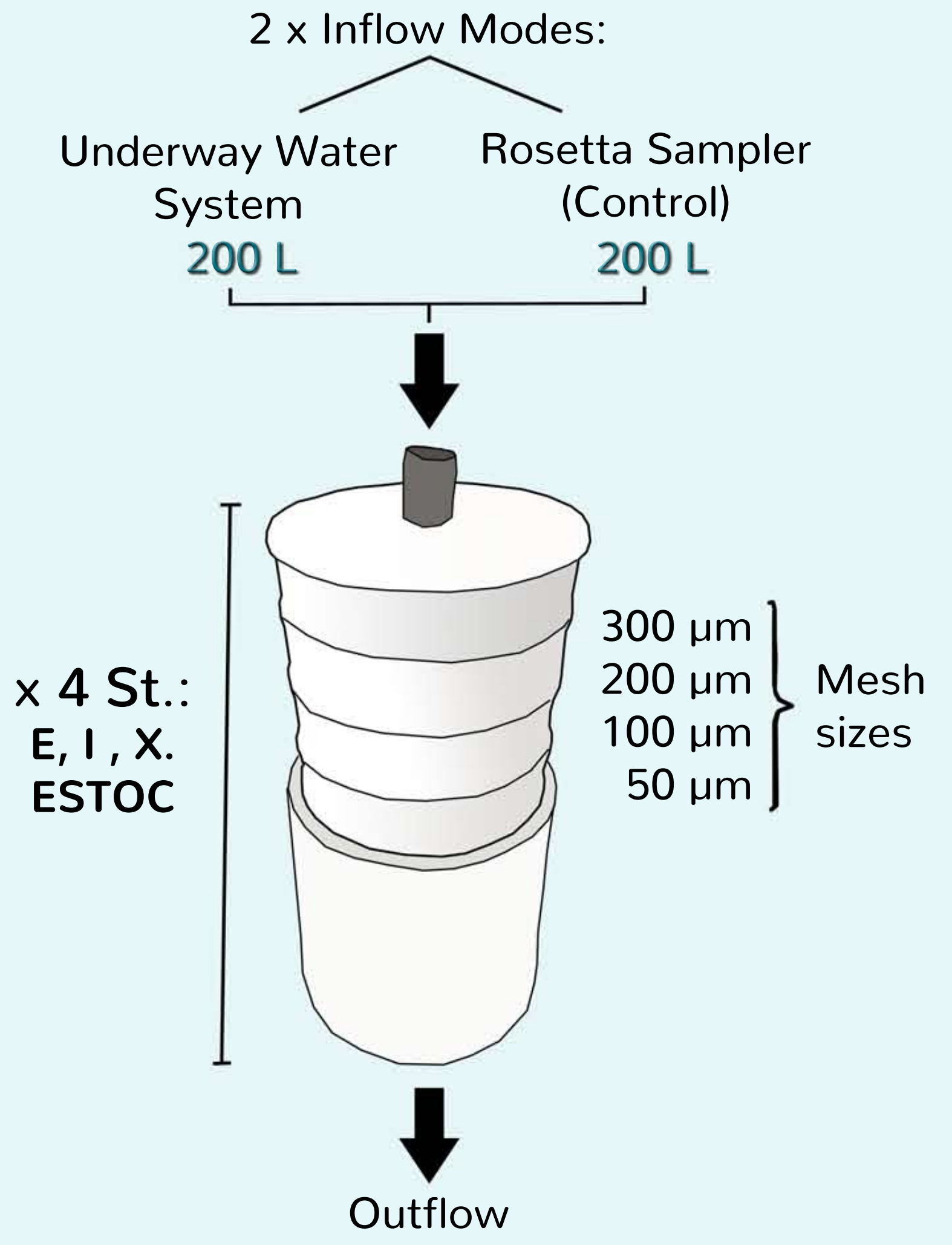
Making use of an improved(*) filtering device [Fig.2], **400 L of subsurface seawater** (≈- 5 m) were filtered at each station:

- 200 L were obtained using the **underway water system** of the ship through a tap located at the wet lab.
- 200 L were collected from the Niskin bottles from the **Rosette Sampler**.

The filtering device consists on four stacked sieves with mesh sizes of 300, 200, 100 and 50 microns. The design comprises a lid -to prevent airbone contamination- and a flowmeter, to ensure equal volume sampled in the different trials performed.

After each sampling volume was acquired, the filtering device was disconnected and each mesh was washed to a screw top jar with MilliQ water. Back in the clean lab, each sample was vacuum filtered onto glass microfiber filters of 0,7 microns pore and visual inspection under a stereoscope and a microscope up to 80X was performed.

(*) Previous designs were tested onboard the R/V Sarmiento de Gamboa and other ships of opportunity, such as recreational vessels [Fig.4].


2 x Inflow Modes:

Underway Water System
200 L

Rosetta Sampler (Control)
200 L

x 4 St.:
E, I, X.
ESTOC

300 µm
200 µm
100 µm
50 µm
Mesh sizes

Outflow

Fig. 2 Filtering device diagram.

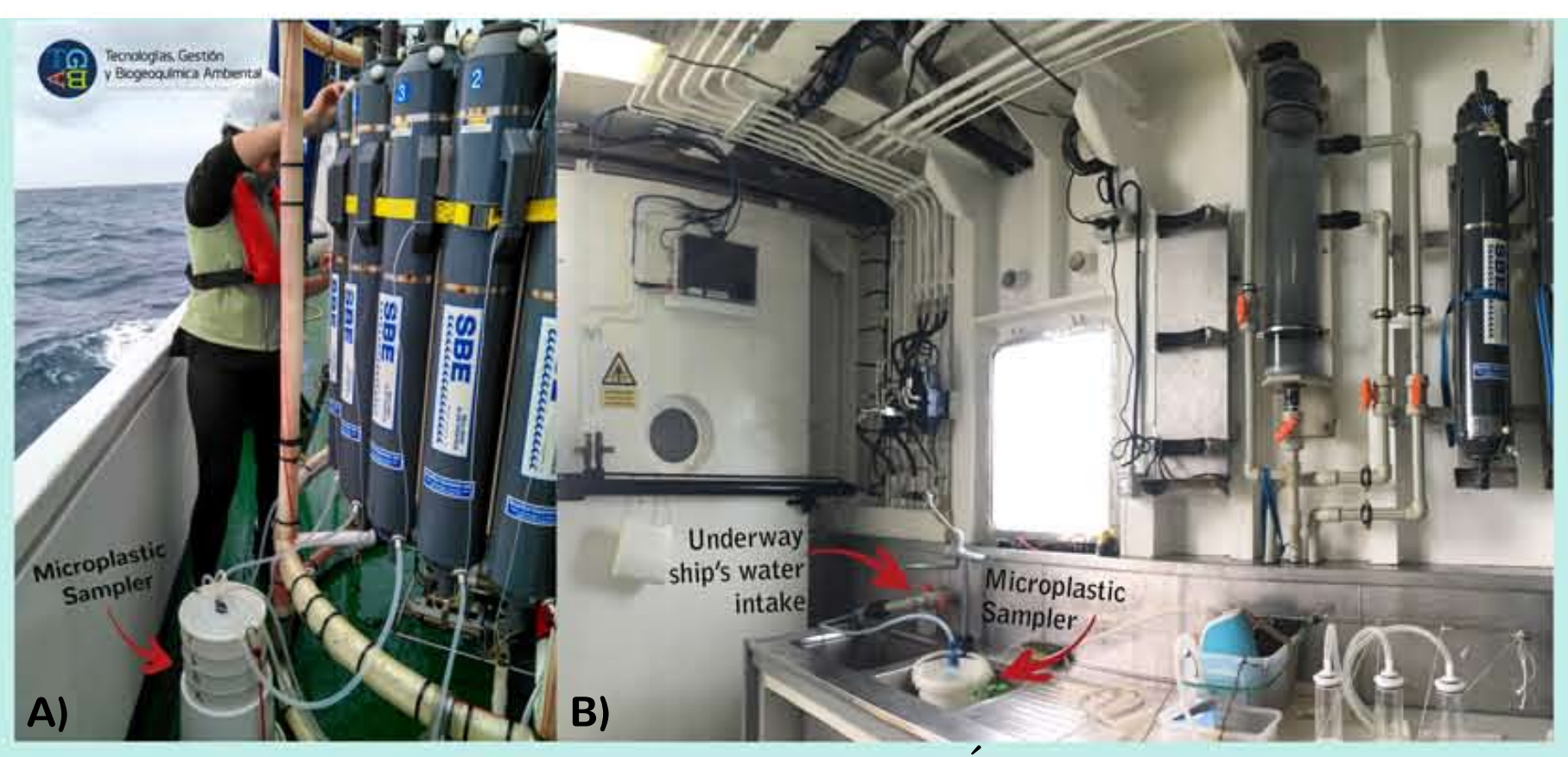


Fig. 3 Filtering procedure onboard the R/V Ángeles Alvariño: A) Water collected by the Niskin bottles from the Rosette Sampler, B) Connected to the underway seawater intake system.

Fig. 4 The filtering device has been designed to be implemented in other opportunity platforms such as recreational vessels. In the picture: set-up of the filtering device on the Acrobat sailing boat for developping essays, as part of the SailingLivingLab project.

RESULTS:

- A total of 1730 L of subsurface water were sampled while testing two different intake methods for the microplastic sampling device operation.
- Microplastic particles were found in all four stations, and ill all samples, either taken with the Rosetta Sampler or the Underway Intake [Fig. 5].
- A total of 572 particles were identified, being the vast majority of them fibres (85%). The oceanic station, ESTOC, shows the highest particle concentration with up to 465 fibres per m³. [Fig. 6].
- The majority of fragments found were black (64%), whereas blue fibres were the most abundant (36%), followed by black (28%), red (16%) and transparent, nylon-alike ones (13%) [Fig.7]

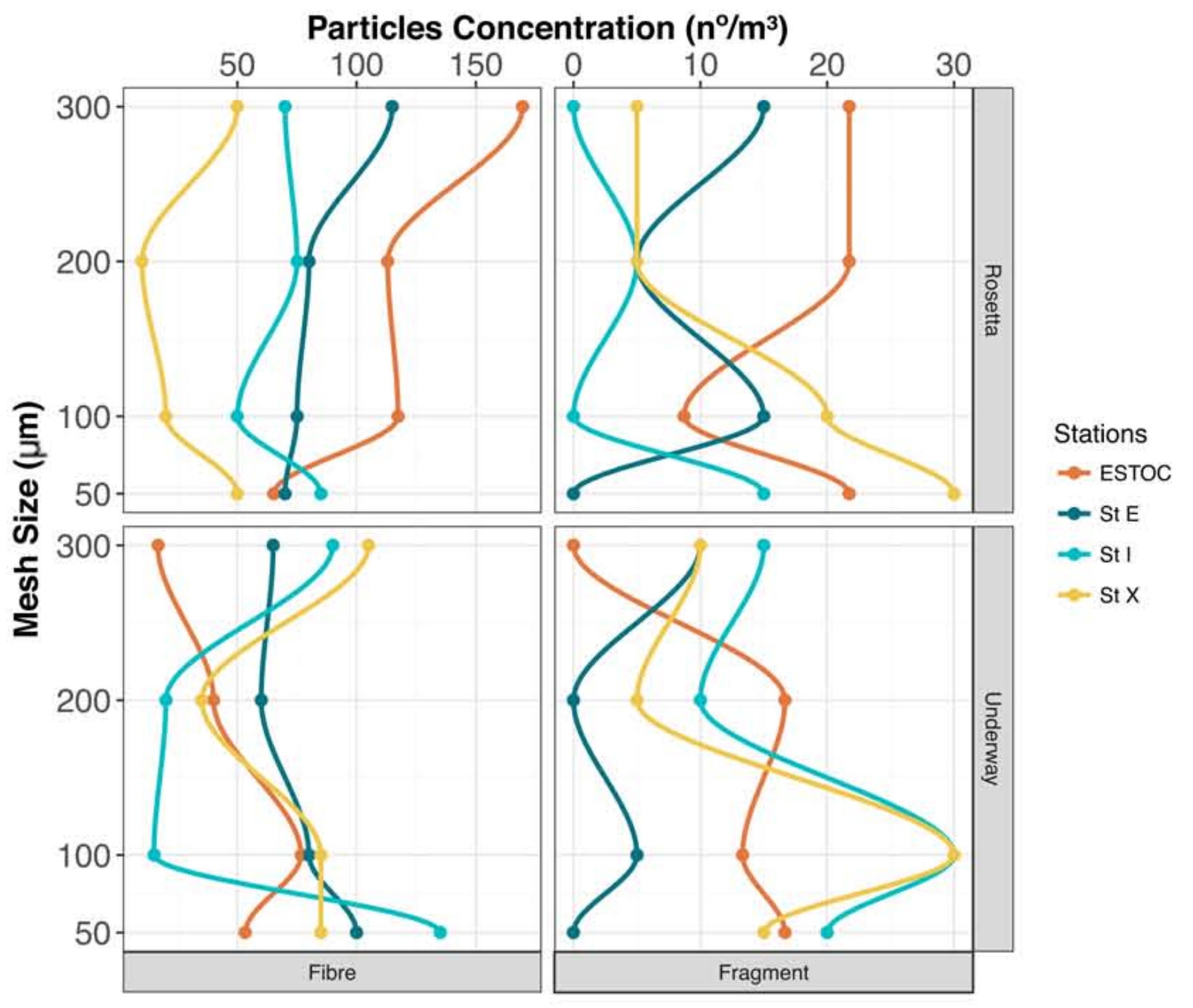


Fig. 5 Particle concentration (Fibres & Fragments) found at the four stations, according to different mesh sizes (300, 200, 100, 50) and uptake mode (Rosetta Sampler Vs Underway System).

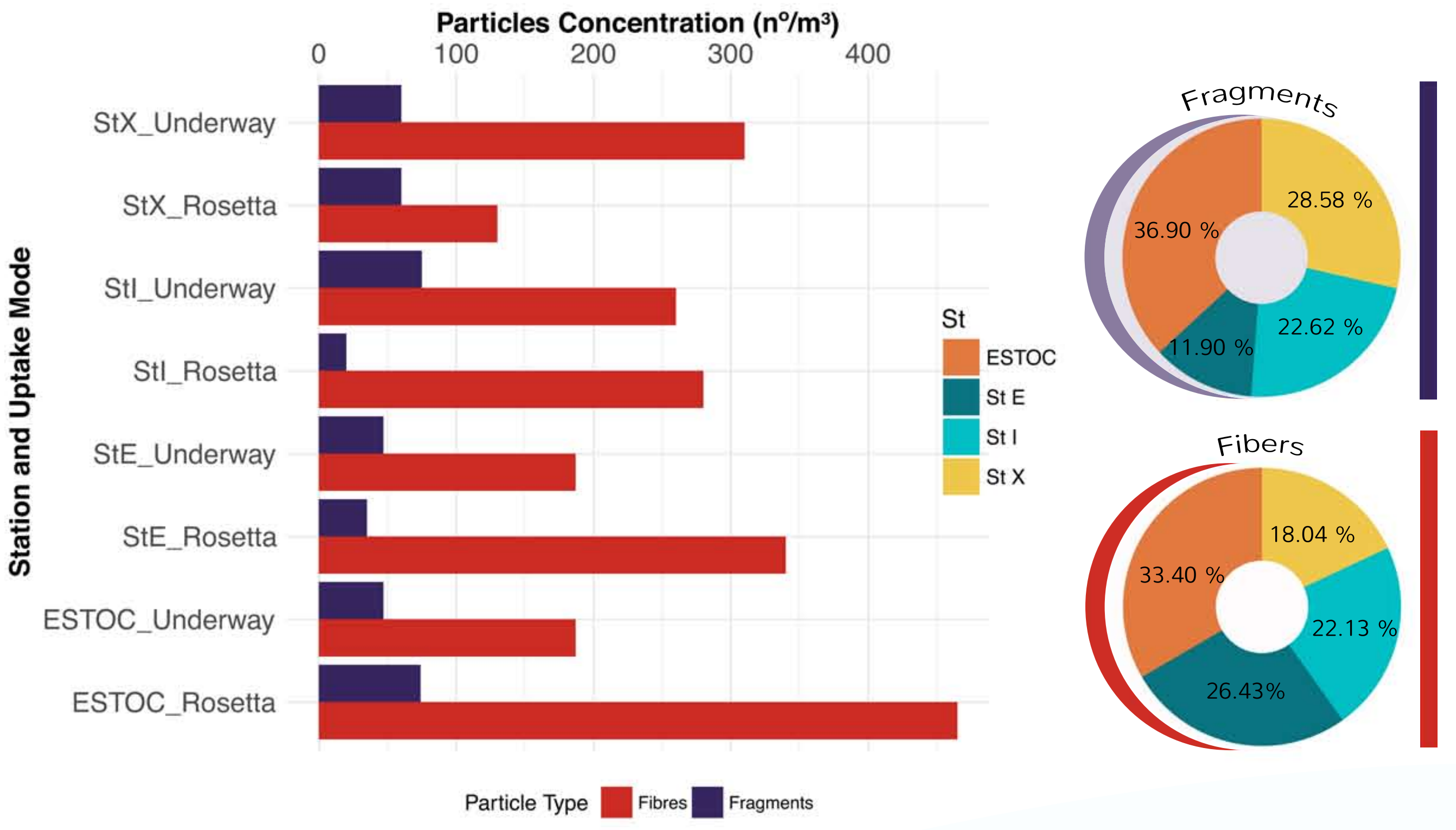
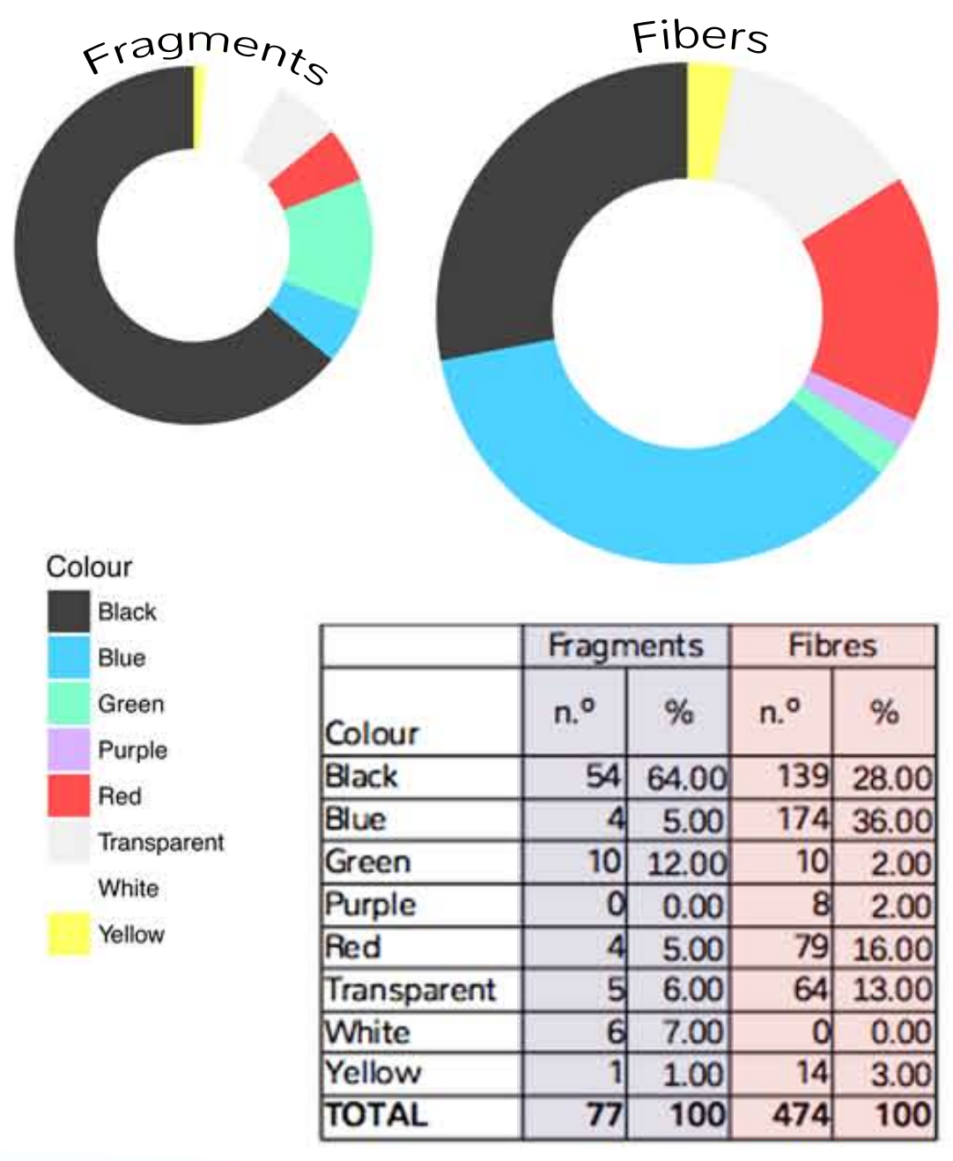


Fig. 6 Density of particles found at each Station (E, I, X & ESTOC) with both intake methods: (U) Underway Intake System and (R) Rosetta Control Sampler. Right: abundance percentage of each type of particle is shown per station.



	Fragments		Fibres	
Colour	n.º	%	n.º	%
Black	54	64.00	139	28.00
Blue	4	5.00	174	36.00
Green	10	12.00	10	2.00
Purple	0	0.00	8	2.00
Red	4	5.00	79	16.00
Transparent	5	6.00	64	13.00
White	6	7.00	0	0.00
Yellow	1	1.00	14	3.00
TOTAL	**77**	**100**	**474**	**100**

Fig. 7 Color distribution of microplastic particles identified, by number & percentage.

DISCUSSION:

This preliminary study demonstrates the potential of the underway water intake system of ships as a method to sample microplastic particles in marine open water environments with vessels of opportunity. Although further trials are required to test the effectiveness and significant difference among the abundance and type of microplastic particles collected using either the Rosetta or the Underway water system, it was been proved as an effective technique that allows continuous sampling without interfering the regular activity of the operating vessel.

Reported abundance in the subsurface ocean waters in the area studied is higher than the reported in other areas in the NE Atlantic, including coastal areas. Color distribution is consistent with the proportions found in other similar studies.

Methods used for identifying particles rely on visual observation assisted with optical microscope and could be omitting plastics. It is important to complement this method with other methods that might aid in the detection of smaller particles and are beneficial to identify the polymer type and potential procedence.

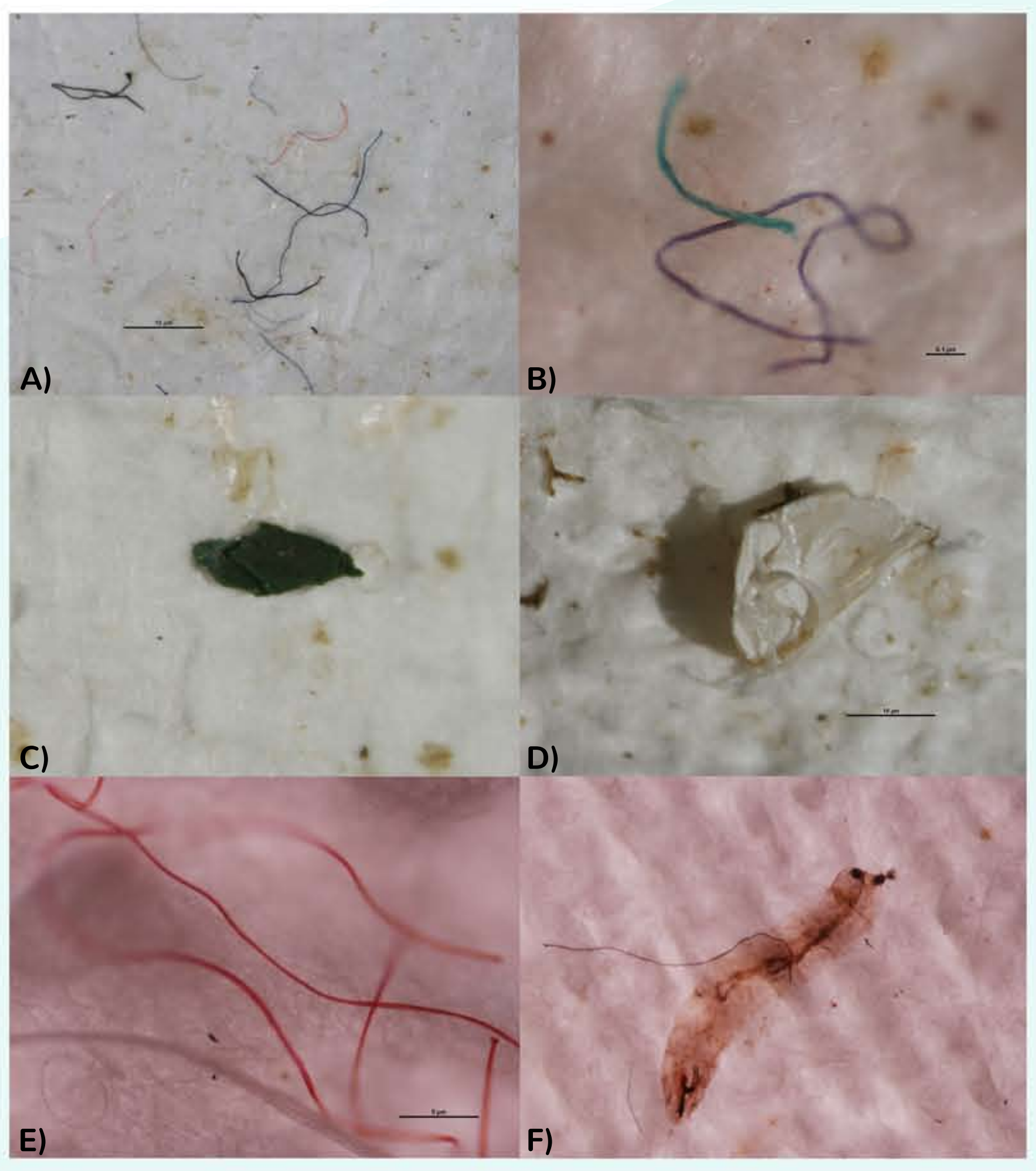


Fig. 8 A) Several fibres taken with the 300 µm mesh, B) Fibres observed under microscope (100X), C) Green fragment observed at 80X, D) White fragment oberved at stereo microscope (20X), E) & F) Fibres observed at microscope (100X and 20X).

CONCLUSION:

Sampling methods standardization and validation are essential to ensure the intercomparability of the data reported in the different sampling efforts worldwide concerning distribution and abundance of microplastics in marine open waters environments.

The use of the underway water system of research vessels as a way of seawater uptake for the use of the filtration device has been proved efficient. This is an important step that allows its use in a wider array of opportunity platforms, such as recreational vessels, therefore increasing the observations at sea and the possibilities for ocean monitoring on microplastic pollution.

Further trials and research will be performed to test additional environmental and sampling factors.

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