Message in a bottle: rapid increase in Asian bottles in the South Atlantic Ocean indicates major debris inputs from ships

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Supplemental Information Appendix

Study site and field methods

Inaccessible Island, one of three main islands in the Tristan da Cunha archipelago, is named for the steep cliffs that encircle the island, but there are cobble and boulder beaches at the foot of many of the cliffs (1). The island is visited only occasionally (at most 1–2 landings per year) by people from the small community on the main island of Tristan (~260 residents), with most landings on the island's more sheltered east coast.

The amounts, composition and origins of anthropogenic debris, including worked timber, have been recorded along 1.1 km of cobble and boulder shoreline on the exposed west coast of Inaccessible Island between Tern Rock (37°17.46´S, 12°41.74´W) and West Point (37°17.73´S, 12°42.37´W) since the 1980s (2, 3, 4). Debris was left *in situ* during most of these surveys, but was collected into caches on the backshore in 1989 to allow for newly-arrived debris to be scored (4). However, some of this cached debris probably was dispersed by subsequent storm waves. To characterise the origins of debris in the 1980s, we used the maximum count per country/region recorded in any of the annual surveys (listed above); almost all data came from 1989.

The standing stock of debris between Tern Rock and West Point was again recorded in October 2009 and September-November 2018. Items were left *in situ* in 2009, but were collected into caches on 15-16 September 2018 (Fig. 2A). Items too heavy or too deeply buried to move were documented with a photo-inventory. All items were identified and grouped by function (fishing gear, packaging, etc.) and type of material (plastic, glass, metal, rubber, etc.), although this paper focuses mainly on bottles and other containers. Debris items were weighed or the mass of very large items estimated from their size. Manufacturers' marks were checked to identify the polymer type for plastic items, the country/region of origin (in some cases a company operating in several countries was identified, restricting the origin to region but not an individual country, *SI Appendix* Table S1) and date stamps. Large containers often carry a stamp with the year and month of manufacture (Fig. 2D). Some food and beverage containers have two dates, one when manufactured and a 'best-before' date (typically 2–12 months after the date

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of manufacture for perishable items, depending on the shelf-life of the product). In these cases, we used the date of manufacture to determine the maximum possible time the item could have been at sea. Other bottles carried a single date, and it was not always clear whether this was a date of manufacture or a sell-by date. We used this date to estimate bottle ages, but note that it could be up to 1 year after the date of manufacture (although Chinese bottles, which make up the bulk of the bottles in 2018, are stamped with the date of manufacture). The presence of bryozoans and goose barnacles *Lepas* spp. was recorded, and for bottles and other containers.

From 16 September to 26 November 2018, the study area was searched for newly stranded debris on 55 days. From 22 September, once we were confident that all superficial debris had been collected, we also recorded debris exhumed from the cobble beach by wave action, and this was added to the standing stock estimate. Exhumed debris was distinguished by the presence of soiling and mechanical damage from being buried, whereas newly-arrived debris was clean apart from a yellow-brown biofilm, bryozoans and/or goose barnacles. All newly-arrived and exhumed debris items were categorised as described above for accumulated debris.

References

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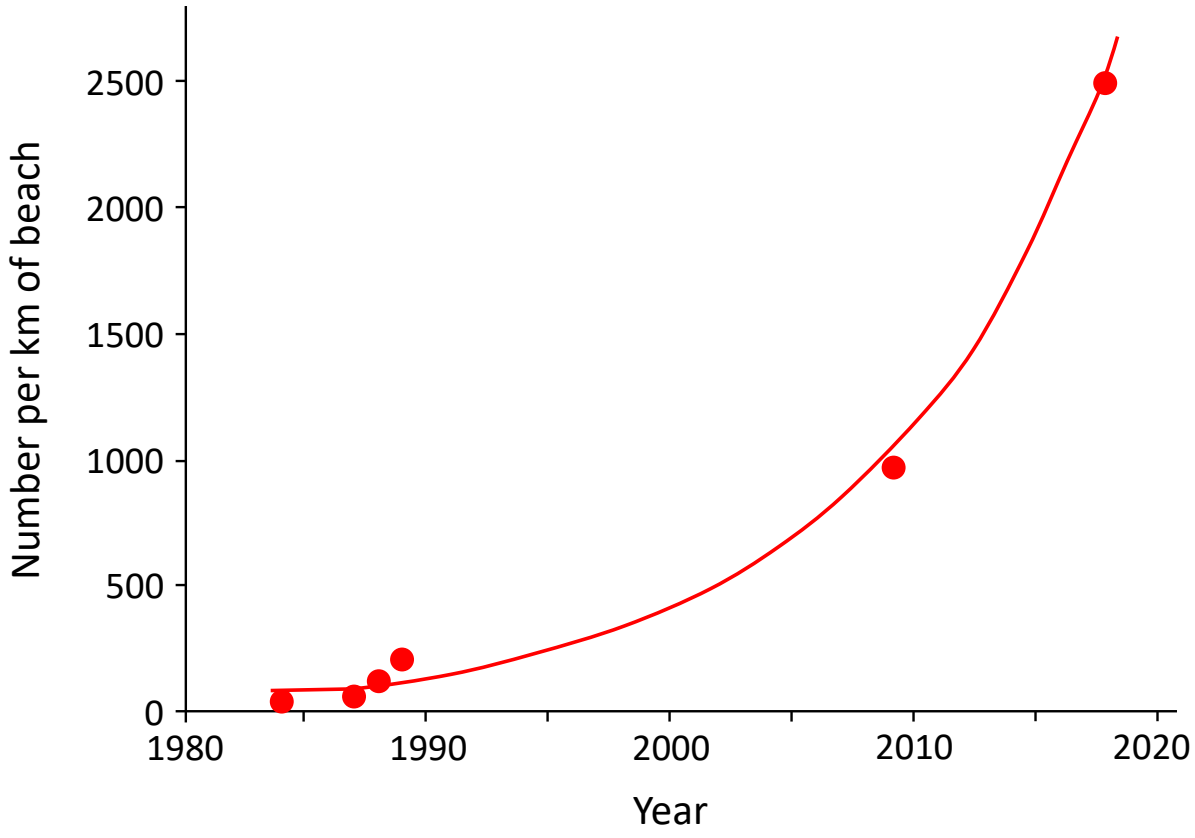

Supplementary Information Figure S1. Trends in the density of bottles and other containers stranded on the west coast of Inaccessible Island, with the best-fit exponential growth model. Debris was left to accumulate in all years except 1989, when it was all cached on the backshore.

Supplementary Information Table S1. The origin of bottles and other containers on Inaccessible Island in 2018 (bottles from Chile, New Zealand and Thailand recorded in previous surveys).

	Newly arrived n=123	Accumulated n=970	Drink n=952	All bottles n=1093
Asia	82.9%	73.4%	79.3%	74.5%
China	59.3%	49.5%	57.5%	50.6%
Malaysia	1.6%	1.5%	1.8%	1.6%
UAE	0.0%	0.7%	0.7%	0.6%
Japan	0.0%	0.6%	0.6%	0.5%
India	0.0%	0.6%	0.3%	0.5%
Singapore	0.8%	0.4%	0.3%	0.5%
Turkey	0.0%	0.5%	0.5%	0.5%
Taiwan	0.0%	0.3%	0.2%	0.3%
Philippines	0.0%	0.3%	0.1%	0.3%
South Korea	0.0%	0.2%	0.0%	0.2%
Saudi Arabia	0.0%	0.2%	0.1%	0.2%
Iran	0.0%	0.1%	0.0%	0.1%
Asia*	21.1%	18.4%	17.1%	18.7%
South America	13.8%	20.9%	16.3%	20.1%
Argentina	3.3%	4.6%	3.0%	4.5%
Brazil	2.4%	3.9%	2.7%	3.8%
Uruguay	0.8%	0.5%	0.5%	0.5%
Peru	0.0%	0.3%	0.2%	0.3%
South America*	7.3%	11.5%	9.8%	11.1%
Africa	2.4%	2.5%	2.4%	2.5%
South Africa	2.4%	2.3%	2.2%	2.3%
Egypt	0.0%	0.1%	0.1%	0.1%
Tanzania	0.0%	0.1%	0.1%	0.1%
Europe	0.8%	2.3%	1.2%	2.1%
France	0.0%	0.4%	0.4%	0.4%
United Kingdom	0.8%	0.2%	0.3%	0.3%
Greece	0.0%	0.3%	0.1%	0.3%
Czechoslovakia	0.0%	0.2%	0.2%	0.2%
Germany	0.0%	0.2%	0.2%	0.2%
Norway	0.0%	0.2%	0.0%	0.2%
Portugal	0.0%	0.2%	0.1%	0.2%
Netherlands	0.0%	0.1%	0.0%	0.1%
Denmark	0.0%	0.1%	0.0%	0.1%
Italy	0.0%	0.1%	0.1%	0.1%
Russia	0.0%	0.1%	0.1%	0.1%
Spain	0.0%	0.1%	0.0%	0.1%
North America	0.0%	0.8%	0.4%	0.7%
USA	0.0%	0.4%	0.2%	0.4%
Canada	0.0%	0.2%	0.1%	0.2%
Mexico	0.0%	0.2%	0.1%	0.2%
Australasia	0.0%	0.1%	0.0%	0.1%
Australia	0.0%	0.1%	0.0%	0.1%

*bottles from the region that could not be restricted to one country (see Methods)

Supplementary Information Table S2. The origins of fishing gear washing up on Inaccessible Island in 1989, 2009 and 2018.

	1989 n=148	2009 n=174	2018 n=491	All fishing gear n=813
Asia	35.1%	37.9%	25.3%	29.8%
Taiwan	6.8%	17.8%	14.1%	13.5%
Japan	0.0%	3.4%	2.2%	2.1%
Korea	0.0%	2.9%	0.2%	0.7%
Asia*	28.4%	13.8%	8.8%	13.4%
South America	49.3%	50.6%	55.0%	53.0%
Argentina	32.4%	23.6%	34.4%	31.7%
Uruguay	9.5%	4.0%	10.4%	8.9%
Brazil	0.7%	2.3%	0.6%	1.0%
Chile	1.4%	0.0%	0.0%	0.2%
South America*	5.4%	20.7%	9.6%	11.2%
Africa	0.0%	0.0%	0.2%	0.1%
South Africa	0.0%	0.0%	0.2%	0.1%
Europe⁺	12.8%	10.9%	19.6%	16.5%
Spain	2.0%	5.2%	10.0%	7.5%
United Kingdom	1.4%	0.6%	3.5%	2.5%
Denmark	1.4%	1.1%	2.9%	2.2%
France	4.1%	0.6%	0.8%	1.4%
Norway	0.0%	1.1%	1.2%	1.0%
Russia	3.4%	0.0%	0.0%	0.6%
Germany	0.0%	0.0%	0.4%	0.2%
Italy	0.0%	1.1%	0.2%	0.4%
Poland	0.0%	0.6%	0.4%	0.4%
Portugal	0.7%	0.6%	0.2%	0.4%
Iceland	0.0%	0.6%	0.0%	0.1%
North America	2.7%	0.6%	0.6%	1.0%
USA	2.7%	0.6%	0.6%	1.0%

*fishing gear from the region that could not be restricted to one country

⁺mostly fishing floats which probably are exported around the world