

Supplementary Material

Microplastics in sediments and fish from the Red Sea coast at Jeddah (Saudi Arabia)

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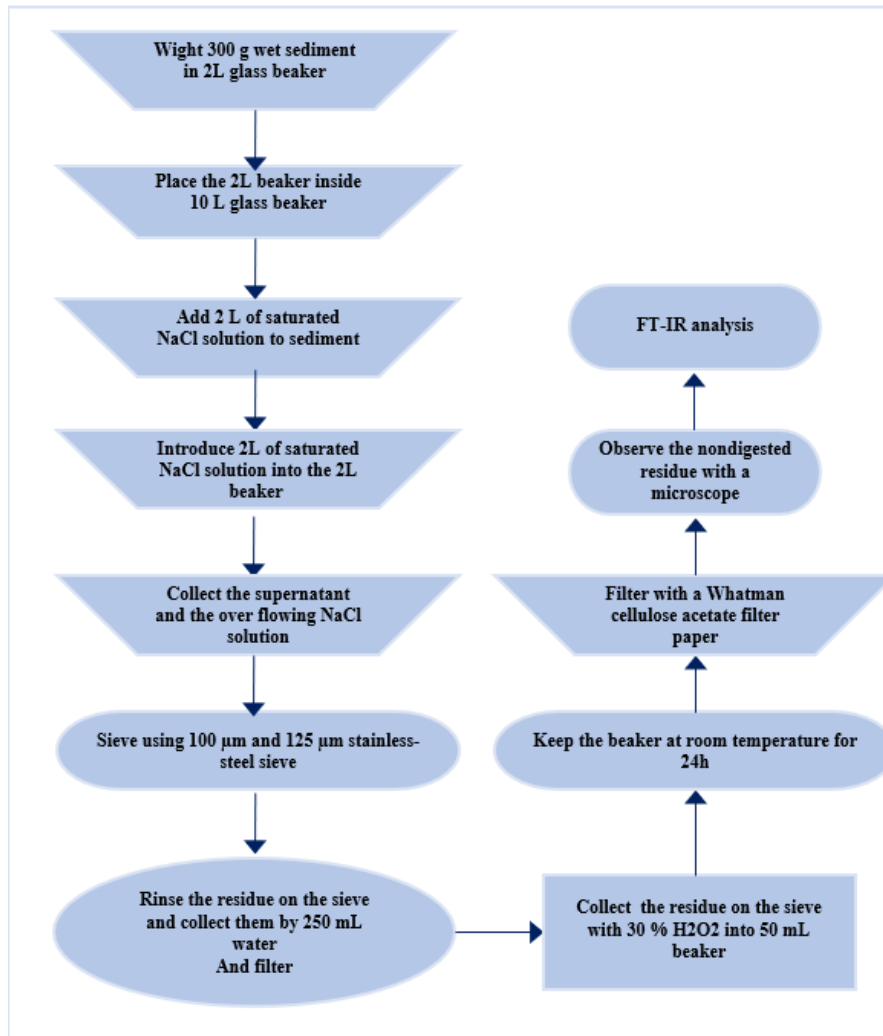


Fig. S1 Chartflow for analysis of microplastics in sediment.

Table S1: Microplastics categories and their dimensions in sediment samples (sample size=300g)

Sample	Fragment size (µm)	Granules size (µm)	Foams size (µm)	Fiber size (µm)	Total
Arb-A1	0	630	772		9
		302	617		
		288			
		616			
		864			
		473			
		555			
Arb-A2	2348	362	3663	165	23
	1262	227	1897	443	
		714		177	
		209		466	
		216		166	
		347		518	
		462		414	
		260		607	
		245		2348	
		346			
Arb-A3	0	126	3836	288	7
		136		157	
		156			
		243			
Arb-A4	0		4549	517	3
				275	
Arb-B1	151				1
Arb-B2	142				1
Arb-B3	0		312		1
Arb-B4	0		0		0
Arb-C1	136		421	413	6
				887	
				1114	
				572	
Arb-C2	0		525	2228	3
				502	
Arb-C3	130		664	742	6
	644			407	
	644				
Arb-C4	268		810		36
	192		149		
	337		244		
	1232		182		
	4705		168		

Table S1 continue: Microplastics categories and their dimensions in sediment samples
(sample size=300g)

Sample	Fragment size (μm)	Granules size (μm)	Foams size (μm)	Fiber size (μm)	Total
	1397		552		
	520		606		
	137		495		
	403		850		
	912		469		
	375		183		
	228				
	978				
	293				
	1078				
	2526				
	203				
	126				
	419				
	800				
	634				
	173				
	1223				
	192				
	224				
	362				
Arb-D1			104	701	2
Arb-D2	1299	127	216	898	16
	1257	218	790	1335	
	159		458	3645	
	221			1868	
	801			2430	
				695	
Arb-D3	771		220	624	8
			310	652	
			164		
			235		
			186		
Arb-D4	170		276	1618	6

Table S1 continue: Microplastics categories and their dimensions in sediment samples
(sample size=300g)

Sample	Fragment size (µm)	Granules size (µm)	Foams size (µm)	Fiber size (µm)	Total
	299		249	1071	
Kum-A1					0
Kum-A2					0
Kum-A3					0
Kum-A4	136		251		4
	1099		149		2
Kum-B1				517	2
				275	
Kum-B2					0
Kum-B3					0
Kum-B4					0
Kum-C1			578	268	3
				249	
Kum-C2		192	1055	1182	3
Kum-C3				0	0
Kum-C4					0
Bad-A1	127			486	2
Bad-A2	781		129		2
Bad-A3					0
Bad-A4			172	710	2
Bad-B1	151		255		3
	104				
Bad-B2	716		191		3
			475		
Bad-B3	171				6
	1148				
	213				
	356				
	401				
	181				
Bad-B4			134		4
			409		
			255		
			139		
Saif1	218		178	886	4
	206				
Saif 2	562	178			9
	1078	289			
	168				
	135				
	311				
	265				

Table S1 continue: Microplastics categories and their dimensions in sediment samples
(sample size=300g)

Sample	Fragment size (μm)	Granules size (μm)	Foams size (μm)	Fiber size (μm)	Total
	173				
Saif 3			3270	292	7
			348		
			173		
			131		
			218		
			562		
Saif 4	145				16
	457				
	129				
	348				
	259				
	126				
	183				
	1404				
	146				
	303				
	793				
	1052				
	3270				
	415				
	708				
	768				

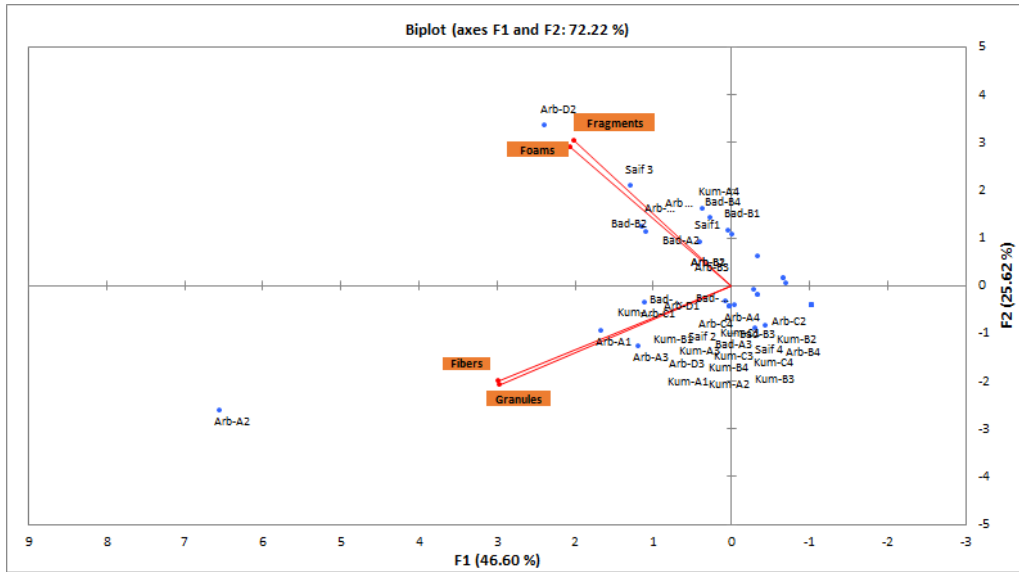


Fig. S2 Bi-plot for a principal Component Analysis (PCA) conducted for all variables identified which influencing the microplastic distribution profile in the analysed sediment samples. Arb (Al-Arbaeen); Kum (Al-Khumrah); Bad (Al-Badee); Saif (Al-Saif).

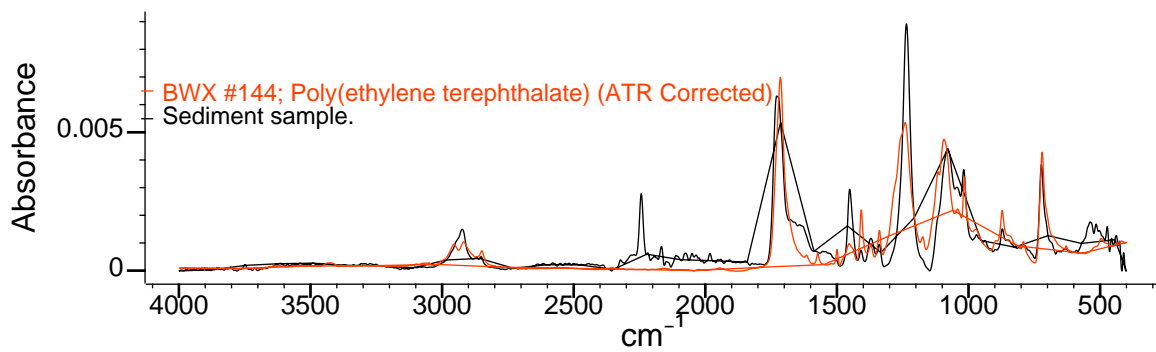


Fig.S3 Fourier-Transform Infrared (FTIR) spectra of microplastic (poly(ethylene terephthalate)) contained in sediment sample and corresponding reference material.

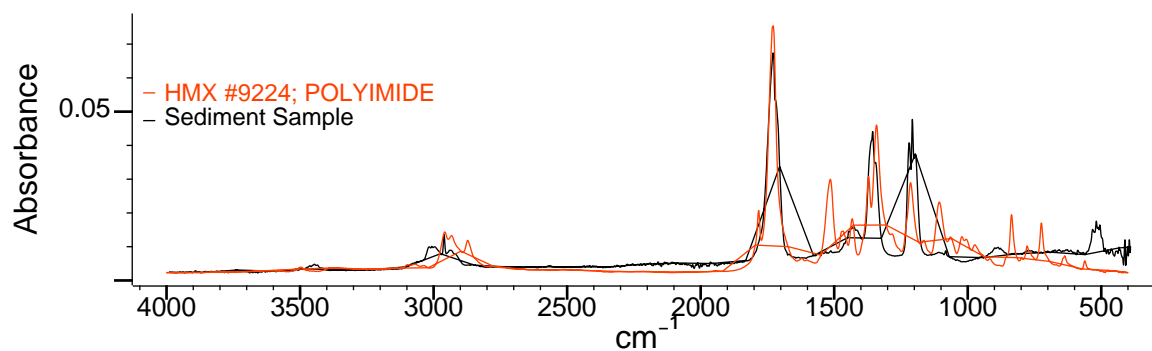


Fig.S4 Fourier-Transform Infrared (FTIR) spectra of microplastic (polyimide) contained in sediment sample and corresponding reference material.

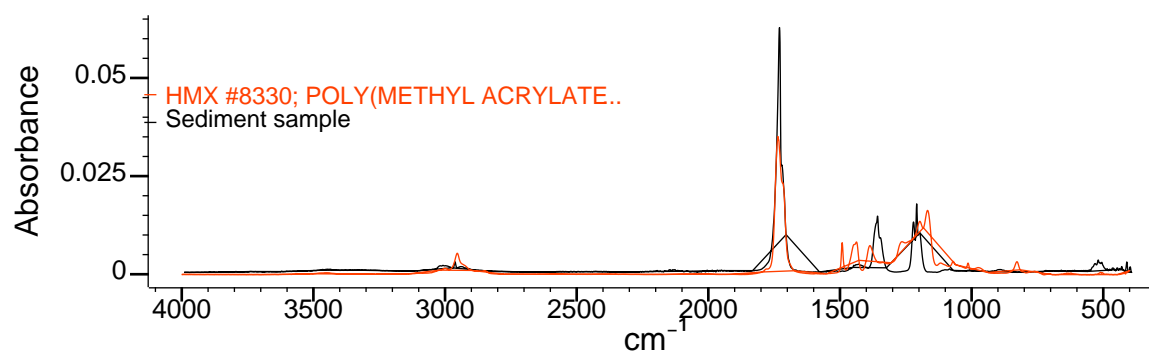


Fig.S5 Fourier-Transform Infrared (FTIR) spectra of microplastic (poly(methylacrylate)) contained in sediment sample and corresponding reference material.

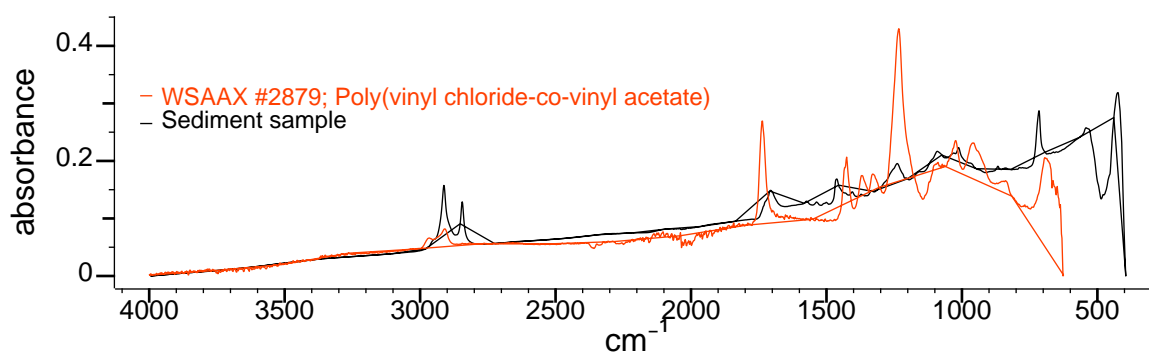


Fig.S6 Fourier-Transform Infrared (FTIR) spectra of microplastic (vinyl chloride-vinyl acetate copolymer) contained in sediment sample and corresponding reference material.

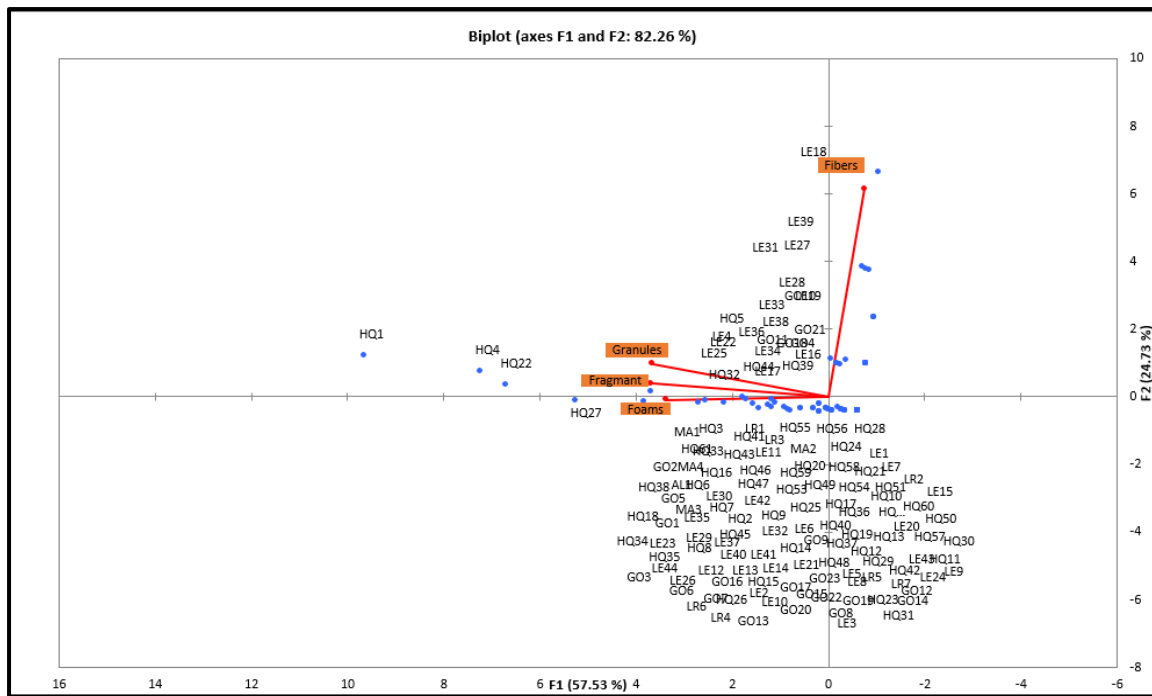


Fig.S7 Bi-plot for a Principal Component Analysis (PCA) as pattern analysis for the microplastic distribution profile in the analysed fish samples (see table3 for variable list). HQ (*Herklotsichthys quadrimaculatus*); LE (*Leiognathus equulus*); MA (*Monodactylus argenteus*); AL (*Atherinomorus lacunosus*); LR (*Leiognathus rivulatus*); GO (*Gerres oyena*).

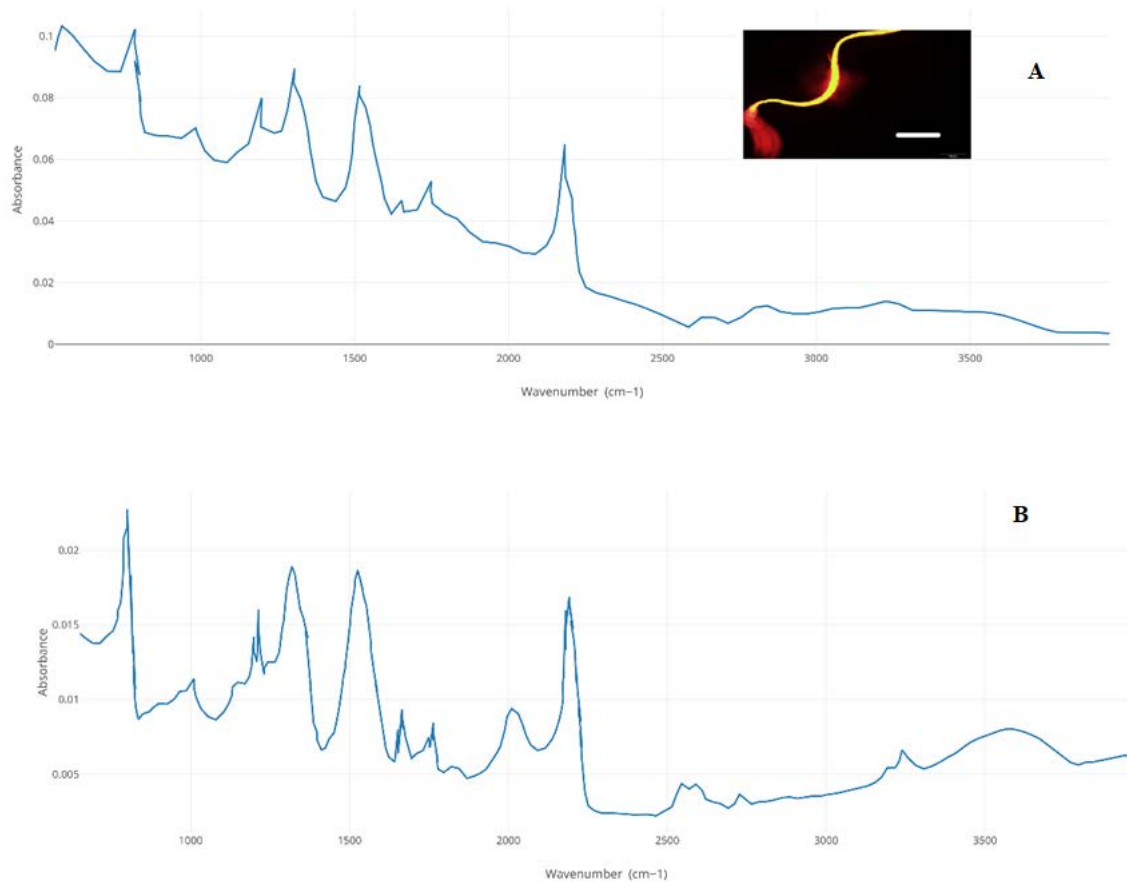


Fig.S8 Fourier-Transform Infrared (FTIR) spectra of microplastic (Polyester) contained in fish sample (A) and corresponding reference material (B). Scale bar on the micrograph represents 100 μm.

Table S2: Dimension, weights, and microplastic particles in individual fish samples; ML (*Monodactylus Argenateus*); LR (*Leiognathus Rivulatus*); AI (*Atherinomorus lacunosus*); GO (*Gerres oyena*); LE (*Leiognathus Equulus*); HQ (*Herklotsichthys quadrimaculatus*)

Species	Length (cm)	Weight (g)	Fragments size (µm)	Granules size (µm)	Foams size (µm)	Fibers size (µm)	Total number
ML	14.5	86	296	131	183		6
					620		
					248		
					319		
ML	17	96.2	139		134		3
			141				
ML	15	74.4					0
ML	15	75.9					0
LR	16.7	67.5	356				1
LR	7.5	4.9					
LR	7.4	5.3	183				2
			279				
LR	7.4	5.6			206		1
LR	7	4					0
LR	7.3	5.2					0
LR	6.9	4.1			1035		2
					632		
AI	11.1	8					0
GO	7.3	4.3					0
GO	7.3	4.5					0
GO	7.5	5.2					0
GO	6.8	40				337	1
GO	7	4					0
GO	7	4.2					0
GO	7.5	5.2					0
GO	7.5	5.3					0
GO	7.3	3.8			346		1
GO	6.9	3.1			0	339	2
						176	
GO	6.5	3.6		323		1592	2
GO	6.6	3.7					0
GO	7	3.2					0
GO	7	4.4					0
GO	6.5	2.8					0
GO	6.5	3.5					0
GO	6.7	3.7					0
GO	7.2	3.7				166	1

Table S2 continue: Dimension, weights, and microplastic particles in individual fish samples; ML (*Monodactylus Argenteus*); LR (*Leiognathus Rivulatus*); AI (*Atherinomorus lacunosus*); GO (*Gerres oyena*); LE (*Leiognathus Equulus*); HQ (*Herklotsichthys quadrimaculatus*)

Species	Length (cm)	Weight (g)	Fragments size (µm)	Granules size (µm)	Foams size (µm)	Fibers size (µm)	Total number
GO	7	3.7					0
GO	6.9	3.4					0
GO	7.1	4				246	1
GO	7	3.7	297				1
GO	7.9	5.2			1640		2
					1316		
LE	14.5	66.8			439		3
					218		
					486		
LE	15.5	83			356		2
					158		
LE	16.5	96.91			0		0
LE	15	58.53	136		204	664	3
LE	12.5	41.21	0	249	0	0	1
LE	13	41.84	210	335	374	0	15
				184	277		
				181	156		
					177		
					156		
					146		
					210		
					270		
					333		
					143		
					573		
LE	14	54.64			434		3
					126		
					393		
LE	14.5	51.28	156	154			5
			222	145			
			137				
LE	13.5	41.24					0
LE	15	73.17		297	138		7
				132	514		
				209	370		
				149			
LE	14	45.75	409	224	164		9
			139	195	303		
					305		
					389		

Table S2 continue: Dimension, weights, and microplastic particles in individual fish samples; ML (*Monodactylus Argenteus*); LR (*Leiognathus Rivulatus*); AI (*Atherinomorus lacunosus*); GO (*Gerres oyena*); LE (*Leiognathus Equulus*); HQ (*Herklotsichthys quadrimaculatus*)

Species	Length (cm)	Weight (g)	Fragments size (µm)	Granules size (µm)	Foams size (µm)	Fibers size (µm)	Total number
					180		
LE	16.7	83.06					0
LE	15.5						0
LE	12.8	38.5					0
LE	12.5	30.1		1339			2
LE				578			
LE	13	37.3				166	1
LE	14.7	51.6				503	1
LE	12.6	31.9		661		144	6
LE						551	
LE						558	
						1839	
						543	
LE	14	53					1
						3017	
LE	12.1	30.5	245				2
			1775				
LE	10.7	23.3	180				1
LE	13	32.8	131		216	873	3
LE	7.5	4.5					0
LE	13	36.3	159				2
			164				
LE	12.7	28.3			289	972	3
					527		
LE	12	30.4	357		869		2
LE	14.5	46.5		199		1110	4
						477	
						653	
LE	16					133	2
						440	
LE	15.8	66.4					0
LE	14.9	55.5					0
LE	13	35.1			251	985	4
						984	
						1026	
LE	14.9	59.6			637		1
LE	13.5	40.1				678	1
LE	11.8	27.5				232	1
LE	8	6.9					0
LE	7.8	6.9				166	1

Table S2continue: Dimension, weights, and microplastic particles in individual fish samples; ML (*Monodactylus Argenateus*); LR (*Leiognathus Rivulatus*); AI (*Atherinomorus lacunosus*); GO (*Gerres oyena*); LE (*Leiognathus Equulus*); HQ (*Herklotsichthys quadrimaculatus*)

Species	Length (cm)	Weight (g)	Fragments size (µm)	Granules size (µm)	Foams size (µm)	Fibers size (µm)	Total number
LE	14	53.9					0
LE	11.8	35.7				902	1
LE	13.2	35.7	242			890	4
						1584	
						575	
LE	12.8	30.1					0
LE	12	27.9					0
LE	8.5	8.4					0
LE	7.9	6		149			2
				131			
LE	8	6.1					0
HQ	8.1	5.6	209	152	189		30
			156	133	298		
			234	139	163		
			2176	135	399		
			461	170	265		
			140	131	265		
			133	207	217		
			162	226	355		
			264	353			
				125			
				126			
				205			
				126			
HQ	8.3	5.69	1097	125			5
			138				
			109				
			132				
HQ	8.8	6.05	144	265	192		10
			265		141		
			249		132		
			273				
			144				
			592				
HQ	8.8	6.67	156	187	195		23
			520	150	330		
			137	132	299		
			405	232			
			330	156			
			161	167			

Table S2 continue: Dimension, weights, and microplastic particles in individual fish samples; ML (*Monodactylus Argenteus*); LR (*Leiognathus Rivulatus*); AI (*Atherinomorus lacunosus*); GO (*Gerres oyena*); LE (*Leiognathus Equulus*); HQ (*Herklotsichthys quadrimaculatus*)

Species	Length (cm)	Weight (g)	Fragments size (µm)	Granules size (µm)	Foams size (µm)	Fibers size (µm)	Total number
			358	131			
			1003				
			218				
			138				
			307				
			501				
			270				
HQ	8.3	5.72				1	1
HQ	8.6	6.28					0
HQ	7.9	4.52					0
HQ	8.6	6.32	260		164		2
HQ	8.5	6	140		1232		4
			161		169		
HQ	8.6	6.12	228		182		5
					152		
					213		
					252		
HQ	8.7	6.45					0
HQ	8	5.24					0
HQ	8	5.24	133				1
HQ	8.2	5.11					0
HQ	8	4.96					0
HQ	7.9	4.55			127		1
HQ	8.7	6.45			177		2
					357		
HQ	8.8	5.95	148		0		1
HQ	6.5	2.95	581		163		5
HQ			3157		151		
					142		
HQ	8.1	5.67	447		185		3
			186				
HQ	11.1	14.1					0
HQ	8.8	6.47	147		190		5
			168		476		
			289				
HQ	7.9	5.77	970	291	150		22
			181	174	132		
			489	364			
			139	175	132		

Table S2 continue: Dimension, weights, and microplastic particles in individual fish samples; ML (*Monodactylus Argenateus*); LR (*Leiognathus Rivulatus*); AI (*Atherinomorus lacunosus*); GO (*Gerres oyena*); LE (*Leiognathus Equulus*); HQ (*Herklotsichthys quadrimaculatus*)

Species	Length (cm)	Thickness (cm)	Weight (g)	Width (cm)	Fragments size (µm)	Granules size (µm)	Foams size (µm)	Fibers size (µm)	Total number
					265	224	458		
					190		137		
					125		2160		
					204		187		
					189		164		
HQ	8	0.9	4.98	1.7	136		152		7
					136		154		
					150		259		
							222		
HQ	8.6	0.9	6.42	2.1			150		3
							336		
							553		
HQ	7.6	1.8	5.6	1.9					0
HQ	8.5	1	5.88	2.1	127	189	396		11
					1237	353	197		
							335		
							132		
							2089		
							258		
							381		
HQ	9.8	0.6	6.17	1.9	254	132	169		20
					139	166	185		
					507		964		
					286		191		
					303		163		
							303		
							282		
							180		
							188		
							157		
							188		
							145		
							1023		
HQ	8.4	1	7.47	2	241		196		4
					319		200		
HQ	8.5	0.9	6.27	2	195	500	195		6
					217		161		
							222		
HQ	7.5	0.9	5.33	1.7	125		966		2

Table S2 continue: Dimension, weights, and microplastic particles in individual fish samples; ML (*Monodactylus Argenateus*); LR (*Leiognathus Rivulatus*); AI (*Atherinomorus lacunosus*); GO (*Gerres oyena*); LE (*Leiognathus Equulus*); HQ (*Herklotsichthys quadrimaculatus*)

Species	Length (cm)	Weight (g)	Fragments size (µm)	Granules size (µm)	Foams size (µm)	Fibers size (µm)	Total number
HQ	7	4.32					0
HQ	8	4.45	294	125	203		13
			150	1221	188		
			174	131	193		
			160	136	244		
			547				
HQ	8.5	6.97	200	151	144		7
				221	2008		
				184	185		
HQ	7.4	3.99	154	133	163		7
			135		1053		
			242		933		
HQ	9	1					0
HQ	7.9	0.9					0
HQ	8.5	1					0
HQ	8.5	0.9			213		1
HQ	8.4	0.9				1054	1
HQ	8.5	0.9			196		1
HQ	8.7	0.9					0
HQ	9.2	1					0
HQ	9.1	1					0
HQ	8.4	1	135	177		771	3
HQ	8.5	0.9					0
HQ	8	0.8					0
HQ	8.4	0.9					0
HQ	8.7	1					0
HQ	8.1	0.7					0
HQ	8.6	0.7					0
HQ	8.5	0.8					0
HQ	7.8	0.7					0
HQ	8.5	0.8					0
HQ	8.7	0.8					0
HQ	8.4	0.9			227		1
HQ	8.3	0.9					0
HQ	7.9	0.8					0
HQ	8.3	0.9					0
HQ	8.9	1					0
HQ	8.9	0.9					0
HQ	7.8	0.9					0

Table S3: Feeding habits and characteristics of the investigated fish species and ingested microplastics amount.

Specie	Milieu*	Feed on*	depth range*
Ponyfish (<i>Leiognathus equulus</i>)	<i>Demersal</i>	Feed on polychaetes, small crustaceans, small fishes and worms	10 - 110 m
silver moonyfish (<i>Monodactylus argenteus</i>)	pelagic-neritic	Feeds on plankton and detritus	depth range 0 - 12 m
Common silver-biddy (<i>Gerres oyena</i>)	reef-associated Also in sand bottoms in sheltered waters near reefs	Feeds on small organisms living on sandy bottoms.	depth range 0 - 20 m
Bluestripe herring (<i>Herklotsichthys quadrimaculatus</i>)	reef-associated	Feeds on zooplankton, mainly at night, chiefly copepods in juvenile stages, but larger prey as adults (chaetognaths, polychaetes, shrimps and small fishes)	depth range 1 - 13 m
Hardyhead silverside (<i>Atherinomorus lacunosus</i>)	reef-associated	Feeds mostly at night when the school disperse. Feeds on a variety of planktonic crustaceans. Preyed upon by sharks, tunas, long toms, and amberjacks which swim alongside the school.	1 - 39 m
Ponyfish (<i>Leiognathus rivulatus</i>)	demersal	Searches for prey using a protruding pipette-like mouth or by sieving potential food through their gill rakers	20 m

*Source: (<http://www.fishbase.org>, accessed 14/04/2019)

Table S4: Microplastics contained sediment and fish samples: Reports from earlier studies compared with here presented findings.

Location	Sample type	Microplastics level	Microplastics diameter range	Reference
Venice Lagoon, Italy, Northern Adriatic Sea	Sediment	Range : 672 to 2172 /Kg particles /kg dry sediment	30- 500 μm	(Vianello, Boldrin et al. 2013)
North Tunisian Coast, Central Mediterranean	Sediment	Range : 141.20 \pm 25.98 and 461.25 \pm 29.74 particles /kg dry sediment Average : 316.03 \pm 123.74 particles /Kg dry sediment	100 to 5000 μm	(Abidli, Antunes et al. 2018)
Caorle Area, Italy and Slovenia, Northern Adriatic	Sediments	Range : 137 to 703 particles /hg dry sediment Average : 403.02 \pm 79.10 particles /Kg dry sediment	100 μm to >20000 μm	(Renzi, Blašković et al. 2018)
Lagoon of Bizerte, Tunisia, Central Mediterranean	Sediment	Range : 3000–18000 particles /Kg dry sediment Average : 7.96 \pm 6.84 particles /Kg dry sediment	300 μm to 5000 μm	(Abidli, Toumi et al. 2017)
Saudi Arabian Red Sea	Sediment	10-160 items/m ²	3000- 4000 μm	(Ruiz-Compean, Ellis et al. 2017)
Jeddah coast, Saudi Arabia	Sediments	Range :nd-120 particles /Kg wet sediment Average: 5 \pm 7 particles /Kg wet sediment	125-4705 μm	The current study
Turkey, Mediterranean	Fish	Range: 1 and 35 particle per individual fish	26-5000 μm	(Güven, Gökdağ et al. 2017)
Musa Estuary, Persian Gulf, Western Asia	Fish	Range : 8 to 20 particle per individual fish	<100 μm to > 1000 μm)	(Abbasi, Soltani et al. 2018)
Jeddah coast, Saudi Arabia	Fish	Range: nd- 30 particles per individual fish, average: 2.3 \pm 4.6 particles per individual fish	125-3157 μm	The current study

References

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