

Faster growth during their first year leads to increased oxidative damage in wild European sardines – Electronic Supplementary Material

Raphaëlle Huard, Karine Salin, Pablo Brosset, Maxime Olmos and Christophe Lebigre

A. Sample collection

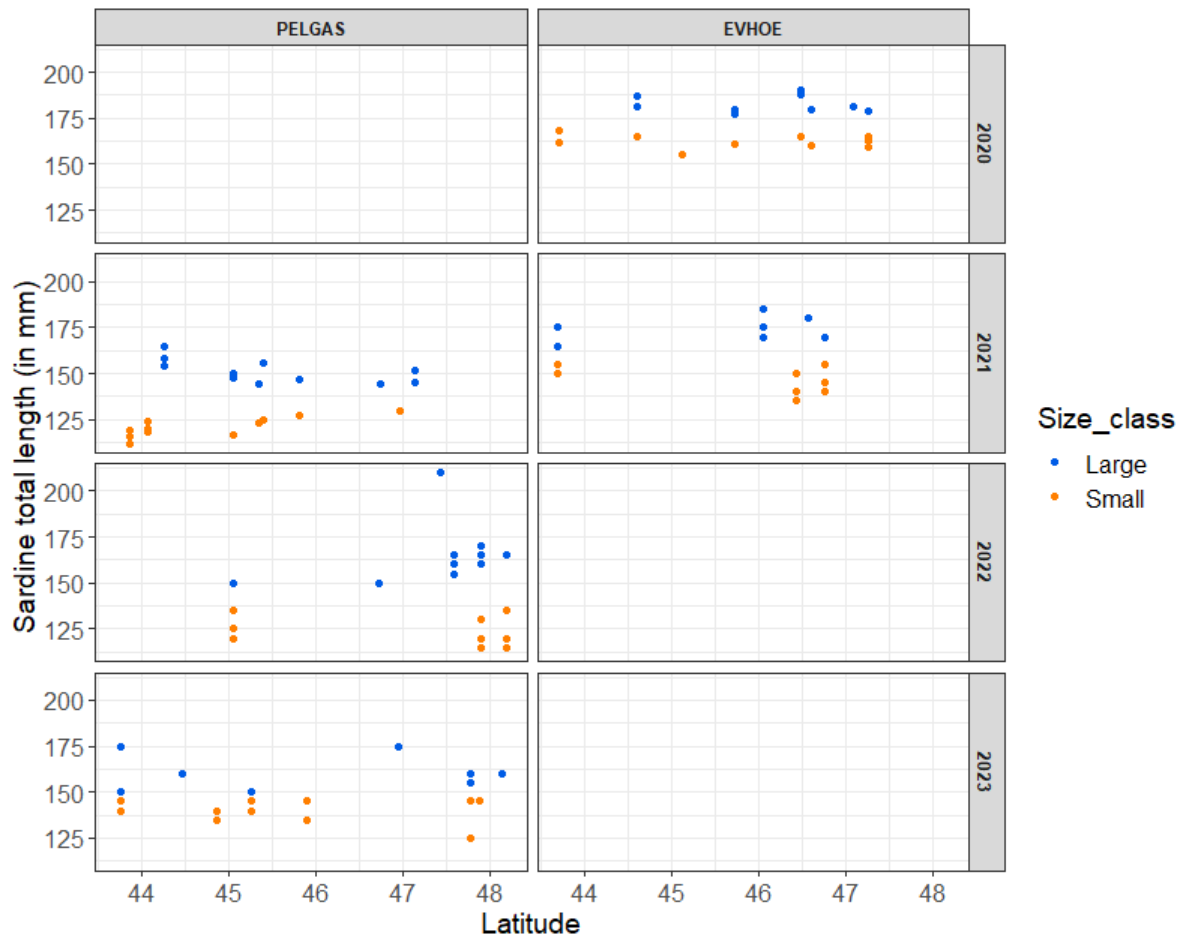


Fig. S1 Selected sardines' size distribution regarding latitude

Fig. S1 emphasizes that our sampling is spatially uniform in sizes, i.e. we do not have for instance all small sardines in the southern part of the Bay of Biscay and all large sardines in the north.

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B. Exploration of the relationship between malondialdehyde and polyunsaturated fatty acid contents

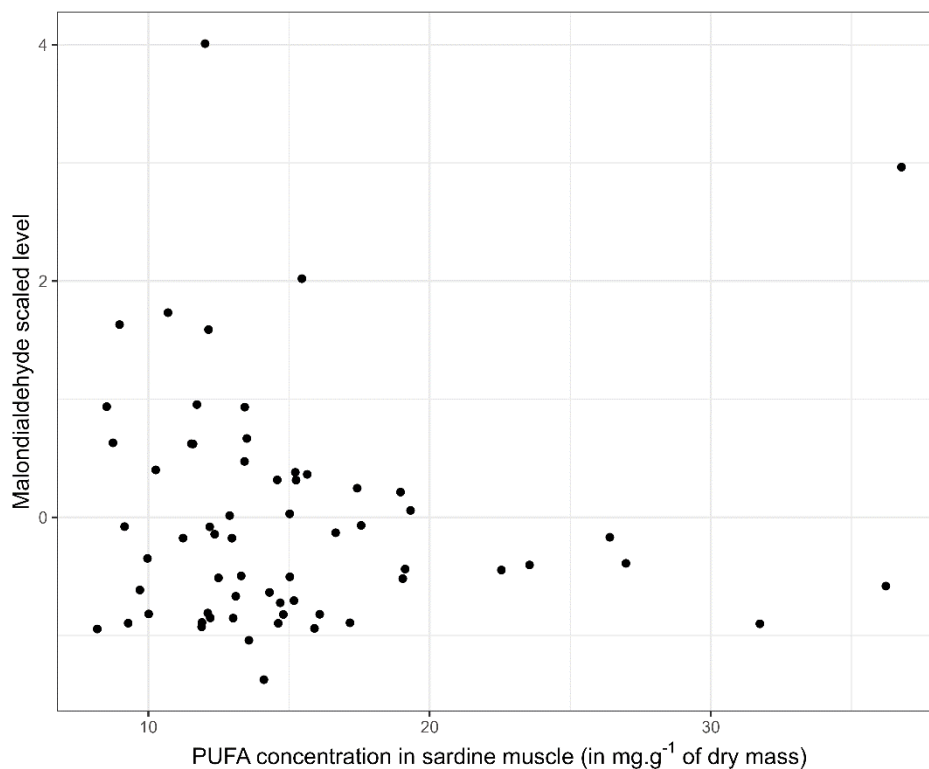


Fig. S2 Relationship between malondialdehyde level and PUFA concentration in sardine muscle

Table S1. Results of the model quantifying the effect of PUFA concentration on MDA level in sardines' muscle

<i>Dependant variable</i>	<i>Source of variation</i>	<i>Parameter estimate ± SE</i>	<i>Statistics</i>
MDA scaled level	Intercept	-0.51 ± 0.34	
	PUFA concentration	0.03 ± 0.02	t value = 1.68 ; p = 0.09

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C. Correlation between biomarkers of oxidative damage

Table S2 Pearson's product moment correlation coefficient (*PCC*) between malondialdehyde and protein carbonyl levels within each survey

	EVHOE 2020	PELGAS 2021	EVHOE 2021	PELGAS 2022	PELGAS 2023
<i>PCC</i>	0.744	0.758	0.440	0.568	0.833
<i>p-value</i>	< 0.001	< 0.001	0.053	0.011	< 0.001

According to Pearson's product moment correlation coefficients (Table S1), malondialdehyde and protein carbonyl contents are positively correlated within each survey. The strength of the correlation varies among surveys, with moderate correlations for EVHOE 2021 and PELGAS 2022, and strong correlations for EVHOE 2020, PELGAS 2021 and for PELGAS 2023. Apart from EVHOE 2021, intra-survey correlation coefficients are significant.

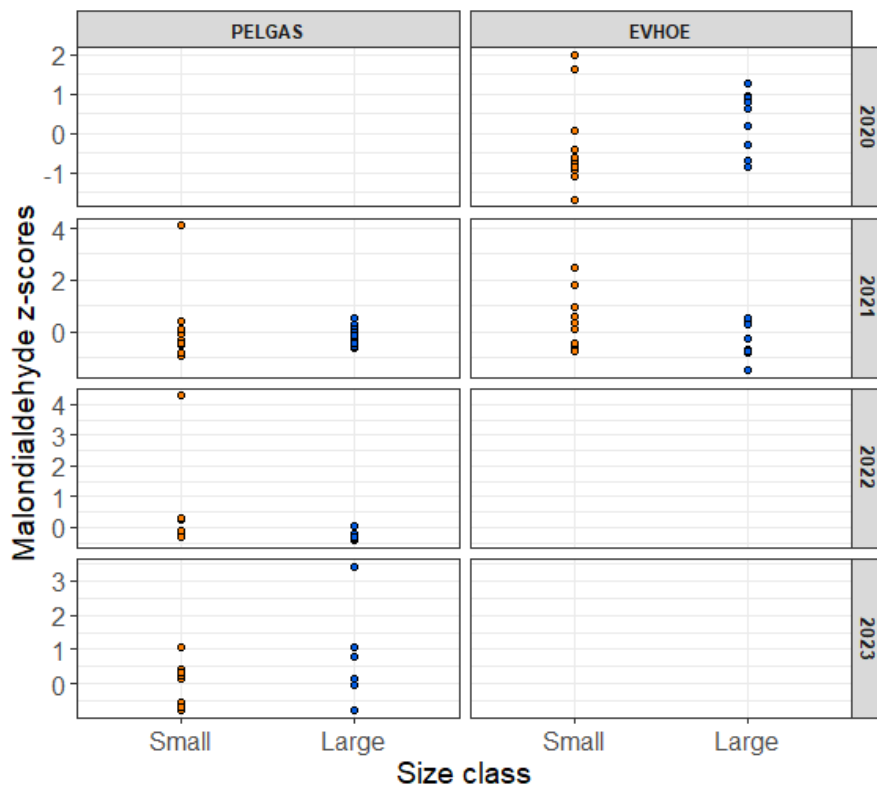


Fig. S3 Representation of the relationships between sardine size class and malondialdehyde z-scores within each survey

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D. Sample size of interactions tested in our statistical analyses

Table S3.a Sample distribution of protein carbonyl data across Size class and Survey

	Small	Large
EVHOE 2020	10	10
PELGAS 2021	10	9
EVHOE 2021	10	10
PELGAS 2022	9	10
PELGAS 2023	10	10

Table S3.b Sample distribution of malondialdehyde data across Size class and Survey

	Small	Large
EVHOE 2020	10	10
PELGAS 2021	11	11
EVHOE 2021	10	10
PELGAS 2022	10	11
PELGAS 2023	11	11

Table S4.a Sample distribution of protein carbonyl data across Size class and Maturity stage

	Small	Large
Immature	30	12
Mature	19	35

Table S4.b Sample distribution of malondialdehyde data across Size class and Maturity stage

	Small	Large
Immature	32	14
Mature	20	37

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E. Results of linear mixed effect models on malondialdehyde z-scores

Table S5.a Linear mixed models on malondialdehyde z-scores and associated degrees of freedom (d.f.), estimates and standard errors (s.e.). This model is weighted using delta. The intercept is set to Size class = Small, Maturity stage = Immature and Survey = EVHOE 2020

<i>Term</i>	<i>d.f.</i>	χ^2	<i>p-value</i>	<i>Fixed effects</i>	<i>Estimate</i>	<i>s.e.</i>
Final model						
Null model				Intercept	0.008	0.105
Dropped terms						
Size class	1	1.971	0.160	Large	-0.269	0.192
Maturity stage	1	1.602	0.206	Mature	0.271	0.214
Survey	4	0.945	0.918	EVHOE 2021	-0.052	0.388
				PELGAS 2021	0.241	0.393
				PELGAS 2022	0.248	0.398
				PELGAS 2023	0.255	0.427
Size class:Survey	4	8.333	0.080	Large:EVHOE 2021	-1.577	0.677
				Large:PELGAS 2021	-1.263	0.656
				Large:PELGAS 2022	-1.226	0.605
				Large:PELGAS 2023	-0.304	0.704
Size class:Maturity stage	1	2.659	0.103	Large:Mature	-0.890	0.546

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Table S5.b Linear mixed models on malondialdehyde z-scores and associated degrees of freedom (d.f.), estimates and standard errors (s.e.). This additional model is not weighted using delta.

<i>Term</i>	<i>d.f.</i>	χ^2	<i>p-value</i>	<i>Fixed effects</i>	<i>Estimate</i>	<i>s.e.</i>
Final model						
				Intercept	-0.568	0.418
Size class	1	0.998	0.318	Large	0.593	0.430
Maturity stage	1	2.261	0.133	Mature	0.410	0.273
Survey	4	0.522	0.971	EVHOE 2021	0.678	0.516
				PELGAS 2021	0.786	0.534
				PELGAS 2022	0.808	0.547
				PELGAS 2023	0.334	0.508
Size_class:Survey	4	9.812	0.044	Large:EVHOE 2021	-1.597	0.641
				Large:PELGAS 2021	-1.223	0.632
				Large:PELGAS 2022	-1.244	0.612
				Large:PELGAS 2023	-0.253	0.612
Dropped terms						
Size class:Maturity stage	1	0.444	0.506	Large:Mature	-0.371	0.557

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Table S5.c Linear mixed models on malondialdehyde z-scores and associated degrees of freedom (d.f.), estimates and standard errors (s.e.). This additional model is fitted using sardines' total body length instead of Size class and is not weighted using delta.

<i>Term</i>	<i>d.f.</i>	χ^2	<i>p-value</i>	<i>Fixed effects</i>	<i>Estimate</i>	<i>s.e.</i>
Final model						
Null model				Intercept	0.005	0.100
Dropped terms						
Maturity stage	1	0.112	0.738	Mature	0.067	0.201
Total length	1	0.454	0.500	Total length	-0.004	0.007
Survey	4	0.265	0.992	EVHOE 2021	-0.128	0.375
				PELGAS 2021	-0.058	0.410
				PELGAS 2022	-0.007	0.401
				PELGAS 2023	0.055	0.391
Total length:Maturity stage	1	0.560	0.454	Total length:Mature	-0.010	0.014
Total length:Survey	4	5.013	0.286	Total length:EVHOE 2021	-0.039	0.026
				Total length:PELGAS 2021	-0.052	0.031
				Total length:PELGAS 2022	-0.040	0.025
				Total length:PELGAS 2023	-0.012	0.030

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F. Results of linear mixed effect models on protein carbonyl z-scores

Table S6.a Linear mixed models on protein carbonyl z-scores and associated degrees of freedom (d.f.), estimates and standard errors (s.e.). This additional model is not weighted using delta.

<i>Term</i>	<i>d.f.</i>	χ^2	<i>p-value</i>	<i>Fixed effects</i>	<i>Estimate</i>	<i>s.e.</i>
Final model						
				Intercept	-0.224	0.163
Size class	1	8.592	0.003	Large	0.542	0.185
Dropped terms						
Maturity stage	1	0.003	0.956	Mature	-0.013	0.232
Survey	4	0.463	0.977	EVHOE 2021	-0.223	0.472
				PELGAS 2021	-0.108	0.456
				PELGAS 2022	0.083	0.491
				PELGAS 2023	0.004	0.452
Size class:Maturity stage	1	1.427	0.232	Large:Mature	0.468	0.391
Size class:Survey	4	1.065	0.900	Large:EVHOE 2021	-0.275	0.606
				Large:PELGAS 2021	0.255	0.754
				Large:PELGAS 2022	0.035	0.756
				Large:PELGAS 2023	-0.319	0.708

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Table S6.b Linear mixed models on protein carbonyl z-scores and associated degrees of freedom (d.f.), estimates and standard errors (s.e.). This additional model is fitted using sardines' total body length instead of Size class and is not weighted using delta.

<i>Term</i>	<i>d.f.</i>	χ^2	<i>P-value</i>	<i>Fixed effects</i>	<i>Estimate</i>	<i>s.e.</i>
Final model						
				Intercept	-2.229	0.790
Total length	1	8.620	0.003	Total length	0.015	0.005
Dropped terms						
Maturity stage	1	0.774	0.379	Mature	-0.239	0.272
Survey	4	2.248	0.690	EVHOE 2021	0.040	0.480
				PELGAS 2021	0.581	0.477
				PELGAS 2022	0.532	0.487
				PELGAS 2023	0.388	0.460
Total length:Survey	4	4.396	0.355	Total length:EVHOE 2021	-0.012	0.024
				Total length:PELGAS 2021	-0.014	0.024
				Total length:PELGAS 2022	-0.035	0.020
				Total length:PELGAS 2023	-0.025	0.025
Total length:Maturity stage	1	0.015	0.902	Total length:Mature	-0.002	0.018