

Supplementary material

Fatty acids, persistent organic pollutants and trace elements in small pelagic fish, eastern Mediterranean Sea

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Table S1. Biometric data of small pelagic fish samples (S).

S	Fish species	Sampling date	Total length range (cm)	Average total length (cm) and standard deviation	Average body mass (g) and standard deviation
2016					
1	sardine	28.07.2016.	13-16	14.28-0.61	21.58-3.11
2	sardine	06.05.2016.	13.5-15.5	14.45-0.58	21.67-3.25
3	sardine	13.06.2016.	12.5-16	13.83-0.82	30.31-3.97
4	sardine	13.06.2016.	11.5-15	13.09-0.62	16.85-2.46
5	sardine	30.06.2016.	12.5-15	13.71-0.77	18.96-3.59
6	sardine	30.04.2016.	12-16	13.81-0.85	20.11-2.89
7	sardine	13.04.2016	12-15.5	13.47-0.76	18.45-2.88
8	sardine	06.05.2016	14-17.5	15.23-0.74	27.85-4.07
9	sardine	31.05.2016.	13-16	14.75-0.73	26.19-3.96
10	sardine	04.07.2016.	13.5-17	14.81-0.73	24.50-4.11
11	sardine	30.08.2016.	11.5-15	13.30-0.70	17.89-2.69
12	sardine	30.08.2016.	12.5-16.5	14.42-0.54	23.64-4.35
13	sardine	09.08.2016.	14-16.5	14.94-0.58	25.37-2.99
14	sardine	17.03.2016.	11-16	13.94-0.89	18.73-3.86
15	sardine	15.03.2016.	11.5-16	13.73-0.86	17.58-3.02
16	sardine	04.07.2016.	13-16.5	14.71 -0.72	24.45 -3.69
17	sardine	08.03.2016.	12.5-15	13.66-0.68	18.76-2.69
18	sardine	30.06.2016.	12.5-17	14.34-0.81	21.58-4.37
19	sardine	05.08.2016.	12-15	12.80-0.45	15.68-1.71
20	sardine	28.07.2016.	13.5-17	14.80-0.81	23.72-3.82
21	sardine	29.4.2016.	12.5-17	14.43-1.10	21.62-7.28
22	sardine	20.11.2015	12-16	14.5-0.97	22.56-4.87
23	anchovy	09.08.2016.	13.0-15.5	14.19-0.51	18.56-2.57
24	horse mackerel	08.04.2016.	15.0-21.0	17.59-1.80	48.79-13.41
25	chub mackerel	04.07.2016.	21-22	21.50-0.25	81.96-1.71
26	anchovy	08.03.2016.	13.0-16.0	14.28-0.83	20.47-3.72
27	anchovy	13.06.2016.	13.0-15.5	13.90-0.68	17.13-2.41
28	horse mackerel	13.06.2016.	18.5-20.5	19.50-1.41	59.65-7.09
29	horse mackerel	30.06.2016.	19.5-21	20.0-0.25	75.9-1.71
30	horse mackerel	28.07.2016.	20.0-21.0	20.50-0.71	63.22-11.13
31	chub mackerel	30.06.2016.	23.5-24.0	23.87-0.25	109.59-4.53
32	chub mackerel	28.07.2016.	23.5-24.5	24.0-0.25	119.42-1.71
33	anchovy	31.05.2016.	12.0-16.5	14.25-1.08	18.44-4.33
34	chub mackerel	28.07.2016.	24.5-25.5	25.0-0.25	130.25-1.71
35	horse mackerel	04.07.2016.	20.0-21.0	20.5-0.70	60.98-3.25
36	anchovy	06.05.2016.	13.0-15.5	14.50-0.68	20.66-2.94
37	round sardinella	30.06.2016.	21.0-23.0	22.0-1.14	76.75-23.34

38	anchovy	30.06.2016.	12.0-14.0	13.22-0.62	13.87-1.94
39	anchovy	30.04.2016.	12.5-16.0	14.15-0.87	18.43-3.29
40	anchovy	30.06.2016.	13.0-14.0	13.33-0.44	14.62-1.23
41	anchovy	28.07.2016.	12.5-15.0	13.55-0.61	14.52-2.42
42	horse mackerel	28.07.2016.	18.5-19.5	19.0-0.25	52.99-1.71
43	anchovy	04.07.2016.	12.0-15.0	13.39-0.64	15.07-1.92
44	anchovy	04.07.2016.	12.0-16.0	13.65-0.73	16.12-2.76
45	round sardinella	28.07.2016.	23.0-25.0	23.67-1.15	93.48-14.17
46	anchovy	08.04.2016.	14.5-16.0	15.0-0.5	19.93-1.37
47	anchovy	29.04.2016.	13.0-16.0	14.31-0.63	20.78-3.54
48	horse mackerel	17.03.2016.	11.0-16.0	13.95-0.89	18.74-3.86
49	anchovy	30.08.2016.	12.0-13.5	12.9-0.54	12.88-1.35

S	Fish species	Sampling date	Total length range (cm)	Average total length (cm) and standard deviation	Average body mass (g) and standard deviation
2015					
50	sardine	09.12.2015.	12.5-16.0	14.35-0.76	21.41-3.44
51	sardine	13.07.2015.	14.0-17.0	15.28-0.24	27.92-4.09
52	anchovy	16.06.2015.	13.0-16.5	14.09-0.85	18.93-4.19
53	sardine	15.11.2015.	13.0-16.0	14.50-0.68	21.28-3.10
54	sardine	24.08.2015.	13.0-16.5	14.86-0.85	24.42-4.95
55	chub mackerel	24.08.2015.	10.5-14.5	12.55-1.31	15.17-4.67
56	round sardinella	23.10.2015.	22.0-30.0	25.35-2.00	104.69-42.56
57	chub mackerel	15.11.2015.	19.5-22.0	20.75-1.77	56-37-43.63
58	chub mackerel	13.07.2015.	30.5-35.5	32.5-2.16	305.01-87.30
59	anchovy	24.08.2015.	13.0-15.5	14.0-0.57	17.63-2.62
60	sardine	16.06.2015.	14.0-17.0	15.36-0.64	28.19-3.55
61	round sardinella	15.11.2015.	19.0-21.0	20.13-0.85	60.36-5.94
62	chub mackerel	23.10.2015.	21.0-27.0	22.71-1.50	93.94-24.12
63	sardine	18.09.2015.	13.0-15.5	14.31-0.56	23.29-3.29
64	sardine	25.06.2015.	13.0-15.5	14.22-0.44	20.73-2.28
65	horse mackerel	15.11.2015.	13.0-19.0	16.0-1.48	29.51-10.15
66	horse mackerel	23.10.2015.	19.0-23.0	21.0-1.19	75.29-12.15
67	anchovy	25.06.2015.	12.0-14.5	13.38-0.48	13.42-1.59
68	sardine	15.02.2016.	12.5-16.0	13.84-0.71	17.08-2.77
69	horse mackerel	20.11.2015.	17.0-22.0	19.45-1.57	57.31-14.31
70	sardine	19.08.2015.	10.5-15.0	12.49-1.17	14.22-4.06
71	sardine	22.09.2015.	13.5-14.5	13.83-0.56	20.60-2.98
72	chub mackerel	09.12.2015.	16.5-17.5	17-0.25	37.35-1.71
73	chub mackerel	20.11.2015.	17.0-20.5	19.17-1.89	56.88-17.19
74	horse mackerel	16.07.2015.	16.0-19.0	17.15-1.07	43.57-6.65
75	chub mackerel	16.07.2015.	24.0-28.0	25.50-1.75	134.89-30.66
76	anchovy	18.09.2015.	13.5-14.0	13.90-0.22	16.38-1.04
77	anchovy	16.07.2015.	14.0-17.5	15.29-0.82	23.64-4.08
78	sardine	14.01.2016.	11.5-15.0	12.77-0.76	14.27-12.61
79	horse mackerel	22.09.2015.	16.5-22.5	19.0-2.19	56.78-15.79
80	anchovy	18.09.2015.	13.5-14.0	13.9-0.22	16.38-1.04
81	round sardinella	25.06.2015.	16.5-17.5	17-0.25	37.86-1.71
82	sardine	20.11.2015.	12.0-16.0	14.5-0.98	22.56-4.87
2014					
83	anchovy	2.6.2014.	13-16.6	14.55-0.66	19.93-3.08
84	sardine	3.7.2014.	13.5-15.5	14.72-0.57	25.46-3.05
85	anchovy	3.7.2014.	12.5-15	13.59-0.52	16.37-1.82
86	horse mackerel	3.7.2014.	11-14	14.06-0.75	21.81-3.61

87	chub mackerel	3.7.2014.	26.5-28.5	27.5-1.41	183.66-26.67
88	sardine	25.8.2014.	13-14.5	13.64-0.44	19.0-2.09
89	anchovy	25.8.2014.	12-15	13.16-0.44	13.78-1.32
90	round sardinella	25.8.2014.	21-26	23.42-1.14	96.75-12.51
91	horse mackerel	25.8.2014.	13.5-16	14.55-0.77	23.60-4.43
92	anchovy	29.9.2014.	10-15	13.24-0.75	13.93-2.23
93	chub mackerel	29.9.2014.	11-25	16.45-3.79	41.76-36.66
94	sardine	29.9.2014.	13-17	14.59-0.76	23.51-3.85
95	sardine	28.10.2014.	15-17	15.91-0.67	31.71-3.72
96	round sardinella	28.10.2014.	22-25	23.86-0.84	109.41-15.39
97	horse mackerel	28.10.2014.	16-21.5	18.7-2.36	56.85-19.94
98	sardine	29.10.2014	13.5-15.5	14.72-0.56	26.19-3.05
99	horse mackerel	29.10.2014	16-19	17.2-1.25	25.83-48.71
100	chub mackerel	29.10.2014	18.9-19.8	19.5-0.25	62.41-1.71
101	anchovy	25.11.2014.	12-15	13.71-0.59	14.41-2.04
102	sardine	25.11.2014.	13-16.5	14.09-0.66	20.74-3.71
103	chub mackerel	25.11.2014.	16-32.5	25.92-5.42	140.32-108.28
104	sardine	19.12.2014.	12.5-15	13.69-0.62	19.27-3.09
105	anchovy	19.12.2014.	13-14.5	13.75-0.44	18.61-2.63

Table S2. Fatty acid (FA) profile (% total fatty acids) in five species of small pelagic fish (sardine, anchovy, round sardinella, chub mackerel and horse mackerel)

	Horse Mackerel		Horse mackerel			SardinSardine			RoundSardinella			ChubMackerel			AnchovyAnchovy			
	min	max	max	min	median	max	min	median	max	min	median	max	min	median	max	min	median	
Myristic	0.01	0.10	0.03	0.02	0.04	0.03	0.02	0.02	0.09	0.6	0.05	1.3	0.02	2.0	0.08	0.05	0.02	0.05
Pentacyclic	0.05	0.10	0.03	0.02	0.04	0.03	0.02	0.02	0.09	0.6	0.05	1.3	0.02	2.0	0.08	0.05	0.02	0.05
Palmitic	C16:0		47.4	29.0	32.4	52.9	28.6	36.8	53.0	34.3	36.5	42.6	25.4	29.5	52.0	26.7	41.0	
Palmitoleic	C16:1		6.2	1.6	4.2	10.7	1.6	3.6	7.2	1.8	2.5	3.2	1.4	2.1	4.8	0.9	2.1	
Margaric	C17:0		2.5	0.9	1.4	2.0	0.7	1.1	3.4	1.0	1.4	3.5	0.9	1.3	3.1	1.0	1.5	
Stearic	C18:0		14.7	6.5	12.1	12.4	4.7	6.5	13.3	6.1	9.2	16.9	8.7	10.6	15.0	4.7	7.2	
Oleic	C18:1n-9		27.5	9.2	21.2	21.1	7.4	13.9	17.1	8.1	11.3	25.4	9.5	14.3	19.9	6.1	12.7	
Linoleic	C18:2n-6		2.3	0.9	1.5	2.7	0.4	2.0	2.2	1.5	1.8	3.0	1.1	2.2	4.9	1.1	1.6	
Arachidic	C20:0		0.5	0.2	0.3	1.1	0.1	0.3	0.7	0.3	0.4	0.7	0.2	0.3	1.3	0.0	0.2	
α -Linolenic	C18:3n-3		1.0	0.0	0.5	1.4	0.1	0.7	1.0	0.0	0.6	0.7	0.0	0.5	0.7	0.0	0.4	
Paullinic	C20:1		1.2	0.3	0.6	1.7	0.0	1.1	1.0	0.3	0.6	2.5	0.4	1.4	0.9	0.2	0.5	
Icosadienoic	C20:2n-6		0.9	0.2	0.4	1.6	0.0	0.4	0.5	0.0	0.4	2.3	0.4	0.5	0.7	0.0	0.4	
Dihomo- γ -linolenic	C20:3n-6		0.1	0.0	0.0	1.0	0.0	0.1	0.2	0.0	0.1	0.2	0.0	0.0	0.3	0.0	0.0	
Eicosatrienoic	C20:3n-3		1.0	0.0	0.2	1.2	0.0	0.4	2.3	0.0	0.2	4.7	0.0	0.4	1.0	0.0	0.3	
Erucic+	C22:1n-		4.8	0.4	1.6	5.4	0.1	0.9	5.5	0.3	1.5	3.4	0.4	2.2	3.5	0.3	1.1	
Arahidonic	9+C20:4n-6																	
Eicosapentaenoic	C20:5n-3		6.9	0.9	3.5	8.8	0.6	4.6	6.7	1.1	3.8	6.7	2.6	4.0	5.9	0.3	3.3	
Docosapentaenoic	C22:5n-3		5.2	0.5	1.5	16.0	0.3	0.8	16.9	0.6	0.9	7.0	0.5	1.1	27.5	0.2	0.5	
Docosahexaenoic	C22:6n-3		24.4	0.4	10.4	56.4	0.6	13.4	52.1	0.0	20.0	30.8	1.3	13.4	59.8	0.2	21.3	
Saturated FAs	SFA		64.4	2.5	48.6	75.3	6.5	52.9	62.0	4.4	53.2	66.2	24.9	48.3	66.3	4.3	52.4	
Monounsaturated FAs	MUFA		64.9	11.0	30.0	65.5	10.1	19.6	76.0	12.6	15.8	45.7	11.5	21.5	74.0	9.4	15.7	
Polyunsaturated FAs	PUFA		31.4	6.4	22.9	43.9	0.8	21.2	34.4	2.6	23.4	41.2	12.7	22.1	53.0	1.7	25.5	
ω -3	n-3		28.3	1.2	2.1	35.7	1.3	2.7	24.1	2.1	2.5	38.7	2.1	2.8	35.3	1.5	2.1	
ω -6	n-6		29.8	1.8	17.4	42.0	2.1	18.9	31.9	2.2	21.1	38.5	1.6	19.1	51.5	1.9	23.6	
ω -3/ ω -6	n-3/n-6		25.7	4.2	11.2	33.6	0.0	7.9	13.0	0.1	9.2	37.0	5.2	8.1	34.0	0.1	13.2	
ω -6/ ω -3	n-6/n-3		9.8	0.1	0.1	16.2	0.0	0.1	3.1	0.1	0.1	22.6	0.1	0.1	13.4	0.0	0.1	

HCB	0.01	0.05	0.01	0.01	0.22	0.07	0.01	0.05	0.01	0.01	0.03	0.01	0.01	0.05	0.01
ΣDDT	0.02	0.65	0.13	0.06	4.02	0.93	0.05	0.32	0.11	0.03	0.54	0.15	0.02	0.40	0.10
ΣiPCB	0.15	3.06	0.70	0.43	9.63	2.96	0.31	1.30	0.57	0.10	1.69	0.80	0.20	2.35	0.38
ΣtoxPCBB	0.11	1.04	0.32	0.26	5.54	1.30	0.16	0.47	0.26	0.09	0.69	0.39	0.12	0.92	0.26
Na	736.7	2636.58	1793.74	857.1	3235.8	1787.48	720.50	2364.97	1371.63	475.98	2516.4	1132.5	1237.9	3869.1	2030.15
Mg	467.2	767.6	608.58	478.56	777.43	647.6	507.540	745.300	647.290	506.75	813.77	584.18	520.72	895.77	671.555
K	5217.3	10122.8	7161.62	4726.9	9420.6	7971.8	6521.55	9090.49	7938.9	6376.7	9368.1	8009.3	4830.5	8187.2	7049.38
Ca	406.1	3216.92	940.61	753.17	4624.37	1691.09	792.650	2797.570	1555.960	212.29	1116.61	687.05	889.44	4289.37	1450.39
Cr	0.01	0.068	0.034	0.007	0.148	0.04	0.005	0.047	0.017	0.009	0.103	0.013	0.006	0.048	0.02
Mn	0.10	0.368	0.172	0.409	1.609	0.654	0.357	0.918	0.534	0.092	0.249	0.153	0.171	1.692	0.59
Fe	4.74	18.22	12.02	11.055	32.02	20.42	11.327	20.020	16.859	8.725	22.57	13.73	9.28	33.18	19.92
Co	0.01	0.02	0.011	0.005	0.021	0.013	0.006	0.015	0.009	0.006	0.015	0.01	0.01	0.052	0.0155
Ni	0.03	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Cu	0.67	2.2	0.915	0.975	2.408	1.5615	0.729	1.716	1.205	0.841	1.893	1.309	0.979	3.025	1.9915
Zn	6.72	20.3	14.5	8.44	33.11	25.045	7.900	24.740	17.100	7.51	19.2	11.71	16.23	36.89	25.12
As	2.79	17.941	4.212	3.848	12.066	6.5065	5.110	11.479	7.871	1.544	7.703	3.381	2.908	14.587	5.8
Se	0.33	1.299	0.687	0.403	1.287	0.7855	0.530	1.059	0.874	0.316	1.304	0.69	0.236	0.578	0.481
Cd	0.0002	0.014	0.005	0.001	0.018	0.009	0.002	0.019	0.005	0.001	0.019	0.009	0.004	0.036	0.0165
Hg	0.01	0.174	0.056	0.002	0.098	0.031	0.002	0.121	0.036	0.003	0.205	0.016	0.004	0.093	0.0295
Pb	0.001	0.026	0.007	0.001	0.035	0.012	0.001	0.032	0.006	0.001	0.02	0.004	0.001	0.018	0.005

Table S3. Levels of organochlorine compounds (ng g^{-1} wet weight) and trace elements (mg kg^{-1} wet weight) in five species of small pelagic fish (sardine, anchovy, round sardinella, chub mackerel and horse mackerel); iPCB–indicator and toxPCB–toxicologically relevant polychlorinated biphenyl

Table S4. Unmix derived source profiles [%]

	Source 1 Short-living POPs	Source 2 Overlapping diet/surrounding environment	Source 3 Overlapping diet/surrounding environment	Source 4 Short-living POPs	Source 5 Naturally occurring inorganic elements burden
Cu	0	3.5	10.8	14.4	71.3
Na	0	3.0	7.0	19.6	70.4
Mn	0	6.3	18.4	7.1	68.2
Ca	0	0	26.5	15.2	58.2
α -HCH	38.6	17.6	0	12.1	31.6
β -HCH	4.7	28.6	5.9	40.8	20.0
γ -HCH	5.6	44.7	0.7	36.6	12.5
HCB	29.6	26.6	7.2	36.5	0
<i>p,p'</i> -DDE	0	51.5	30.3	18.2	0
<i>p,p'</i> -DDD	13.9	55.3	14.9	15.8	0
<i>p,p'</i> -DDT	13.2	44.6	13.1	21.6	7.5
PCB-28	47.6	0	0	37.8	14.6
PCB-101	14.0	32.1	41.0	12.8	0
PCB-138	0	37.1	46.7	16.2	0
PCB-153	0	33.1	48.3	18.6	0
PCB-180	0	41.7	36.9	21.5	0
PCB-105	1.6	48.6	13.4	22.8	13.6
PCB-114	25.1	71.5	0	0	3.4
PCB-118	0	45.5	39.7	14.8	0
PCB-123	-17.5	49.3	46.1	22.1	0
PCB-156	21.1	43.2	19.3	13.3	3.0
PCB-157	0	13.5	67.4	19.0	0
PCB-167	-7.5	45.6	41.2	20.7	0
PCB-189	-8.1	25.6	36.6	44.7	1.2
PCB-60	40.6	30.2	0	0	29.2
PCB-74	94.3	3.8	0	0	1.9
PCB-170	0	31.7	47.1	21.2	0
Average contribution	11.7	30.9	22.9	19.4	15.1

Table S5. Output of the one-way ANOVA analysis for the studied fatty acids and elements in marine fish; significant differences are given in bold; data on round sardinella were not included in calculation due to the number of samples

Fatty acids						
Anchovy						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
<i>Between Groups</i>	43551.851	18	2419.54728	141.515236	2.12E-169	1.627506
<i>Within Groups</i>	7471.57824	437	17.0974331			
<i>Total</i>	51023.4292	455				
Horse Mackerel						
<i>Between Groups</i>	20978.9731	18	1165.4985	176.243621	2.49E-136	1.642758
<i>Within Groups</i>	1759.05715	266	6.6129968			
<i>Total</i>	22738.0302	284				
Chub Mackerel						
<i>Between Groups</i>	16114.8344	18	895.268576	109.825028	8.28E-112	1.642758
<i>Within Groups</i>	2168.37133	266	8.1517719			
<i>Total</i>	18283.2057	284				
Sardine						
<i>Between Groups</i>	79786.1003	18	4432.56113	266.315094	0	1.614722
<i>Within Groups</i>	15811.8453	950	16.6440477			
<i>Total</i>	95597.9456	968				
Elements						
Anchovy						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
<i>Between Groups</i>	1102160229	14	78725730.7	611.106955	1.03E-233	1.720525
<i>Within Groups</i>	44444555.6	345	128824.799			
<i>Total</i>	1146604785	359				
Horse Mackerel						
<i>Between Groups</i>	741246786	14	52946199	293.819503	1.98E-129	1.739123
<i>Within Groups</i>	37841946.1	210	180199.743			
<i>Total</i>	779088732	224				
Chub Mackerel						
<i>Between Groups</i>	859106748	14	61364767.7	917.174725	1.01E-179	1.739123
<i>Within Groups</i>	14050323.1	210	66906.3005			
<i>Total</i>	873157071	224				
Sardine						
<i>Between Groups</i>	2904168798	14	207440628	1355.88159	0	1.704971
<i>Within Groups</i>	114744881	750	152993.174			
<i>Total</i>	3018913679	764				