SOLID WASTE ON THE ISRAELI COAST--COMPOSITION, SOURCES, AND MANAGEMENT

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ABSTRACT

Counts of litter pieces of six Mediterranean Sea beaches in Israel were conducted at monthly intervals between May 1988 and January 1989. Litter consisted of 71.6% plastic items, 7.9% wood, 5.7% metal pieces, 3.1% glass, and 11.7% other. Most of the litter, such as beverage bottles, food containers, cosmetics remnants, plastic bags, pieces of garments, and foam rubber mattresses, is related to recreation activity and is therefore land-based garbage. The absence of fishing gear remnants and large food packaging material indicative of ships' garbage, and the sparseness of litter with inscriptions and imprints showing foreign origin, further support the conclusion that most of this garbage is land-based.

This finding contrasts those of similar studies which were carried out on other coasts around the world such as Amchitka Island, Alaska; Helgoland Island, Germany; and the west European shores. There, most rubbish consisted of fishing gear, lavatory cleansers, household cleaners, and containers bearing inscriptions indicative of foreign origin, and is marine-based. The difference in the litter reflects the differences between Israel and the mentioned locations in coastal use, ship traffic, and winds, waves, currents, and tide conditions.

The significance of identifying the litter source is that mitigation of this problem in Israel is rather simple because it is easier to control land-based litter than sea-based. There are indications that proper publicity, education, and control will reduce the problem.

INTRODUCTION

During the last two or three decades, there has been growing concern about marine pollution by persistent litter. Most of the reports on this subject deal with litter in the oceans and only a few with coastal litter. Some reports, such as those of Carpenter et al. (1972), Gregory (1977,

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1983), and Shiber (1979, 1987), provided qualitative and quantitative information on coastal garbage; others showed the deleterious effect of the coastal rubbish on seals (Merrell 1980) and seabirds (Schrey and Vauk (1987); and others investigated the sources and fate of the coastal litter (Dixon and Cooke 1977; Merrell 1980; Dixon and Dixon 1981; Vauk and Schrey 1987).

Due to the temperate climate of the Mediterranean Sea and the large number of sunshine hours, its surrounding countries are presently undergoing an intensive development of coastal-oriented tourism. Although coastal pollution is one of the deterrents to tourism, tourism may be important as a contributor of waste to the beaches. Very little information is available on litter pollution of the Mediterranean Sea and its coasts. Shiber (1979, 1982, 1987) reported on the occurrence of plastic beads on the beaches of Lebanon and Spain, Saydam et al. (1985) on floating garbage off Turkey, and Morris (1980) and McCoy (1988) on litter floating in the east Mediterranean.

The gravity of solid waste as a marine and coastal pollutant was recognized by the Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention) which, in one of its protocols, prohibits the dumping into the Mediterranean Sea Area of (among others) ". . .persistent plastic and other persistent materials. . . ." In order to evaluate the magnitude of this pollutant in the Mediterranean Sea, the United Nations Environmental Programme has set up a program to monitor solid and persistent litter in the Mediterranean Sea and on some of its coasts. This report is a partial result of that effort.

THE ISRAELI COASTLINE

The Mediterranean coastline of Israel extends for 200 km from the Egyptian border in the south to Akhziv on the Lebanese border in the north (Fig. 1). It is a smooth, slightly curving coastline, with Haifa Bay being the only large indentation in it, and may be divided into two sections. The southern section, from the Egyptian border to Akko, consists of long beaches, 30-50 m wide, covered by fine to medium quartz sand. The northern part, from Akko to the Lebanese border, is mostly a rocky coastline with pocket beaches which are covered by coarse, biogenic sand.

During the winter, alternating high and low barometric pressures cross the east Mediterranean Sea from west to east, subjecting the Israeli shoreline to storms at about a 10-day frequency. During the storms, winds blow from the west and southwest. Before and after the storms, wind direction is generally from the east. During spring and autumn, winds are commonly from the east (land), and during summer, the sea breeze changes from a maximum of 18-20 km/h shoreward at noon to no wind at night and about 6 km/h seaward early in the morning. The mean significant wave height during the winter is 1.1 m, during spring and autumn 0.5 m, and in the summer 0.7 m. The alongshore current during the winter storms is from south to north; whereas during the summer it is mostly from north to south in the study area. Tidal range is approximately 30 cm, and tidal currents are insignificant.

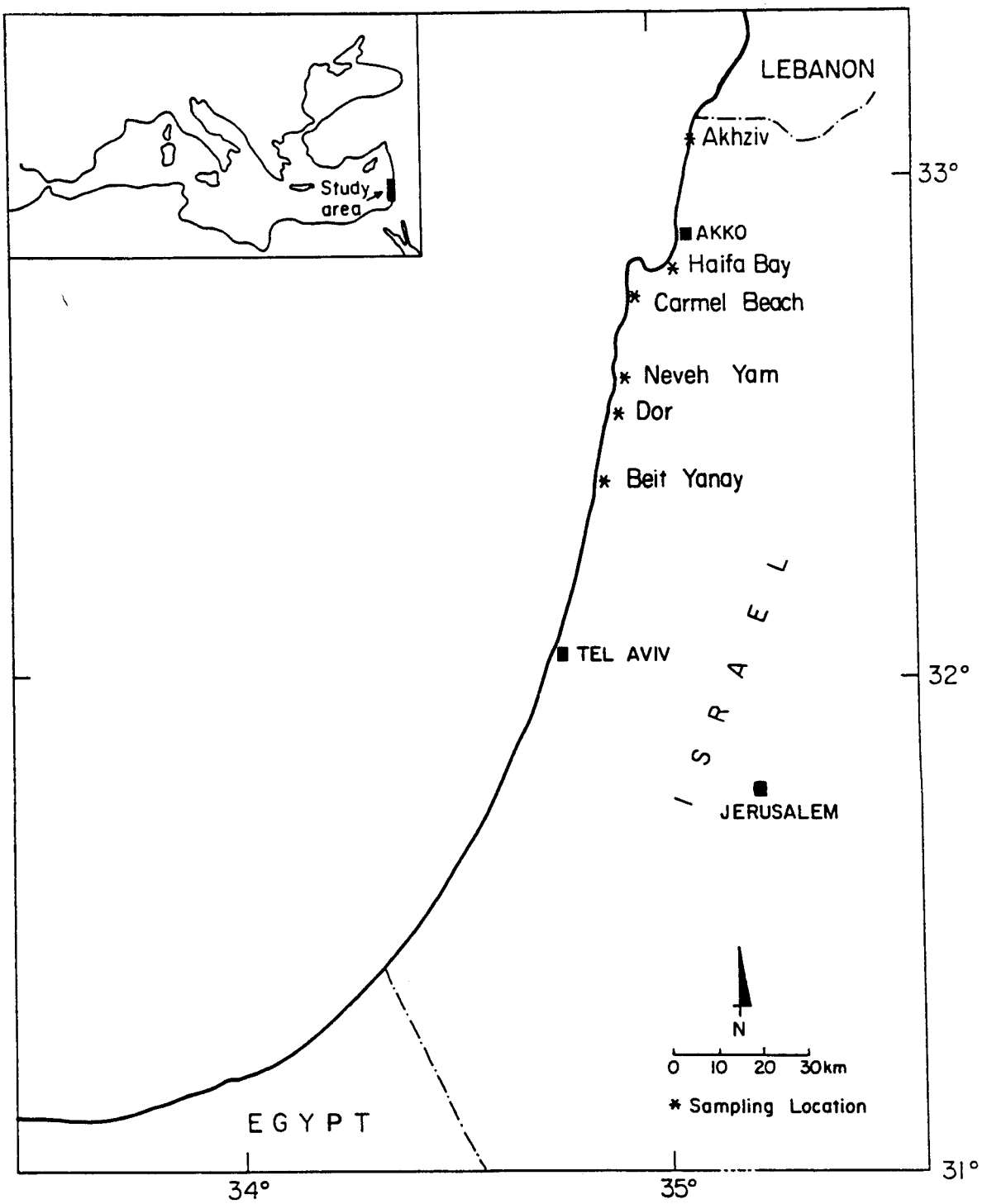

Figure 1.--Station location map.

Some 70 beaches, declared as public swimming beaches, are present on the Israeli coastline. "Declared" beaches are operated by the various municipalities, which are responsible, among other things, for keeping these beaches clean during the swimming season. Though most of the bathers go to declared beaches, undeclared beaches are popular too and are visited by many during the summer. Once or twice a year, the Office of Environmental Quality, together with local councils, conducts a cleanup of almost the entire shoreline of Israel.

The purposes of this study were to evaluate the quantity of the coastal litter on the Israeli coastline, to find out if there is any relationship between beach morphology or beach use and litter, to determine whether the rubbish is land-based or sea-based, and to recommend means and ways to treat this problem.

METHODS

Six beaches were selected for this study. They differ in their morphology, sedimentology, and type of use; their locations are given in Figure 1.

On each beach five to eight transects were established. The locations of transects were randomly determined at each sampling date. The transect was 5 m wide, oriented normal to the beach, from the water line to the back of the beach. The back of the beach was determined as the foot of the coastal cliff, the dunes, or the vegetated area. All litter pieces larger than 2 cm found on a transect constituted a sample. Sampling started in May 1988 and continued until January 1989 at roughly monthly intervals, yielding 330 samples.

RESULTS

Because the sampling program still continues as these lines are written, the distribution of litter in space and time will be discussed in the future. Only litter composition is treated here.

The relative abundance of the various litter constituents and the types of materials identified are summarized in Figure 2 and Table 1. The most abundant components are plastic fragments. Most of these are hard plastic ranging in size from 2 cm (the smallest size counted) to 30 cm, and in most cases they could be identified as fragments of plastic containers or bottles. There were also a few straps from large packing crates. Although no special count was made, most of the plastic containers and bottles originally contained beverages, food, and cosmetics (mostly suntan lotion). Only a small fraction of the plastic containers were cleansers or various types of oil related to household or industrial activities. Plastic and metal caps were counted separately, but they came from the plastic containers and bottles and were included under the plastic category. Most of the metal components were tins used for beverages; the rest were either food cans or aerosols. In a similar way the glass fraction was dominated by soft drink bottles, with low numbers of other items such as light bulbs. The wood category included driftwood as well as crate fragments.

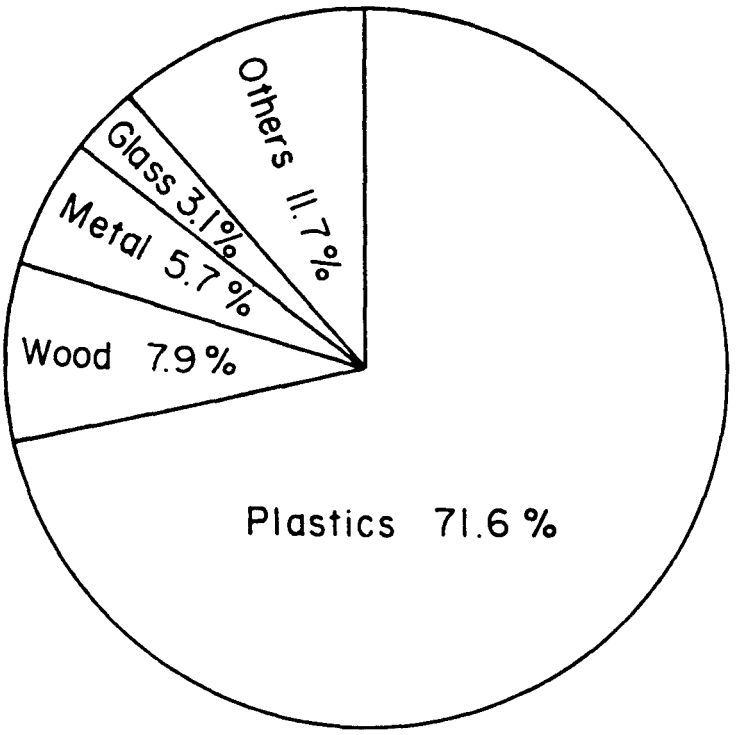

Figure 2.--Relative abundance of litter components.

Items of foreign origin (as indicated by inscription or imprinting) were found in low numbers. Most of these were from Lebanon but a few items with Turkish, Greek, and Spanish inscriptions were found as well. Although items were found at most of our sampling stations, the one in Akhziv, close to the border of Lebanon, contained the most.

DISCUSSION

Rubbish Composition and Sources

Examination of the litter components shows that most of the garbage on the Israeli coastline results from beach recreation activity. This is indicated by the original contents of most of the containers, bottles, and cans (beverages, food, and cosmetics), by the plastic bags used by beachgoers to carry their food and other belongings, by fragments of Styrofoam floats for children who go into the water, by remnants of rubber foam mattresses for lying on the beach, and by the various garment pieces, such as rubber sandals, which are good indicators of beachgoers. Mixed with this, and represented in smaller quantities, is garbage that originated from other sources. This fraction is represented by wood, rope, miscellaneous bottles and containers, and plastic and metal straps.

The absence of fishing gear remnants and packaging material of food in bulk, characteristic of ship litter, is considered to be evidence that most of the coastal litter is land-based. The paucity of foreign garbage pieces

Table 1.--Total litter in sampling stations during study period.

Material	Number of items		Percentage	
Plastic				
Fragments	3,634		31.9	
Bags	2,322		20.4	
Containers and bottles	1,076		9.5	
Caps and covers	1,069		9.4	
Other	40		0.4	
Subtotal		8,141		71.6
Wood		904		7.9
Metal				
Cans	498		4.4	
Containers	90		0.8	
Aerosols	66		0.6	
Subtotal		654		5.8
Glass				
Bottles	308		2.7	
Other	51		0.4	
Subtotal		359		3.1
Other				
Cartons	358		3.1	
Ropes	319		2.8	
Styrofoam	292		2.6	
Garments	234		2.0	
Foam rubber	105		0.9	
Subtotal		1,311		11.4
Total		11,366		99.8

is further evidence of this. Foreign litter on Akhziv beach is a result of the alongshore current which flows during summer mostly from the north and carries the garbage from Lebanon to Israel, thus impacting the northern beaches of Israel. Had it been ships' litter, the whole coastline would have been affected.

Comparison With Litter From Other Coastlines

Merrell (1980, 1984, 1985), who studied the coastal litter in Amchitka Island, Alaska, between 1972 and 1982, found that out of the 24 most common litter items, 12 were used in commercial fishing. In 1974, these constituted 65% by counts, and in 1982, 34%. Merrell attributes the rest of the litter to garbage which was discarded from the fishing fleets in the Pacific Ocean. Vauk and Schrey (1987), who investigated litter on

the beach of Helgoland Island in the German Bight, reported that 99.2% of the 8,539 waste items found on the beach were identifiable as ships' waste.

Dixon and Dixon (1981, 1983) report on a series of coastal litter surveys which were conducted in the United Kingdom; the Western Isles of Scotland; Cherbourg Peninsula, France; West Jutland, Denmark; and Portugal. In all instances they noted that the most abundant plastic containers found were for lavatory and household cleaners. Plastic and carton containers for milk were also abundant, but their relative abundance was not the same on all of these coasts. Bottles of mineral water, wine, and soft drinks were found in small percentages. The geographical origins of the containers indicated that many were from countries foreign to the beach on which they were found. In short, most of the litter stranded on the beaches of western Europe is seaborne and has not been brought by people coming for recreational purposes.

The difference between the coastal litter found on the Israeli shore and litter items described above is clear--most of the waste in Israel is of local origin and is related to beach recreation activity, whereas a major proportion of the discussed examples is foreign and related to commercial fisheries and ship traffic. The reasons for this difference are clear. For the islands of Amchitka and Helgoland, the litter production by local inhabitants is negligible in comparison to that which lands from the sea. On western European shores, intensive ship traffic and commercial fisheries produce much marine-based litter which is spread widely by the strong winds, currents, and tide. The input of land-based litter by beachgoers, on the other hand, is rather limited due to the short summer recreation period in these countries. The situation in Israel is the opposite. The summer beach recreation period is long (April-November), ship traffic in the east Mediterranean is much lighter than in the North Sea, the English Channel, and the eastern Atlantic, and winds and currents which may bring garbage from the sea are moderate (see above).

Mitigation of Coastal Litter in Israel

The significance of the findings of this study is that the control of solid waste on the Israeli shore is less of a problem than it is on many other coastlines. Most students of coastal and marine litter problems admit that there is little hope of controlling disposal of garbage from ships in the near future (Dixon and Dixon 1981; Bean 1987). As this source of garbage is limited in the case of the Israeli coastline, the attention there should be focused on those who pollute the beach, namely the beachgoers. This is a matter of culture, and has to be treated with the classical tools of education, legislation, and law enforcement. Indeed various programs to educate bathers to keep the beach clean are under way. Plastic refuse bags are distributed to beachgoers by youngsters, and classes of young students are called for voluntary beach cleaning operations. The idea is that these activities will not only help to clean beaches but will also educate children to keep them so in the future. There are signs that this approach will be successful. Figure 3 shows a plastic bag which was filled with garbage by beachgoers who were conscientious not to leave their refuse spread on the beach. However, due

Figure 3.--Plastic bag filled by beachgoers with their garbage to prevent it from spreading on the beach.

to the lack of a nearby trash bin, the bag was left on the beach. A program of placing trash bins on some nondeclared beaches is now under way in Israel.

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