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Plastic Debris in the Surface Waters of the South Atlantic

ROBERT J. MORRIS

Institute of Oceanographic Sciences, Wormley, Surrey, UK

Polyethylene and polypropylene pellets, together with tarballs, were found to be the most common contaminants of the sea surface in the Cape Basin area of the South Atlantic Ocean. This is an area far removed from any obvious source of such materials.

During the last few years there has been a growing body of evidence that plastics are becoming a common contaminate of both beaches and coastal waters of Europe (Morris & Hamilton, 1974; Kartar *et al.*, 1973, 1976) the Mediterranean (Shiber, 1979), North and Central America (Carpenter *et al.*, 1972; Colton *et al.*, 1974; Hays & Cormons, 1974; Austin & Stoops, 1973) and New Zealand (Gregory, 1977). Similar contamination of the Sargasso Sea surface has been reported (Carpenter & Smith, 1972). All of the sea areas so far investigated have been in the vicinity of possible coastal industrial sources, near major shipping lanes, or, in the case of the Sargasso Sea, subject to conditions more likely to retain and accumulate floating material than to disperse it due to its particular water circulation pattern.

This note reports the presence of polyethylene and polypropylene pellets as being, together with tar balls, the most common contaminate of the sea surface in the Cape Basin area of the Southern Atlantic Ocean, which is an area far removed from any obvious source of such materials.

Methods

Surface hauls were made with a neuston sledge (David, 1965) using a clean nylon 54 mesh (0.32 mm mesh size) net during a cruise of *R.R.S. Discovery* to the Cape Basin area of the South Atlantic in January 1979 (see Table 1 for sample details). The sledge was towed just in front of the ship's bow wave when steaming at 2–4 knots. The duration of the tow varied between 20 and 45 min. Tar balls and plastic debris were sorted by hand from the plankton haul, counted and weighed and their distribution estimated (Table 1).

Results

The plastic particles were mostly hard white or colourless spherules or pellets ranging in diameter from 3 to 5 mm (Fig. 1). All had well rounded ends which might suggest a considerable period of weathering. Solvent assays, and burning properties of the particles indicated that they were not acrylics, cellulosic plastics or polyvinyl chlorides. Density measurements (0.90–0.97) indicated that they were probably a mixture of polyethylene and polypropylene. Similar types of plastic debris have been reported in the Sargasso Sea (Carpenter & Smith, 1972) and in continental shelf waters off the east coast of the United States (Colton

TABLE 1
Sample details.

Sample	Location	Speed of net (knots)	Duration of tow (min)	Wt. tarballs collected (g)	Estimated* density of tarballs (g km ⁻²)	No. plastic pellets collected	Estimated* density of pellets (no./km ⁻²)
1	33°43'S 16°25'E	3½	35	0.031	26.6	0	—
2	33°40'S 15°10'E	3½	40	0.064	48.0	2	1500
3	33°44'S 14°03'E	3½	45	0.212	141.3	2	1333
4	33°59'S 12°24'E	2	25	0.020	24.0	0	—
5	34°04'S 11°24'E	2	25	0.153	183.5	3	3600
6	34°13'S 9°45'E	3½	40	0.781	585.7	4	3010
7	34°33'S 7°44'E	4	25	0.103	123.6	2	2400
8	36°02'S 8°48'E	4	25	0.018	21.6	3	3400
9	35°19'S 11°49'E	3½	20	0.078	117.0	1	1500
10	34°20'S 16°38'E	3½	30	0.244	278.8	2	2000

*Assuming 100% fishing efficiency of neuston net — see text.

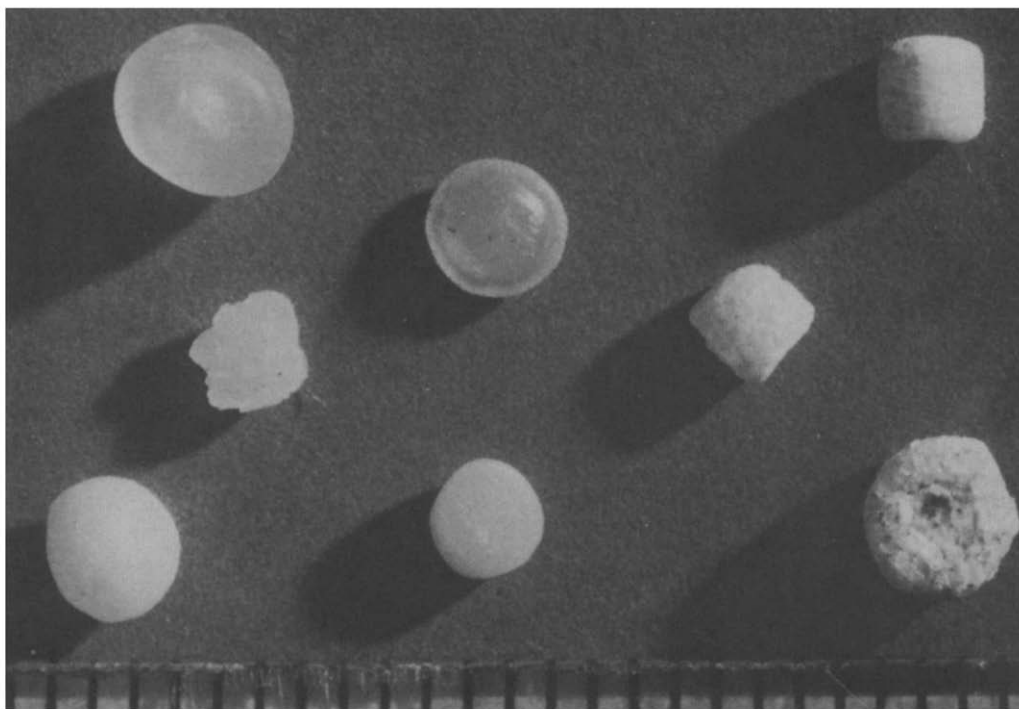


Fig. 1 Samples of the various plastic pellets collected in the Cape Basin area (cm scale).

et al., 1974) with a distribution in roughly the same order of magnitude as found in this work.

Closer inshore, these earlier workers found a much greater distribution of plastic debris (Carpenter *et al.*, 1972; Captenter & Smith, 1972) composed of a greater range of plastic types. Most of these other types of plastic have a higher density and will presumably only remain at the surface for relatively short periods of time unless there is strong vertical mixing. In open ocean waters the more dense plastic debris will gradually sink either to the sediments (e.g. acrylics, cellulosic plastics, substituted polymers, vinyl polymers) or down to the denser, cold mid-water layers (e.g. polystyrenes, styrene copolymers) where they will attain neutral buoyancy and remain in suspension in the oceanic water column. Furthermore, any estimate of the floating debris is likely to be an underestimate, as few neuston nets will sample the air-sea interface with anything like 100% efficiency. In the present work the sampling efficiency was estimated to range from 25 to 50% depending on sea state. Therefore, while the distribution of the plastic particles given in Table 1 is a measure of the floating debris assuming 100% fishing efficiency, this is likely to be a considerable under-estimate of the amount of plastic debris in the water column.

The sample sites (Table 1) are away from the major shipping lanes and under the influence of the Antarctic west-wind surface drift with possibly some input from the Brazil current. There appear to be no immediate sources for the floating plastic debris in the sample area, apart from the loss of cargo by a ship transporting the raw material well down in the South Atlantic. The other interpretation of the data is that plastic debris has now become as ubiquitous a contaminant of the world's ocean surface as are tarballs. Certainly in the ocean area under

study which is remote from the major sources of these materials, namely the wastewater discharges from the major plastic producing or processing plants, the less dense plastics are present at the sea surface in high levels (1000–2000 particles km^{-2}).

There is some disagreement as to the possible environmental hazards of plastic debris. Those plastics containing polychlorinated biphenyls and phthallates as plasticizers could well be a source of these compounds which are known contaminants of oceanic waters and organisms (Morris, 1970; Giam *et al.*, 1978; Addison, 1976; Fowler & Elder, 1978; Elder & Villeneuve, 1977). The possible dangers to marine life as a result of ingestion of these floating particles has received considerable attention (Kartar *et al.*, 1973; Carpenter *et al.*, 1972; Colton *et al.*, 1974; Hays & Cormons, 1974; *Mar. Pollut. Bull.*, 1975) but the data are conflicting. What is not in doubt is that plastic debris is causing an aesthetic marring of the sea and coasts.

The various types of plastic debris are generally far more resistant to microbial or chemical breakdown than are tar balls. For tar balls, there is likely at some stage to be an equilibrium point established when the rate of release equals the rate of breakdown. Such a situation is unlikely for the majority of plastic debris and the problem will gradually worsen. Contrary to the conclusion of a plant emission study by the Society of the Plastics Industry Inc., Colton *et al.* (1974) felt that the widespread distribution of plastic debris in the rivers, estuaries and coastal waters of the United States must indicate that improper wastewater disposal is common practice in the plastics industry. They suggested that stronger federal, state and municipal pollution control was necessary.

The data in this paper would indicate that plastic pollution is becoming a problem in even the most remote areas of

the world's oceans. Clearly a strong lead is required from an international environmental organization such as UNEP if this problem is to be seriously tackled. Only in this way can satisfactory pollution control measures for plastic waste become the norm and be effective.

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Abnormal Development of *Dentalium* due to the *Amoco Cadiz* Oil Spill

A. S. J. KOSTER and J. A. M. VAN DEN BIGGELAAR

*Station Biologique, 29211 Roscoff, France and Zoological Laboratory, State University of Utrecht, Padualaan 8, 3508 TB Utrecht, The Netherlands**

*Correspondence should be addressed to the latter address.

A comparison was made between the development of *Dentalium* eggs, spawned by animals, collected before and after the *Amoco Cadiz* oil spill. Development of eggs from animals collected before the oil spill was significantly better than development of eggs from animals collected after the oil spill. It is suggested that development is affected by oil hydrocarbons, accumulated during oogenesis in the lipid-rich phases of the oocytes.

During our stay at the Station Biologique at Roscoff in August 1978, the planned embryological investigations with *Dentalium vulgare* have been continuously frustrated by abnormal development of the embryos. There are, however, some results suggesting that this might be due to the *Amoco Cadiz* oil spill in March 1978.

By coincidence, a number of females of *Dentalium* were kept from July 1977 in the running sea-water system of the laboratory, thus escaping the oil-contamination in their natural habitat. This fortunate circumstance enabled us to make a comparison between the development of embryos and larvae from oocytes of females, collected before and after the oil spill. The results reported here indicate that the disturbances of normal development may be explained by accumulation of oil hydrocarbons in the oocytes.

Materials and Methods

Dentalium vulgare (da Costa) (Scaphopoda, Mollusca) was collected in the Bay of Morlaix, 300–400 m North of 'La Vieille' (depth 25–30 m) and kept in the laboratory in a layer of bottom-grit, either in running sea-water at 17°C or in daily changed sea-water at 12°C. The animals, collected in 1977 passed the winter in running seawater in the aquarium of the laboratory. Spawning was induced by transferring the animals to glass containers (with about 100 ml of sea-water), left to equilibrate to room temperature. Oocytes were fertilized by adding a sperm suspension of adequate dilution. Cleaving embryos and larvae were kept in millipore-filtered sea-water, which was changed daily.

Results

As a rule, fertilization of oocytes spawned by females freshly collected in 1978 was extremely poor. In the batches of oocytes, in which fertilization succeeded, no more than 30% of the eggs started cleavage; adding more sperm in these cases did not improve fertilization rate. First cleavage in about 20% of the cases was abnormal. The following deviations of normal cleavage were seen: retarded cleavage, unequal cleavage and/or premature regression of the polar lobe constriction and regression of cleavage furrows.