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Supplementary Materials for

Microfibers in oceanic surface waters: A global characterization

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Supplementary Text
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Legend for data file S1

Other Supplementary Material for this manuscript includes the following:

(available at advances.sciencemag.org/cgi/content/full/6/23/eaay8493/DC1)

Data file S1

Compensating for the effect of different mesh sizes and sample depth

Filter mesh size and, for large mesh sizes, sample volume, both influence fiber retention rates (Ryan et al. 2019). To compensate for differences in mesh sizes used to process samples (see Table S5), we estimated crude correction factors based on pairwise comparisons of samples collected at the same location and filtered through different mesh sizes (Ryan et al. 2019). The pairwise sample comparisons are noisy (see Fig 1 in Ryan et al. 2019) and not all effects were significant, but on average, 20 µm mesh collected 41% more fibres than 63 µm mesh ($n = 69$, $P < 0.05$), 0.7 mm filters retained 44% more fibres than 25 mm filters ($n = 85$ stations, $P = 0.002$), and 25 µm mesh collected 10% more fibres than 50 µm mesh ($n = 30$, $P = 0.2$). Combining these average retention data using linear interpolation, and assigning 100% retention score to the 0.7 µm mesh, gives the retention rates for different mesh sizes in Table S1. We then modeled these data (Fig. S1) to predict appropriate correction factors for all mesh sizes used (Table S1), and applied these correction factors to fiber counts from all samples to compensate for differences in mesh size.

Similarly, comparison of samples of surface and subsurface water collected from the same site and filtered through the same mesh size showed that fiber densities in water collected 5 m subsurface averaged 2.6 times less than samples collected from surface waters (paired t-test; $t_{109} = 5.555$; 1-tailed $P < 0.001$; $n = 110$). The correlation between these samples was significant ($r_{108} = 0.187$, $P < 0.05$), although the data were very noisy because of varying sample volumes (Fig. 3 in Ryan et al. 2019). When only samples with similar water volumes were compared ($n = 21$), the density of fibers in subsurface samples was still 2.4 times lower than in paired surface samples (IQR: 2.6; SD: 1.8; 95% CI: 1.7-3.2). Accordingly, we used a conservative correction of 2.4 to estimate surface values for sites were only sub-surface samples were available.

These correction factors are per force crude. However, a key conclusion from Ryan et al. (2019) is that replicate samples collected in the same way at the same location show high variability in fiber counts, irrespective of factors such as mesh size, depth or volume filtered. This highlights the need for multiple samples at each sampling location, and although we took 2-4 samples at most sites, larger sample sizes are needed to obtain robust density estimates. As a result, our fiber densities should be regarded as semi-quantitative, and suitable only for gross comparisons among regions. Given the crude nature of the correction factors used, both uncorrected and corrected counts are presented throughout.

Table S1. Mesh size retention coefficients and extrapolated correction factors. Estimated fiber retention rates (%) for the six different mesh openings used in this study. Retention coefficients were computed from the data presented in Ryan et al. (2019), and associated correction factors were estimated from the exponential model in Fig. S1.

Mesh size opening (µm)	Retention rate (%)	Estimated correction factors
0.7	100	1.00
20	76	1.30
25	69	1.38
37	67	1.56
50	62	1.71
63	54	1.79

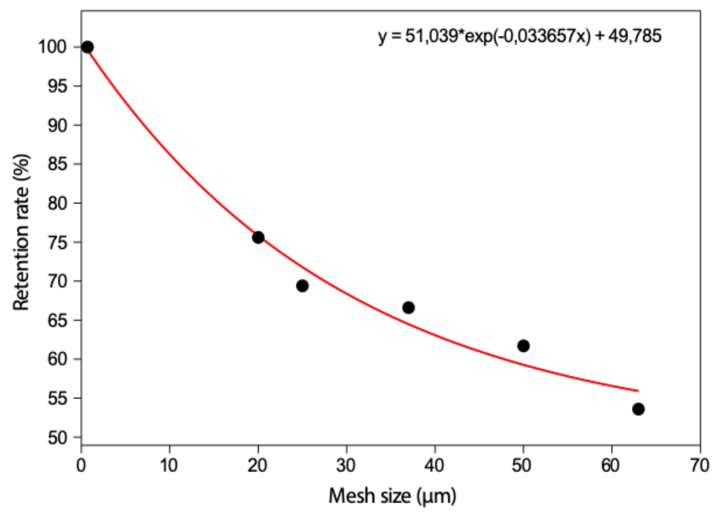

Fig. S1. Exponential fit of fiber retention rate data from Table S1. The exponential model (shown) had a lower Akaike Information Criteria score (AIC: 39.626) than either linear or quadratic models. Mesh size correction factors estimated from this model are listed in Table S1.

Table S2: Mann-Whitney pairwise comparisons of fiber concentrations in all basins. The results of Mann-Whitney pairwise comparisons of fiber concentration values (number·l^{-1}) measured in all oceanic basins (bold) and sub-basins surveyed and computed using **(A)** the corrected fiber concentration dataset and **(B)** the uncorrected dataset. Raw P values (uncorrected Bonferroni significance) are shown above the diagonal and Mann-Whitney U below the diagonal in both tables. Significant pairwise comparisons (P < 0.05) are highlighted in yellow.

A) Corrected dataset	**Mediterranean Sea**	**Indian Ocean**	**Atlantic Ocean**	North Atlantic	South Atlantic	**Southern Ocean**	Southern Ocean (40-60 °S)	Southern Ocean (> 60°S)
Mediterranean Sea		2.1×10^{-23}	7.3×10^{-29}	2.1×10^{-21}	3.8×10^{-23}	9.0×10^{-18}	3.4×10^{-13}	1.1×10^{-15}
Indian Ocean	5842		0.0588	0.00142	0.7564	0.0521	0.0506	0.3073
Atlantic Ocean	3321	33200		0.04502	0.1527	0.00020	0.00055	0.0120
North Atlantic	1078	10807	9417		0.00298	9.0×10^{-06}	2.6×10^{-05}	0.00031
South Atlantic	2242	22393	16527	5277		0.04486	0.04478	0.1984
Southern Ocean	6149	36209	25635	8247	17388		0.7779	0.6776
Southern Ocean (40-60°)	4396	22913	16301	5273	11028	21866		0.5457
Southern Ocean (> 60°S)	1753	13296	9334	2974	6360	12004	7586	

B) Uncorrected dataset	**Mediterranean Sea**	**Indian Ocean**	**Atlantic Ocean**	North Atlantic	South Atlantic	**Southern Ocean**	Southern Ocean (40-60 °S)	Southern Ocean (> 60°S)
Mediterranean Sea		2.0×10^{-21}	2.7×10^{-32}	1.1×10^{-23}	4.3×10^{-26}	8.5×10^{-29}	5.4×10^{-23}	2.5×10^{-22}
Indian Ocean	6316		1.8×10^{-07}	5.9×10^{-09}	0.00256	2.3×10^{-05}	0.00025	0.00195
Atlantic Ocean	2708	27108		0.01796	0.08934	0.2794	0.3995	0.3329
North Atlantic	854	8272	9119		0.00043	0.00163	0.00534	0.00432
South Atlantic	1853	18835	16229	4979		0.4488	0.454	0.618
Southern Ocean	3754	31744	29924	9315	18841		0.906	0.8618
Southern Ocean (40-60°)	2705	20475	19369	6078	12059	22073		0.8003
Southern Ocean (> 60°S)	1049	11269	10555	3237	6782	12211	7793	

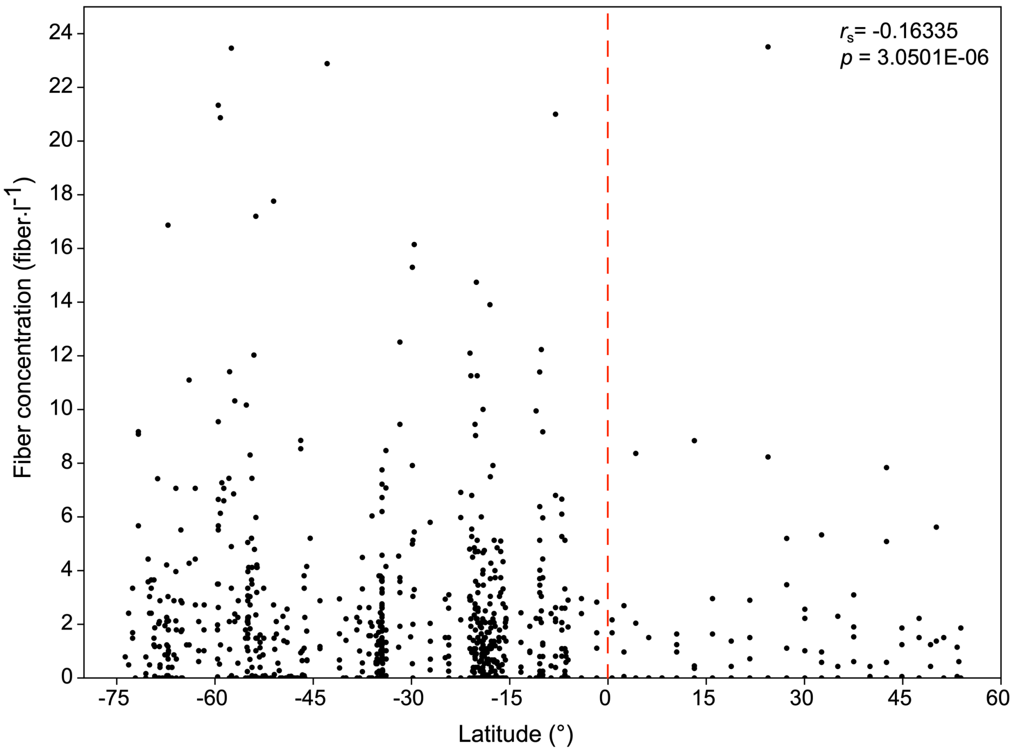

Fig. S2. Correlation between latitude and fiber concentration. Fiber concentrations (fibers·l^{-1}) as a function of latitude (°) over the entire corrected dataset used in this study, excluding samples from the Mediterranean Sea (n = 808 samples). Spearman's correlation coefficient (r_s) and P value are shown in the top-right corner. The vertical dashed line corresponds to the equator. Samples > 25 fibers·l^{-1} (n = 5) are not shown for clarity.

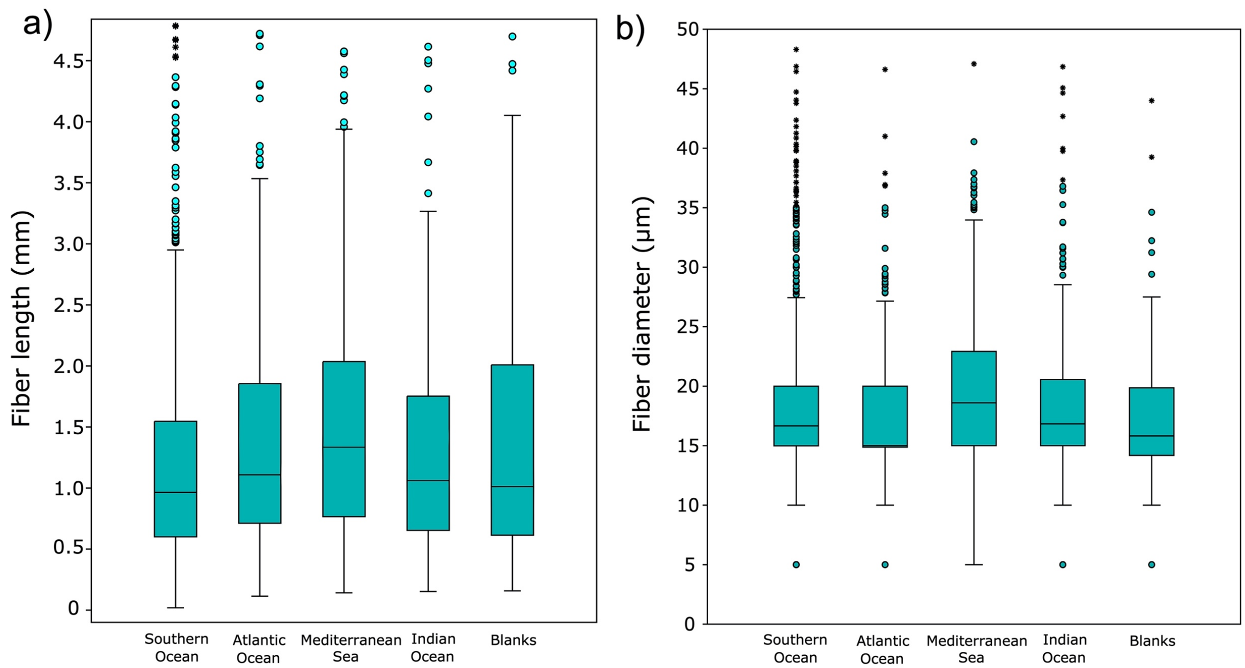

Fig. S3: Length and diameter of the fibers collected in blank and seawater samples. The length **(A)** and diameter **(B)** of all fibers measured in the Southern Ocean (n = 1000), Atlantic Ocean (n = 338), Mediterranean Sea (n = 336), Indian Ocean (n = 342) and in blank samples (n = 161). Boxes show 25-75 percentiles with median values as central lines. Whiskers denote upper and lower inner fences and values outside them are shown as circles. Fibers longer than 5 mm **(A)** and thicker than 50 µm **(B)** are not shown for clarity.

Table S3: Mann-Whitney pairwise comparisons of fiber lengths and diameters. Results of Mann-Whitney pairwise comparisons of **(A)** fiber lengths and **(B)** fiber diameters measured in the Southern Ocean (n = 1000), Atlantic Ocean (n = 338), Mediterranean Sea (n = 336), Indian Ocean (n = 342) and in the blank samples (n = 161). In both tables, raw *P* values (uncorrected Bonferroni significance) are shown above the diagonal and Mann-Whitney U below the diagonal. Significant pairwise comparisons ($P < 0.05$) are highlighted in yellow.

A. Fiber lengths	Southern Ocean	Atlantic Ocean	Mediterranean Sea	Indian Ocean	Blanks
Southern Ocean		0.00050	$2.6x10^{-10}$	0.04367	0.2070
Atlantic Ocean	147620		0.01777	0.2073	0.3060
Mediterranean Sea	129315	50792		0.00039	0.00511
Indian Ocean	158519	54567	48413		0.9361
Blanks	75517	25667	22852	27408	

B. Fiber diameters	Southern Ocean	Atlantic Ocean	Mediterranean Sea	Indian Ocean	Blanks
Southern Ocean		0.02356	$5.7x10^{-06}$	0.3062	0.0735
Atlantic Ocean	155131		$4.1x10^{-08}$	0.00565	0.9423
Mediterranean Sea	140281	42949		0.00384	$8.0x10^{-06}$
Indian Ocean	164678	50733	50089		0.02646
Blanks	73444	27100	20359	24159	

Table S4: FTIR composition of the fibers analyzed in blanks and seawater samples. The number of fibers analyzed through µFTIR (*n*) and the relative polymeric composition (%) of all fibers extracted from blank and seawater samples collected in the main oceanic basins and sub-basins surveyed.

		Cellulosics		Animal		Synthetic				
	n	**Cotton**	**Others**	**Wool**	**Silk**	**Polyester**	**Acrylic**	**Nylon**	**Polypropylene**	**Aramid**
Mediterranean Sea	*336*	47.3	39.6	5.4	0.9	4.2	0.3	0.9	0.9	0.6
Indian Ocean	*324*	51.2	33.6	7.4	0.3	7.4	0.0	0.0	0.0	0.0
North Atlantic Ocean	*226*	46.5	32.7	13.3	0.9	4.9	0.9	0.9	0.0	0.0
South Atlantic Ocean	*188*	50.0	24.5	17.6	0.5	4.8	2.1	0.5	0.0	0.0
Southern Ocean (40-60°S)	*696*	52.7	24.2	13.9	0.6	6.9	0.4	0.9	0.1	0.3
Southern Ocean (> 60°S)	*214*	47.2	25.7	13.6	0.9	7.9	1.9	0.9	1.4	0.5
All	***1984***	**50.0**	**29.5**	**11.6**	**0.7**	**6.2**	**0.7**	**0.7**	**0.4**	**0.3**
Blanks	*150*	62.0	25.4	4.7	0.0	3.3	2.0	0.7	2.0	0.0

Table S5: Details of the dataset used in this study. Name of research cruise, oceanographic vessel, number of samples collected for each sampling method and the mesh size used during each survey.

Research cruise	Vessel name	Geographical coverage	Number of samples	Mesh size
Antarctic Circumnavigation Expedition (ACE)	*R/V Akademik Tryoshnikov*	Southern Ocean & Atlantic Ocean	Sub-surface (188) Surface (220)	20 µm (70 samples) 37 µm (265 samples) 63 µm (73 samples)
ICHNUSSA 17	*R/V Minerva Uno*	Central-Western Mediterranean Sea	Surface (108)	20 µm (78 samples) 25 µm (30 samples)
IIOE2 (2nd International Indian Ocean Expedition)	*SA Agulhas II*	Western Indian Ocean	Surface (304)	0.7 µm (73 samples) 25 µm (231 samples)
Marion Island Relief Voyage	*SA Agulhas II*	Cape Town to Marion Island	Surface (18) Sub-surface (18)	25 µm (18 samples) 50 µm (18 samples)
SEAmester II	*SA Agulhas II*	South East Atlantic	Surface (60)	0.7 µm (20 samples) 25 µm (20 samples) 50 µm (20 samples)

Supplementary Data file (dataset_suaria.xlsx)

Description: date, time, cruise name, ocean basin, latitude, longitude, raw and corrected fibers concentrations found in all samples (n = 916). Filtered volume, number of counted fibers, number of fibers analyzed, as well as the number of cellulosic, animal and synthetic fibers found in all samples are also provided in the data file.