frontiers

Supplementary Material

From west to east: Heterogeneity in the life history traits of the European sardine throughout the Mediterranean

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Supplementary Table 1. Summary of the sampled individuals of European sardine (*Sardina pilchardus*) by season. N: number of total individuals and the identified by sex (F, female or M, male); Atl: Atlantic Ocean; Med: Mediterranean Sea; *Kn*: Le Crens's index; HSI: hepatosomatic index. Parentheses include the minimum and the maximum by subarea and season for each parameter.

Area	Season	N		Mean length ± SD (cm)	*Kn*	Tissue fat content ± SD (%)	Mesenteric fat (median) (#)	HSI ± SD (%)
		F	M					
South Portugal (FAO Division 27.9.a) Atl	Winter	189		18.372 ± 0.918	0.864 ± 0.063	7.722 ± 2.250	1	0.468 ± 0.292
	Feb, Mar	87	102	(13.5 - 20.4)	(0.713 - 1.057)	(3.7 - 14.70)	(1 - 3)	(0.053 - 1.536)
	Spring	204		16.859 ± 1.314	0.998 ± 0.113	13.369 ± 7.13	(1 - 7)	0.739 ± 0.482
	May, Jun	100	104	(13.9 - 20.1)	(0.692 - 1.353)	(3.0 - 27.9)		(0.098 - 2.793)
	Summer	101					(4 - 7)	

	Sep	50	51	17.502 ± 1.185 (14.4 - 21.0)	1.231 ± 0.114 (0.919 - 1.535)	22.325 ± 2.978 (12.2 - 30.25)		0.752 ± 0.340 (0.189 - 1.742)
	Autumn	105		18.486 ± 0.815	1.194 ± 0.091	19.309 ± 2.148	7	-
	Oct	49	56	(16.6 - 22.0)	(0.905 - 1.440)	(7.9 - 24.95)	(2 - 7)	
	Winter	20		19.235 ± 0.908	0.868 ± 0.051	8.578 ± 1.883	1	0.240 ± 0.097
	Feb	7	13	(15.9 - 20.4)	(0.794 - 0.976)	(4.75 - 11.25)	(1 - 2)	(0.080 - 0.480)
Northern Alboran (GSA 1) Med	Spring	208		14.958 ± 3.547	0.990 ± 0.092	7.441 ± 2.198	2	0.378 ± 0.268
	Apr, Jun	53	52	(9.1 - 20.4)	(0.745 - 1.372)	(3.90 - 15.50)	(1 - 6)	(0.071 - 2.111)
	Summer	99		16.303 ± 0.941	1.129 ± 0.081	16.322 ± 2.144	7	0.735 ± 0.266
	Aug	44	54	(10.8 - 19.1)	(0.922 - 1.442)	(6.95 - 20.60)	(1 - 7)	(0.174 - 1.691)
	Autumn	202					6	

	Oct, Nov	95	107	16.522 ± 3.149 (11.1 - 23.0)	1.089 ± 0.066 (0.724 - 1.238)	13.874 ± 6.282 (4.05 - 24.65)	(2 - 7)	0.535 ± 0.229 (0.086 - 1.414)
Northern Spain (GSA 6) Med	Winter	233		13.427 ± 1.083 (10.8 - 17.3)	0.857 ± 0.079 (0.673 - 1.293)	5.515 ± 1.641 (2.15 - 11.15)	1 (1 - 4)	0.400 ± 0.256 (0.040 - 1.488)
	Feb, Mar	102	131					
	Spring	110		13.144 ± 1.012 (9.5 - 16.0)	1.018 ± 0.052 (0.782 - 1.162)	10.013 ± 3.481 (3.50 - 18.40)	5 (1 - 7)	0.520 ± 0.327 (0.074 - 1.971)
	May, Jun	68	34					
	Summer	105		13.635 ± 1.016 (10.9 - 15.4)	1.027 ± 0.067 (0.866 - 1.269)	13.489 ± 3.756 (2.60 - 20.95)	6 (1 - 7)	0.480 ± 0.177 (0.154 - 0.949)
	Jul, Aug	60	39					
	Autumn	204		14.627 ± 1.068 (11.7 - 17.6)	0.981 ± 0.096 (0.794 - 1.968)	11.150 ± 3.274 (4.40 - 17.20)	4 (1 - 7)	0.468 ± 0.192 (0.140 - 1.021)
	Oct, Nov, Dec	91	113					
Northern	Winter	202		13.811 ± 0.944 (11.2 - 16.0)	0.978 ± 0.109	6.985 ± 2.948	2 (1 - 7)	0.957 ± 0.493
	Jan, Feb	114	88					

Adriatic Sea					(0.788 - 1.421)	(3.10 - 18.65)		(0.165 - 2.474)
(GSA 17) **Med**	Spring May, Jun	200	108	92	12.775 ± 0.586 (11.0 - 14.5)	1.065 ± 0.150 (0.834 - 1.711)	12.187 ± 3.349 (4.30 - 22.0)	5 (1 - 7)	0.949 ± 0.456 (0.123 - 2.223)
	Summer Sep	101	63	37	13.391 ± 0.613 (12.3 - 15.6)	1.041 ± 0.069 (0.780 - 1.246)	15.291 ± 1.922 (11.05 - 21.35)	7 (3 - 7)	0.668 ± 0.277 (0.039 - 1.472)
	Autumn Nov, Dec	201	126	75	13.497 ± 0.832 (10.7 - 15.6)	1.014 ± 0.173 (0.786 - 1.764)	8.176 ± 3.994 (3.30 - 16.85)	2 (1 - 7)	0.365 ± 0.261 (0.043 - 2.888)
Aegean Sea **(GSA 22)** **Med**	Winter Jan, Feb	216	44	172	12.134 ± 0.865 (10.6 - 16.3)	0.972 ± 0.075 (0.795 - 1.424)	5.142 ± 1.630 (3.10 - 12.60)	1 (1 - 3)	0.432 ± 0.290 (0.056 - 1.927)
	Spring Jun	102	85	17	12.797 ± 0.530 (11.7 - 14.5)	1.031 ± 0.071 (0.765 - 1.184)	9.800 ± 2.806 (4.35 - 16.85)	5 (1 - 6)	0.570 ± 0.318 (0.073 - 1.369)

Summer Jul	100 70	30	13.794 ± 0.577 (12.3 - 15.6)	1.095 ± 0.060 (0.968 - 1.264)	17.509 ± 2.818 (10.85 - 26.20)	6 (2 - 7)	0.750 ± 0.262 (0.071 - 1.342)
Autumn Oct, Nov, Dec	199 82	116	13.205 ± 1.078 (10.2 - 15.5)	0.997 ± 0.076 (0.463 - 1.222)	9.666 ± 3.637 (2.05 - 17.90)	3 (1 - 7)	0.355 ± 0.256 (0.041 - 2.213)

Supplementary Table 2. Summary of the variables/indices comparing subareas of European sardine (*S. pilchardus*) by reproductive stage. L_T: total length (cm); W_T: total weight (g); W_E: eviscerated weight (g); *Kn*: relative condition index; *GSI*: gonadosomatic index (%); *HSI*: hepatosomatic index (%); *% V*: stomach vacuity index (%). Significance values: $P < 0.05$*; < 0.001**; < 0.0001***.

Immature									
Variable/Index	Mean ± SD					N	Test	Statistic	*P*
	Atl	GSA 1	GSA 6	GSA 17	GSA 22				
L_T (cm)	13.50 ± 0.00	12.19 ± 1.15	12.22 ± 1.32	12.95 ± 0.35	11.37 ± 0.54	79	Welch test	F = 3.07	0.0214 *
W_T (g)	15.70 ± 0.00	14.84 ± 4.84	14.29 ± 4.98	17.30 ± 0.42	10.66 ± 1.85	79	Welch test	F = 3.651	0.00906 **
W_E (g)	13.60 ± 0.00	13.56 ± 4.54	12.86 ± 4.38	15.60 ± 0.42	9.57 ± 1.65	79	Welch test	F = 3.831	0.00695 **
Kn	0.79 ± 0.00	1.07 ± 0.08	1.00 ± 0.06	1.05 ± 0.12	0.97 ± 0.06	79	Kruskal-Wallis	X^2 = 23.813	0.00008708 ***

GSI	0.2243 ± 0.0000	0.2834 ± 0.1801	0.1877 ± 0.1511	0.1108 ± 0.0541	0.1784 ± 0.0877	79	Kruskal-Wallis	X^2 = 9.1255	0.05804 NS
HSI	0.1184 ± 0.0000	0.4477 ± 0.1080	0.5269 ± 0.4054	0.7119 ± 0.0044	0.3310 ± 0.1769	79	Kruskal-Wallis	X^2 = 8.7205	0.06848 NS
Tissue fat content	6.90 ± 0.00	6.81 ± 2.67	8.78 ± 4.42	15.25 ± 1.70	5.74 ± 1.72	79	Welch test	F = 5.701	0.000469 ***
Mesenteric fat (median)	1	5	3	6	2	79	Pearson's X^2 test	X^2 = 29.479	0.2026 NS
% V	0.00	75.00	35.71	0.00	0.00	79	Pearson's X^2 test	X^2 = 52.692	0.00000001237 ***

Developing

Variable/Index	Mean ± SD					N	Test	Statistic	*P*
	Atl	GSA 1	GSA 6	GSA 17	GSA 22				
***L_T* (cm)**	17.98 ± 1.04	15.14 ± 2.34	14.55 ± 1.11	13.08 ± 0.75	13.23 ± 0.79	665	Welch test	F = 724.87	2.2e-16 ***
***W_T* (g)**	57.75 ± 9.54	32.16 ± 18.65	24.33 ± 5.91	18.66 ± 2.66	18.18 ± 3.55	665	Welch test	F = 718.84	2.2e-16 ***
***W_E* (g)**	51.22 ± 8.54	29.32 ± 16.60	22.28 ± 5.47	16.75 ± 2.43	16.38 ± 3.27	665	Welch test	F = 696.14	2.2e-16 ***
Kn	1.18 ± 0.12	1.09 ± 0.06	1.00 ± 0.11	1.09 ± 0.13	1.01 ± 0.08	665	Welch test	F = 72.62	2.2e-16 ***
GSI	1.2048 ± 0.9707	2.1990 ± 0.9159	1.4695 ± 1.093	0.4326 ± 0.1724	2.0885 ± 2.0745	665	Welch test	F = 113.24	2.2e-16 ***
HSI	0.8209 ± 0.3935	0.6963 ± 0.3733	0.4938 ± 0.1787	1.0299 ± 0.4520	0.4061 ± 0.2906	665	Welch test	F = 59.273	2.2e-16 ***
Tissue fat content	20.44 ± 3.32	11.02 ± 4.13	12.47 ± 3.33	14.11 ± 2.16	10.20 ± 3.44	665	GLM	z = 3.763	0.000168 ***

Mesenteric fat (median)	7	6	5	6	4	665	Pearson's X^2 test	$X^2 = 412.2$	2.2e-16 ***
% V	5.38	0.00	15.38	23.77	2.50	665	Pearson's X^2 test	$X^2 = 159.74$	2.2e-16 ***

Spawning capable									
Variable/Index	Mean ± SD					N	Test	Statistic	*P*
	Atl	GSA 1	GSA 6	GSA 17	GSA 22				
***L_T* (cm)**	18.44 ± 1.20	19.51 ± 0.86	14.83 ± 1.13	13.41 ± 0.97	13.83 ± 0.94	191	Kruskal-Wallis	$X^2 = 148.71$	2.2e-16 ***
***W_T* (g)**	61.98 ± 13.72	70.23 ± 8.28	25.73 ± 7.06	18.79 ± 3.83	20.76 ± 5.09	191	Welch test	F = 513.92	2.2e-16 ***
***W_E* (g)**	54.84 ± 11.79	62.07 ± 7.13	23.30 ± 6.54	16.95 ± 3.35	18.69 ± 4.58	191	Welch test	F = 523.4	2.2e-16 **
Kn	1.16 ± 0.15	1.10 ± 0.07	0.98 ± 0.08	1.02 ± 0.20	0.99 ± 0.04	191	Welch test	F = 23.217	2.545e-10
GSI	4.2735 ± 1.8342	4.5439 ± 1.4230	3.4604 ± 1.5329	1.9365 ± 1.3709	2.3444 ± 1.6667	191	ANOVA	F = 17.29	4.46e-12 ***
HSI	0.6240 ± 0.2410	0.5077 ± 0.2131	0.4830 ± 0.2141	0.5405 ± 0.5642	0.5032 ± 0.1550	191	Kruskal-Wallis	$X^2 = 4.9247$	0.2951 NS
Tissue fat content	17.74 ± 5.89	19.86 ± 2.29	10.93 ± 2.85	8.37 ± 4.22	12.84 ± 3.76	191	Welch test	F = 102.54	2.2e-16 ***
Mesenteric fat (median)	6	6	4	4	5	191	Pearson's X^2 test	$X^2 = 126.12$	7.788e-16 ***
% V	8.33	9.09	22.73	0.00	0.00	191	Pearson's X^2 test	$X^2 = 69.923$	5.091e-12 ***

Actively spawning									
Variable/Index	Mean ± SD					N	Test	Statistic	*P*
	Atl	GSA 1	GSA 6	GSA 17	GSA 22				
***L_T* (cm)**	17.59 ± 1.45	18.95 ± 0.95	13.65 ± 1.04	13.71 ± 0.89	12.30 ± 1.03	1158	Welch test	F = 1110.3	2.2e-16 ***
***W_T* (g)**	41.28 ± 10.17	55.15 ± 11.05	17.34 ± 4.73	20.43 ± 4.14	14.65 ± 5.00	1158	Welch test	F = 574.79	2.2e-16 ***
***W_E* (g)**	36.12 ± 8.83	49.43 ± 9.35	15.57 ± 4.22	17.90 ± 3.40	12.74 ± 4.10	1158	Welch test	F = 613.93	2.2e-16 ***
Kn	0.88 ± 0.06	0.95 ± 0.09	0.86 ± 0.08	0.99 ± 0.14	0.98 ± 0.08	1158	Welch test	F = 119.03	2.2e-16 ***
GSI	5.2253 ± 2.4577	4.6119 ± 3.3453	3.3739 ± 1.4386	4.0605 ± 1.7536	5.4905 ± 1.9421	1158	Welch test	F = 57.321	2.2e-16 ***
HSI	0.4705 ± 0.3196	0.3808 ± 0.3011	0.3773 ± 0.2132	0.6318 ± 0.4655	0.4229 ± 0.2862	1158	Welch test	F = 19.948	5.93e-15 ***
Tissue fat content	7.46 ± 2.27	10.11 ± 5.00	6.18 ± 2.29	7.42 ± 3.43	5.51 ± 2.18	1158	Welch test	F = 40.836	2.2e-16 ***
Mesenteric fat (median)	1	2	1	2	1	1158	Pearson's X^2 test	X^2 = 346.29	2.2e-16 ***
% V	1.20	5.88	41.71	19.32	17.58	1158	Pearson's X^2 test	X^2 = 247.5	2.2e-16 ***

Regressing									
Variable/Index	Mean ± SD					N	Test	Statistic	*P*
	Atl	GSA 1	GSA 6	GSA 17	GSA 22				
***L_T* (cm)**	16.22 ± 1.67	18.09 ± 1.09	13.34 ± 1.16	13.28 ± 0.88	13.84 ± 0.86	186	GLM	z = -6.555	5.57e-11 ***

***W_T* (g)**	30.68 ± 7.94	47.32 ± 6.65	18.66 ± 5.35	18.36 ± 4.16	21.82 ± 5.33	186	Welch test	F = 181.01	2.2e-16 ***
***W_E* (g)**	27.47 ± 7.29	43.36 ± 6.38	16.84 ± 4.92	16.23 ± 3.95	19.62 ± 4.83	186	Welch test	F = 172.11	2.2e-16 ***
Kn	0.88 ± 0.09	0.98 ± 0.10	0.99 ± 0.09	0.99 ± 0.12	1.04 ± 0.15	186	ANOVA	F = 7.946	0.00000636 ***
GSI	1.3382 ± 0.8301	0.9701 ± 0.5440	0.6750 ± 0.5489	1.4763 ± 0.9229	0.4367 ± 0.1463	186	Welch test	F = 16.492	0.00000003385 ***
HSI	0.4464 ± 0.2584	0.4716 ± 0.2791	0.5371 ± 0.2994	0.9856 ± 0.4909	0.8361 ± 0.2406	186	Welch test	F = 9.6597	0.0001329 **
Tissue fat content	6.54 ± 2.40	10.99 ± 4.36	8.70 ± 4.42	8.71 ± 3.91	14.72 ± 6.12	186	Kruskal-Wallis	X^2 = 22.665	0.0001477 **
Mesenteric fat	1	3	4	3	5	186	Pearson's X^2 test	X^2 = 122.82	3.05e-15 ***
% V	3.85	6.12	14.55	45.45	0	186	Pearson's X^2 test	X^2 = 48.243	0.00000008877 ***

Regenerating									
Variable/Index	Mean ± SD					N	Test	Statistic	*P*
	Atl	GSA 1	GSA 6	GSA 17	GSA 22				
***L_T* (cm)**	17.81 ± 0.77	15.29 ± 1.92	13.67 ± 0.93	12.90 ± 0.57	13.34 ± 0.81	721	Welch test	F = 849.54	2.2e-16 ***
***W_T* (g)**	54.51 ± 7.00	32.18 ± 11.85	20.29 ± 4.25	17.30 ± 2.40	20.01 ± 4.25	721	Welch test	F = 734.01	2.2e-16 ***
***W_E* (g)**	48.02 ± 6.32	29.48 ± 10.80	18.44 ± 4.04	15.41 ± 2.16	17.89 ± 3.82	721	Welch test	F = 699.29	2.2e-16 ***
Kn	1.14 ± 0.11	1.09 ± 0.10	1.02 ± 0.06	1.04 ± 0.13	1.07 ± 0.07	721	Welch test	F = 36.512	2.2e-16 ***
GSI	0.5290 ± 0.3107	0.4485 ± 0.3741	0.32096 ± 0.2499	0.2929 ± 0.1969	0.3416 ± 0.1754	721	Welch test	F = 15.493	1.236e-11 ***

HSI	0.9417 ± 0.4500	0.6839 ± 0.2844	0.4969 ± 0.2388	0.7369 ± 0.3795	0.6844 ± 0.3049	721	Welch test	F = 23.572	2.2e-16 ***
Tissue fat content	20.1802 ± 3.5600	12.2360 ± 4.7578	11.9923 ± 3.6743	12.6252 ± 3.8208	14.4915 ± 4.9073	721	GLM	z = 4.649	0.00000333 ***
Mesenteric fat	7	7	6	5	5	721	Pearson's X^2 test	X^2 = 239.18	2.2e-16 ***
% V	1.19	12.5	15.00	33.14	3.40	721	Pearson's X^2 test	X^2 = 213.18	2.2e-16 ***