ISSN 1070-3632, Russian Journal of General Chemistry, 2011, Vol. 81, No. 13, pp. 2717–2723. © Pleiades Publishing Ltd., 2011.
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Litter on the Beaches of the Red Sea of Yemen

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Received February 2, 2010

Abstract—Distribution of litter: ropes, netting, lamb bulbs, foot wear, plastic bags, bottles, aluminum cans, cardboard, wood loges, rubber, polystyrene blocks and plastic sheets accumulating on Red Sea beaches of Yemen were examined. The results of the study reflected these wastes to be varied from a region to region but they were similar in almost all-coastal areas. Most of the litter were plastics including food bags, oil and water bottles, bait bags, and also vehicles tires. Most of pollution occurred from the sea, due to the heavy traffic and to the fishing vessels, which fish in the area.
DOI: 10.1134/S1070363211130135

The amount of plastic washed up on our beaches indicated that the large amount of rubbish was being illegally dumped to Red Sea and to the beaches of Yemen. Plastic is cheap, it does not degrade easily and can float great distances at sea. Discarded plastic has even been found on uninhabited South Pacific islands. Seabirds, fish and sea mammals easily entangle in plastic 6-pack rings, plastic strapping and nylon ropes. Being unable to free themselves, they may suffer a long and painful death. Turtles eat jellyfish but often swallow plastic bags floating in the water by mistake. Inquisitive seals have starved to death because they have become muzzled by plastic rings. Birds have become entangled in discarded fishing line and drowned, while lost drift nets were particularly dangerous to marine species, killing sharks, dolphins, whales and turtles.

There has been growing interest in the presence of debris in Red Sea marine environments. The swift economic and demographic development that followed oil exploitation in the region has accelerated the rate of accumulation of man-made litter on shorelines.

According to results published in [1], marine litter includes primary and secondary packaging, cargo and engine- room wastes as well as fishing gear. A high proportion of such materials are discarded at sea as shipboard generated solid wastes. The marine litter problem has been studied in other regions of the world [2–5]. Some studies were concerned to litter composition and derivation [6, 7], while others considered effects of particular items such as fishing nets on fish and seabirds [8, 9] or of plastic packing materials and nets on marine mammals [10, 11]. Large number of small plastic spherules have escaped into the oceans [12, 13]. Much marine litter is thought to originate either from recreational activities in the beaches themselves [3, 14], or from international or accidental disposal of rubbish from ships at sea [5, 15–17]. However, domestic and industrial effluents are also considered as important sources of litter and therefore the developed western countries have tried to strictly control the discharge of these effluents into the sea.

Litter or marine debris is any persistent, manufactured or processed solid material that is discarded, disposed or abandoned to the marine and coastal environment. Lost and discarded material, whether originating from land or from ships, is now recognizing as a major from of marine pollution [18]. Litter can affect marine species by entanglement or by ingestion. Entanglement, suffocation and ingestion are the problems for many

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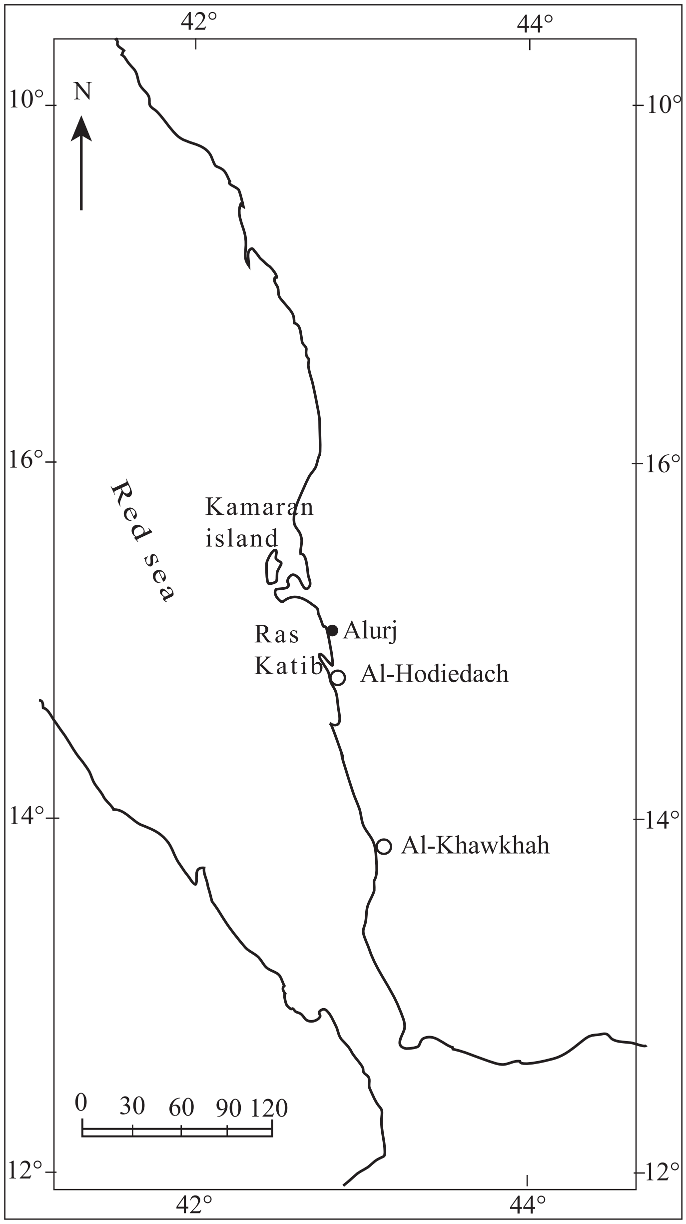

Fig. 1. Map of the sampling locations.

groups of marine organisms, such as turtles, birds and marine mammals. However, even sessile organisms, such as corals, may be entangled and smothered by plastic bags or netting.

OBJECTIVE

The basic objective of the present study is to investigate the density, composition, and distribution of litter as well as to identify potential origins of the litter accumulating on beach of the Red Sea coast of Yemen (Fig. 1).

STUDY AREA AND DATA COLLECTION

The study area with a square 9000 m^2 has been chosen on the basis of close proximity to major shipping routes, fishing grounds, population centers, and industrial complexes. It is therefore close to the points of marine litter discharge. Potential sampling sites were identified following a thorough survey of the Red Sea coast to determine the degree of accessibility to the shore and their remoteness from land-generated litter sources.

Concentration of the litter collected from Red Sea beach of Yemen

Stations	Concentration of the litter, g m^{-2}			
	ropes	netting	lamp bulbs	bottles
Kamaran Island	10	12	6	16
Al-urg	8	10	2	13
Rs Katib	5	9	1	11
Al-Hodiedah	6	3	1	8
Al- Khawkhah	8	9	2	18
	10–5	12–3	6–1	18–8
	7.4	8.6	2.4	13.2
	plastic bags	plastic sheets	polystyrene blocks	rubber
Kamaran Island	25	30	20	4
Al-urg	23	24	16	8
Rs Katib	20	23	13	6
Al-Hodiedah	27	20	18	10
Al- Khawkhah	25	27	20	3
Range	27–20	30–20	20–13	10–3
Mean	24.0	24.8	17.4	6.2
	foot wear	aluminum cans	cardboard	wood loges
Kamaran Island	8	30	27	23
Al-urg	3	28	20	14
Rs Katib	5	25	22	16
Al-Hodiedah	1	23	15	10
Al-Khawkhah	3	29	11	13
Range	8–1	30–23	27–11	23–10
Mean	4.0	27.0	19.0	15.2

Five sampling locations were selected along the Red Sea Yemeni shoreline extending some 500 km. The sampling sites distribution is illustrated in Fig. 1. Three 30 m wide transects at each sampling site were marked running from the low water edge at the time of data collection to 20 m shoreward extending into the fore-dunes of the backshore zone where litter removed from the shore by wind action accumulates. Each sampling transect was 50 m from the next one. All data collected from 13 to 20 October, 2004.

Only items of man-made materials were identified and counted during this survey. The single exception was the inclusion of dead animals. Eleven categories were defined into which litter was divided as follows:

(a) dead animals including dead fish, birds, turtles, goats, sheep, etc.;

(b) wood logs including timber, boxes, fragments pallets, weapons and ammunition crates, etc.;

(c) cardboard including paper, cards, waxed products, food and drink containers;

(d) plastic bags made between polyethylene and polypropylene bags;

(e) lamp bulbs made between tungsten, fluorescent, flash or emergency lights;

(f) discarded or mislaid fishing gears: ropes and netting;

(g) bottles: mostly plastic but including those of glass;

(h) polystyrene blocks: styrofoam blocks of 10 cm diameter or more;

(i) tins: mainly soft drink, metal drums, etc.;

(j) footwear: mostly “flip-flops” or “thongs” but including all types;

(k) rubber matters: predominantly tires but including belts, flanges, etc.

At each site 2 observers walked perpendicularly to low water line and covered 20 m long and 2 m wide. A 30 m wide transect was totally surveyed through 15 shuttle trips. All debris was examined and reported in terms of abundance, orientation, and condition.

Despite the inherent biases of beach surveys, this methodology was adopted and recommended in marine litter research programs by authors in the work [1] for the following reasons:

(a) sampling constraints are more easily overcome because representative areas of shoreline can be surveyed more easily and accurately than water masses, under most weather conditions;

(b) litter tends to accumulate on beaches, therefore “statistically reliable” samples can be collected at almost any given time, thereby avoiding uncertain extrapolations from small samples;

(c) durable non–floating items of litter may ultimately become stranded on the shore and can be incorporated into assessment of composition; this cannot be accomplished in any other way.

RESULTS AND DISCUSSION

In the present investigation 9000 m^2 of Red Sea beach of Yemen was surveyed for man-made debris. The Yemen coastline is substantially impacted by high litter accumulation. While quantitative surveys are yet to be carried out, qualitative inspection indicates a mixture of ship and local urban material. The most visible types of materials are ropes, netting, lamp bulbs, foot wear, plastic bags, bottles, aluminum cans, cardboard, wood logs, rubber, polystyrene blocks and plastic sheets used to wrap that (Table).

Ropes ranged between 10 and 5 g m^{-2} with mean of 7.4 g m^{-2}. The minimum value is at the station 3, while maximum value is at the station 1 (Table, Fig. 2).

Nettings ranged between 12 and 3 g m^{-2} with mean of 8.6 g m^{-2}. The minimum value is at the station 4, while maximum value is at the station 1 (Table, Fig. 2).

Lamp bulbs ranged between 6 and 1 g m^{-2} with mean of 2.4 g m^{-2}. The minimum value is at the stations 3 and 4, while maximum value is at the station 1 (Table, Fig. 2).

Bottles ranged between 18 and 8 g m^{-2} with mean of 13.2 g m^{-2}. The minimum value is at the station 4, while maximum value is at the station 1 (Table, Fig. 2).

Plastic bags ranged between 27 and 20 g m^{-2} with mean of 24.0 g m^{-2}. The minimum value is at the station 3, while maximum value is at the station 4 (Table, Fig. 3).

Plastic sheets ranged between 30 and 20 g m^{-2} with mean of 24.8 g m^{-2}. The minimum value is at the station 4, while maximum value is at the station 1 (Table, Fig. 3).

Polystyrene blocks ranged between 20 and 13 g m^{-2} with mean of 17.4 g m^{-2}. The minimum value is at the station 3, while maximum value is at the stations 1 and 5 (Table, Fig. 3).

Rubber ranged between 10 and 3 g m^{-2} with mean of 6.2 g m^{-2}. The minimum value is at the station 5, while maximum value is at the station 4 (Table, Fig. 3).

Foot wears ranged between 8 and 1 g m^{-2} with mean of 4.0 g m^{-2}. The minimum value is at the station 4, while maximum value is at the station 1 (Table, Fig. 4).

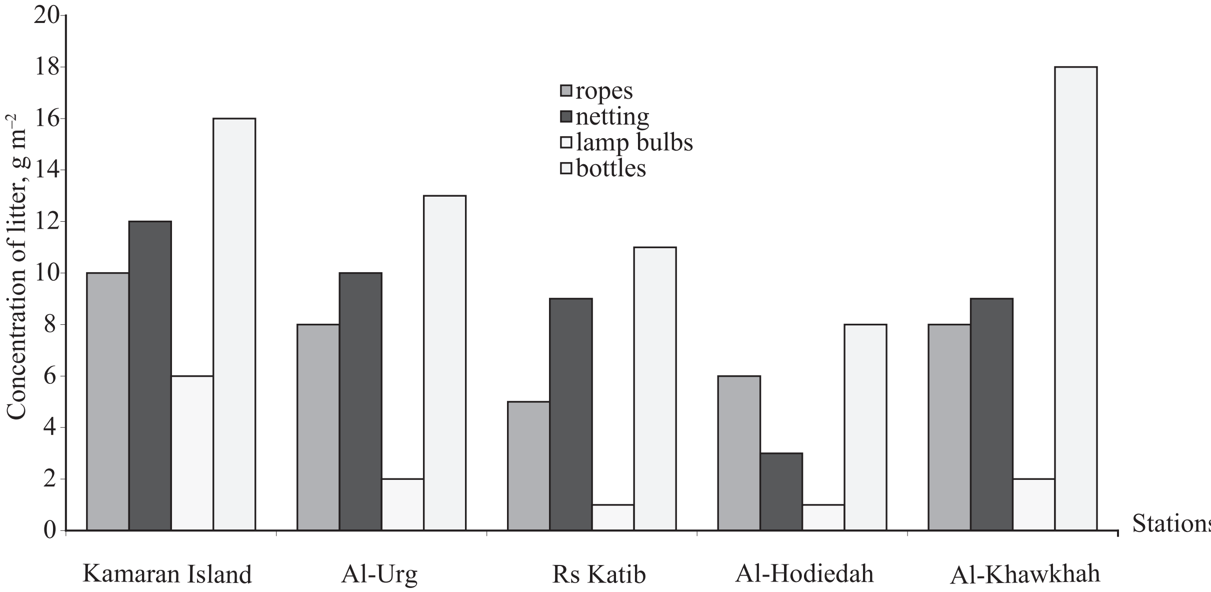

Fig. 2. Concentration of the litter collected from Red Sea beach of Yemen.

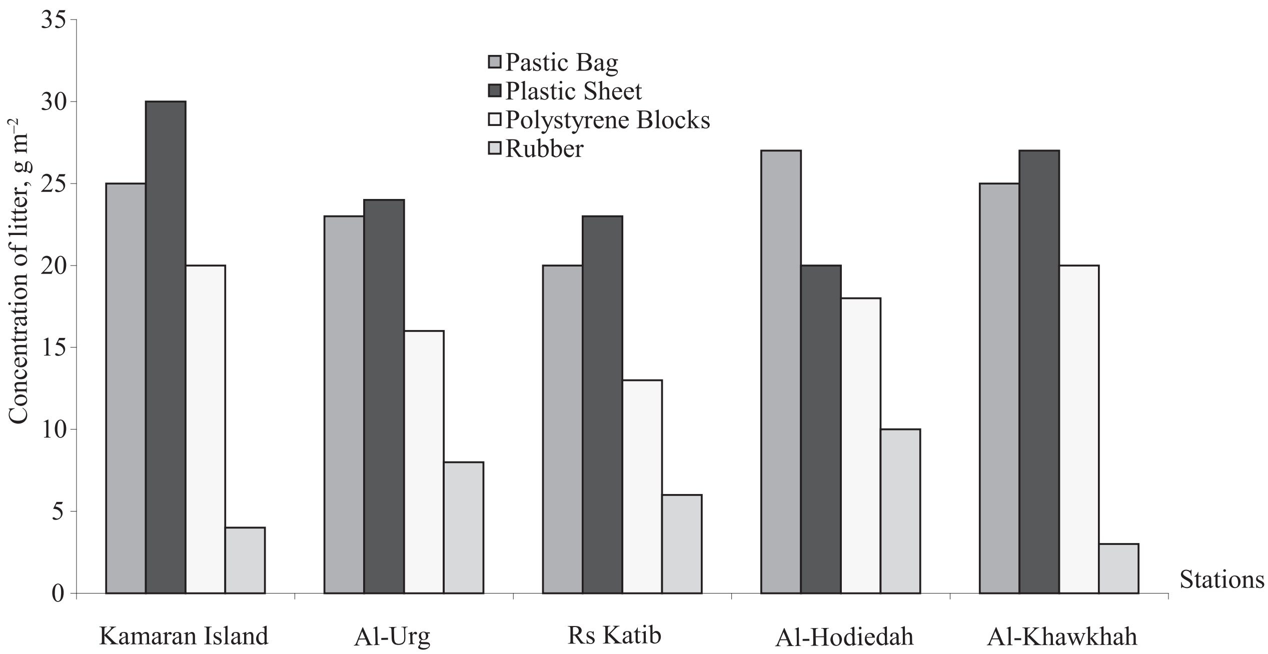

Fig. 3. Concentration of the litter collected from Red Sea beach of Yemen.

Aluminum cans ranged between 30 and 23 g m^{-2} with mean of 27.0 g m^{-2}. The minimum value is at the station 5, while maximum value is at the station 1, (Table, Fig. 4).

Cardboard ranged between 27 and 11 g m^{-2} with mean of 19.0 g m^{-2}. The minimum value is at the station 5, while maxim um value is at the station 1 (Table, Fig. 4).

Wood loges ranged between 23 and 10 g m^{-2} with mean of 15.2 g m^{-2}. The minimum value is at the station 4, while maximum value is at the station 1 (Table, Fig. 4).

Urban communities in Yemen have very limited forms of garbage collection and disposal. Therefore, garbage accumulates in the towns and in their environs (coastal environment) by coastal communities.

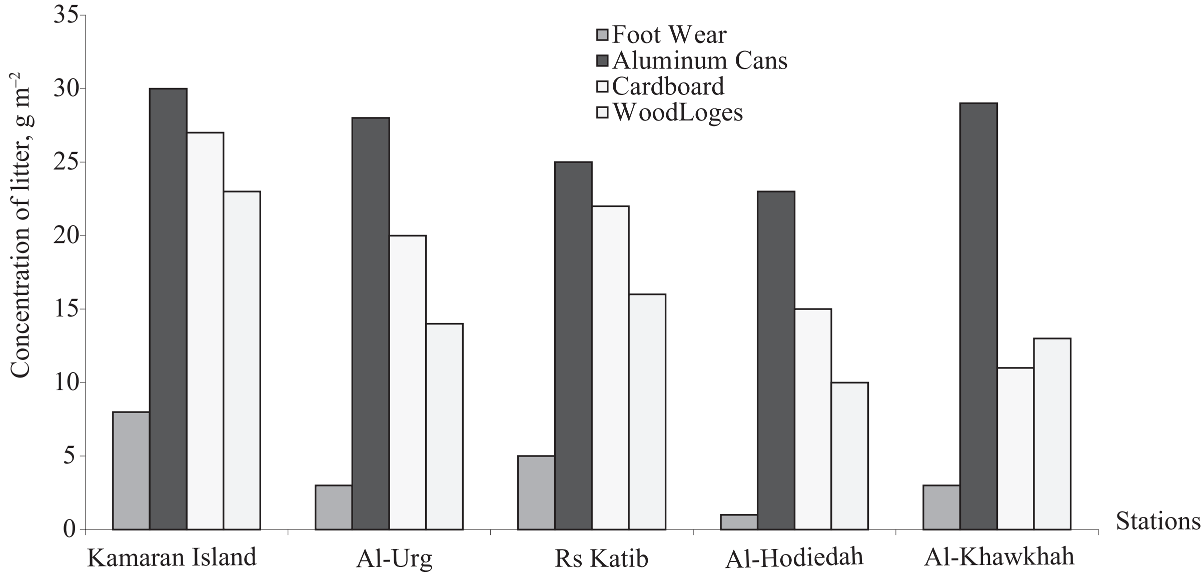

Fig. 4. Concentration of the litter collected from Red Sea beach of Yemen.

According to the results obtained in [1], bottles made from the major thermoplastic, especially high-density polyethylene are photodegradable out of water. Photodegradation causes the embattlement of plastic followed by fragmentation, probably within 2 years of them being discarded. If there is an accumulation of plastic bottles, it is of duration of less 2 years and takes place beyond the reach of normal wave action in the backshore zones of beaches.

Marine-based sources were considered as major contributor to litter found on the beaches of Amchitka Island in Alaska [19], Hegoland Island in German Bight [20], and may other Western European Countries [6]. They attributed it to commercial fisheries and intensive ship traffic in the North Sea, English Channel and East Atlantic.

It is one of the common problem in Red Sea beach of Yemen but due to the issue of the Public Cleanliness Law No. 39, 1999 and its bylaw issued in 2000, there is a little bit improvement in respect of the litter.

Those listed in Annex V of the MARPOL convention and amended by the 1978 protocol, which is considered as preventive approach to reduce input of litter into the marine environment by ships.

CONCLUSIONS

(a) The litter is one of the common problems in Red Sea beach of Yemen.

(b) These wastes vary from a region to region but appear almost in all-coastal areas.

(c) Most of the litter is plastic, including food bags, oil and water bottles, bait, bags, and vehicles tires.

(d) Most of the litter on beach come from the sea (sea born pollution from the ships, due to the heavy traffic and from the fishing vessels, which fish in the area.

RECOMMENDATIONS

(a) It is very difficult to provide a specific "cause of death" diagnosis when dealing with fish-kills in the open sea. We recommend a multidisciplinary monitoring study to come up with some sound facts, so that an objective investigation can be made.

(b) Since litter is the major source of pollution to the Red Sea and Gulf of Aden, measure should be taken by EPC to enforce the enacting Law No. (16) of 2004 regarding the protection of marine environment from pollution in particular Article 3 Yemeni Government is kindly requested to implement International Convention (MARPOL) concerning the protection of the marine environment from pollution in general and litter pollution in particular.

(c) Evaluation of possible risks imposed on different population segments in Yemen and/or the rest of the Red Sea region due to prolonged seafood consumption requires further investigations involving seasonal analysis of edible tissues of different species/size/age categories of locally consumed fish in addition to conducting seafood consumption surveys.

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