

ONLINE RESOURCE 5: SUMMARY STATISTICS AND STATISTICAL TESTS

Summary statistics European hake data

Table S5.1. Summary statistics of European hake isotopic values, presented overall and separated by assigned provenance.

Isotope	Assigned Class (provenance)	N	Mean	Variance	SD	Median	Min	Max
$\delta^{13}\text{C}$	Atlantic	21	-12.68	0.24	0.49	-12.68	-13.73	-11.73
	Mediterranean	10	-14.19	1.66	1.29	-13.70	-16.74	-12.75
	All samples	31	-13.16	1.18	1.08	-12.83	-16.74	-11.73
$\delta^{15}\text{N}$	Atlantic	21	12.78	0.37	0.61	12.70	11.72	14.05
	Mediterranean	10	10.66	0.70	0.84	10.76	9.57	11.84
	All samples	31	12.09	1.47	1.21	12.27	9.57	14.05

Table S5.2. Summary statistics of estimated total length of European hake specimens, presented overall and by assigned provenance, both across all sites and for each site individually.

SITE	Assigned class (provenance)	Total length (mm)						
		N	Mean	Variance	SD	Median	Min	Max
All sites	Atlantic	21	765.3	15429.6	124.2	764.0	550.0	1018.9
	Mediterranean	10	651.4	34573.4	185.9	700.0	440.0	1017.0
El Born CCM	Atlantic	1	617.7	-	-	617.7	617.7	617.7
	Mediterranean	2	486.0	391.8	19.8	486.0	472.0	500.0
	All regions	3	529.9	5981.3	77.3	500.0	472.0	617.7
Fishermen's huts	Atlantic	8	723.4	7429.5	86.2	750.0	600.0	837.5
	Mediterranean	3	543.3	32033.3	179.0	440.0	440.0	750.0
	All regions	11	674.3	18684.3	136.7	750	440.0	837.5
Montsoriu castle	Atlantic	9	847.0	13784.4	117.4	800.0	655.4	1018.9
	Mediterranean	2	722.7	1028.7	32.1	722.7	700.0	745.4
	All regions	11	824.4	13659.1	116.9	800	655.4	1018.9
Pedralbes monastery kitchen dump	Atlantic	3	680.8	14519.6	120.5	705.1	550.0	787.3
	Mediterranean	3	822.3	29051.1	170.4	750.0	700.0	1017.0
	All regions	6	751.6	23438.3	153.1	727.6	550.0	1017.0

Statistical tests European hake data

Table S5.3. Statistical tests of European hake isotopic values: correlation to body size (total length in mm)

SAMPLE	VARIABLE	Correlation with body size (TL mm)
ALL SAMPLES	$\delta^{15}\text{N}$ (n=31)	<u>Pearson correlation</u> r (correlation)= 0.60 / df=29 / 95% CI = [0.31/ 0.79] p-value = 0.0004 <i>H₀ rejected (significant correlation)</i>
	$\delta^{13}\text{C}$ (n=31)	<u>Pearson correlation</u> r (correlation)= 0.50 / df=29 / 95% CI = [0.17/ 0.72] p-value = 0.0046 <i>H₀ rejected (significant correlation)</i>
MEDITERRANEAN ASSIGNED SAMPLES	$\delta^{15}\text{N}$ (n=31)	<u>Pearson correlation</u> r (correlation)= 0.91 / df=8 /95% CI = [0.65/ 0.98] p-value = 0.0003 <i>H₀ rejected (significant correlation)</i>
	$\delta^{13}\text{C}$ (n=31)	<u>Pearson correlation</u> r (correlation)= 0.53 /df=8 / 95% CI = [-0.15/0.87] p-value = 0.1171 <i>H₀ not rejected (no significant correlation)</i>
ATLANTIC ASSIGNED SAMPLES	$\delta^{15}\text{N}$ (n=31)	<u>Pearson correlation</u> r (correlation)= 0.29 /df=19 /95% CI = [-0.16/0.64] p-value = 0.2026 <i>H₀ not rejected (no significant correlation)</i>
	$\delta^{13}\text{C}$ (n=31)	<u>Pearson correlation</u> r (correlation)= 0.14 /df=19 /95% CI = [-0.3117/0.54] p-value = 0.5487 <i>H₀ not rejected (no significant correlation)</i>

Table S5.4. Statistical tests of European hake isotopic values: differences between chronological periods.

Statistical hypothesis testing: H_0 testing hypotheses:

- **Normality test (Shapiro–Wilk test)** → H_0 : samples ARE normally distributed
- **Barlett's test** → H_0 : variances ARE equal
- **Kruskal-Wallis / Wilcoxon-Whitney-Mann test (W-W-M)** → H_0 : median of samples ARE equal
- **ANOVA/ t-Student test** → H_0 : mean of samples ARE equal

SAMPLES	VARIABLE	ASSUMPTIONS TESTING (Normality = Shapiro-Wilk test / Homoscedasticity = Barlett's test)				HYPOTHESIS TEST AND RESULT					
		14th	15th-16th	17th	18th						
ALL SAMPLES	$\delta^{15}\text{N}$ (n=31)	NA (N=2)	W = 0.86548 p-value = 0.0678 H_0 accepted	W = 0.87260 p-value = 0.0705 H_0 accepted	W = 0.9861 p-value = 0.9775 H_0 accepted	ANOVA					
		Variances test (Tests for homoscedasticity): Bartlett's K-squared = 4.6625, df = 3, p-value = 0.1982 H_0 accepted					Df	Sum_sq	Mean_sq	F_value	Pr (>F)
						Period	3	4.31	1.437	0.976	0.419
						Residuals	27	39.77	1.473		
		H_0 accepted (no significant differences)									
	$\delta^{13}\text{C}$ (n=31)	NA (N=2)	W = 0.80652 p-value = 0.0115 H_0 rejected	W = 0.85839 p-value = 0.0467 H_0 rejected	W = 0.93280 p-value = 0.6019 H_0 accepted	Kruskal-Wallis test $\chi^2 = 6.8633$, df= 3, p-value= 0.07639 H_0 accepted (no significant differences)					
MEDITERRANEAN ASSIGNED SAMPLES	$\delta^{15}\text{N}$ (n=10)	NA (N=2)	NA (N=2)	W = 0.76229 p-value = 0.0273 H_0 rejected	W = 0.98792 p-value = 0.7897 H_0 accepted	Kruskal-Wallis test $\chi^2 = 5.0909$, df= 3, p-value= 0.1653 H_0 accepted (no significant differences)					
	$\delta^{13}\text{C}$ (n=10)	NA (N=2)	NA (N=2)	W = 0.83941 p-value = 0.2125 H_0 accepted	W = 0.7604146 p-value = 0.0231 H_0 rejected	Kruskal-Wallis test $\chi^2 = 7.4364$, df= 3, p-value= 0.05922 H_0 accepted (no significant differences)					
ATLANTIC ASSIGNED SAMPLES	$\delta^{15}\text{N}$ (n=21)		W = 0.94236 p-value = 0.6070 H_0 accepted	W = 0.95642 p-value = 0.7602 H_0 accepted	W = 0.99610 p-value = 0.8806 H_0 accepted	ANOVA					
		Variances test (Tests for homoscedasticity): Bartlett's K-squared = 0.71185, df = 2, p-value = 0.6981 H_0 accepted					Df	Sum_sq	Mean_sq	F_value	Pr (>F)
						Period	2	0.932	0.4660	1.282	0.302
						Residuals	18	6.543	0.3635		
		H_0 accepted (no significant differences)									
	$\delta^{13}\text{C}$ (n=21)		W = 0.93607 p-value = 0.5412 H_0 accepted	W = 0.85732 p-value = 0.0896 H_0 accepted	W = 76041 p-value = 0.0231 H_0 rejected	Kruskal-Wallis test $\chi^2 = 5.3484$, df= 2, p-value= 0.06896 H_0 accepted (no significant differences)					

Table S5.5. Effect of assigned provenance on the body size (total length in mm) of European hake

Statistical hypothesis testing: H_0 testing hypotheses:

- **Normality test (Shapiro–Wilk test)** → H_0 : samples ARE normally distributed
- **F test** → H_0 : variances ARE equal
- **Kruskal-Wallis / Wilcoxon-Whitney-Mann test (W-W-M)** → H_0 : median of samples ARE equal
- **ANOVA/ Student t-test** → H_0 : mean of samples ARE equal

SAMPLES	VARIABLE	ASSUMPTIONS TESTING (Normality = Shapiro-Wilk test / Homoscedasticity = F test)		Hypothesis test and result
		Mediterranean	Atlantic	
All sites	Total length (n= 31)	W = 0.96202 p-value = 0.5576 H ₀ accepted	W = 0.87820 p-value = 0.1244 H ₀ accepted	Student t-test t = 1.758, df = 12.968, p-value = 0.1023 95 % confidence interval: -26.08662; 253.73498 H ₀ accepted (<i>no significant differences</i>)
		F-test to compare two variances (test of homoscedasticity) F = 2.2407, num df = 9, denom df = 20, p-value = 0.1276 H ₀ accepted		
El Born CCM	Total length (n= 3)	NA (n=2)	NA (n=1)	The number of observations is too small
Fishermen's huts	Total length (n= 11)	W = 0.75 p-value = 0.00 H ₀ rejected	W = 0.89466 p-value = 0.2584 H ₀ accepted	W-W-M W = 4.5, p-value = 0.1417 H ₀ accepted (<i>no significant differences</i>)
Montsoriu castle	Total length (n= 11)	NA (n=2)	W = 0.94448 p-value = 0.630 H ₀ accepted	Student t-test t = 2.7482, df = 7.5045, p-value = 0.0267 95 % confidence interval: 18.79234; 229.82662 H ₀ rejected (<i>significant differences</i>)
		F-test to compare two variances (test of homoscedasticity) F = 0.07463, num df = 1, denom df = 8, p-value = 0.4167 H ₀ accepted		
Pedralbes monastery Kitchen dump	Total length (n= 6)	W = 0.86489 p-value = 0.2811 H ₀ accepted	W = 0.96945 p-value = 0.6645 H ₀ accepted	Student t-test t = -1.1745, df = 3.5996, p-value = 0.312 95 % confidence interval: -491.3418; 208.2616 H ₀ accepted (<i>no significant differences</i>)
		F-test to compare two variances (test of homoscedasticity) F = 2.0008, num df = 2, denom df = 2, p-value = 0.6665 H ₀ accepted		

Table S5.6. Effect of site on the body size of European hake

Statistical hypothesis testing: H_0 testing hypotheses:

- **Normality test (Shapiro–Wilk test)** → H_0 : samples ARE normally distributed
- **Barlett’s test** → H_0 : variances ARE equal
- **Kruskal-Wallis / Wilcoxon-Whitney-Mann test (W-W-M)** → H_0 : median of samples ARE equal
- **ANOVA/ t-Student test** → H_0 : mean of samples ARE equal

SAMPLE	VARIABLE	ASSUMPTIONS TESTING (Normality = Shapiro-Wilk test / Homoscedasticity = F Fischer test)				Hypothesis test and result
		Low-status sites		High-status sites		
		EL Born CCM	Fishermen’s Huts	Montsoriu Castle	Pedralbes monastery Kitchen Dump	
ALL PROVENANCES	Total length (n= 204)	W = 0.94663 p-value = 0.0270 H ₀ rejected	W = 0.85985 p-value = 0.0573 H ₀ rejected	W = 0.94772 p-value = 0.0749 H ₀ accepted	W = 0.99082 p-value = 0.7308 H ₀ accepted	Kruskal-Wallis test χ ² = 71.598, df= 3 p-value= 1.941e-15 H ₀ rejected (<i>significant differences</i>) <i>*Post Hoc Dunn test performed</i>
	Total length (n= 204)	W = 0.99087 p-value = 0.3958 H ₀ accepted		W = 0.94772 p-value = 0.0749 H ₀ accepted		W-W-M W = 4834, p-value = 1.62e-08 H ₀ rejected (<i>significant differences</i>)
		F-test to compare two variances (test of homoscedasticity) F = 0.35281, num df = 37, denom df = 159, p-value = 0.0003974 H ₀ rejected				
MEDITERRANEAN ASSIGNED SAMPLES	Total length (n= 10)	W = 0.86475 p-value = 0.1339 H ₀ accepted		NA (n=2)		W-W-M W = 9.5, p-value = 0.7921 H ₀ rejected (<i>significant differences</i>)
ATLANTIC ASSIGNED SAMPLES	Total length (n= 21)	W = 0.93333 p-value = 0.4167 H ₀ accepted		W = 0.94448 p-value = 0.6298 H ₀ accepted		Student t-test t = 3.0238, df = 14.786, p-value = 0.008661
		F-test to compare two variances (test of homoscedasticity) F = 1.6283, num df = 8, denom df = 11, p-value = 0.4453 H ₀ accepted				95 % confidence interval: 42.08007; 243.96013 H ₀ rejected (<i>significant differences</i>)

Post Hoc Dunn Test Following Kruskal–Wallis Analysis of total length by site for European hake			
<u>Comparison*</u>	<u>Z-score</u>	<u>Raw p-value</u>	<u>Adjusted p-value (Holm)</u>
EB-FH	-2.72	0.0066	0.0396
EB-MC	-8.17	3.112e-16	1.867e-15
FH-MC	-2.51	0.01205	0.07230
EB-PMKD	-6.27	3.498e-10	2.099e-09
FH-PMKD	-0.59	0.5539	0.5539
MC-PMKD	3.52	0.000425	0.0025

*EB = EL Born CCM; FH = Fishermen's huts; MC= Montsoriu castle; PMKD= Pedralbes monastery kitchen dump;

Summary statistics Atlantic Cod data

Table S5.7. Summary statistics of Atlantic cod isotopic values.

Isotope	N	Mean	Variance	SD	Median	Min	Max
$\delta^{13}\text{C}$	15	-14.6607	0.504178	0.710055	-14.9	-15.59	-13.01
$\delta^{15}\text{N}$	15	14.46133	1.521027	1.233299	14.66	11.82	16.25

Table S5.8. Summary statistics of estimated total length of European hake specimens, presented overall and by assigned provenance, both across all sites and for each site individually.

SITE	Assigned class (provenance)	Total length (mm)						
		N	Mean	Variance	SD	Median	Min	Max
All sites	All regions	15	632.7	10399.5	102.0	651.6	484.8	807.4
El Born CCM	Arctic Norway	1	501.3			501.3	501.3	501.3
Fishermen's huts	Arctic Norway	3	532.2	2245.2	47.4	532.1	484.8	579.6
	Kattegat / Western Baltic Sea	2	609.8	3493.6	59.1	609.8	568.0	651.6
	Newfoundland	2	558.6	85.7	9.3	558.6	552.0	565.1
	All regions	7	561.9	2553.8	50.5	565.1	484.8	651.6
Montcada's palace	Irish/southern North Sea	1	680.9			680.9	680.9	680.9
Pedralbes monastery kitchen dump	Arctic Norway	2	698.4	1881.8	43.4	698.4	667.7	729.0
	Newfoundland	1	655.6			655.6	655.6	655.6
	All regions	3	684.1	1549.7	39.4	667.7	655.6	729.0
Pedralbes monastery service house	Newfoundland	3	774.4	2168.7	46.6	794.6	721.1	807.4
	All regions	3	774.4	2168.7	46.6	794.6	721.1	807.4

Statistical tests Atlantic cod data

Table S5.9. Statistical tests of Atlantic cod isotopic values: correlation to body size (total length in mm)

SAMPLE	VARIABLE	Correlation with body size (TL mm)
ALL SAMPLES	$\delta^{15}\text{N}$ (n=15)	<u>Pearson correlation</u> r (correlation)= 0.28, df=13 , 95% CI = [-0.27/ 0.69] p-value = 0.3121 <i>H₀ not rejected (no significant correlation)</i>
	$\delta^{13}\text{C}$ (n=15)	<u>Pearson correlation</u> r (correlation)= 0.50, df=13, 95% CI = [-0.37/ 0.63] p-value = 0.542 <i>H₀ not rejected (no significant correlation)</i>

Table S5.10. Statistical tests of Atlantic cod values: differences between chronological periods.

Statistical hypothesis testing: H₀ testing hypotheses:

- **Normality test (Shapiro–Wilk test)→** H₀: samples ARE normally distributed
- **Barlett's test →** H₀: variances ARE equal
- **Kruskal-Wallis / Wilcoxon-Whitney-Mann test (W-W-M) →** H₀: median of samples ARE equal
- **ANOVA/ t-Student test →** H₀: mean of samples ARE equal

SAMPLES	VARIABLE	ASSUMPTIONS TESTING (Normality = Shapiro-Wilk test / Homoscedasticity = Barlett's test)			HYPOTHESIS TEST AND RESULT
		Late 16th	17th	18th	
ALL SAMPLES	$\delta^{15}\text{N}$ (n=15)	NA (n=1)	W = 0.87318 p-value = 0.1088 H ₀ accepted	W = 91630 p-value = 0.5164 H ₀ accepted	Kruskal-Wallis test $\chi^2 = 0.7425$, df = 2, p-value = 0.6899 H ₀ accepted (no significant differences)
	$\delta^{13}\text{C}$ (n=15)	NA (n=1)	W = 0.92344 p-value = 0.3866 H ₀ accepted	W = 0.87015 p-value = 0.2983 H ₀ accepted	Kruskal-Wallis test $\chi^2 = 0.43828$, df = 2, p-value = 0.8032 H ₀ accepted (no significant differences)

Table 5.11. Effect of assigned provenance on the body size (total length in mm) of Atlantic cod

Statistical hypothesis testing: H_0 testing hypotheses:

- **Normality test (Shapiro–Wilk test) →** H_0 : samples ARE normally distributed
- **F test →** H_0 : variances ARE equal
- **Kruskal-Wallis / Wilcoxon-Whitney-Mann test (W-W-M) →** H_0 : median of samples ARE equal
- **ANOVA/ Student t-test →** H_0 : mean of samples ARE equal

VARIABLES	ASSUMPTIONS TESTING (Normality = Shapiro-Wilk test / Homoscedasticity = Barlett's test)				HYPOTHESIS TEST AND RESULT
	Arctic Norway	Newfoundland	Irish/southern North Sea	Kattegat / Western Baltic Sea	
Total length (n= 15)	W = 0.91183 p-value = 0.4485 H_0 accepted	W = 0.8797 p-value = 0.3620 H_0 accepted	NA (n=1)	NA (n=2)	Kruskal-Wallis test (all groups) $\chi^2 = 2.7583$, df = 3, p-value = 0.4304 H_0 accepted (no <i>significant differences</i>)

Table 5.12. Effect of site on the body size of Atlantic cod

Statistical hypothesis testing: H_0 testing hypotheses:

- **Normality test (Shapiro–Wilk test) →** H_0 : samples ARE normally distributed
- **Barlett's test →** H_0 : variances ARE equal
- **Kruskal-Wallis / Wilcoxon-Whitney-Mann test (W-W-M) →** H_0 : median of samples ARE equal
- **ANOVA/ t-Student test →** H_0 : mean of samples ARE equal

VARIABLE	ASSUMPTIONS TESTING (Normality = Shapiro-Wilk test / Homoscedasticity = F Fischer test)					Hypothesis test and result
	Low-status sites		High-status sites			
	EL Born CCM	Fishermen's huts	Montcada's palace	Pedralbes monastery kitchen dump	Pedralbes monastery service quarters	
Total length (n= 283)	W = 0.96116 p-value = 0.8104 H _o accepted	W = 0.95454 p-value = 0.7568 H _o accepted	NA (n=2)	W = 0.98127 p-value = 0.5320 H _o accepted	W = 0.94991 p-value = 0.7104 H _o accepted	Kruskal-Wallis test (all groups) $\chi^2 = 26.696$, df = 4, p-value = 2.29e-05 H _o rejected (<i>significant differences</i>) <i>*Post Hoc Dunn test performed</i>
Total length (n= 83)	W = 0.97916 p-value = 0.9491 H _o accepted		W = 0.98289 p-value = 0.4966 H _o accepted			W-W-M W = 939.5, p-value = 1.996e-05 H _o rejected (<i>significant differences</i>)
	F-test to compare two variances (test of homoscedasticity) F = 3.4624, num df = 65, denom df = 16, p-value = 0.00784 H _o rejected					

Post Hoc Dunn Test Following Kruskal–Wallis Analysis of total length by site for Atlantic cod			
<u>Comparison*</u>	<u>Z-score</u>	<u>Raw p-value</u>	<u>Adjusted p-value (Holm)</u>
FH - PMSQ	-3.83765	1.242e-4	1.1179e-03
FH - PMKD	-2.27081	0.0232	0.139
PMSQ - PMKD	2.805923	0.005	0.0351
FH - EB	0.627319	0.5305	1
PMSQ - EB	4.576225	4.734e-06	4.7344e-05
PMKD - EB	3.238756	0.0012	0.0096
FH - MP	-1.64652	0.0997	0.3986
PMSQ - MP	0.780621	0.435	1
PMKD - MP	-0.61616	0.5378	0.5378
EB - MP	-2.05506	0.0399	0.1994

*EB = EL Born CCM; FH = Fishermen's huts; MP= Montcada's palace; PMKD= Pedralbes monastery kitchen dump; PMSQ=Pedralbes monastery service quarters