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Supplementary Information for

Lizards from warm and declining populations are born with extremely short telomeres

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Fig. S1. Localization of the 22 populations along altitudinal gradients (1000-1600m) in the Massif Central Mountain range (France). Each population is identified by its code.

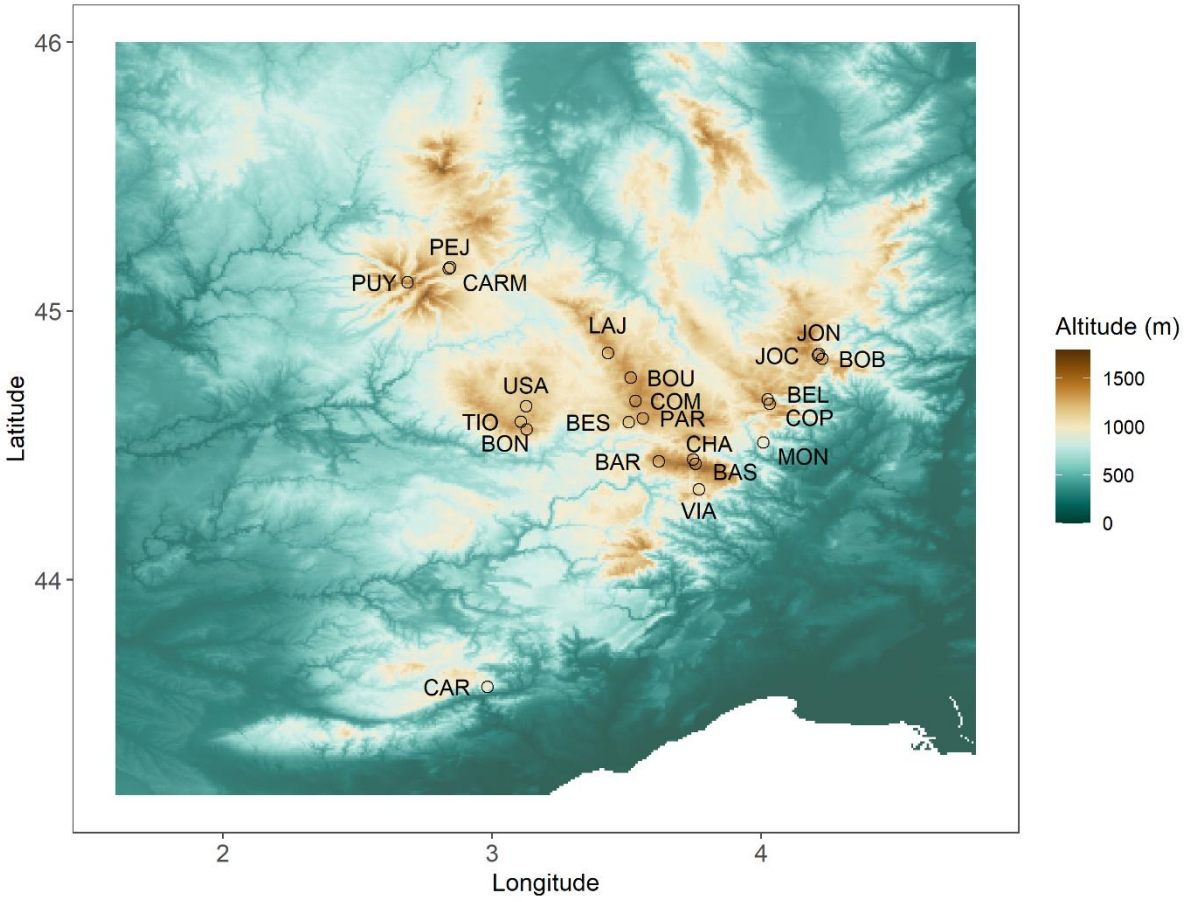

Fig. S2. Principal component analyses to investigate the co-variations in three life-history traits (mean body size = BodySize, recruitment of yearling at 1 yo = Yearling recruitment, and range of ordinal parturition dates = Soonest and Latest parturition), relative changes in lizard abundance over the last decade (Δabundance), microclimatic temperatures (daily average of minimal temperature, mean temperature and maximal temperature = Tmin, Tmean, and Tmax) and altitude. Circled populations are those used in the present study for telomere assays.

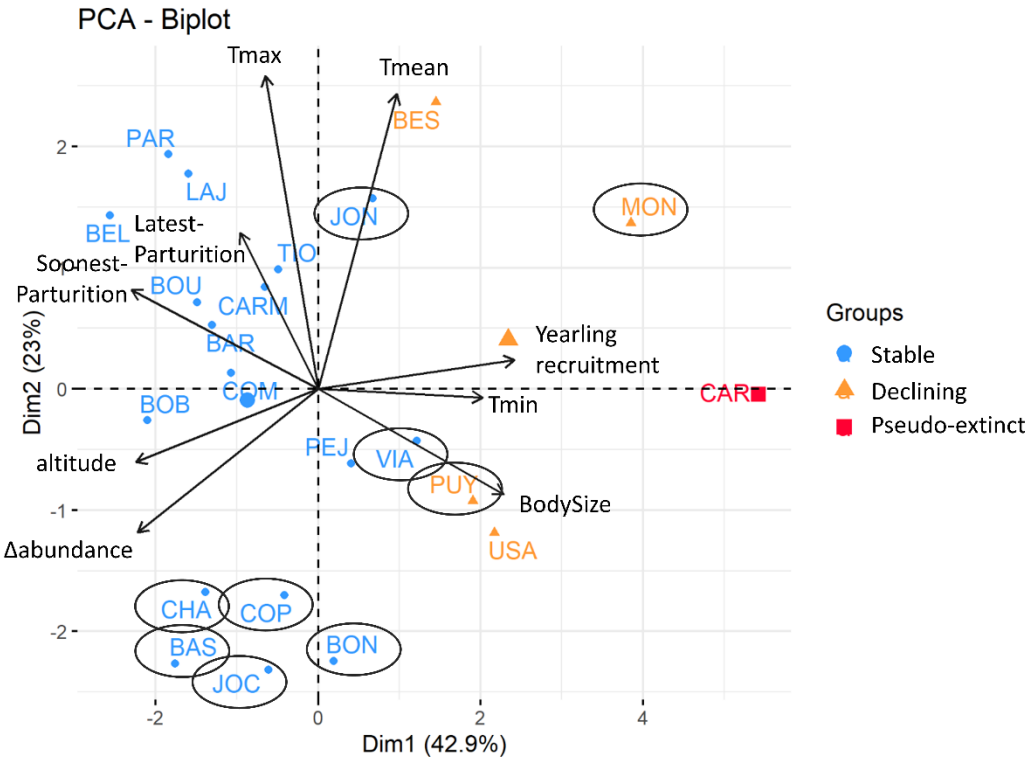

Figure S3. Threshold relationships between TL of common lizards and the relative change in population abundance between 2005 and 2015-2018. Breakpoint occurs for qualitatively similar values of population abundance change in A) offspring (breakpoint: 13.6%, CI95%: -30.7 – 58.0%), B) yearlings (breakpoint: 5.6%, CI95%: -14.6 – 25.8%) and C) adult females (breakpoint: 5.8%, CI95%: -54.5 – 66.1%). Data for yearlings were obtained from an earlier study (1).

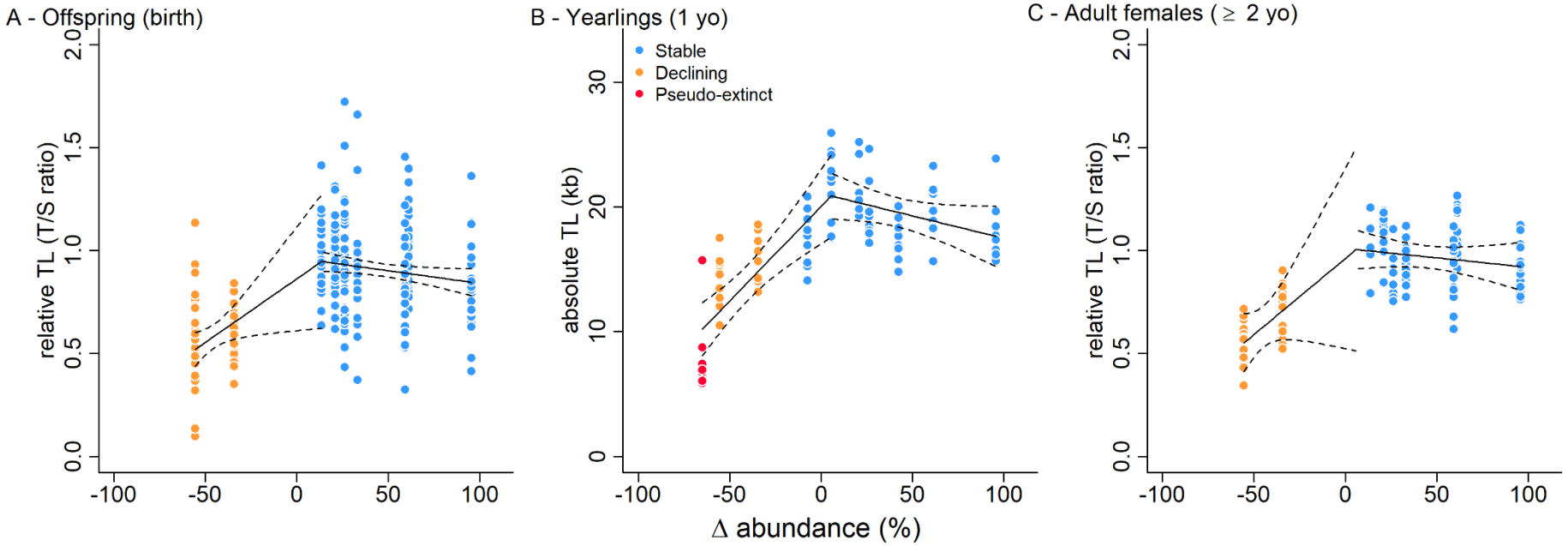

Figure S4. Operative temperatures measured for the two mother basking time treatments in a laboratory where females were maintained at a room temperature shifting according to natural, daily outdoor variability. For each basking time treatment (lights on 3h – blue ribbon, or lights on 9h – red ribbon), we assessed averaged temperature (solid lines) surrounding by thermal ranges (± 95% confidence interval) using biophysical models and HOBO sensors (2). For graphical purpose, this plot was restricted to a short 12-day timing but note that treatments lasted until female parturition (between 6 and 32 days). Maximal critical thermal limit (CTmax) ranges from 43.8 to 44.1°C in this species (3), thus highlighting a strong differential between the two basking treatments. See text for details.

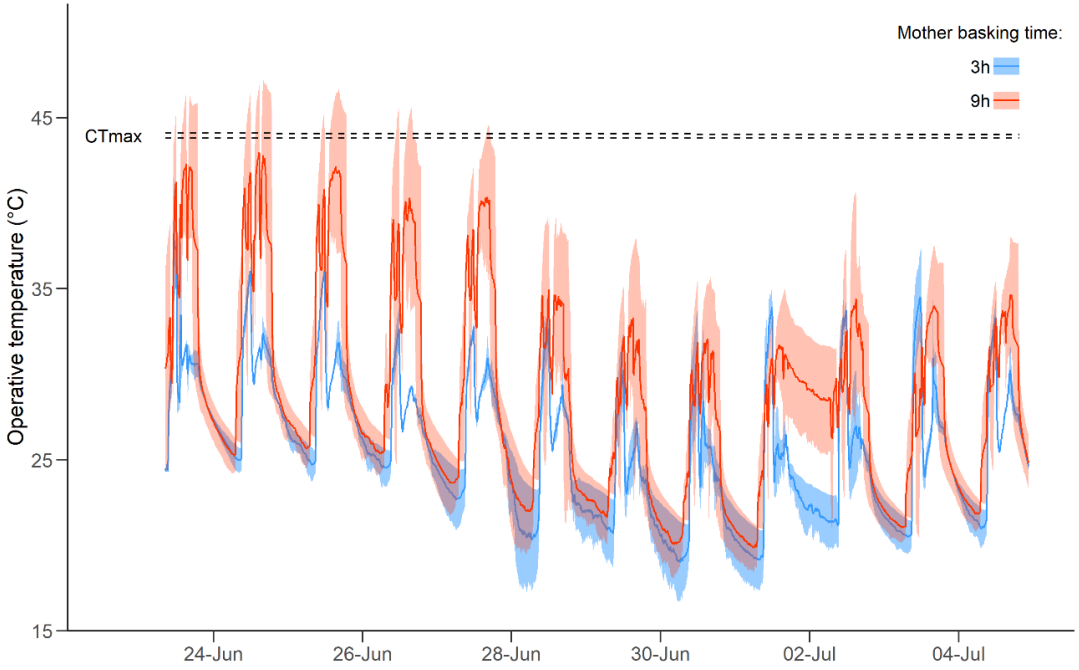

Table S1. Summarized outcomes of final selected models for offspring TL, total fecundity of females and reproductive success of females (see Table S2 & S3). Table provides information on sample size, marginal and condition R2, mean value (intercept), estimates (variance terms and fixed effects β ± SE) together with test statistics. See methods section for details on statistical models and analyses.

Lizards	Models	Model summary								
Offspring	TL ~ Population state + Parturition date + Mother TL + Population state * Parturition date + (1|Population) + (1|Mother)	Number of individuals	R^2_m	R^2_c	Mean TL (T/S ratio)	Type	Term	Variance		
		n = 231	0.33	0.60	0.839	Random	Population	0.01		
							Mother ID	0.27		
							Residual	0.40		
								β (± SE)	t-stat	P value
						Fixed	Intercept	-0.97 ± 0.15	-6.4	0.000 ***
							Mother TL	0.16 ± 0.07	2.4	0.018 *
							Population state			
							Stable vs Declining	1.24 ± 0.17	7.2	0.000 ***
							Parturition date	-0.09 ± 0.03	-3.0	0.003 **
							Population state * parturition date	0.11 ± 0.03	3.2	0.002 **
Females	Fecundity ~ SVL + population state + female TL + population state * female TL + (1|Population)	Number of individuals	r^2_m	r^2_c	Mean litter size	Type	Term	Variance		
		n = 126	0.40	0.43	6.1	Random	Population	0.03		
							Residual	0.56		
								β (± SE)	t-stat	P value
						Fixed	Intercept	-0.06 ± 0.19	-0.29	0.769
							SVL	0.60 ± 0.07	8.6	0.000 ***
							Population state			
							Stable vs Declining	0.07 ± 0.22	0.31	0.769
							Female TL	-0.39 ± 0.16	-2.5	0.016 *

						Population state * female TL	0.58 ± 0.18	3.2	0.002	**
Reproductive success ~ SVL + population state + female TL + population state * female TL + (1|Population)	Number of individuals	r^2_m	r^2_c	Mean success (%)	Type	Term	Variance			
	n = 126	0.11	0.19	80.8	Random	Population	0.32			
							β (± SE)	z-value	P value	
					Fixed	Intercept	0.87 ± 0.44	2.0	0.050	*
						SVL	0.20 ± 0.11	1.9	0.053	·
						Population state				
						Stable vs Declining	1.24 ± 0.51	2.4	0.015	*
						Female TL	0.63 ± 0.23	2.7	0.007	**
						Population state * female TL	-0.81 ± 0.28	-2.9	0.004	**

Table S2. Investigation of factors explaining TL variation in offspring at birth. Models are ranked by Akaike Information Criterion (AIC). For offspring, 275 models were generated due to the number of factors examined, so this summary is restricted only to the top-ranked models for AIC < 3 for clarity. Note that including sex did not ameliorate model selection so we discarded this effect for simplicity. All models accounted for population and mother identity as random terms and fixed effects were estimated on maximum likelihood.

Response	Fixed effects												Model summary					
Offpsring TL	(Intercept)	Juvenile SVL	Basking treatment	Mother SVL	Mother TL	Parturition date	Population state	Population state * Juvenile SVL	Population state * Basking Treatment	Population state * Mother SVL	Population state * Mother TL	Population state * Parturition Date	rank	df	Log Like	AICc	ΔAIC	weight
	0.26				**0.16**	**0.02**	**+**					**+**	**1**	**8**	**-271.7**	**560.0**	**0.0**	**0.1**
	0.26				0.21	0.02	+				+	+	2	9	-270.6	560.1	0.1	0.1
	0.26	0.10		-0.11	0.21	0.03	+				+	+	3	11	-268.5	560.2	0.2	0.1
	0.26	0.09		-0.11	0.16	0.03	+					+	4	10	-269.7	560.4	0.4	0.1
	0.26	0.07			0.22	0.03	+				+	+	5	10	-269.7	560.5	0.5	0.1
	0.26			-0.08	0.15	0.02	+					+	6	9	-271.0	560.7	0.7	0.1
	0.26	0.06			0.16	0.02	+					+	7	9	-271.0	560.8	0.8	0.1
	0.26			-0.08	0.20	0.02	+				+	+	8	10	-270.0	561.0	1.0	0.1
	0.26	0.10		-0.13	0.21	0.03	+			+	+	+	9	12	-268.1	561.6	1.6	0.0
	0.26	0.09		-0.13	0.15	0.03	+			+		+	10	11	-269.4	562.0	2.0	0.0
	0.26	0.12		-0.11	0.21	0.03	+	+			+	+	11	12	-268.3	562.0	2.0	0.0
	0.26	0.11		-0.11	0.16	0.03	+	+				+	12	11	-269.5	562.2	2.1	0.0
	0.26		+		0.16	0.02	+					+	13	9	-271.7	562.2	2.2	0.0
	0.26		+		0.21	0.02	+				+	+	14	10	-270.6	562.3	2.3	0.0
	0.26			-0.10	0.15	0.02	+			+		+	15	10	-270.7	562.3	2.3	0.0
	0.26			-0.10	0.20	0.02	+			+	+	+	16	11	-269.6	562.4	2.4	0.0
	0.25	0.10	+	-0.11	0.21	0.03	+				+	+	17	12	-268.5	562.4	2.4	0.0
	0.26	0.09			0.22	0.03	+	+			+	+	18	11	-269.6	562.4	2.4	0.0

0.25	0.09	+	-0.11	0.16	0.03	+					+	19	11	-269.7	562.6	2.6	0.0
0.27					0.02	+					+	20	7	-274.1	562.6	2.6	0.0
0.26	0.08			0.17	0.03	+	+				+	21	10	-270.8	562.6	2.6	0.0
0.26	0.09		-0.12		0.02	+					+	22	9	-271.9	562.7	2.7	0.0
0.26	0.07	+		0.22	0.03	+				+	+	23	11	-269.7	562.7	2.7	0.0
0.27			-0.09		0.02	+					+	24	8	-273.1	562.9	2.9	0.0
0.26		+	-0.08	0.15	0.02	+					+	25	10	-271.0	562.9	2.9	0.0
0.26	0.06	+		0.17	0.02	+					+	26	10	-271.0	563.0	2.9	0.0

Table S3. Investigation of the relationship between female TL and reproductive performance at adulthood. Models are ranked by Akaike Information Criterion (AIC). All models are presented and accounted for population as random terms and fixed effects were estimated on maximum likelihood. TL and SVL are for individual adult females.

Response	Fixed effects					Model summary					
	(Intercept)	TL	Population state	SVL	Population state * TL	rank	df	logLik	AICc	ΔAICc	weight
Fecundity	**-0.06**	**-0.39**	**+**	**0.60**	**+**	**1**	**7**	**-144.5**	**304.0**	**0.0**	**0.8**
	-0.01			0.57		2	4	-149.9	308.0	4.1	0.1
	-0.01	0.07		0.57		3	5	-149.5	309.5	5.5	0.1
	-0.07		+	0.57		4	5	-149.8	310.1	6.1	0.0
	-0.07	0.07	+	0.57		5	6	-149.5	311.6	7.6	0.0
	-0.02					6	3	-176.2	358.7	54.7	0.0
	-0.02	0.06				7	4	-176.0	360.4	56.4	0.0
	-0.12		+			8	4	-176.2	360.6	56.7	0.0
	-0.11	-0.26	+		+	9	6	-174.3	361.2	57.3	0.0
	-0.12	0.06	+			10	5	-175.9	362.4	58.4	0.0
Reproductive success	**0.87**	**0.63**	**+**	**0.20**	**+**	**1**	**6**	**-196.4**	**405.6**	**0.0**	**0.6**
	0.91	0.60	+		+	2	5	-198.3	407.1	1.5	0.3
	0.81		+	0.19		3	4	-201.0	410.3	4.8	0.1
	0.86		+			4	3	-202.6	411.4	5.9	0.0
	0.81	0.09	+	0.19		5	5	-200.8	412.0	6.5	0.0
	1.82			0.18		6	3	-203.3	412.7	7.2	0.0
	0.86	0.07	+			7	4	-202.5	413.2	7.7	0.0
	1.84					8	2	-204.7	413.5	8.0	0.0
	1.82	0.08		0.18		9	4	-203.1	414.5	8.9	0.0
	1.84	0.06				10	3	-204.6	415.4	9.8	0.0

SI References

1. A. Dupoué, *et al.*, Shorter telomeres precede population extinction in wild lizards. *Sci. Rep.* **7**, 16976 (2017).
2. D. Rozen-Rechels, *et al.*, Interaction of hydric and thermal conditions drive geographic variation in thermoregulation in a widespread lizard. *Ecol. Monogr.* **91**, e01440 (2021).
3. L. Gvozdik, A. M. Castilla, A comparative study of preferred body temperatures and critical thermal tolerance limits among populations of *Zootoca vivipara* (Squamata: Lacertidae) along an Altitudinal Gradient. *J. Herpetol.* **35**, 486–492 (2001).