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Benthic Debris Accumulation in Bathyal Grounds in the Antalya Bay, Eastern Mediterranean

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Abstract

The present study was carried out in the Bay of Antalya (eastern Mediterranean) between January and May 2012. A conventional bottom trawl was operated onboard of an research vessel. The depth of the sampling area varied between 200 and 800 m. The material, abundance and distribution of large marine pollutants were investigated in bathyal benthic zone. During the 32 hauls, a total of 220 kg debris and 920 items were collected. The mass of overall debris concentration range from 18.5 to 2,186 kg/km^2, number of debris range from 115 to 2,762 item/km^2. There is no significant difference between depth ranges for any kind of marine debris ($P<0.05$). The number percentage of plastic metal, glass, and other debris in total were 81.1%, 2.2%, 3.9% and 12.8%, respectively. Plastic litter was the most dominant material category by means of number.

Keywords: Marine pollution, debris, litter, bathal zone, Antalya Bay.

Antalya Körfezi (Doğu Akdeniz) Batial Zonunda Bentik Çöp Birikimi

Özet

Sunulan bu çalışma Ocak-Mayıs 2012 tarihleri arasında Antalya Körfezinde (doğu Akdeniz) yürütülmüştür. Geleneksel bir dip trolüne sahip olan araştırma gemisi kullanılarak 200 ile 800 m arasındaki derinliklerde örneklemeler yapıldı. Batial zonun bentiğinde bulunan büyük boyutlu deniz kirleticilerin materyal, bolluk ve dağılımları incelendi. 32 trol çekimi süresince toplamı 220 kg olan 920 parça kirletici toplandı. Çöpün yoğunluk miktarları tüm alan içerisinde 18,5-2.186,0 kg/km^2 ve 115-2.762,0 parça/km^2 arasında değişmektedir. Derinlik katmanları ile çöplerin herhangi bir gurubunun dağılımı arasında anlamlı bir fark bulunmamıştır ($P<0,05$). Adet olarak elde edilen toplam çöpün plastik, metal, cam ve diğer guruplara yüzdesel olarak dağılımları sırasıyla, %81,1, %2,2, % 3,9 ve %12,8'dir. Adet olarak plastik en yoğun malzeme gurubunu oluşturmaktadır.

Anahtar Kelimeler : Deniz kirliliği, atık, çöp, batial zone, Antalya Körfezi.

Introduction

Marine litter is a complex and multi-dimensional problem with significant implications for the marine and coastal environment and human activities the world over. It originates from many sources and has a wide spectrum of negative environmental, economic, safety, health and cultural impacts (UNEP, 2009). Despite international, national and local prohibitions, the level of manufactured litter lost or deliberately discarded into the world's seas and oceans is substantial and represents a growing threat to marine environments and industries (Cheshire *et al*., 2009).

Since the 1970s, various studies have dealt with the problem of debris on continental shelves and slopes along European Seas, including the Baltic Sea, the North Sea, the Celtic Sea, the Bay of Biscay and different areas in the north-western basin of the Mediterranean Sea, the Adriatic Sea (Galgani *et al*., 2000) and Black Sea. Most studies of marine litter describe its composition and origin (i.e. plastic, metal, fishing gear), calculate its concentrations for each type and estimate its density (Koutsodendris *et al*., 2008). In the literature, six different methods for the study on the qualification and quantification of benthic marine debris were recorded: bottom trawl net (48.3%), snorkeling (17.2%), scuba diving (13.8%), manta tow (10.3%), submersible (6.9%) and sonar (3.5%) (Spengler and Costa, 2008).

Although useful data on marine litter exists in the Mediterranean (types, quantities, etc.) it is inconsistent and geographically restricted mainly to

parts of the North Mediterranean (UNEP, 2009). The first study conducted with a purpose of assessment of coastal and marine litter in the Mediterranean was a organized in 1979 (Shiber, 1979). In the following years, many individual studies conducted in Mediterranean to emphasize dimensions of the marine pollution in the regional sense. Most of these studies concerns floating debris (McCoy, 1988; Aliani *et al*., 2003; Aliani and Molcard, 2003; Martinez-Ribes *et al*., 2007b) or litter along the coast (Shiber, 1979; 1987; Pruter, 1987; Gabrielides *et al*., 1991; Alkalay *et al*., 2007; De Falco *et al*., 2007; Martinez-Ribes *et al*., 2007a), particularly on beaches where it is abundant.

There are also some studies concerning the deep water marine litter monitoring across the Mediterranean Sea. For western Mediterranean Sea, accumulation areas, formed with the effect of geomorphologic and hydrologic conditions, were reported (Galgani *et al*., 1996; 2000). In addition to this, presence of dense population areas and river discharges have been reported to be effective in the formation of the densely polluted areas. Studies performed in the coast of Greece showed that increased pollution in coastal areas and bays. Fishing activities and dense populated industrial regions plays an important role in the formation of reported pollution (Katsanevakis and Katsarou, 2004; Koutsodendris *et al*., 2008). One major fact, for all of the previous studies concerning with marine debris conducted in Mediterranean Sea, was plastic materials reported as the primal source of the pollution.

Studies on marine pollution in the seas of Turkey starts with a pilot survey (Bingel *et al*., 1987), concerning plastic materials in trawl catches, as a landmark activity for the assessment of coastal and marine litter in the Levant sea (eastern Mediterranean). In subsequent years similar studies carried out along the south-eastern İskenderun Bay (eastern Mediterranean) (Yılmaz *et al*., 2002) and in the western part of the Turkish Black Sea coast (Topçu and Öztürk, 2010).

Gulf of Antalya is under the influence of pollution due to the truism activities, commercial and tourist boat traffic, residential areas with dense population and river discharges to the area. Antalya providence, with a resident population of 1.98 million, has been host to more than 8.5 million tourists in 2010 (Anonymous, 2011). Besides this, 35.6% of the overall greenhouse production land of Turkey is in Antalya providence (Anonymous, 2007). Gulf of Antalya is also in effect of two of the important rivers "Manavgat" and "Aksu" rivers.

The main objective of this paper was to understand the current status of the marine litter problem on the seafloor at bathyal depths (between 200 m and 800 m) in the Antalya Bay and also provide data on abundance, distribution and qualification in different categories according to their material. Data collected from this study is crucial for comparisons of the distribution of benthic marine debris over the Mediterranean.

Materials and Methods

This study was carried out within the frame work of a project (2010.01.0111.001) on the population dynamics and spatio-temporal distribution of the Blackbelly rosefish (*Helicolenus dactylopterus*) in the Antalya Bay (Deval *et al*., 2012). A total of 32 hauls were evaluated for recent study between January - May 2012. Pollutants were collected with bottom trawling and sampling was carried out between 200 - 800 m depth range on continental shelf (Figure 1). Towing duration was between 1 - 3 hours with a total of 40 hours. Trawl operations were conducted with R/V "Akdeniz Su" at an average speed of 2.5 nautical miles/h [between 2.2-2.7] with a conventional bottom trawl (600 meshes at mouth opening; codend in polyethylene, mesh opening 44 mm, equipped with a polyamide cover, mesh opening 24 mm). To avoid under estimations due to mash size of the trawl net an cover net was used during hauls.

Litters were sorted to three different sub-groups (glass, metal and plastic) according to material types, rest of the pollutants were evaluated under a group named as "divers objects" (Table 1). Marine debris items were then counted and weighed.

The swept area (*a*) was estimated from (Sparre and Venema, 1992);

$$a = D * hr * X_2,$$

where X_2 is the fraction of the head-rope length, *hr* is the length of the head-rope (17 m). X_2 is that fraction of the head-rope length, hr, which is equal to the width of the path swept by the trawl, the "wing spread", $hr * X_2$. In the study value of X_2 = 0.5 was used. The distance towed (*D*) was estimated in units of nautical miles (nm), by:

$$D\ (nm) = 60 * \sqrt{(Lat_1 - Lat_2)^2 + (Long_1 - Long_2)^2 * Cos^2(0.5(Lat_1 - Lat_2))}$$

where; Lat_1 = latitude at start of towing (degrees); Lat_2 = latitude at end of towing (degrees); Lon_1 = longitude at start of towing (degrees), Lon_2 = longitude at end of towing (degrees) Than *D* value was multiplied with 1852 and distance towed was calculated in units of meters (m).

The two-way ANOVA's were processed to test differences between kind of marine debris (glass/metal/plastic/divers objects) and depth stratum (200 to 800 m) with SPSS v.18 software. A natural logarithm transformation was used to normalize the distributions and stabilize the variances for debris number and mass. Distribution of marine debris were shown in abundance (N/km^2) and in weight (kg/km^2) and presented on maps with proportionally sized symbols for all sampling locations with SURFER v.10 software by post map option.

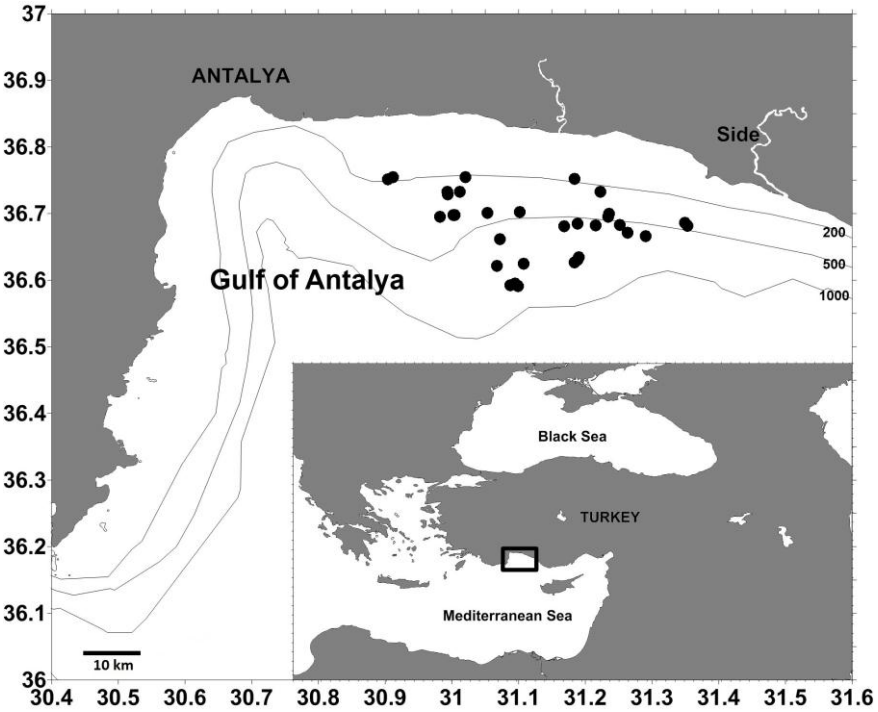

Figure 1. Locations of the sampling stations in Antalya Bay. Sampling sites (●).

Table 1. Composition of the main groups used for the analysis

Glass	Metal	Plastic	Divers objects
Bottles	Beverage cans, spray cans, oil tins	Bottles, plastic bags, hose, scotch tapes, nylon rope, food packaging, plastic accessories	Scouring pads, foam padding sanitary napkins, diapers, sacks, clothing, wooden planks, fishing gear

Results

During the 32 hauls a total of 220.4 kg and 920 items were collected in Antalya Bay. Weight of overall debris concentration range from 18 to 2186 kg/km^2 in the different depth stratums, number of debris range from 115 to 2762 item/km^2. Weight percentage of metal, glass, plastic and other debris in total were 2.9%, 7.30%, 27.5% and 62.2% respectively. While number percentage of same groups were 2.2%, 3.9%, 81.1%, and 12.8% respectively.

There is no doubt that plastics compose most of the marine litter worldwide. It is reveal that plastic litter was the second abundant debris group between 200 - 600 m depth range by means of weight (Table 2) while it is also most abundant pollutant in all depth ranges by number of items (Table 3) in Gulf of Antalya. "Divers objects" were the dominant pollutant by weight up to 200 m depth because of the various type of land-based heavy items in this group. Beside this, with the effect of fisheries equipment collected 300 m depth range and oil tins collected from shipping route which is located ahead of 800 m depth contour, metal pollutants were stands out (Table 2).

Correlation results between different debris groups, total debris and depth ranges were given in Table 4. Pearson correlation tests revealed that there is no relationship between depth increase and debris abundance. It is clear that plastic debris and divers objects groups had a direct effect on total debris amounts.

There were three main high concentrated debris accumulation zones in sampling area. First one is located 16 km south of the coast with 360 m depth (N 36°43′- E30°59′) (Figure 3 and 4). This zone formed with all kind of debris groups by means of weight and number of items collected. The second area is located 16 km south of the coast with 630 m dept (N 36°40′- E 31°17′) (Figure 3c/d, Figure 4c/d). Mostly plastic and diverse objects were formed the debris for this location. Third is located 28 km south of the coast with 750 m depth (N 36°35′- E 31°05′) (Figure 3c, Figure 4c). Plastic subgroup was the abundant debris for this location by means of items collected.

Discussion

The distribution and abundance of large marine debris items on the bathyal zone of the Antalya Bay

Table 2. Weight per hour (kg/h) of the debris and sub-groups according to depth stratums

Depth (m)	Metal	Glass	Plastic	Divers objects	Total Debris
200	0.01	0.02	0.21	1.58	1.81
300	0.20	0.05	0.26	0.32	0.83
400	0.05	0.04	0.50	0.73	1.32
500	0.001	0.01	0.12	0.14	0.27
600	0.03	0.04	0.19	0.63	0.88
700	0.01	0.01	0.16	0.02	0.21
800	0.12	0	0.07	0.01	0.19
Mean	0.40	0.16	1.52	3.43	5.51

Table 3. Item per hour (N/h) of the debris and sub-groups according to depth stratums

Depth (m)	Metal	Glass	Plastic	Divers objects	Total Debris
200	0.15	0.05	3.60	0.33	4.13
300	0.35	0.15	3.38	0.50	4.38
400	0.05	0.13	3.65	0.73	4.55
500	0.03	0.03	2.18	0.18	2.40
600	0.08	0.15	2.98	1.00	4.20
700	0.15	0.03	1.98	0.18	2.33
800	0.08	0.00	0.90	0.05	1.03
Mean	0.12	0.7	2.67	0.42	3.29

Table 4. Pearson correlation results between different debris groups and depth stratum (DO : divers objects; Correlation is significant at the 0.05 level ([a]) and at the 0.01 level ([b]))

		Depth	Kg				N			
			Metal	Glass	Plastic	DO	Metal	Glass	Plastic	DO
Kg	Metal	0.024	-	-	-	-				
	Glass	-0.189	0.316	-	-	-				
	Plastic	0.188	0.026	0.067	-	-				
	DO	-0.336	-0.013	0.468[b]	0.185	-				
	Total	-0.348	0.132	0.512[b]	0.365[a]	0.972[b]				
N	Metal	-0.152					-	-	-	-
	Glass	-0.171					0.354[a]	-	-	-
	Plastic	0.412					0.215	0.277	-	-
	DO	-0.104					-0.101	-0.088	0.368[a]	-
	Total	-0.385					0.246	0.266	0.949b	0.624[b]

was investigated by using the bottom trawl cruises between January and May 2012.

Antalya region hosts 32% of overall tourism activity of Turkey occurred with more than 8.5 million tourist (Anonymous, 2011). Especially in summer, accommodation facilities along the coast line causes the increase of population in the region. This causes an increase of land-based pollutants. Excess of the consumer product packaging with different materials due to boat trips with touristic purpose constitute a significant pollution from boats sailing in the area. Additionally to touristic activity in the area, intense fishing activity (mostly artisanal fisheries (gillnet, trammel net, long-line and bottom trawl) also carried out. There are 698 registered fishing vessels in the region (Anonymous, 2012). As a result, proportion of the fishing gear in total debris was 2.6%. Considering the size of fishing fleet in the area, proportion of fishing gear in total litter was relatively high in the study area (Table 3).

Marine debris concentration in Gulf of Antalya was higher than most of the areas in Mediterranean Sea (Table 5). The number of debris range from 115 to 2762 item/km^2 in the different depth stratums. Our results showed that the major sources of the collected litter were from land-based activities while the predominant items were composed of plastic (81% in items). Plastic also has the second biggest percentage by means of weight (27.5%). Various land-based litter were identified and evaluated under the group. According to the review of UNEP (2009), most of the Mediterranean marine litter is from land-based sources, rather than ships. Marine litter *on beaches* originates from shoreline and recreational activities and is composed mainly of plastics, aluminium and glass (52% in items), and from smoking related

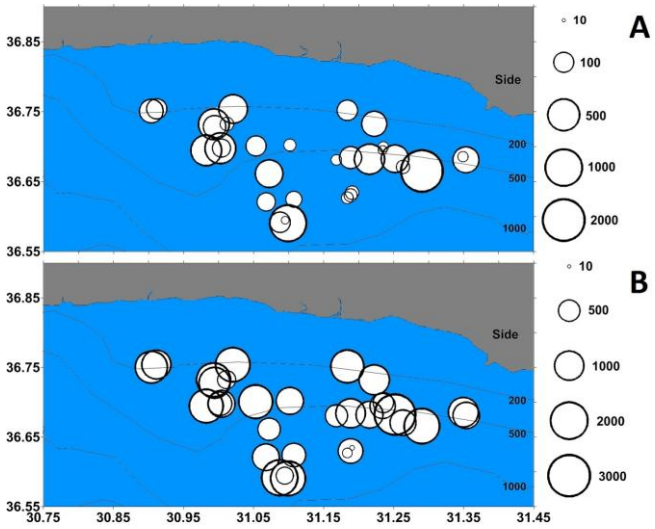

Figure 2. Weight (A) (kg/km^2) and number (B) (N/km^2) of total debris were indicated, proportionally sized with the amount of debris, with symbols in the "post map".

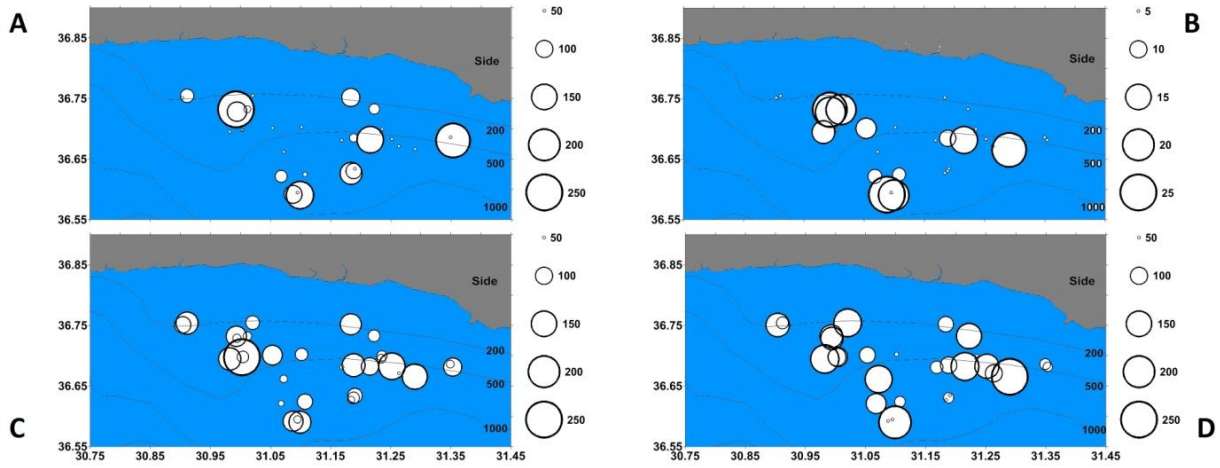

Figure 3. Proportionally sized, with the weight of marine debris sub-groups, symbols were shown on map. (A- metal, B-glass, C-plastic, D-other) (kg/km^2)

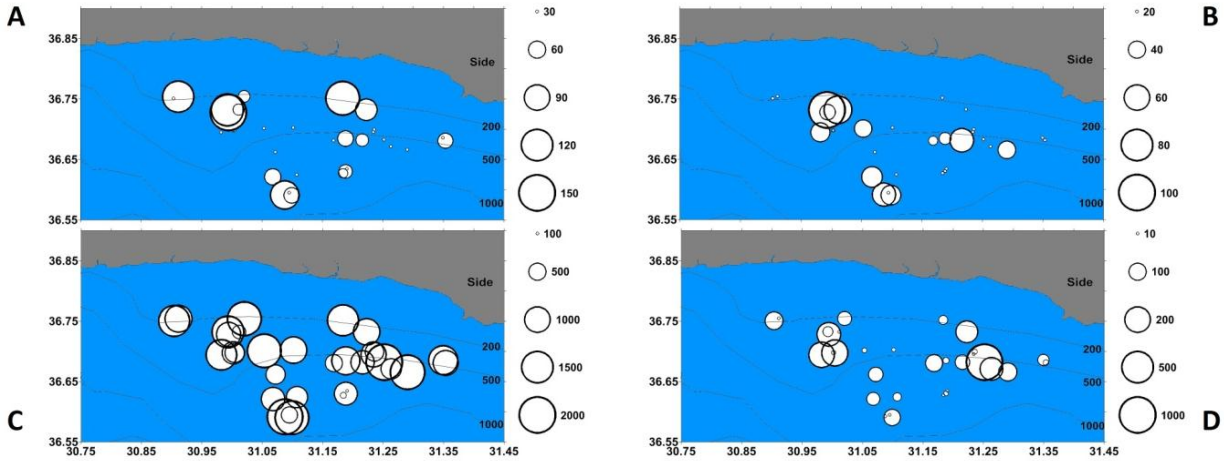

Figure 4. Proportionally sized, with the number of marine debris sub-groups, symbols were shown on map (A- metal, B-glass, C-plastic, D-other) (N/km^2).

Table 5. Abundance and proportions of significant litter types from Mediterranean Sea (P: plastic; FG: Fishing gear)

Reference	Area	depth (m)	kg/km^2	item/km^2	P (%)	FG (%)
Galil *et al*., 1995	Eastern Mediterranean (17 sites)	194-4614		2400	-	-
Galgani *et al*., 1996	NW Mediterranean Sea	<200	-	111	68	-
		200 - 100	-	696	85	-
		>1000		3712	85	-
Stefatos *et al*., 1999	Echinadhes Gulfs ,Greece	247-360	-	89	79	1
	Patras Gulfs ,Greece	80-120	-	240	83	2
Galgani *et al*., 2000	Gulf of Lions		-	143	70.5	2.7
	East Corsica	up to 2700	-	229	45.8	-
	Adriatic Sea		-	378	69.5	-
Yılmaz *et al*., 2002	Gulf of Iskenderun	0 - 50	16	-	-	-
Katsanevakis and Katsarou, 2004	59 coastal sites, Greece	0 - 350	6- 47	14-900	55.5	-
Koutsodendris *et al*., 2008	West and South Greece	0 - 25	-	72-437	55.9	9.2
Topçu and Öztürk, 2010	Black Sea	25 - 100	8 - 217	128-1320	79.6	1.3
Present study	Antalya Bay, Turkey	200-600	18-2186	115-2762	81.1	2.6

activities accounts for 40% (in items) which is considerably higher than the global average. In terms of marine litter *floating in the sea*, plastics account for about 83.0%, while all other major categories account for about 17% (in items).

In the Gulf of Lions, only small amounts of debris were collected on the continental shelf. Most of the debris was found in canyons descending from the continental slope and in the bathyal plain, with high amounts occurring to a depth of more than 500 m (Galgiani *et al*., 1996). In four major gulfs along the western coast of Greece was conducted a deep water marine litter monitoring programs and reaching depths of 300 m. The results showed that the major sources of the collected litter were from land-based activities while the predominant items were composed of plastic (56%). The most burdened area was that of the Gulf of Patras (a major urban centre as well as fishing hub and commercial port) with a recorded number of items ranging between 72 and 437 per km^2 (Koutsodendris *et al*., 2008).

Previous studies draw attention to the effect of the rivers on type and distribution of marine debris in coastal areas (Galgani *et al*., 2000; Koutsodendris *et al*., 2008). In our case land-based pollutants evaluated in divers objects group were due to the two river (Köprüçay and Manavgat) discharge to the area.

The litter distribution on the sea bottom is probably affected by hydrodynamic circulation (Galgani *et al*., 2000) and transportation of debris in relation to the local upwellings occurring along the coast must also be considered (Millot and Wald, 1980, Millot *et al*., 1994). There is a trans-boundary problem of marine litter in Mediterranean coast Turkey, originated from eastern Mediterranean countries (Israel, Lebanon, Syria, etc.), arising with the effect of current systems in the area (Avşar, 1999). Main current system are parallel to shoreline and anticlockwise direction. Currents passing through Israel and Lebanon coast with the northern direction, continues westwards through the shoreline (Ünlüata *et al*., 1983). It is reported that 32% of plastic debris were foreign sourced (Yılmaz *et al*., 2002). Observations in current study reveals that some of the plastic debris carries text written with Arabic alphabets. This is due to the current system carrying debris and also with the effect of commercial fishing activity in the area.

Due to the lack of information on marine debris for the area, it isn't possible to compare the results of this study to reveal the change of pollution in years. Examination of the debris shows that items collected during the study didn't underwent long period of time in sea. This suggests the idea that pollution in the area was increased last years.

In conclusion, the continuous monitoring of benthic litter items is important in order to properly quantify these problems, find out their sources, develop appropriate measures to mitigate such pollution and assess the effectiveness of the international regulations (Koutsodendris *et al*., 2008; Topçu and Öztürk, 2010). There is no current national management framework in Turkey to assess, manage and monitor benthic litter items. Moreover, a joint policy between Mediterranean countries for the management of marine litter is required as it was similarly suggested by Lee *et al*. (2006) for the marine area between Korea, China and Japan (Koutsodendris *et al*., 2008).

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References

Aliani, S., Griffa, A. and Molcard, A. 2003. Floating debris in the Ligurian Sea, north-western Mediterranean. Marine Pollution Bulletin, 46: 1142–1149.

Aliani, S. and Molcard, A. 2003. Hitch-hiking on floating marine debris: macrobenthic species in the Western Mediterranean Sea. Hydrobiologia, 503: 59–67.

Alkalay, R., Pasternak, G., Zask, A. and Ran, A. 2007.

Israel's 'Clean Coast' Programme successfully tailors solution to Marine Litter Problem. Israel Environment Bulletin, 30: 8-11.

Anonymous 2007. Agricultural Structure 2007, Productions, prices and values. Turkish Statistical Institute, Publication number 3020, Ankara, 544 pp.

Anonymous 2011. Tourism Statistics 2010. Turkish Statistical Institute, Publication number 3603, Ankara, 82 pp.

Anonymous 2012. Fishery Statistics 2011. Turkish Statistical Institute, Publication number 3876, Ankara, 71 pp.

Avşar, D. 1999. Yeni bir skifomedüz (*Rhopilema nomadica*)'ün dağılımı ile ilgili olarak Doğu Akdeniz'in fizikokimyasal özellikleri. Tr. J. of Zoology, 2: 605-616.

Bingel, F., Avsar, D. and Ünsal, M. 1987. A note on plastic materials in trawl catches in the north-eastern Mediterranean. Meeresforsch, 31: 227–233.

Cheshire, A.C., Adler, E., Barbière, J., Cohen, Y., Evans, S., Jarayabhand, S., Jeft ic, L., Jung, R.T., Kinsey, S., Kusui, E.T., Lavine, I., Manyara, P., Oosterbaan, L., Pereira, M.A., Sheavly, S., Tkalin, A., Varadarajan, S., Wenneker, B. and Westphalen, G. 2009. UNEP/IOC Guidelines on Survey and Monitoring of Marine Litt er. UNEP Regional Seas Reports and Studies, No. 186; IOC Technical Serious No. 83. UNEP, New York.

De Falco, G., Simeone, S. and Baroli, M., 2007. Management of Beach-Cast *Posidonia oceanica* Seagrass on the Island of Sardinia (Italy, Western Mediterranean). Journal of Coastal Research, 23(4): 69-75.

Deval, M.C., Kebapçıoğlu, T., Güven, O., Kaya, Y., Özgen, G. and Saygu, İ., 2012. Population dynamics and catch of Blackbelly rosefish (*Helicolenus dactylopterus*, De Laoche, 1809) in the Gulf of Antalya, eastern Mediterranean. Akdeniz University Scientific Research Projects Coordination Unit Project (Project no: 2010.01.0111.001), Antalya, 44 pp.

Gabrielides, G.P., Golic, A., Loizides, L., Marino, M., Bingel, F. and Torregrossa, M.V. 1991. Man-made garbage pollution on the Mediterranean coastline, Marine Pollution Bulletin, 23: 437-441.

Galgani, F., Souplet, A. and Cadiou, Y. 1996. Accumulation of debris on the deep sea floor off the French Mediterranean coast. Mar. Ecol. Prog. Ser., 142: 225–234.

Galgani, F., Leaute, J.P., Moguedet, P., Souplet, A., Verin, Y., Carpentier A., Goraguer, H., Latrouite, D., Andral, B., Cadiou, Y., Mahe, J.C., Poulard, J.C. and Nerisson, P. 2000. Litteron the sea floor along European coasts. Mar. Pollut. Bull., 40(6): 516–527.

Galil, B.S., Golik A. and Turkay, M. 1995. Litter at the bottom of the sea: A Sea bed survey in the Eastern Mediterranean, Mar. Pollut. Bull., 30: 22–24.

Katsanevakis, A. and Katsarou, A. 2004. Influences on the distribution of marine litter on the seafloor of swallow coastal areas in Greece (Eastern Mediterranean). Water, Air and Soil Pollution, 159: 325–337.

Koutsodendris, A., Papatheodorou, G., Kougiourouki, O. and Georgiadis, M. 2008. Benthic marine litter in four Gulfs in Greece, Eastern Mediterranean; abundance, composition and source identification. Estuarine, Coastal and Shelf Science, 77: 501-512.

Lee, D.I., Cho, H.S. and Jeong, S.B. 2006. Distribution characteristics of marine litter on the sea bed of the East China Sea and the South Sea of Korea. Estuarine, Coastal and Shelf Science, 70: 187-197.

Martinez-Ribes, L., Basterretxea, G., Palmer, M. and Subirana, J.T. 2007a. Origin and abundance of beach debris in the Balearic Islands. Scientia Marina, 71(2): 305-314.

Martinez-Ribes, L., Basterretxea, G., Arqueros, L., Jordi, A., Estrany, T., Aguilò, J.M. and Tintoré, J. 2007b. Influence of wind on floating debris distribution in the Balearic Islands. Management of Natural Resources, Sustainable Development and Ecological Hazards, 553-564.

McCoy, F. 1988. Floating megalitter in the eastern Mediterranean, Marine Pollution Bulletin, 19: 25-28

Milot, C. and Wald, L. 1980. The effect of mistral wind on the Ligurian current near Provence. Ocean01 Acta., 3(4): 399-402

Millot, C., Taupier-Letaye, I., Leborgne, P., Lopez-Garcia, M.J. and Vald, L. 1994. Dynamical oceanography studies from infrared remote sensing in the western Mediterranean Sea. Mem. Inst. Oceanogr. Monaco, 18: l-11

Pruter, A.T. 1987. Sources, quantities and distribution of persistent plastics in the marine environment. Marine Pollution Bulletin, 186(B): 305-310.

Shiber, J.G. 1979. Plastic pellets on the coast of Lebanon, Marine Pollution Bulletin, 10: 28-30.

Shiber, J.G. 1987. Plastic pellets and tar on Spain's Mediterranean beaches, Marine Pollution Bulletin, 18: 84-86.

Sparre, P. and Venema, S.C. 1992. Introduction to tropical fish stock assessment, Part 1. Manual. FAO Fish. Techn. Pap., 306 (1): 1-376.

Spengler, A. and Monica, F.C. 2008. Methods applied in studies of benthic marine debris, Marine Pollution Bulletin, 56: 226–230.

Stefatos, A., Charalampakis, M., Papatheodorou, G., Ferentinos, G., 1999. Marine litter on the seafloor of the Mediterranean Sea: example of two enclosed Gulfs in Western Greece. Marine Pollution Bulletin 36: 389-393.

Topçu, E.N. and Öztürk, B. 2010. Abundance and composition of solid waste materials on the western part of the Turkish Black Sea seabed. Aquatic Ecosystem Health and Management, 13(3): 301-306.

UNEP 2009. Marine Litter: A Global Challenge. UNEP. Nairobi, 232 pp.

Ünlüata, Ü., Oğuz, T. and Özsoy, E. 1983. Blocking of steady circulation by coastal geometry. Journal of Physical Oceanography, 13(6): 1055-1062.

Yılmaz, A.B., Başusta, N. and İşmen, A. 2002. A study on plastic materials accumulation in the south-eastern İskenderun Bay. E.U. J. of Fish. Aquat. Sci., 19(3–4): 485–488.