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No evidence for the 'rate-of-living' theory across the tetrapod tree of life

Gavin Stark[1] | Daniel Pincheira-Donoso[2] | Shai Meiri[1,3]

[1]School of Zoology, Faculty of Life Sciences, Tel Aviv University, Tel Aviv, Israel
[2]School of Biological Sciences, Queen's University Belfast, Belfast, United Kingdom
[3]The Steinhardt Museum of Natural History, Tel Aviv University, Tel Aviv, Israel

Correspondence
Gavin Stark, School of Zoology, Faculty of Life Sciences, Tel Aviv University, Tel Aviv, 6997801, Israel.
Email: gavinstark89@gmail.com

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Abstract

Aim: The 'rate-of-living' theory predicts that life expectancy is a negative function of the rates at which organisms metabolize. According to this theory, factors that accelerate metabolic rates, such as high body temperature and active foraging, lead to organismic 'wear-out'. This process reduces life span through an accumulation of biochemical errors and the build-up of toxic metabolic by-products. Although the rate-of-living theory is a keystone underlying our understanding of life-history trade-offs, its validity has been recently questioned. The rate-of-living theory has never been tested on a global scale in a phylogenetic framework, or across both endotherms and ectotherms. Here, we test several of its fundamental predictions across the tetrapod tree of life.

Location: Global.

Time period: Present.

Major taxa studied: Land vertebrates.

Methods: Using a dataset spanning the life span data of 4,100 land vertebrate species (2,214 endotherms, 1,886 ectotherms), we performed the most comprehensive test to date of the fundamental predictions underlying the rate-of-living theory. We investigated how metabolic rates, and a range of factors generally perceived to be strongly associated with them, relate to longevity.

Results: Our findings did not support the predictions of the rate-of-living theory. Basal and field metabolic rates, seasonality, and activity times, as well as reptile body temperatures and foraging ecology, were found to be unrelated to longevity. In contrast, lower longevity across ectotherm species was associated with high environmental temperatures.

Main conclusions: We conclude that the rate-of-living theory does not hold true for terrestrial vertebrates, and suggest that life expectancy is driven by selection arising from extrinsic mortality factors. A simple link between metabolic rates, oxidative damage and life span is not supported. Importantly, our findings highlight the potential for rapid warming, resulting from the current increase in global temperatures, to drive accelerated rates of senescence in ectotherms.

KEYWORDS
basal metabolic rate, body size, body temperature, environmental temperature, field metabolic rate, longevity, the rate-of-living theory

1 | INTRODUCTION

The flame that burns twice as bright burns half as long.

The light that burns twice as bright burns half as long.

The quotes above, ascribed to Lau Tze (Laozi) and from 'Blade Runner', respectively, are thought to convey a universal truth: we have a semi-fixed capacity to do things, and we can either get through them intensively and quickly – or relaxedly but over a longer time. A fundamental principle of life history theory predicts that increased energy expenditure reduces life expectancy (Finkel & Holbrook, 2000; Furness & Speakman, 2008; Glazier, 2015; Hulbert, Pamplona, Buffenstein, & Buttemer, 2007; Magalhães, Costa, & Church, 2007; Pearl, 1928; Rubner, 1908; Van Voorhies, Khazaeli, & Curtsinger, 2003). The mechanistic explanation for this relationship stems from the assumption that higher metabolic rates increase the production of free radicals and other oxidants produced during aerobic respiration. These, in turn, trigger biomolecular damage that accelerates senescence (Barja, 2002; Beckman & Ames, 1998; Sohal, 2002). In line with these mechanisms, multiple studies have suggested that an organism's longevity is an inverse function of mass-specific metabolic rates (Atanasov, 2005; Kapahi et al., 2010; Ku, Brunk, & Sohal, 1993; Sohal, Svensson, Sohal, & Brunk, 1989; Wright et al., 2004). This trade-off is commonly referred to as the 'rate-of-living' theory (Pearl, 1928). According to this theory, degenerative processes lead to a failure of cellular constituents due to the accumulation of biochemical errors and the build-up of toxic metabolic by-products (Sohal, 1986). In support of this theory, comparative and experimental studies have shown that the increased expression of free radicals can shorten life span (Barja & Herrero, 1998; Melov et al., 2000; Orr & Sohal, 1994; Parkes et al., 1998; Sun & Tower, 1999).

Some alternative theories (Hamilton, 1966; Kirkwood, 1977; Kirkwood & Austad, 2000; Medawar, 1952; Réale et al., 2010) have been proposed to explain the variations in life span among animals. According to the evolutionary theories of senescence, species that are exposed to low intrinsic (e.g., replication errors and metabolic waste products and oxidation damage by reactive agents) and extrinsic (such as predation, food shortages or accidents) mortality rates will adapt by slowing down their 'pace of life' (Scharf et al., 2015). Accordingly, they will expand their reproductive potential by evolving longer life spans (Healy, Ezard, Jones, Salguero-Gómez, & Buckley, 2019; De Magalhães et al., 2007). In contrast, animals that are more likely to die due to extrinsic factors, rather than through senescence, benefit from investing in early reproduction at the expense of investment in long-term maintenance (Hamilton, 1966; Kirkwood, 1977; Kirkwood & Austad, 2000; Medawar, 1952).

Life span represents trade-offs between reproduction and maintenance (e.g., the 'disposable soma theory'; Kirkwood, 2017). In taxa facing high extrinsic mortality rates, investing in maintenance is unlikely to pay off if an individual will be preyed upon before it has a chance to reproduce. According to this theory, this will lead to selection for earlier reproduction, and thus earlier senescence and a shorter life span in taxa suffering high extrinsic mortality rates (Kirkwood & Austad, 2000). Under the disposable soma theory, early reproduction is thought to expose animals to a greater accumulation of age-specific mutations with pleiotropic effects (Gavrilov & Gavrilova, 2002). This has been associated with the 'antagonistic pleiotropy theory', which suggests that some genes encode phenotypes that offer benefits early on in life, while also encoding other traits that are harmful in advanced age (Hamilton, 1966; Kirkwood, 1977; Kirkwood & Austad, 2000; Medawar, 1952; Réale et al., 2010). Such harmful traits, expressed late in life, will be invisible to selection in animals that reproduce young, but will select strongly against animals that reproduce at older ages (Williams, Day, Fletcher, & Rowe, 2006).

The rate-of-living theory has been studied in insects, fish, birds and mammals (Austad & Fischer, 1991; Kelemen, Cao, Cao, Davidowitz, & Dornhaus, 2019; Lindstedt & Calder, 1976; Liu & Walford, 1975; Herreid, 1964). For example, Healy et al. (2014) found that metabolic rate was negatively associated with longevity in non-volant endotherms (supporting the rate-of-living theory). However, several limitations detract from the evidence supporting it. For example, some studies have ignored the influence of phylogenetic non-independence (Austad & Fischer, 1991; Hulbert et al., 2007; Lindstedt & Calder, 1976). Furthermore, some relatively recent studies (Furness & Speakman, 2008; Glazier, 2015; Magalhães et al., 2007; Speakman, 2005) contradict the expectations of the theory. For example, bats and birds have higher metabolic rates compared to, similar-sized, non-volant mammals (Brunet-Rossinni & Austad, 2004; Kleiber, 1947; Réale et al., 2010; Wilkinson & Adams, 2019). Bats, nonetheless, are exceptionally long-lived (Lagunas-Rangel, 2019) and use twice as much energy over their lifetimes as do similar sized terrestrial mammals (Healy et al., 2014), indicating there is no fixed amount of energy consumption allocated to an organism's life span.

Magalhães et al. (2007) examined the effect of several factors, including metabolic rates, on the longevity of 1,456 vertebrate species. Their analyses revealed no relationship between metabolism and longevity in eutherians and birds, and a negative link in marsupials. That study, however, was almost entirely restricted to endotherms (94% of the species examined were mammals or birds) and thus could not provide a general explanation for the diversity of longevity across the vertebrate metabolic range. Other such studies (Austad & Fischer, 1991; Furness & Speakman, 2008; Healy et al., 2014; Herreid, 1964; Hulbert et al., 2007; Ku et al., 1993) have also focused almost exclusively on birds and mammals. Although selection from environmental factors (e.g., ambient temperature) may differ dramatically between endotherms and ectotherms, only a few comparative studies (Scharf et al., 2015; Stark & Meiri, 2018) have focused on ectotherm vertebrates, and these have generally ignored metabolic rates. A recent theory (Worm & Tittensor, 2018) suggests that ecological pressures shape evolutionary processes on small spatial and phylogenetic scales while environmental factors, particularly temperature, dominate on larger scales. Environmental effects are thus expected to strengthen when comparing ectotherms with endotherms. A comprehensive empirical test of the rate-of-living theory across all land vertebrate groups could therefore be highly informative.

To fill this gap we assembled an unprecedented, global-scale, dataset for 4,100 species of terrestrial vertebrates (birds, mammals, reptiles and amphibians), and implemented a highly replicable, comparative test of the rate-of-living theory. We examined the relationship between longevity and a range of metabolically relevant factors, across mammals, birds, reptiles and amphibians. We tested the fundamental predictions that:

1. Slower metabolic rates are associated with prolonged longevity (Nunn & Barton, 2000; Sohal, 1986). This is a direct test of the rate-of-living theory. However, basal metabolic rates are problematic to define for ectotherms – and field metabolic rates for anything but endotherms are exceedingly rare (see below). We examined the relationship between longevity and a suite of additional proxies that are expected to be strongly correlated with metabolic rates.
2. Ectotherms (amphibians and reptiles) will live longer than similar-sized endotherms (mammals and birds) because their lower metabolic rates translate to lower mutation and oxidative damage rates (Hulbert et al., 2007; Sohal, 1986).
3. Nocturnal species (especially ectotherms) will live longer than diurnal ones. Nocturnality reduces exposure to solar radiation, and the lower night-time temperatures reduces ectotherm metabolic rates.
4. Reptiles that actively forage for food will have substantially higher metabolic rates than closely related 'sit-and-wait' foragers with otherwise similar ecologies – even in the same habitat (e.g., Anderson & Karasov, 1981; Nagy, Huey, & Bennett, 1984). Because high metabolic rates are expected to be linked to low longevities, we predict that 'sit-and-wait' foragers will live longer than 'actively-foraging' ones.
5. Body temperature will be negatively associated with ectotherm longevity because ectotherm metabolic rates increase with increasing temperature.
6. In seasonally cold regions many mammals and ectotherms hibernate or aestivate for extended periods (Turbill, Bieber, & Ruf, 2011), reducing metabolic rates, and are thus expected to live longer (Stark & Meiri, 2018; Stark, Tamar, Itescu, Feldman, & Meiri, 2018; Wilkinson & Adams, 2019). Furthermore, ectotherms inhabiting seasonally cold regions grow and metabolize slowly and thus present lower rates of metabolic by-product accumulation. We thus predicted that they will live longer than species living in warmer regions.

2 | METHODS

2.1 | Data collection

We assembled a global dataset on the maximum life span of 4,100 terrestrial vertebrate species (538 amphibians, 1,153 birds, 1,061 mammals and 1,348 reptiles) from the literature (mainly from De Magalhaes & Costa, 2009; Stark & Meiri, 2018; and Stark et al., 2018; see Appendix for a full list of sources). We corrected for the potential bias in which larger samples increase the chance of finding a higher maximum (Stark & Meiri, 2018; Stark et al., 2018) by using sample size as a predictor. We recorded sample sizes from the original publications reporting longevity. Much of our data (especially for endotherms) were taken from the AnAge database (De Magalhaes & Costa, 2009). In AnAge sample sizes are classified as 'small' (up to 10 specimens), 'medium' (11–100), 'high' (101–1,000 individuals) and 'Questionable' for missing data on sample size. We opted to be conservative and classified AnAge 'small' samples as relying on data from one individual; medium samples as relying on data from 11, and large samples as based on data on 101 sampled individuals. Species with no sample sizes were classified as questionable. Analyses in which we used the midpoint of the size estimates from AnAge (i.e., 5, 55 and 555 specimens for 'small', 'medium' and 'large' samples, respectively) yielded qualitatively similar results (not shown).

We performed a sensitivity analysis incorporating only the 2,140 species for which maximum longevity was estimated from 30 or more individuals (i.e., based on numerical data from the primary literature indicating at least 30 specimens were studied, and only on the 'high' category of AnAge). We accounted for the fact that longevity of captive individuals is often higher than that of wild ones (Scharf et al., 2015; Stark & Meiri, 2018) by treating data origin as another predictor. Data on the predictor variables (see Supporting Information Appendix S1) were gathered from the sources used to estimate longevity, and, if not reported there, from the primary literature (see Appendix for a full list of sources). We accounted for body size in our analysis by using body mass (in grams) as a predictor. We collected data on mean body mass for each species using data from AnAge (De Magalhaes & Costa, 2009) for birds and mammals, from Slavenko, Tallowin, Itescu, Raia, and Meiri (2016) for reptiles and from Stark and Meiri (2018) for amphibians. To account for differences between the sexes we averaged the mean body size of females and males if those were reported separately. For endotherms, mass data are routinely reported. For amphibians and reptiles body size data are almost always reported as lengths (Meiri, 2010; Pincheira-Donoso & Hodgson, 2018; Santini, Benítez-lópez, Ficetola, & Huijbregts, 2018). To enable a comparison of all taxa we converted body length to mass using the clade and measurement-specific allometric equations (Feldman & Meiri, 2013; Feldman, Sabath, Pyron, Mayrose, & Meiri, 2016; Santini et al., 2018).

We classified species as diurnal, nocturnal, crepuscular or cathemeral (the latter two were expected to have intermediate longevities). We defined 706 reptiles for which data were available as either 'sit-and-wait' or 'active foragers' (Meiri, 2018).

Distribution data are from Roll et al. (2017) for reptiles, the International Union for Conservation of Nature (IUCN; https://www.iucnredlist.org/resources/spatial-data-download) for amphibians and mammals, and BirdLife (http://datazone.birdlife.org) for birds. Climatic data were obtained by intersecting range maps with mean annual temperature and temperature seasonality (from CHELSA; Karger et al., 2017) at 30 arc seconds (high resolution).

Field metabolic rates (FMR, in kJ/day) were obtained from the primary literature (e.g., Green & Christian, 2007; Kingsbury, 1995; Murray et al., 2014; Murray et al., 2015; Nagy, 2005; Smith, Christian, & Green, 2008). Basal metabolic rates (ml O_2/hr) were obtained from the literature (Bushuev, Tolstenkov, Zubkova, Solovyeva, & Kerimov, 2017; Lovegrove, 2003; McKechnie & Wolf, 2004; Naya, Naya, & White, 2018; Sieg et al., 2009; Uyeda, Pennell, Miller, Maia, & McClain, 2017; White, Frappell, & Chown, 2012; White, Phillips, & Seymour, 2006; White & Seymour, 2003; Žagar, Simčič, Carretero, & Vrezec, 2015; Zhang, Guo, Zhang, Lin, & Ji, 2018). Metabolic rate data were available for 820 species in our database.

Comparing metabolic rates between endotherms and ectotherms is problematic. Endotherm metabolic rates are lowest at intermediate temperatures, their thermoneutral zone (TNZ, e.g., Hill, Wyse, & Anderson, 2012; usually around 25°C). Thus, endotherm basal metabolic rates are easy to define, standardize and measure. Ectotherm metabolic rates, however, generally increase monotonically with body temperature, at least within the range of temperatures used to study their standard metabolic rates (Andrews & Pough, 1985; White et al., 2006). Furthermore, ectotherm tetrapod performance increases with temperature until an 'optimum' maximal rate is reached, and then decreases sharply (e.g., Huey & Kingsolver, 1989). Ectotherm metabolic rates and performances are thus usually examined at several experimental temperatures. We opted to compare the metabolic rates that result in maximized potential performance. We consider these temperatures to be at the TNZ of endotherms – but at the optimal temperatures for ectotherms. At these temperatures endotherms do not need to expend extra energy for thermoregulation – while ectotherms operate most efficiently. Therefore, we used basal metabolic rate (BMR) data for endotherms. For ectotherms, when data from more than one temperature were available for a given species, we selected the metabolic rate data that were measured at the operative temperature closest to the class or order mean. Thus, for reptiles we selected data measured at temperatures as close as possible to 31°C, which is the average body temperature of active squamates (across 1,089 species; Meiri, 2020). In amphibians we selected data measured as close as possible to 30°C for anurans, and to 25°C for urodeles, based on experimental analyses of their temperature preferences (Anderson & Beitinger, 1979; Araujo et al., 2013; Bachmann, 1969; Ballinger & McKinney, 1966; Bider & Morrison, 1981; Bohlin & Beitinger, 1979; Bradford, 1984; Brattstrom, 1963; Brattstrom, 1968; Brattstrom, 1970; Brown, 1975; Catenazzi, Lehr, & Vredenburg, 2014; Darlington, 1957; Frishkoff, Hadly, & Daily, 2015; Katz & Gil, 1997; Luddecke & Sanchez, 2002; Richter-Boix et al., 2015; Stuart, 1951; Wells, 2007; Wygoda & Williams, 1991). A sensitivity analysis in which resting metabolic rates were those measured at temperatures as close as possible to 25°C yielded qualitatively identical results. We refer to these rates collectively as resting metabolic rates (RMR, comprising BMR for mammals and birds and resting metabolic rates for amphibians and reptiles as defined above).

We compared longevities of endotherms and ectotherms to determine whether this fundamental difference in metabolic rates influences longevity (Gillooly, Gomez, & Mavrodiev, 2017). We also analysed mammals, birds, reptiles and amphibians separately, to determine whether these fundamental divisions of the vertebrate tree of life result in specific metabolism/longevity relationships. Our aim was to examine this relationship on different parts of the tree, rather than merely treat them as nuisance variables to be corrected for using phylogenetic regression.

We $\log_{10}$ transformed data on body size, maximum longevity, basal and field metabolic rates and sample size, to normalize residuals and reduce heteroscedasticity. All statistical tests were performed using R 3.6.1 (R Core Team, 2019).

We combined the most up-to-date, complete phylogenetic trees for each class (Faurby & Svenning, 2015; Jetz & Pyron, 2018; Prum et al., 2015; Stark et al., 2018), and estimated the phylogenetic signal in longevity data using phylogenetic generalized least squares regression (PGLS; Freckleton, Harvey, & Pagel, 2002), implemented in the R package 'caper' (and its dependencies: 'ape', 'phytools', 'plyr', 'car', 'fmsb' and 'FSA'). We combined the trees using the methods and scripts outlined in Roquet, Lavergne, and Thuiller (2014). We accounted for shared ancestry using PGLS (Freckleton et al., 2002; Orme, Freckleton, Thomas, & Petzoldt, 2013) with the maximum likelihood value of Pagels's λ. A λ of 0 indicates that no phylogenetic signal exists (i.e., that the trait has evolved independently of phylogeny). A λ close to 1 indicates a strong phylogenetic signal, in agreement with a Brownian motion model of evolution (Freckleton et al., 2002).

To tease apart the potential effects of body size and metabolic rates on longevity, we compared Akaike information criterion (AIC) scores of models containing FMRs or RMRs alone, FMRs or BMRs and body size, and body size alone, as predictors. If the full model presented a higher AIC than a partial model nested in it, we interpreted this as a sign that the additional predictors have little effect following Arnold (2010). We verified this by comparing the significance of the body size and metabolic rate terms in the full models.

We possessed FMR data for *c*. 5% (209 species) and RMR data for *c*. 20% (820 species) of our species. For other variables we possessed data for > 80% (often > 95%) of species. Thus, we ran models with three different combinations of predictors for all land vertebrates and for each class separately (all corrected for body size, data origin, sample size and phylogeny): (a) with FMRs; (b) with RMRs; (c) with mean annual temperature, temperature seasonality, and activity time together. For reptiles, we fitted two additional models: with foraging mode and with body temperature (all corrected for body size, data origin, sample size and phylogeny).

To estimate whether we had sufficient statistical power to reject a null hypothesis we conducted power analyses (using an online power calculator: https://www.danielsoper.com/statcalc/calculator.aspx?xml:id=9) for the regressions of resting metabolic rate (RMR), FMR, temperature seasonality and mean annual temperature analyses. Because body size was a factor in all these analyses, we set the number of predictors to two. Because our null models were always either strongly rejected ($p < .005$), or clearly not rejected ($p \geq .1$, see the Results section and tables), we used two alpha values: the 'traditional' .05 (Fisher, 1925) and a more stringent .005 (Johnson, 2013; Benjamin

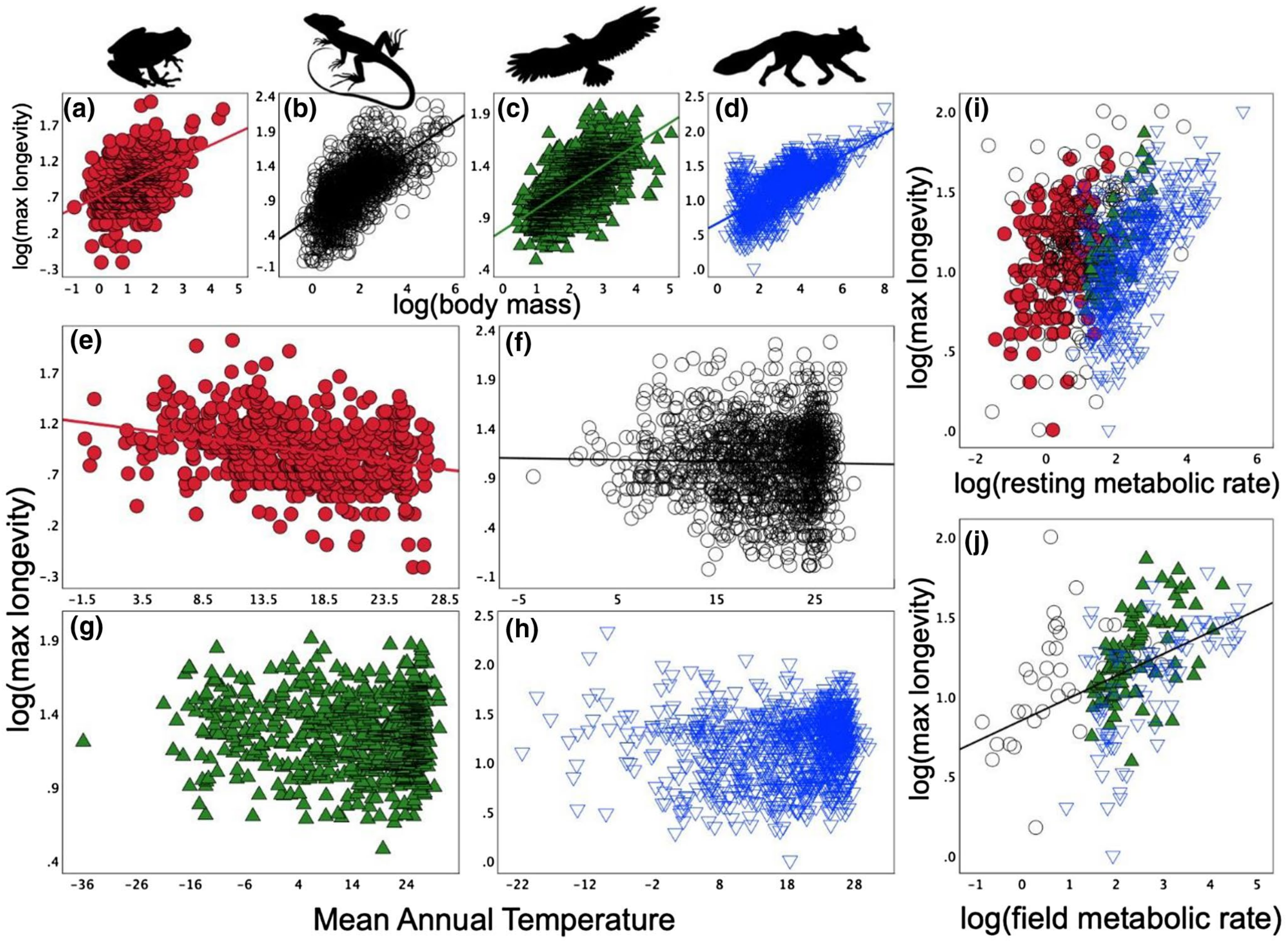

FIGURE 1 The relationship between longevity (*y* axis of all panels, $\log_{10}$ transformed) and (a–d) body mass (in g, $\log_{10}$ transformed) of amphibians (red circles), reptiles (black circles), birds (green triangles) and mammals (inverted blue triangles). (e–h) Mean annual temperature (regression lines only shown for amphibians and reptiles for which the relationship is significant), (i) basal metabolic rate (in ml O_2/hr, $\log_{10}$ transformed), according to the colour codes depicted in the top plots and (j) field metabolic rate (kJ/day, $\log_{10}$ transformed) [Colour figure can be viewed at wileyonlinelibrary.com]

et al., 2018) to calculate power. Sample sizes were those for the relevant clades and analyses. We estimated power for two hypothetical relationships: a weak pattern (R^2 = .15) and a medium one (R^2 = .4). Analyses were conducted for each class separately. The power analyses we used do not take into account the phylogenetic correction, and may thus overestimate the power associated with PGLS models to some extent (due to the lower degrees of freedom associated with the non-independence of phylogenetically structured data). While it is difficult to estimate exactly how this will affect power, PGLS retains much of the power of non-phylogenetic analyses, and hence we believe that the power we estimate is at least close to the actual power of our tests. We found most of our analyses had high power to reject a null hypothesis, for all taxa. Exceptions were restricted to low power (β = .21 for alpha of .005 and β = .56 for alpha of .05) for the FMR analysis of reptiles with a weak effect size. All other analyses had power > .8, mostly > .9 (see Supporting Information Appendix S2.1 for full power analyses results).

3 | RESULTS

The relationships between BMRs/RMRs and FMRs and longevity were not significant across all the land vertebrates or within any class, except for reptilian FMRs (Figure 1a,c; Table 1), when accounting for body size, phylogeny, sampling intensity and data origin (wild/captive individuals) (Supporting Information Appendix S3). The results remained similar (also for reptile FMR) when we analysed only species for which longevity estimates were based on large sample sizes ($n \geq 30$; Supporting Information Appendix S2.2). Most of our statistical models strongly favoured models with body size over models with metabolic rates, or models with a combination of size and metabolic rates (see Supporting Information Appendix S2.3).

Contrary to the predictions of the rate-of-living theory, activity times were uncorrelated with vertebrate longevities, nor were they associated with longevities within any class, with the exception of cathemeral tetrapods, which live 11.1% longer (n = 538, λ = .634,

TABLE 1 Phylogenetic generalized least squares regression (PGLS) model for the relationship between metabolic rates and longevity among and within land vertebrates

Metabolic rate (MR)	Group	*n*	Slope ± *SE*	R^2	λ	*p*
Resting/Basal MR	Tetrapods	662	−0.028 ± 0.024	.19	.913	.24
	Amphibia	123	0.089 ± 0.053	.14	.494	.09
	Reptilia	165	−0.004 ± 0.037	.12	.849	.91
	Mammalia	405	−0.050 ± 0.042	.23	.831	.23
	Aves	94	0.035 ± 0.091	.31	.650	.70
Field MR	Tetrapods	183	−0.039 ± 0.074	.19	.820	.59
	Reptilia[a]	25	−0.338 ± 0.084	.79	.000	.0007
	Mammalia	74	0.021 ± 0.096	.22	.962	.82
	Aves	84	0.096 ± 0.145	.19	.400	.50

Note: Slopes are for metabolic rates, lambda and R^2 values are for the full model [with sample size, body size and data origin (captivity/wild) as predictors]. Tetrapods = all land vertebrates.

[a]No data on amphibian field metabolic rates were available.

TABLE 2 Full phylogenetic generalized least squares regression (PGLS) model for land vertebrates

Factor	Estimate ± 1 *SE*	*t*	*R*
Intercept	0.758 ± 0.177	4.2	< .0001
Body mass ($\log_{10}$ grams)	0.132 ± 0.008	16.4	< .0001
Origin of data (wild)[a]	−0.065 ± 0.012	−5.1	< .0001
Sample size ($\log_{10}$)	0.085 ± 0.006	13.6	< .0001
Mean annual temperature (°C)	−0.001 ± 0.006	−2.0	.04
Temperature seasonality (standard deviation [a]100)	0.001 ± 0.001	0.8	.40
Activity time (cathemeral)[b]	0.042 ± 0.018	2.3	.02
Activity time (crepuscular)[b]	0.020 ± 0.022	0.8	.37
Activity time (nocturnal)[b]	0.005 ± 0.016	0.3	.75

Note: Model R^2 = .20, *n* = 3,050 species, λ = .920, *p* < .0001.

[a]This is the difference between the intercept for species for which longevity is estimated from individuals in nature and for those for which it is known from captive individuals.

[b]Values for activity times are intercepts and are compared to the intercept (0.758 ± 0.177) for diurnal species.

R^2 = .15, p < .0001; Table 2) and nocturnal amphibians, which live 13.5% longer (n = 538, λ = .588, R^2 = .24, p < .0001) than diurnal species. Likewise, temperature seasonality was uncorrelated with vertebrate longevity either across or within classes (Table 2).

Mean annual temperature emerged as the only climatic predictor significantly (and negatively) associated with tetrapod longevity (slope = −0.001 ± 0.006 log years/°C; p = .04; Figure 1b; Table 2). Life spans were longer in colder climates. Interestingly, considered individually, the longevities of endotherm classes (Mammalia: slope=−0.004 ± 0.006, p = .53; Aves: slope=−0.001 ± 0.009, p = .17) were not associated with temperature, whereas amphibian and reptilian longevities were higher in colder regions (Amphibia: n = 404, λ = .580, slope=−0.009 ± 0.002, p < .0001; Reptilia: n = 953, λ = .801, slope =−0.006 ± 0.002, p = .005). Models based only on well-sampled species gave mostly qualitatively similar results (Supporting Information Appendix S2.2). Reptile body temperature (n = 453, λ = .794, slope= −0.001 ± 0.002; p = .49) was not associated with longevity. Moreover, foraging mode (active versus sit-and-wait foraging: intercept = 0.977 ± 0.190, p = .65, n = 496, λ = .838) was not associated with reptilian longevity (see Supporting Information Appendix S2.2 for well-sampled models).

Finally, we observed that ectotherms (amphibians and reptiles together) demonstrate similar longevities to similar-sized endotherms (birds and mammals together), despite an order of magnitude difference in BMRs (Supporting Information Appendix S2.4). Accounting for body size and phylogeny alone, birds live longer than amphibians and reptiles, which, in turn, live longer than mammals (Supporting Information Appendix S2.4).

4 | DISCUSSION

The rate-of-living theory (Finkel & Holbrook, 2000; Lints, 1989; Pearl, 1928; Speakman, 2005) underpins key predictions of life history and ageing theories (Jin, 2010). Despite using the most comprehensive world-wide vertebrate dataset created to date, we failed to find support for the predictions of this theory. We implemented both direct and indirect measurements of metabolic rates. Very few measurements gave any indication that fast metabolic rates are associated with longevity within vertebrate classes, across the fundamental divide in the metabolic range of 'fast-living' endotherms versus 'slow-living' ectotherms, or across all tetrapods. RMRs and FMRs were uncorrelated with longevity (except for reptile FMR, which varies with longevity according to the rate-of-living predictions, but with $n = 25$). Furthermore, proxies for metabolic rates, such as activity times, seasonality and body temperatures, did not reveal a relationship with longevity across the tetrapod tree of life. Animals grow faster in warmer regions (Kingsolver & Huey, 2008), and ectothermic vertebrates are no exception. This can lead to small adult size ('the temperature–size rule'; Atkinson, 1994; Stillwell, 2010; Van Rijn, Buba, DeLong, Kiflawi, & Belmaker, 2018) and shorter life span. In our study, we found a similar and significant role for high environmental temperatures in driving shorter life span (although the temperature–size rule is unlikely to be the driver, as amphibians and reptiles show no size–temperature clines either within or between species; Adams & Church, 2008; Slavenko et al., 2019; Slavenko & Meiri, 2015). Our findings align with recent predictions emerging from the mathematical integration between neutral, metabolic and niche theories (Worm & Tittensor, 2018) that evolutionary processes on a global scale are dominated by environmental temperatures.

4.1 | The drivers of ageing in tetrapods

The paucity of direct estimates of metabolic rate led us to examine indirect proxies for which much more data were available. Ectotherm metabolic rates vary positively with activity body-temperature across most of the temperature range (Gillooly, Brown, West, Savage, & Charnov, 2001). We had thus predicted that shorter life span should be associated with higher energy expenditure (via high activity), diurnal activity and high body temperature. These predictions were not supported by our data. The major differences in body temperatures, and both RMRs and FMRs, between ectotherms and endotherms (White et al., 2006) do not translate into differences in life spans. We did find that the variation in reptilian longevity is related to their FMR. However, the small sample size (25 species, 19 if considering only those for which data on the sample size were used to determine longevity) and weak power (Tversky & Kahneman, 1971) make this link tenuous. However, even with additional predictors (such as sample size or body size) in our power analysis, most of our models maintained high power (> .8).

A caveat is required. Our data on FMRs and RMRs of reptiles are poorly correlated with our indirect indices of reptile metabolic rates: neither are related to activity times (although just one species for which we have FMR data is nocturnal), foraging mode nor mean annual temperature. Body temperature was (positively) correlated with standard metabolic rates ($n = 173$) but not with FMRs ($n = 25$; mass was used as a covariate in all these analyses). Thus, it may be that the factors we examined are not good proxies for metabolic rates (see results for the relationship between RMR and FMR in Supporting Information Appendix S2.4). Alternatively, metabolic rates, being measured at rest for all species, regardless of factors such as foraging mode, may not capture the actual underlying rates during activity. Data on FMRs may well be much more useful but, again, are hard to come by. The null findings for endotherms in our study might also be due to the potential association between flight and increased life span (Healy et al., 2014; Holmes & Austad, 1994; Munshi-South & Wilkinson, 2010; Wilkinson & South, 2002).

Nocturnal ectotherms have lower body temperatures, and thus lower FMRs, than diurnal ones. Furthermore, diurnal animals are exposed to solar radiation, which may subject them to harmful mutations. Nocturnality, however, was only (positively) associated with longevity in amphibians (as also shown in Stark & Meiri, 2018), whereas the other groups demonstrated no such relationship. We postulate that the effects of solar radiation may be mitigated through the possession of more resistant skin. That reptiles, unlike amphibians, do not show an effect of activity time on longevity, suggests that it is radiation that probably causes the differences in longevity between diurnal and nocturnal amphibians. Diel differences in temperatures and the resulting difference in metabolic rates, however, do not affect longevity (otherwise, we would expect these also to affect reptiles). It may be that the effect of activity time on longevity operates via differential predation pressures on different parts of the diel cycle. For example, Healy et al. (2014) found that crepuscular flying endotherms have shorter life spans (compared to nocturnal or diurnal species), perhaps because they are exposed to both diurnal and nocturnal predators, resulting in higher extrinsic mortality.

Most ectotherms and many mammals reduce their metabolism in highly seasonal regions by means of hibernation, aestivation or torpor (Storey & Storey, 1990; Turbill et al., 2011). During this time they may also be less exposed to predation (Turbill et al., 2011). Seasonality, however, was not associated with longevity.

Large species demonstrate slower mass-specific metabolic rates (Clarke, Rothery, & Isaac, 2010; Kleiber, 1947; Nagy, 2005; White, Blackburn, & Seymour, 2009), and this has been linked to longer life spans (Kirkwood, 1977; Sohal, 1986). However, our findings suggest that the relationship between size and longevity does not stem from metabolic rates, but from other size-related intrinsic and extrinsic factors. Larger animals may be less vulnerable to predation (e.g., they can be preyed upon by fewer species), starvation and extreme environmental conditions, such as drought (Peterson & Wroblewski, 1984; Sogard, 1997), which could affect mortality rate independently of metabolic rate. Moreover, reduced extrinsic mortality, as a consequence of larger size, may alter the optimum for investment in somatic maintenance: lower predation risk could lead to investment in somatic maintenance and repair becoming more profitable. Longer lives could allow organisms to achieve a larger size, which in turn enables greater reproduction success. This is because larger mothers often have larger offspring, which may be more likely to survive (Kirkwood & Holliday, 1979). In ectotherms, larger size also allows more offspring to be produced. We thus view size as a factor that affects longevity through mechanisms (such as its relationship with time to maturity, and predation rates) not directly related to metabolic rates or affected by them. In other words, the relationship between metabolic rate and longevity is spurious and only arises because both are correlated with body size.

4.2 | Ageing and climate change: the 'burning quickly' hypothesis

Importantly, we found that high environmental temperature is associated with low ectotherm longevity. This observation may reflect an effect of mortality rates. First, in colder environments animals are usually active for shorter periods during the year (Johnston & Dunn, 1987), thereby reducing their exposure to predation risk and food shortages (Turbill et al., 2011). Moreover, hotter, more tropical, regions probably host a greater diversity of species. Consequently, more predator and parasite species are likely to inhabit such regions. If higher predator and parasite species diversity (rather than their abundance, specificity and lethality) results in high extrinsic mortality risk, this may select for shorter life span. This observation suggests an unexpected link between the vulnerability of a species (especially ectotherms) and the unprecedented global warming that the planet is currently experiencing (IPCC, 2013). Indeed, if increasing ambient temperatures reduce longevity, then multiple life-history characteristics that evolve in coordination with a species' life span (e.g., reduced lifetime reproductive success, skewed sex ratios etc.) could be affected (Bókony, Milne, Pipoly, Székely, & Liker, 2019; Cunningham, While, & Wapstra, 2017; Huey et al., 2012; Seebacher, White, & Franklin, 2015). This may increase extinction risk across a wide range of taxa. Importantly, therefore, our findings add a previously overlooked layer to the range of factors that are commonly used to develop predictions regarding the threat of extinction to species in the Anthropocene.

The use of maximum longevity in comparative studies is not ideal. Maxima may be unrepresentative of the species as a whole (Carey, 2003). Furthermore, longevity estimates based on unequal numbers of individuals for different species would result in higher maxima reported for species associated with larger samples, biasing the analyses (Scharf et al., 2015). Unfortunately, much more data exist on maxima than on actuarial ageing (Healy et al., 2014; Scharf et al., 2015), which would be a better indicator for testing the 'rate-of-living' theory. However, maxima are the commonest metric of longevity in comparative studies (Healy et al., 2014; Magalhães et al., 2007; Scharf et al., 2015; Wilkinson & Adams, 2019), and are likely to be tightly associated with means. Additionally, we accounted here for the uneven sampling in our analyses.

The rate-of-living theory has been proposed as an explanation for the variation in longevity across the animal tree of life (Atanasov, 2005; Healy et al., 2019; Hulbert et al., 2007; Kapahi et al., 2010; Ku et al., 1993; Sohal, Svensson, Sohal, & Brunk, 1989; Wright et al., 2004). Despite the high power of our statistical models, our analysis lends it no support. We thus conclude that the evidence supporting the theory is at best idiosyncratic. Recently, some smaller-scale experimental and meta-analytical studies (Glazier, 2015; Hou & Amunugama, 2015; Hulbert et al., 2007; Vaanholt, Daan, Garland, & Visser, 2010; Van Voorhies et al., 2003;) revealed no effects of metabolism on longevity, challenging the validity of the theory. Our global-scale phylogenetic comparative analyses provide the first body of robust evidence that the rate-of-living theory does not hold across a broad spectrum of life-history and ecological traits from across the vertebrate tree of life. Our study resets our fundamental understanding of the role of metabolic rates on the trajectories of adaptive evolution, and raises serious questions about many of the current assumptions and predictions, for which we found no support or validation in our study.

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DATA AVAILABILITY STATEMENT

All data used in the analyses and the associated metadata are avlifesailable in Supporting Information Appendix S1.

ORCID

Gavin Stark https://orcid.org/0000-0002-4391-2806
Daniel Pincheira-Donoso https://orcid.org/0000-0002-0050-6410
Shai Meiri https://orcid.org/0000-0003-3839-6330

REFERENCES

Adams, D. C., & Church, J. O. (2008). Amphibians do not follow Bergmann's Rule. *Evolution*, *62*, 413–420. https://doi.org/10.1111/j.1558-5646.2007.00297.x

Anderson, K. A., & Beitinger, T. L. (1979). Body heating and cooling in the mudpuppy, Necturus maculosus. *Herpetologica*, *35*, 234–239.

Anderson, R. A., & Karasov, W. H. (1981). Contrasts in energy intake and expenditure in sit-and-wait and widely foraging lizards. *Oecologia*, *49*, 67–72. https://doi.org/10.1007/BF00376899

Andrews, R. M., & Pough, F. H. (1985). Metabolism of squamate reptiles: Allometric and ecological relationships. *Physiological Zoology*, *58*, 214–231. https://doi.org/10.1086/physzool.58.2.30158569

Araujo, M. B., Ferri-Yáñez, F., Bozinovic, F., Marquet, P. A., Valladares, F., & Chown, S. L. (2013). Heat freezes niche evolution. *Ecology Letters*, *16*, 1206–1219. https://doi.org/10.1111/ele.12155

Arnold, T. W. (2010). Uninformative parameters and model selection using Akaike's Information Criterion. *The Journal of Wildlife Management*, *74*, 1175–1178. https://doi.org/10.1111/j.1937-2817.2010.tb01236.x

Atanasov, A. T. (2005). The linear allometric relationship between total metabolic energy per life span and body mass of poikilothermic animals. *Biosystems*, *82*, 137–142.

Atkinson, D. (1994). Temperature and organism size - A biological law for ectotherms? *Advances in Ecological Research*, *25*, 1–58.

Austad, S. N., & Fischer, K. E. (1991). Mammalian aging, metabolism, and ecology: Evidence from the bats and marsupials. *Journal of Gerontology*, *46*, B47–B53. https://doi.org/10.1093/geronj/46.2.B47

Bachmann, K. (1969). Temperature adaptations of amphibian embryos. *The American Naturalist*, *102*, 115–130. https://doi.org/10.1086/282588

Ballinger, R. E., & McKinney, C. O. (1966). Developmental temperature tolerance of certain anuran species. *Journal of Experimental Zoology*, *161*, 21–28. https://doi.org/10.1002/jez.1401610104

Barja, G. (2002). Endogenous oxidative stress: Relationship to aging, longevity and caloric restriction. *Ageing Research Reviews*, *1*, 397–411. https://doi.org/10.1016/S1568-1637(02)00008-9

Barja, G., & Herrero, A. (1998). Localization at complex I and mechanism of the higher free radical production of brain nonsynaptic mitochondria in the short-lived rat than in the longevous pigeon. *Journal of Bioenergetics and Biomembranes*, *30*, 235–243.

Beckman, K. B., & Ames, B. N. (1998). The free radical theory of aging matures. *Physiological Reviews*, *78*, 547–581. https://doi.org/10.1152/physrev.1998.78.2.547

Benjamin, D. J., Berger, J. O., Johannesson, M., Nosek, B. A., Wagenmakers, E. J., Berk, R., et al. (2018). Redefine statistical significance. *Nature Human Behaviour*, *2*(1), 6–10.

Bider, J. R., & Morrison, K. A. (1981). Changes in toad (*Bufo americanus*) responses to abiotic factors at the northern limit of their distribution. *American Midland Naturalist*, *106*, 293–304. https://doi.org/10.2307/2425165

Bohlin, R. G., & Beitinger, T. L. (1979). Heat exchange in the aquatic salamander, *Amphiuma means*. *Journal of Thermal Biology*, *4*, 63–67. https://doi.org/10.1016/0306-4565(79)90047-0

Bókony, V., Milne, G., Pipoly, I., Székely, T., & Liker, A. (2019). Sex ratios and bimaturism differ between temperature-dependent and genetic sex-determination systems in reptiles. *BMC Evolutionary Biology*, *19*, 57–64. https://doi.org/10.1186/s12862-019-1386-3

Bradford, D. F. (1984). Temperature modulation in a high-elevation amphibian, *Rana muscosa*. *Copeia*, *1984*, 966–976. https://doi.org/10.2307/1445341

Brattstrom, B. H. (1963). Preliminary review of the thermal requirements of amphibians. *Ecology*, *44*, 238–255.

Brattstrom, B. H. (1968). Thermal acclimation in anuran amphibians as a function of latitude and altitude. *Comparative Biochemistry and Physiology*, *24*, 93–111. https://doi.org/10.1016/0010-406X(68)90961-4

Brattstrom, B. H. (1970). Amphibia. In G. C. Whittow (Ed.), *Comparative physiology of thermoregulation* (pp. 135–166). New York, NY: Academic Press.

Brown, H. A. (1975). Temperature and development of the tailed frog, *Ascaphus truei*. *Comparative Biochemistry and Physiology*, *50A*, 397–405. https://doi.org/10.1016/0300-9629(75)90033-X

Brunet-Rossinni, A. K., & Austad, S. N. (2004). Ageing studies on bats: A review. *Biogerontology*, *5*, 211–222. https://doi.org/10.1023/B:BGEN.0000038022.65024.d8

Bushuev, A., Tolstenkov, O., Zubkova, E., Solovyeva, E., & Kerimov, A. (2017). Basal metabolic rate in free-living tropical birds: The influence of phylogenetic, behavioral, and ecological factors. *Current Zoology*, *64*, 33–43. https://doi.org/10.1093/cz/zox018

Carey, J. R. (2003). *Longevity: The biology and demography of life span*. Princeton, NJ: Princeton University Press.

Catenazzi, A., Lehr, E., & Vredenburg, V. T. (2014). Thermal physiology, disease, and amphibian declines on the eastern slopes of the Andes. *Conservation Biology*, *28*, 509–517. https://doi.org/10.1111/cobi.12194

Clarke, A., Rothery, P. R., & Isaac, N. J. B. (2010). Scaling of basal metabolic rate with body mass and temperature in mammals. *Journal of Animal Ecology*, *79*, 610–619. https://doi.org/10.1111/j.1365-2656.2010.01672.x

Cunningham, G. D., While, G. M., & Wapstra, E. (2017). Climate and sex ratio variation in a viviparous lizard. *Biology Letters*, *13*, 20170218. https://doi.org/10.1098/rsbl.2017.0218

Darlington, P. J. (1957). *Zoogeography*. New York, NY: Wiley.

De Magalhães, J. P., & Costa, J. (2009). A database of vertebrate longevity records and their relation to other life-history traits. *Journal of Evolutionary Biology*, *22*, 1770–1774. https://doi.org/10.1111/j.1420-9101.2009.01783.x

Faurby, S., & Svenning, J. C. (2015). A species-level phylogeny of all extant and late Quaternary extinct mammals using a novel heuristic-hierarchical Bayesian approach. *Molecular Phylogenetics and Evolution*, *84*, 14–26. https://doi.org/10.1016/j.ympev.2014.11.001

Feldman, A., & Meiri, S. (2013). Length–mass allometry in snakes. *Biological Journal of the Linnean Society*, *108*, 161–172. https://doi.org/10.1111/j.1095-8312.2012.02001.x

Feldman, A., Sabath, N., Pyron, R. A., Mayrose, I., & Meiri, S. (2016). Body sizes and diversification rates of lizards, snakes, amphisbaenians and the tuatara. *Global Ecology and Biogeography*, *25*, 187–197. https://doi.org/10.1111/geb.12398

Finkel, T., & Holbrook, N. J. (2000). Oxidants, oxidative stress and the biology of ageing. *Nature*, *408*, 239. https://doi.org/10.1038/35041687

Fisher, R. A. (1925). *Statistical methods for research workers*. Edinburgh, UK: Oliver & Boyd.

Freckleton, R. P., Harvey, P. H., & Pagel, M. (2002). Phylogenetic analysis and comparative data: A test and review of evidence. *The American Naturalist*, *160*, 712–726. https://doi.org/10.1086/343873

Frishkoff, L. O., Hadly, E. A., & Daily, G. C. (2015). Thermal niche predicts tolerance to habitat conversion in tropical amphibians and reptiles. *Global Change Biology*, *21*, 3901–3916. https://doi.org/10.1111/gcb.13016

Furness, L. J., & Speakman, J. R. (2008). Energetics and longevity in birds. *Age*, *30*, 75–87. https://doi.org/10.1007/s11357-008-9054-3

Gavrilov, L. A., & Gavrilova, N. S. (2002). Evolutionary theories of aging and longevity. *The Scientific World Journal*, *2*, 339–356. https://doi.org/10.1100/tsw.2002.96

Gillooly, J. F., Brown, J. H., West, G. B., Savage, V. M., & Charnov, E. L. (2001). Effects of size and temperature on metabolic rate. *Science*, *293*, 2248–2251. https://doi.org/10.1126/science.1061967

Gillooly, J. F., Gomez, J. P., & Mavrodiev, E. V. (2017). A broad-scale comparison of aerobic activity levels in vertebrates: Endotherms versus ectotherms. *Proceedings of the Royal Society B: Biological Sciences*, *284*, 20162328.

Glazier, D. S. (2015). Is metabolic rate a universal 'pacemaker' for biological processes? *Biological Reviews*, *90*, 377–407. https://doi.org/10.1111/brv.12115

Green, B., & Christian, K. (2007). Field metabolic rates (FMRs) and water fluxes in free-living varanid lizards: A review. *Mertensiella*, *16*, 240–246.

Hamilton, W. D. (1966). The moulding of senescence by natural selection. *Journal of Theoretical Biology*, *12*, 12–45. https://doi.org/10.1016/0022-5193(66)90184-6

Healy, K., Ezard, T. H., Jones, O. R., Salguero-Gómez, R., & Buckley, Y. M. (2019). Animal life history is shaped by the pace of life and the distribution of age-specific mortality and reproduction. *Nature Ecology and Evolution*, *3*, 1217–1224. https://doi.org/10.1038/s41559-019-0938-7

Healy, K., Guillerme, T., Finlay, S., Kane, A., Kelly, S. B., McClean, D., … Cooper, N. (2014). Ecology and mode-of-life explain lifespan variation in birds and mammals. *Proceedings of the Royal Society B: Biological Sciences*, *281*, 20140298.

Herreid, C. F. II (1964). Bat longevity and metabolic rate. *Experimental Gerontology*, *1*, 1–9. https://doi.org/10.1016/0531-5565(64)90002-6

Hill, R. W., Wyse, G. A., & Anderson, M. (2012). *Animal physiology* (3rd ed.). Sunderland, MA: Sinauer Associates.

Holmes, D. J., & Austad, S. N. (1994). Fly now, die later: Life-history correlates of gliding and flying in mammals. *Journal of Mammalogy*, *75*, 224–226. https://doi.org/10.2307/1382255

Hou, C., & Amunugama, K. (2015). On the complex relationship between energy expenditure and longevity: Reconciling the contradictory empirical results with a simple theoretical model. *Mechanisms of Ageing and Development*, *149*, 50–64. https://doi.org/10.1016/j.mad.2015.06.003

Huey, R. B., Kearney, M. R., Krockenberger, A., Holtum, J. A., Jess, M., & Williams, S. E. (2012). Predicting organismal vulnerability to climate warming: Roles of behaviour, physiology and adaptation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*, 1665–1679.

Huey, R. B., & Kingsolver, J. G. (1989). Evolution of thermal sensitivity of ectotherm performance. *Trends in Ecology and Evolution B*, *4*, 131–135. https://doi.org/10.1016/0169-5347(89)90211-5

Hulbert, A. J., Pamplona, R., Buffenstein, R., & Buttemer, W. A. (2007). Life and death: Metabolic rate, membrane composition, and life span of animals. *Physiological Reviews*, *87*, 1175–1213. https://doi.org/10.1152/physrev.00047.2006

IPCC. (2013). Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. In T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, … P. M. Midgley (Eds.), (p. 1535). UK: Cambridge University Press. doi:https://doi.org/10.1017/CBO9781107415324

Jetz, W., & Pyron, R. A. (2018). The interplay of past diversification and evolutionary isolation with present imperilment across the amphibian tree of life. *Nature Ecology and Evolution*, *2*, 850–858. https://doi.org/10.1038/s41559-018-0515-5

Jin, K. (2010). Modern biological theories of aging. *Aging and Disease*, *1*, 72–74.

Johnson, V. E. (2013). Revised standards for statistical evidence. *Proceedings of the National Academy of Sciences*, *110*(48), 19313–19317.

Johnston, I. A., & Dunn, J. E. F. F. (1987). Temperature acclimation and metabolism in ectotherms with particular reference to teleost fish. *Symposia of the Society for Experimental Biology*, *41*, 67–93.

Kapahi, P., Chen, D., Rogers, A. N., Katewa, S. D., Li, P. W. L., Thomas, E. L., & Kockel, L. (2010). With TOR, less is more: A key role for the conserved nutrient-sensing TOR pathway in aging. *Cell Metabolism*, *11*(6), 453–465. https://doi.org/10.1016/j.cmet.2010.05.001

Karger, D. N., Conrad, O., Böhner, J., Kawohl, T., Kreft, H., Soria-Auza, R. W., … Kessler, M. (2017). Climatologies at high resolution for the earth's land surface areas. *Scientific Data*, *4*, 170122. https://doi.org/10.1038/sdata.2017.122

Katz, U., & Gil, N. (1997). Different temperature relations of two species of toads that coexist at the border of their geographic distribution. *Amphibia-Reptilia*, *18*, 259–268.

Kelemen, E. P., Cao, N., Cao, T., Davidowitz, G., & Dornhaus, A. (2019). Metabolic rate predicts the lifespan of workers in the bumble bee *Bombus impatiens*. *Apidologie*, *50*, 195–203. https://doi.org/10.1007/s13592-018-0630-y

Kingsbury, B. A. (1995). Field metabolic rates of a eurythermic lizard. *Herpetologica*, *51*, 155–159.

Kingsolver, J. G., & Huey, R. B. (2008). Size, temperature, and fitness: Three rules. *Evolutionary Ecology Research*, *10*, 251–268.

Kirkwood, T. B. (1977). Evolution of ageing. *Nature*, *270*, 301–304. https://doi.org/10.1038/270301a0

Kirkwood, T. B. (2017). 2: The disposable soma theory. In Richard P. Shefferson, Owen R. Jones, & Roberto Salguero-Gómez (Eds.), *Evolution of senescence in the tree of life* (pp. 23–39). Cambridge, UK: Cambridge University Press.

Kirkwood, T. B., & Austad, S. N. (2000). Why do we age? *Nature*, *408*, 233–238. https://doi.org/10.1038/35041682

Kirkwood, T. B., & Holliday, R. (1979). The evolution of ageing and longevity. *Proceedings of the Royal Society B: Biological Sciences*, *205*, 531–546.

Kleiber, M. (1947). Body size and metabolic rate. *Physiological Reviews*, *27*, 511–541. https://doi.org/10.1152/physrev.1947.27.4.511

Ku, H. H., Brunk, U. T., & Sohal, R. S. (1993). Relationship between mitochondrial superoxide and hydrogen peroxide production and longevity of mammalian species. *Free Radical Biology and Medicine*, *15*, 621–627. https://doi.org/10.1016/0891-5849(93)90165-Q

Lagunas-Rangel, F. A. (2019). Why do bats live so long?—Possible molecular mechanisms. *Biogerontology*, *21*, 1–11.

Lindstedt, S. L., & Calder, W. A. (1976). Body size and longevity in birds. *The Condor*, *78*, 91–94. https://doi.org/10.2307/1366920

Lints, F. A. (1989). The rate of living theory revisited. *Gerontology*, *35*, 36–57. https://doi.org/10.1159/000212998

Liu, R. K., & Walford, R. L. (1975). Mid-life temperature-transfer effects on life-span of annual fish. *Journal of Gerontology*, *30*, 129–131. https://doi.org/10.1093/geronj/30.2.129

Lovegrove, B. G. (2003). The influence of climate on the basal metabolic rate of small mammals: A slow-fast metabolic continuum. *Journal of Comparative Physiology B*, *173*, 87–112. https://doi.org/10.1007/s00360-002-0309-5

Luddecke, H., & Sanchez, O. R. (2002). Are tropical highland frog calls colds-adapted? The case of the Andean frog *Hyla labialis*. *Biotropica*, *34*, 281–288.

Magalhães, J. P. D., Costa, J., & Church, G. M. (2007). An analysis of the relationship between metabolism, developmental schedules, and longevity using phylogenetic independent contrasts. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *62*, 149–160. https://doi.org/10.1093/gerona/62.2.149

McKechnie, A. E., & Wolf, B. O. (2004). The allometry of avian basal metabolic rate: Good predictions need good data. *Physiological and Biochemical Zoology*, *77*, 502–521. https://doi.org/10.1086/383511

Medawar, P. B. (1952). *An unsolved problem of biology*. London: Lewis.

Meiri, S. (2020). What geckos are - an ecological-biogeographic perspective. *Israel Journal of Ecology and Evolution*.

Meiri, S. (2010). Length–weight allometries in lizards. *Journal of Zoology*, *281*, 218–226. https://doi.org/10.1111/j.1469-7998.2010.00696.x

Meiri, S. (2018). Traits of lizards of the world: Variation around a successful evolutionary design. *Global Ecology and Biogeography*, *27*, 1168–1172. https://doi.org/10.1111/geb.12773

Melov, S., Ravenscroft, J., Malik, S., Gill, M. S., Walker, D. W., Clayton, P. E., … Lithgow, G. J. (2000). Extension of life-span with superoxide dismutase/catalase mimetics. *Science*, *289*, 1567–1569. https://doi.org/10.1126/science.289.5484.1567

Munshi-South, J., & Wilkinson, G. S. (2010). Bats and birds: Exceptional longevity despite high metabolic rates. *Ageing Research Reviews*, *9*, 12–19. https://doi.org/10.1016/j.arr.2009.07.006

Murray, I. W., Fuller, A., Lease, H. M., Mitchell, D., Wolf, B. O., & Hetem, R. S. (2014). The actively foraging desert lizard *Pedioplanis husabensis* (Husab Sand Lizard) behaviorally optimizes its energetic economy. *Canadian Journal of Zoology*, *92*, 905–913.

Murray, I. W., Fuller, A., Lease, H. M., Mitchell, D., Wolf, B. O., & Hetem, R. S. (2015). Low field metabolic rates for geckos of the genus Rhoptropus may not be surprising. *Journal of Arid Environments*, *113*, 35–42. https://doi.org/10.1016/j.jaridenv.2014.09.006

Nagy, K. A. (2005). Field metabolic rate and body size. *Journal of Experimental Biology*, *208*, 1621–1625. https://doi.org/10.1242/jeb.01553

Nagy, K. A., Huey, R. B., & Bennett, A. F. (1984). Field energetics and foraging mode of Kalahari lacertid lizards. *Ecology*, *65*, 588–596. https://doi.org/10.2307/1941421

Naya, D. E., Naya, H., & White, C. R. (2018). On the interplay among ambient temperature, basal metabolic rate, and body mass. *The American Naturalist*, *192*, 518–524. https://doi.org/10.1086/698372

Nunn, C. L., & Barton, R. A. (2000). Allometric slopes and independent contrasts: A comparative test of Kleiber's law in primate ranging patterns. *The American Naturalist*, *156*, 519–533. https://doi.org/10.1086/303405

Orme, D., Freckleton, R., Thomas, G., & Petzoldt, T. (2013). The caper package: Comparative analysis of phylogenetics and evolution in R. *R package version 5*, 1–36.

Parkes, T. L., Elia, A. J., Dickinson, D., Hilliker, A. J., Phillips, J. P., & Boulianne, G. L. (1998). Extension of Drosophila lifespan by

overexpression of human SOD1 in motorneurons. *Nature Genetics*, *19*, 171–174. https://doi.org/10.1038/534
Pearl, R. (1928). *The rate of living*. UK: University of London Press.
Peterson, I., & Wroblewski, J. S. (1984). Mortality rate of fishes in the pelagic ecosystem. *Canadian Journal of Fisheries and Aquatic Sciences*, *41*, 1117–1120. https://doi.org/10.1139/f84-131
Pincheira-Donoso, D., & Hodgson, D. J. (2018). No evidence that extinction risk increases in the largest and smallest vertebrates. *Proceedings of the National Academy of Sciences USA*, *115*, E5845–E5846. https://doi.org/10.1073/pnas.1804633115
Prum, R. O., Berv, J. S., Dornburg, A., Field, D. J., Townsend, J. P., Lemmon, E. M., & Lemmon, A. R. (2015). A comprehensive phylogeny of birds (Aves) using targeted next-generation DNA sequencing. *Nature*, *526*, 569–573. https://doi.org/10.1038/nature15697
R Core Team. (2019). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/
Réale, D., Garant, D., Humphries, M. M., Bergeron, P., Careau, V., & Montiglio, P. O. (2010). Personality and the emergence of the pace-of-life syndrome concept at the population level. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*, 4051–4063. https://doi.org/10.1098/rstb.2010.0208
Richter-Boix, A., Katzenberger, M., Duarte, H., Quintela, M., Tejedo, M., & Laurila, A. (2015). Local divergence of thermal reaction norms among amphibian populations is affected by pond temperature variation. *Evolution*, *69*, 2210–2226. https://doi.org/10.1111/evo.12711
Roll, U., Feldman, A., Novosolov, M., Allison, A., Bauer, A. M., Bernard, R., … Meiri, S. (2017). The global distribution of tetrapods reveals a need for targeted reptile conservation. *Nature Ecology and Evolution*, *1*, 1677–1682. https://doi.org/10.1038/s41559-017-0332-2
Roquet, C., Lavergne, S., & Thuiller, W. (2014). One tree to link them all: A phylogenetic dataset for the European Tetrapoda. *PLoS Currents*, *6*. https://doi.org/10.1371/currents.tol.5102670fff8aa5c918e78f5592790e48
Rubner, M. (1908). *Das Problem der Lebensdaur und seiner Beziehung zum Wachstum und Ernährung*. Munich, Germany: Oldenberg-Verlag.
Santini, L., Benítez-lópez, A., Ficetola, G. F., & Huijbregts, M. A. (2018). Length–mass allometries in amphibians. *Integrative Zoology*, *13*, 36–45. https://doi.org/10.1111/1749-4877.12268
Scharf, I., Feldman, A., Novosolov, M., Pincheira-Donoso, D., Das, I., Böhm, M., … Meiri, S. (2015). Late bloomers and baby boomers: Ecological drivers of longevity in squamates and the tuatara. *Global Ecology and Biogeography*, *24*, 396–405. https://doi.org/10.1111/geb.12244
Seebacher, F., White, C. R., & Franklin, C. E. (2015). Physiological plasticity increases resilience of ectothermic animals to climate change. *Nature Climate Change*, *5*, 61–66. https://doi.org/10.1038/nclimate2457
Sieg, A. E., O'Connor, M. P., McNair, J. N., Grant, B. W., Agosta, S. J., & Dunham, A. E. (2009). Mammalian metabolic allometry: Do intraspecific variation, phylogeny, and regression models matter? *The American Naturalist*, *174*, 720–733. https://doi.org/10.1086/606023
Slavenko, A., Feldman, A., Allison, A., Bauer, A. M., Bohm, M., Chirio, L., … Meiri, S. (2019). Global patterns of body size evolution in squamate reptiles are not driven by climate. *Global Ecology and Biogeography*, *28*, 471–483. https://doi.org/10.1111/geb.12868
Slavenko, A., & Meiri, S. (2015). Mean body sizes of amphibian species are poorly predicted by climate. *Journal of Biogeography*, *42*, 1246–1254. https://doi.org/10.1111/jbi.12516
Slavenko, A., Tallowin, O. J., Itescu, Y., Raia, P., & Meiri, S. (2016). Late Quaternary reptile extinctions: Size matters, insularity dominates. *Global Ecology and Biogeography*, *25*, 1308–1320. https://doi.org/10.1111/geb.12491
Smith, J. G., Christian, K., & Green, B. (2008). Physiological ecology of the mangrove-dwelling varanid Varanus indicus. *Physiological and Biochemical Zoology*, *81*, 561–569.
Sogard, S. M. (1997). Size-selective mortality in the juvenile stage of teleost fishes: A review. *Bulletin of Marine Science*, *60*, 1129–1157.
Sohal, R. S. (1986). The rate of living theory: A contemporary interpretation. In K.-G. Collatz, & R. S. Sohal (Eds.), *Insect aging* (pp. 23–44). Berlin, Germany: Springer.
Sohal, R. S. (2002). Role of oxidative stress and protein oxidation in the aging process. *Free Radical Biology and Medicine*, *33*, 37–44.
Sohal, R. S., Svensson, I., Sohal, B. H., & Brunk, U. T. (1989). Superoxide anion radical production in different animal species. *Mechanisms of Ageing and Development*, *49*, 129–135. https://doi.org/10.1016/0047-6374(89)90096-1
Speakman, J. R. (2005). Body size, energy metabolism and lifespan. *Journal of Experimental Biology*, *208*, 1717–1730. https://doi.org/10.1242/jeb.01556
Stark, G., & Meiri, S. (2018). Cold and dark captivity: Drivers of amphibian longevity. *Global Ecology and Biogeography*, *27*, 1384–1397. https://doi.org/10.1111/geb.12804
Stark, G., Tamar, K., Itescu, Y., Feldman, A., & Meiri, S. (2018). Cold and isolated ectotherms: Drivers of reptilian longevity. *Biological Journal of the Linnean Society*, *125*, 730–740. https://doi.org/10.1093/biolinnean/bly153
Stillwell, R. C. (2010). Are latitudinal clines in body size adaptive? *Oikos*, *119*, 1387–1390. https://doi.org/10.1111/j.1600-0706.2010.18670.x
Storey, K. B., & Storey, J. M. (1990). Metabolic rate depression and biochemical adaptation in anaerobiosis, hibernation and estivation. *The Quarterly Review of Biology*, *65*, 145–174. https://doi.org/10.1086/416717
Stuart, L. C. (1951). The distributional implications of temperature tolerances and haemoglobin values in the toads *Bufo marinus* (Linnaeus) and *Bufo bocourti* Brocchi. *Copeia*, *1951*, 220–229.
Sun, J., & Tower, J. (1999). FLP recombinase-mediated induction of Cu/Zn-superoxide dismutase transgene expression can extend the life span of adult *Drosophila melanogaster* flies. *Molecular and Cellular Biology*, *19*, 216–228.
Turbill, C., Bieber, C., & Ruf, T. (2011). Hibernation is associated with increased survival and the evolution of slow life histories among mammals. *Proceedings of the Royal Society B: Biological Sciences*, *278*, 3355–3363. https://doi.org/10.1098/rspb.2011.0190
Tversky, A., & Kahneman, D. (1971). Belief in the law of small numbers. *Psychological Bulletin*, *76*, 105–110. https://doi.org/10.1037/h0031322
Uyeda, J. C., Pennell, M. W., Miller, E. T., Maia, R., & McClain, C. R. (2017). The evolution of energetic scaling across the vertebrate tree of life. *The American Naturalist*, *190*, 185–199. https://doi.org/10.1086/692326
Vaanholt, L. M., Daan, S., Garland, T. Jr, & Visser, G. H. (2010). Exercising for life? Energy metabolism, body composition, and longevity in mice exercising at different intensities. *Physiological and Biochemical Zoology*, *83*, 239–251. https://doi.org/10.1086/648434
Van Rijn, I., Buba, Y., DeLong, J., Kiflawi, M., & Belmaker, J. (2018). Large but uneven reduction in fish size across species in relation to changing sea temperatures. *Global Change Biology*, *23*, 3667–3674. https://doi.org/10.1111/gcb.13688
Van Voorhies, W. A., Khazaeli, A. A., & Curtsinger, J. W. (2003). Selected contribution: Long-lived *Drosophila melanogaster* lines exhibit normal metabolic rates. *Journal of Applied Physiology*, *95*, 2605–2613.
Wells, K. D. (2007). *The ecology and behaviour of amphibians*. Chicago, IL: University of Chicago Press.
White, C. R., Blackburn, T. M., & Seymour, R. S. (2009). Phylogenetically informed analysis of the allometry of mammalian basal metabolic rate supports neither geometric nor quarter-power scaling. *Evolution*, *63*, 2658–2667. https://doi.org/10.1111/j.1558-5646.2009.00747.x
White, C. R., Frappell, P. B., & Chown, S. L. (2012). An information-theoretic approach to evaluating the size and temperature dependence of metabolic rate. *Proceedings of the Royal Society B: Biological Sciences*, *279*, 3616–3621. https://doi.org/10.1098/rspb.2012.0884
White, C. R., Phillips, N. F., & Seymour, R. S. (2006). The scaling and temperature dependence of vertebrate metabolism. *Biology Letters*, *2*, 125–127. https://doi.org/10.1098/rsbl.2005.0378

White, C. R., & Seymour, R. S. (2003). Mammalian basal metabolic rate is proportional to body mass2/3. *Proceedings of the National Academy of Sciences USA*, *100*(7), 4046–4049.
Wilkinson, G. S., & Adams, D. M. (2019). Recurrent evolution of extreme longevity in bats. *Biology Letters*, *15*, 20180860. https://doi.org/10.1098/rsbl.2018.0860
Wilkinson, G. S., & South, J. M. (2002). Life history, ecology and longevity in bats. *Aging Cell*, *1*, 124–131. https://doi.org/10.1046/j.1474-9728.2002.00020.x
Williams, P. D., Day, T., Fletcher, Q., & Rowe, L. (2006). The shaping of senescence in the wild. *Trends in Ecology and Evolution*, *21*, 458–463. https://doi.org/10.1016/j.tree.2006.05.008
Worm, B., & Tittensor, D. P. (2018). *A theory of global biodiversity (MPB-60)* (Vol. *79*). New Jersey, USA: Princeton University Press.
Wright, A. F., Jacobson, S. G., Cideciyan, A. V., Roman, A. J., Shu, X., Vlachantoni, D., … Riemersma, R. A. (2004). Lifespan and mitochondrial control of neurodegeneration. *Nature Genetics*, *36*, 1153–1158. https://doi.org/10.1038/ng1448
Wygoda, M. L., & Williams, A. A. (1991). Body temperatures in free-ranging green tree frogs (*Hyla cinerea*): A comparison with “typical” frogs. *Herpetologica*, *47*, 328–335.
Žagar, A., Simčič, T., Carretero, M. A., & Vrezec, A. (2015). The role of metabolism in understanding the altitudinal segregation pattern of two potentially interacting lizards. *Comparative Biochemistry and Physiology Part A: Molecular and Integrative Physiology*, *179*, 1–6. https://doi.org/10.1016/j.cbpa.2014.08.018
Zhang, L., Guo, K., Zhang, G. Z., Lin, L. H., & Ji, X. (2018). Evolutionary transitions in body plan and reproductive mode alter maintenance metabolism in squamates. *BMC Evolutionary Biology*, *18*, 45–53. https://doi.org/10.1186/s12862-018-1166-5

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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APPENDIX

LONGEVITY DATA SOURCES

Abts, M. (1987). Environment and variation in life history traits of the chuckwalla, *Sauromalus obesus*. *Ecological Monographs*, *57*, 215–232.
Adams, C. (2004). Obituary. Iguana Specialist Group Newsletter, 7/1: 1–14. Accessed February 28, 2011 at http://www.iucn-isg.org/newsletters/pdf/ISG_News_7(1).pdf.
Aguirre, T. A., & Gatica, C. A. (2010). Ficha técnica de Coleonyx brevis. In: Gatica C. A. (Ed.). *Diagnóstico de algunas especies de anfibios y reptiles del Norte de México*. Laboratorio de Ecología y Biodiversidad Animal. Instituto de Ciencias Biomédicas, Universidad Autónoma de Ciudad Juárez. Bases de datos SNIB-CONABIO. Proyecto No. CK007. México, D.F.
Ainley, D. (2002). *The Adelie penguin: Bellwether of climate change*. New York, NY: Columbia University Press.
Alcala, A. (1966). *Populations of three tropical lizards on Negros Island, Philippines* (Unpublished Ph.D. thesis). California: Stanford University.
Alcala, A. C., & Brown, W. C. (1966). Thermal relations of two tropical lizards on Negros Island, Philippine Islands. *Copeia*, *1966*, 593–594.
Alderton, D. (1988). *Turtles & tortoises of the world*. New York, NY: Facts on File.
Alderton, D., & Tanner, B. (1991). *Crocodiles & alligators of the world*. London, UK: Facts on File.
Al-Johany, A. M., & Al-Sadoon, M. K. (1996). Selected body temperature and metabolic rate–temperature curves of three species of desert snakes. *Journal of Arid Environments*, *34*, 363–370.
Allen, A. P., Gillooly, J. F., Savage, V. M., & Brown, J. H. (2006). Kinetic effects of temperature on rates of genetic divergence and speciation. *Proceedings of the National Academy of Sciences USA*, *103*, 9130–9135.
Allison, A. (1982). *Distribution and ecology of New Guinea lizards*. In J. L. Gressitt (Ed.), *Biogeography and ecology of New Guinea* (pp. 803–813). Dordrecht, the Netherlands: Springer.
Al-Sadoon, M. K. (2002). Measurement of resting and active aerobic and anaerobic metabolism of the sand fish, *Scincus mitra* Nus at selected temperatures. *Pakistan Journal of Biological Sciences*, *5*, 192–195.
Al-Sadoon, M. K., Paray, B. A., & Rudayni, H. A. (2018). Metabolism of the spade-headed Amphisbaenian worm lizard, *Diplometopon zarudnyi* (Nikolsky, 1907), in Saudi Arabia (Reptilia: Trogonophidae). *Saudi Journal of Biological Sciences*, *25*, 178–181.
Altunisik, A., & Özdemir, N. (2015). Life history traits in Bufotes variabilis (Pallas, 1769) from 2 different altitudes in Turkey. *Turkish Journal of Zoology*, *39*, 153–159.
Altunişik, A., Gül, Ç., Ozdemir, N., Tosunoğlu, M., & Ergül, T. (2013). Age structure and body size of the Strauch's racerunner, *Eremias strauchi strauchi* Kessler, 1878. *Turkish Journal of Zoology*, *37*, 539–543.
Amat, F., Oromí, N., & Sanuy, D. (2010). Body size, population size, and age structure of adult palmate newts (*Lissotriton helveticus*) in Pyrenean Lakes. *Journal of Herpetology*, *44*, 313–319.
Amat, F., Oromí, N., Sanuy, D., & Carranza, S. (2015). Sexual dimorphism and age structure of the Montseny newt (*Calotriton arnoldi*). *Amphibia-Reptilia*, *36*, 245–252.
AmphibiaWeb. (2017). *AmphibiaWeb*. http://amphibiaweb.org. Berkeley: University of California. Accessed 2 April 2017.
Anastasiadis, J. M., & Whitaker, A. H. (1987). Longevity of free-living Hoplodactylus maculatus (Reptilia: Gekkonidae). *New Zealand Journal of Ecology*, *10*, 141–142.
Anderson, R. A., & Karasov, W. H. (1981). Contrasts in energy intake and expenditure in sit-and-wait and widely foraging lizards. *Oecologia*, *49*, 67–72.
Andreone, F., & Guarino, F. M. (2003). Giant and long-lived? Age structure in *Macroscincus coctei*, an extinct skink from Cape Verde. *Amphibia-Reptilia*, *24*, 459–470.

Andreone, F., Guarino, F. M., & Randrianirina, J. E. (2005). Life history traits, age profile, and conservation of the panther chameleon, *Furcifer pardalis* (Cuvier 1829), at Nosy Be, NW Madagascar. *Tropical Zoology*, *18*, 209–225.

Andreone, F., Vences, M., Guarino, F. M., Glaw, F., & Randrianirina, J. E. (2002). Natural history and larval morphology of *Boophis occidentalis* (Anura: Mantellidae: Boophinae) provide new insights into the phylogeny and adaptive radiation of endemic Malagasy frogs. *Journal of Zoology*, *257*, 425–438.

Andrews, R. M., & Pough, F. H. (1985). Metabolism of squamate reptiles: allometric and ecological relationships. *Physiological Zoology*, *58*(2), 214–231.

Antonio, F. (1980). Mating behavior and reproduction of the eyelash viper (*Bothrops schlegeli*) in captivity. *Herpetologica*, *36*, 231–233.

Arakelyan, M., Petrosyan, R., Ilgaz, Ç., Kumlutaş, Y., Durmuş, S. H., Tayhan, Y., & Danielyan, F. (2013). A skeletochronological study of parthenogenetic lizards of genus Darevskia from Turkey. *Acta Herpetologica*, *8*, 99–104.

Arantes, Í. D. C., Vasconcellos, M. M., Boas, T. C., Veludo, L. B., & Colli, G. R. (2015). Sexual dimorphism, growth, and longevity of two toad species (Anura, Bufonidae) in a Neotropical savanna. *Copeia*, *103*(2), 329–342.

Arnold, E. N. (2002). *Reptiles and amphibians of Europe*. New Jersey: Princeton University Press.

Arribas, O. J. (2004). Characteristics of the reproductive biology of *Iberolacerta aurelioi* (Arribas, 1994). *Herpetozoa*, *17*, 3–18.

Artacho, P., Saravia, J., Ferrandiere, B. D., Perret, S., & Le Galliard, J. F. (2015). Quantification of correlational selection on thermal physiology, thermoregulatory behavior, and energy metabolism in lizards. *Ecology and Evolution*, *5*(17), 3600–3609.

Ash, A. N., Bruce, R. C., Castanet, J., & Francillon-Vieillot, H. (2003). Population parameters of Plethodon metcalfi on a 10-year-old clear cut and in nearby forest in the southern Blue Ridge Mountains. *Journal of Herpetology*, *37*, 445–452.

Ashton, K. G. (2005). Life history of a fossorial lizard, *Neoseps reynoldsi*. *Journal of Herpetology*, *39*, 389–395.

Atkins, Z. S., Clemann, N., Chapple, D. G., Edwards, A. M., Sinsch, U., Hantzschmann, A. M., ... Robert, K. A. (2019). Demographic and life history variation in two sky-island populations of an endangered alpine lizard. *Journal of Zoology*, *310*, 34–44. https://doi.org/10.1111/jzo.12728

Auffenberg, W. (1981). *The behavioral ecology of the Komodo monitor*. Florida: University Press of Florida.

Avery, R. (1975). Age-structure and longevity of common lizard (*Lacerta vivipara*) populations. *Journal of Zoology*, *176*, 555–558.

Axtell, R. W., & Axtell, C. A. (1971). A new lizard (*Sceloporus jarrovii cyanostictus*) from the Sierra Madre of Coahuila, Mexico. *Copeia*, *1971*(1), 89–98.

Baig, K. J., Wagner, P., Ananjeva, N. B., & Boehme, W. (2012). A morphology-based taxonomic revision of *Laudakia* Gray, 1845 (Squamata: Agamidae). *Vertebrate Zoology*, *62*, 213–260.

Baker, R. C., Wilke, F., & Baltzo, C. H. (1970). The northern fur seal (No. 336). U.S. Bureau of Commercial Fisheries.

Bannock, C. A., Whitaker, A. H., & Hickling, G. J. (1999). Extreme longevity of the common gecko (*Hoplodactylus maculatus*) on Motunau Island, Canterbury, New Zealand. *New Zealand Journal of Ecology*, *23*, 101–103.

Barbault, R. (1976). Population dynamics and reproductive patterns of three African skinks. *Copeia*, *3*, 483–490.

Barrows, C. W., Rotenberry, J. T., & Allen, M. F. (2010). Assessing sensitivity to climate change and drought variability of a sand dune endemic lizard. *Biological Conservation*, *143*(3), 731–736.

Bars-Closel, M., Camacho, A., & Kohlsdorf, T. (2018). Shifts in space and time: ecological transitions affect the evolution of resting metabolic rates in microteiid lizards. *Journal of Experimental Biology*, *221*(14), jeb175661.

Bartlett, P. P., Griswold, B., & Bartlett, R. D. (2001). *Reptiles, amphibians, and invertebrates: an identification and care guide*. Hauppauge, New York: Barrons Educational Series.

Bartlett, P., & Wagner, E. (1997). *Pythons: A complete pet owner's manual*. Hauppaauge, NY 11718: Barons Educational Series.

Bartlett, R., & Bartlett, P. (2000). *Ball pythons*. Hauppauge, New York: Barrons Educational Series.

Bartlett, R., & Bartlett, P. (2001). *Day geckos*. Hauppauge, NY: Barron's Educational Series.

Başkale, E., Yildirim, E., Çevik, I. E., & Kaya, U. (2013). Population size and age structure of metamorphic and pedomorphic forms of *Ommatotriton ophryticus* (Berthold, 1846) in the northwestern Black Sea region of Turkey. *Journal of Herpetology*, *47*(2), 270–276.

Bastien, H., & Leclair, R. (1992). Aging wood frogs (Rana sylvatica) by skeletochronology. *Journal of Herpetology*, *26*(2), 222–225.

Bateman, H. L., & Chung-MacCoubrey, A. (2012). Growth and activity of Sceloporus cowlesi (southwestern fence lizard). *Herpetological Review*, *43*(1), 39–41.

Bateman, H. L., Snell, H. L., Chung-MacCoubrey, A., & Finch, D. M. (2010). Growth, activity, and survivorship from three sympatric parthenogenic whiptails (Family Teiidae). *Journal of Herpetology*, *44*(2), 301–306.

Bauer, A. M., Sumontha, M., Grossmann, W., Pauwels, O. S., & Vogel, G. (2004). A new species of Dixonius (Squamata: Gekkonidae) from Kanchanaburi Province, western Thailand. *Current Herpetology*, *23*(1), 17–26.

Bauwens, D., & Diaz-Uriarte, R. (1997). Covariation of life-history traits in lacertid lizards: a comparative study. *The American Naturalist*, *149*(1), 91–111.

Beane, J. C., Graham, S. P., Thorp, T. J., & Pusser, L. T. (2014). Natural history of the southern hognose snake (Heterodon simus) in North Carolina. *Copeia*, *2014*(1), 168–175.

Beck, D. D., & Lowe, C. H. (1994). Resting metabolism of helodermatid lizards: allometric and ecological relationships. *Journal of Comparative Physiology B*, *164*(2), 124–129.

Bedford, G. S., & Christian, K. A. (1998). Standard metabolic rate and preferred body temperatures in some Australian pythons. *Australian Journal of Zoology*, *46*(4), 317–328.

Behler, J. L., & King, F. W. (2000). *National Audubon Society field guide to North American amphibians and reptiles*. New York, NY: Knopf.

Beşer, N., Ilgaz, Ç., Kumlutaş, Y., Avcı, A., Candan, K., & Üzüm, N. (2019). Age structure and body size of a critically endangered species, *Acanthodactylus harranensis* (Squamata: Lacertidae) and its demography. *Animal Biology*, *69*(4), 421–431.

Best, T., & Henry, T. (1994). *Lepus arcticus*. *Mammalian Species*, 457, 1–9.

Best, T., Titus, A., Lewis, C., & Caesar, K. (1990). *Ammospermophilus nelsoni*. *Mammalian Species*, *367*, 1–7.

Bionda, C. D. L., Kost, S., Salas, N. E., Lajmanovich, R. C., Sinsch, U., & Martino, A. L. (2015). Age structure, growth and longevity in the common toad, *Rhinella arenarum*, from Argentina. *Acta Herpetologica*, *10*(1), 55–62.

Blair, D. (1991). West Indian iguanas of the genus Cyclura: Their current status in the wild, conservation priorities and efforts to breed them in captivity (online pdf). Accessed March 06, 2011 at http://www.vipersgarden.at/PDF/DB_Cyclura.pdf.

Blair, W. (1976). Some aspects of the biology of the ornate box turtle, *Terrapene ornata*. *The Southwestern Naturalist*, *21*, 89–103.

Bock, B. C., Zapata, A. M., & Páez, V. P. (2010). Survivorship rates of adult Anolis mariarum (Squamata: Polychrotidae) in two populations with differing mean and asymptotic body sizes. *Papéis Avulsos de Zoologia* (São Paulo), *50*(3), 43–50.

Bogaerts, S. (2006). First data in the reproduction of Lanzai's skinks, *Chalcides lanzai* Pasteur, *Podarcis*, *1967*, 7.

Bogin, Y., Efrati, N. P., & Werner, Y. L. (1999). Captive longevity in Lacerta laevis laevis (Reptilia: Sauria): Hypothetical effects of sex, temperature and climate. *Russian Journal of Herpetology*, *6*(2), 87–91.

Bonin, F., Devaux, B., & Dupré, A. (2006). Turtles of the world. Baltimore: JHU Press.

Boretto, J. M., Cabezas-Cartes, F., & Ibargüengoytía, N. R. (2015). Energy allocation to growth and reproduction in a viviparous lizard endemic to the highlands of the Andes, Argentina. *Journal of Zoology*, *297*(1), 77–86.

Bornschein, M. R., Pizo, M. A., Sobotka, D. D., Belmonte-Lopes, R., Golec, C., Machado-de-Souza, T., … Reinert, B. L. (2015). Longevity records and signs of aging in marsh ant wren *Formicivora acutirostris* (Thamnophilidae). *The Wilson Journal of Ornithology*, *127*, 98–102.

Bosch, J., & González-Miras, E. (2012). *Seguimiento de Alytes dickhilleni: Informe final*. *Monografías SARE*. Madrid, Spain: Asociación Herpetológica Española-Ministerio de Medio Ambiente y Medio Rural y Marino.

Bouskila, A., & Amitai, P. (2001). *Handbook of amphibians and reptiles of Israel*. Jerusalem, Israel: Keter Publishing House.

Bowler, J. K. (1977). *Longevity of reptiles and amphibians in North American collections as of 1 November, 1975*. Society for the Study of Amphibians and Reptiles. Ohio.

Bowyer, R., Van Ballenberghe, V., & Kie, J. (2003). Moose: Alces alces. In G. Feldhamer, B. Thompson, & J. Chapman (Eds.), *Wild mammals of North America: Biology, management and conservation* (pp. 931–964). Baltimore, MD: John Hopkins University Press.

Boycott, R. C., & Morgan, D. R. (1990). Observations on reproduction in Southern African boomslang, *Dispholidus typus*. *The Journal of the Herpetological Association of Africa*, *38*(1), 51–52.

Branch, B. (2012). *Tortoises, terrapins & turtles of Africa*. Cape Town, South Africa: Random House Struik.

Brito, J. C., & Rebelo, R. (2003). Differential growth and mortality affect sexual size dimorphism in *Vipera latastei*. *Copeia*, *2003*(4), 865–871.

Brito, S. P., Abe, A. S., & Andrade, D. V. (2001). Tupi nambis merianae Tegu lizard—Longevity. *Herpetological Review*, *32*(4): 260–261.

Broadley, D. G. (1983). *FitzSimons' snakes of southern Africa*. Johannesburg, South Africa: Delta Books.

Brochu, C. A. (2003). Taxonomy & nomenclature (On-line). Accessed November 18, 2008 at http://spot.colorado.edu/~humphrey/fact%20sheets/gharial/gharial.htm#threats.

Bronikowski, A., & Vleck, D. (2010). Metabolism, body size and life span: a case study in evolutionarily divergent populations of the garter snake (*Thamnophis elegans*). *Integrative and Comparative Biology*, *50*(5), 880–887.

Brouwer, K., Jones, M. L., King, C. E., & Schifter, H. (1992). Longevity and breeding records of storks Ciconiidae in captivity. *International Zoo Yearbook*, *31*(1), 131–139.

Brouwer, K., Jones, M. L., King, C. E., & Schifter, H. (2000). Longevity records for Psittaciformes in captivity. *International Zoo Yearbook*, *37*(1), 299–316.

Brown, D. (2012). *A guide to Australian dragons in captivity*. Burleigh, Australia: Reptile Publications.

Bruce, R. C., Castanet, J., & Francillon–Vieillot, H. (2002). Skeletochronological analysis of variation in age structure, body size, and life history in three species of desmognathine salamanders. *Acta Herpetologica*, *58*(2), 181–193.

Brushko, Z. (1979). Age structure of the population and length of life of the big-eared roundhead lizard in the sandy plains of the central course of the Ili river. *Soviet Journal of Ecology*, *10*(1), 84–86.

Bülbül, U., Kurnaz, M., Eroğlu, A. İ., Koç, H., & Kutrup, B. (2016). Age and growth of the red-belied lizard, *Darevskia parvula*. *Animal Biology*, *66*(1), 81–95.

Buono, V., Guarino, F. M., & Vignoli, L. (2014). Maximum body size and age distribution in the Italian stream frog, *Rana italica* Dubois 1987 (Amphibia: Anura). *Acta Herpetologica*, *9*(2), 231–235.

Busack, S. D., & Jaksic, F. M. (1982). Autecological observations of *Acanthodactylus erythrurus* (Sauria: Lacertidae) in southern Spain. *Amphibia-Reptilia*, *3*(2), 237–255.

Buttemer, W. A., Battam, H., & Hulbert, A. J. (2008). Fowl play and the price of petrel: long-living Procellariiformes have peroxidation-resistant membrane composition compared with short-living Galliformes. *Biology Letters*, *4*(4), 351–354.

Cabezas-Cartes, F., Boretto, J. M., & Ibargüengoytía, N. R. (2015). Age, growth and life-history parameters of an endemic vulnerable lizard from Patagonia, Argentina. *The Herpetological Journal*, *25*(4), 215–224.

Cabezas-Cartes, F., Boretto, J. M., & Ibargüengoytía, N. R. (2018). Effects of climate and latitude on age at maturity and longevity of lizards studied by skeletochronology. *Integrative and Comparative Biology*, *58*(6), 1086–1097.

Cadeddu, G., Giacoma, C., & Castellano, S. (2012). Sexual size dimorphism in the Tyrrhenian tree frog: A life-history perspective. *Journal of Zoology*, *286*(4), 285–292.

Caetano, M. H., & Leclair, R. Jr. (1996). Growth and population structure of red-spotted newts (*Notophthalmus viridescens*) in permanent lakes of the Laurentian Shield, Quebec. *Copeia*, *1996*, 866–874.

Caetano, M. H., & Leclair, R. Jr. (1999). Comparative phenology and demography of *Triturus boscai* from Portugal. *Journal of Herpetology*, *33*(2), 192–202.

Cajade, R., Marangoni, F., & Gangenova, E. (2013). Age, body size and growth pattern of *Argenteohyla siemersi pederseni* (Anura: Hylidae) in northeastern Argentina. *Journal of Natural History*, *47*, 237–251.

Campbell, T. (2000). The brown anole, Anolis sagrei. Institute for Biological Invasions Invader of the Month. Accessed March 19, 2003 at http://invasions.bio.utk.edu/invaders/sagrei.html.

Carey, J. R., & Judge, D. S. (2000). *Longevity records: Life spans of mammals, birds, reptiles, amphibians and fish*. Odense Monographs on Population Aging, B. Jeaune & J. W. Vaupel (Eds). Denmark: Odense University Press.

Carey, J. R., & Judge, D. S. (2002). *Longevity records: Life spans of mammals, birds, amphibians, reptiles, and fish*. Monographs on Population Aging (Vol. 8). Denmark: Odense University Press.

Carr, A. (1952). *Handbook of turtles*. Ithaca, NY: Cornell University Press.

Carr, J. L., & Giraldo, A. (2009). *Rhinoclemmys nasuta* (Boulenger 1902) – large-nosed wood turtle, Chocoan river turtle. In: A. G. J. Rhodin, P. C. H. Pritchard, P. P. van Dijk, R. A. Saumure, K. A. Buhlmann, J. B. Iverson, & R. A. Mittermeier (Eds.), Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group (pp. 034.1–034.6). Chelonian Research Monographs No. 5, https://doi.org/10.3854/crm.5.034.nasuta.v1.2009, http://www.iucn-tftsg.org/cbftt/.

Castanet, J. (1994). Age estimation and longevity in reptiles. *Gerontology*, *40*, 174–192.

Castanet, J., & Baez, M. (1991). Adaptation and evolution in Gallotia lizards from the Canary Islands: age, growth, maturity and longevity. *Amphibia-Reptilia*, *12*(1), 81–102.

Castanet, J., Pinto, S., Loth-Marie, M., & Lamotte, M. (2000). Age, longevity and bone growth dynamics in *Nectophrynoides occidentalis* (Anuran, Bufonidae). *Annales de s Sciences Naturelles Zoologie et Biologie Animale*, *21*(1), 11–17.

Chacón, D., Gomez, A., & Corrales, G. (2016). Captive longevity for Micrurus nigrocinctus (Serpentes: Elapidae) at Instituto Clodomiro Picado, Costa Rica. *Mesoamerican Herpetology*, *3*, 1101–1104.

Chapple, D. G. (2003). Ecology, life-history, and behavior in the Australian scincid genus Egernia, with comments on the evolution of complex sociality in lizards. *Herpetological Monographs*, *17*, 145–180.

Chen, B. Y., Liao, W. B., & Mi, Z. P. (2011). Body size and age of the China Wood Frog (*Rana chensinensis*) in northeastern China. *North-Western Journal of Zoology*, *7*(2), 236–242.

Chen, W., & Lu, X. (2011). Age and body size of *Rana amurensis* from northeastern China. *Current Zoology*, *57*(6), 781–784.

Chen, W., Wu, Q. G., Su, Z. X., & Lu, X. (2012). Age, body size and clutch size of *Rana kunyuensis*, a subtropical frog native to China. *The Herpetological Journal*, *22*(3), 203–206.

Chen, W., Yu, T. L., & Lu, X. (2011). Age and body size of *Rana kukunoris*, a high-elevation frog native to the Tibetan plateau. *The Herpetological Journal*, *21*(2), 149–151.

Cheong, S. W., Park, D. S., Sung, H. C., Lee, J. H., & Park, S. R. (2007). Skeletochronological age determination and comparative demographic analysis of two populations of the gold-spotted pond frog (*Rana chosenica*). *Journal of Ecology and Environment*, *30*(1), 57–62.

Cherry, M. I., & Francillon-Vieillot, H. (1992). Body size, age and reproduction in the leopard toad, *Bufo pardalis*. *Journal of Zoology*, *228*(1), 41–50.

Çiçek, K., Kumaş, M., Ayaz, D., Mermer, A., & Engin, Ş. D. (2011). Age structure of Levant water frog, *Pelophylax bedriagae*, in Lake Sülüklü (Western Anatolia, Turkey). *Basic and Applied Herpetology*, *25*(2011), 73–80.

Çiçek, K., Kumaş, M., Ayaz, D., & Tok, C. V. (2012). Preliminary data on the age structure of *Phrynocephalus horvathi* in Mount Ararat (Northeastern Anatolia, Turkey). *Biharean Biologist*, *6*(2), 112–115.

Cissé, M., Karns, D. R., & Karns, K. C. (1977). Aspects of the ecology of *Acanthodactylus dumerili* Milne Edwards (Sauria: Lacertidae) in Senegal. *Bulletin de l'Institut français d'Afrique noire. Série A, Sciences naturelles*, *39*(1), 190–218.

Clapp, R., Klimkiewicz, M., & Kennard, J. (1982). Longevity records of North American birds: Gaviidae through Alcidae. *Journal of Field Ornithology*, *53*(2): 81–124.

Clemente, C. J., Withers, P. C., & Thompson, G. G. (2009). Metabolic rate and endurance capacity in Australian varanid lizards (Squamata: Varanidae: Varanus). *Biological Journal of the Linnean Society*, *97*(3), 664–676.

Cogalniceanu, D., & Miaud, C. (2003). Population age structure and growth in four syntopic amphibian species inhabiting a large river floodplain. *Canadian Journal of Zoology*, *81*(6), 1096–1106.

Cogălniceanu, D., Roşioru, D., Székely, P., Székely, D., Buhaciuc, E., Stănescu, F., & Miaud, C. (2014). Age and body size in populations of two syntopic spadefoot toads (genus Pelobates) at the limit of their ranges. *Journal of Herpetology*, *48*(4), 537–545.

Cogălniceanu, D., Székely, P., Iosif, R., Székely, D., & Stănescu, F. (2013) Life history and conservation of spadefoot toads (genus Pelobates) in Romania. *FrogLog*, *21*(2013), 24–26.

Cogălniceanu, D., Székely, P., Székely, D., Roşioru, D., Băncilă, R. I., & Miaud, C. (2013). When males are larger than females in ectotherms: Reproductive investment in the Eastern spadefoot toad *Pelobates syriacus*. *Copeia*, *2013*(4), 699–706.

Comas, M., Reguera, S., Zamora–Camacho, F. J., Salvadó, H., & Moreno–Rueda, G. (2016). Comparison of the effectiveness of phalanges vs.

humeri and femurs to estimate lizard age with skeletochronology. *Animal Biodiversity and Conservation*, *39*(2), 237–240.

Conant, R., & Collins, J. (1998). *Reptiles and amphibians: Eastern/Central North America*. New York, NY: Houghton Mifflin Company.

Converse, S., Iverson, J., & Savidge, J. (2005). Demographics of an ornate box turtle population experiencing minimal human-induced disturbances. *Ecological Applications*, *15*, 2171–2179.

Cooper, W., & Vitt, L. (1987). Deferred agonistic behavior in a long-lived scincid lizard *Eumeces laticeps*: Field and laboratory data on the roles of body size and residence in agonistic strategy. *Oecologia*, *72*, 321–326.

Corry, E., Martin, L., Morton, M. N., Hilton, G. M., Young, R. P., & Garcia, G. (2010). A species action plan for the Montserrat galliwasp *Diploglossus montisserrati*. Montserrat: Department of Environment.

Cree, A., & Hare, K. M. (2016). New Zealand lizards. In David G. Chapple (ed.), *Reproduction and life history of New Zealand lizards* (pp. 1–14). Cham, Switzerland: Springer.

Cuadrado, M., Martín, J., & López, P. (2001). Camouflage and escape decisions in the common chameleon *Chamaeleo chamaeleon*. *Biological Journal of the Linnean Society*, *72*(4), 547–554.

Davenport, J., Hills, J., Glasspool, A., & Ward, J. (2001). Threats to the critically endangered endemic Bermudian skink *Eumeces longirostris*. *Oryx*, *35*(4), 332–339.

de Espinoza, N. C., Rothenstein, D., Salas, A., & Werner, Y. L. (1990). Radiation and convergence among desert geckos: Phyllodactylus species resembling both Ptyodactylus and Stenodactylus. *Amphibia-Reptilia*, *11*(1), 1–13.

de Magalhaes, J. (2013). AnAge entry for *Crocodylus novaeguineae*. *The Animal Ageing and Longevity Database*. Accessed June 19, 2013 at http://genomics.senescence.info/species/entry.php?species=Crocodylus_novaeguineae.

de Magalhaes, J., & Costa, J. (2009). A database of vertebrate longevity records and their relation to other life history traits. *Journal of Evolutionary Biology*, *22*, 1770–1774.

De Vosjoli, P. (1992). *The green iguana manual*. Lakeside, CA: Advanced Vivarium Systems.

Dearing, M. D., & Schall, J. J. (1994). Atypical reproduction and sexual dimorphism of the tropical Bonaire Island whiptail lizard, Cnemidophorus murinus. *Copeia*, *3*, 760–766.

Degenhardt, W. G., Painter, C. W., & Price, A. H. (1996). *Amphibians and reptiles of New Mexico*. New Mexico: University of New Mexico Press.

d'Huart, J., & Grubb, P. (2001). Distribution of the common warthog (Phacochoerus africanus) and the desert warthog (*Phacochoerus aethiopicus*) in the Horn of Africa. *African Journal of Ecology*, *39*, 156–169.

Diaz-Paniagua, C., Mateo, J. A., & Andreu, A. C. (1996). Age and size structure of populations of small marbled newts (*Triturus marmoratus pygmaeus*) from Donana National Park (SW Spain). A case of dwarfism among dwarfs. *Journal of Zoology*, *239*(1), 83–92.

Dickinson, H. C., & Fa, J. E. (2000). Abundance, demographics and body condition of a translocated population of St Lucia whiptail lizards (*Cnemidophorus vanzoi*). *Journal of Zoology*, *251*(2), 187–197.

Dietrich, R., & Preston, D. (1977). The red backed vole (*Clethrionomys rutilus*) as a laboratory animal. *Laboratory Animal Science*, *27*, 507–511.

Din, S. M. B. E. (1999). A new species of Tropiocolotes (Reptilia: Gekkonidae) from Egypt. *Zoology in the Middle East*, *19*, 17–26.

Dmi'el, R. (1972). Relation of metabolism to body weight in snakes. *Copeia*, *1*, 179–181.

Dodd, C. K. (2013). *Frogs of the United States and Canada*, 2-vol. set (Vol. 1). Baltimore, Maryland: JHU Press.

Dubey, S., Sinsch, U., Dehling, M. J., Chevalley, M., & Shine, R. (2013). Population demography of an endangered lizard, the Blue Mountains Water Skink. *BMC Ecology*, *13*(1), 4.

Dubos, N. (2013). New locality record for Phelsuma grandis (Sauria: Gekkonidae) in Reunion, in sympatry with the critically endangered *Phelsuma inexpectata*. *Herpetology Notes*, *6*, 309–311.

Duffield, G. A., & Bull, M. C. (1996). Characteristics of the litter of the Gidgee skink, *Egernia stokesii*. *Wildlife Research*, *23*(3), 337–341.

Dunham, A. E. (1981). Populations in a fluctuating environment: the comparative population ecology of *Sceloporus merriami* and *Lrosaurus ornatus*. *Miscellaneous Publications*, *University of Michigan Museum of Zoology*, *158*, 1–62

Eckhardt, F., Kappeler, P. M., & Kraus, C. (2017). Highly variable lifespan in an annual reptile, Labord's chameleon (*Furcifer labordi*). *Scientific Reports*, *7*(1), 11397.

Eipper, S. (2012). *A guide to Australian snakes in captivity: Elapids & colubrids*. Australia: Australian Reptile Publications.

Eisenberg, T., & Werning, H. (2012). Phymaturus cf. palluma in captivity: Observations on its reproduction and biology. *Salamandra*, *48*, 198–206.

Elgar, M. A., & Harvey, P. H. (1987). Basal metabolic rates in mammals: Allometry, phylogeny and ecology. *Functional Ecology*, *1*, 25–36.

Ento, K., & Matsui, M. (2002). Estimation of age structure by skeletochronology of a population of *Hynobius nebulosus* in a breeding season (Amphibia, Urodela). *Zoological Science*, *19*(2), 241–247.

Ergül, T., Özdemir, N., Gül, Ç., & Tosunoğlu, M. (2014). Variation in body size and age structure of *Stellagama stellio* (L., 1758) (Reptilia: Agamidae) from Turkey. *Acta Zoologica Bulgarica*, *66*, 65–72.

Erişmiş, U. C., Arıkan, H., Konuk, M., & Guarino, F. M. (2011). Age structure and growth in Caucasian parsley frog *Pelodytes caucasicus* (Boulenger, 1896) from Turkey. *Russian Journal of Herpetology*, *16*(1), 19–26.

Erismis, U. C., & Chinsamy, A. (2010). Ontogenetic changes in the epiphyseal cartilage of *Rana caralitana* (Anura: Ranidae). *The Anatomical Record*, *293*(11), 1825–1837.

Ernst, C., & Ernst, E. (2011). *Venomous reptiles of the United States, Canada, and Northern Mexico*. Baltimore, MD: Johns Hopkins University Press.

Ernst, C., Barbour, R., & Lovich, J. (1994). *Turtles of the United States and Canada*. Washington, DC: Smithsonian Institution Press.

Ernst, C. H., & Barbour, R. W. (1989). *Snakes of Eastern North America*. Fairfax, VA: George Mason University Press.

Ernst, C. H., & Ernst, E. M. (2003). *Snakes of the United States and Canada*. Fairfax, VA: Smithsonian Books.

Ernst, C. H., & Lovich, J. E. (2009). *Turtles of the United States and Canada*. Baltimore, MA: JHU Press.

Eroglu, A. I., Bulbul, U., & Kurnaz, M. (2017). Age structure and growth in a Turkish population of the Crimean Wall Lizard, *Podarcis tauricus* (PALLAS, 1814) (Squamata: Sauria: Lacertidae). *Herpetozoa*, *29*(3–4), 125–133.

Esteban, M., García-París, M., & Castanet, J. (1996). Use of bone histology in estimating the age of frogs (*Rana perezi*) from a warm temperate climate area. *Canadian Journal of Zoology*, *74*(10), 1914–1921.

Esteban, M., García-París, M., Buckley, D., & Castanet, J. (1999). Bone growth and age in *Rana saharica*, a water frog living in a desert environment. *Annales Zoologici Fennici*, *36*(1), 53–62.

Esteban, M., Sánchez-Herráiz, M. J., Barbadillo, L. J., & Castanet, J. (2004). Age structure and growth in an isolated population of *Pelodytes punctatus* in northern Spain. *Journal of Natural History*, *38*(21), 2789–2801.

Esteban, M., & Sanchiz, B. (2000). Differential growth and longevity in low and high-altitude *Rana iberica* (Anura, Ranidae). *Herpetological Journal*, *10*(1), 19–26.

Estes, R. (1991). *The behavior guide to African mammals*. Berkeley: University of California Press.

Fattah, A., Slimani, T., Grolet, O., & Joly, P. (2014). Age structure of a population of *Barbarophryne brongersmai* (Hoogmoed 1972) (Anura, Bufonidae) inhabiting an arid environment in the Central Jbilets (West-Morocco). *Acta Herpetologica*, *9*(2), 237–242.

Feder, M. E., & Feder, J. H. (1981). Diel variation of oxygen consumption in three species of Philippine gekkonid lizards. *Copeia*, *1*, 204–209.

Fellers, G. M., Drost, C. A., Mautz, W. J., & Murphey, T. G. (1998). *Ecology of the Island Night Lizard, Xantusia riversiana, on San Nicolas Island. California*, VA: US Navy.

Ferguson, G., Murphy, J. Ramanamanjato, J., & Raselimanana, A. P. (2004). *The panther chameleon: Color variation, natural history, conservation, and captive management*. Malabar, FL: Krieger Publishing Company.

Fielder, D. P., Limpus, D. J., & Limpus, C. J. (2015). Reproduction and population ecology of the vulnerable western saw-shelled turtle, *Myuchelys bellii*, in the Murray–Darling Basin, Australia. *Australian Journal of Zoology*, *62*(6), 463–476.

Filippi, E., & Luiselli, L. (2000). Status of the Italian snake fauna and assessment of conservation threats. *Biological Conservation*, *93*, 219–225.

Fisher, D. O., Owens, I. P., & Johnson, C. N. (2001). The ecological basis of life history variation in marsupials. *Ecology*, *82*(12), 3531–3540.

Fitch, H. (1960). Autecology of the copperhead. *University of Kansas Museum of Natural History Publications*, *13*, 85–288.

Fitch, H. S. (1973). Population structure and survivorship in some Costa Rican lizards. Estructura poblacional y sobrevivencia en algunas lagartijas costarricenses. *Occasional Papers*, *18*, 1–41.

Fleming, T. H., & Hooker, R. S. (1975). *Anolis cupreus*: The response of a lizard to tropical seasonality. *Ecology*, *56*(6), 1243–1261.

Fornasiero, S., Bonnet, X., Dendi, F., & Zuffi, M. A. (2016). Growth, longevity and age at maturity in the European whip snakes, *Hierophis viridiflavus* and H. carbonarius. *Acta Herpetologica*, *11*(2), 135–149.

Foufopoulos, J., & Ives, A. R. (1999). Reptile extinctions on land-bridge islands: Life-history attributes and vulnerability to extinction. *The American Naturalist*, *153*(1), 1–25.

Fransson, T., Kolehmainen, T., Kroon, C., Jansson, L. & Wenninger, T. (2010). EURING list of longevity records for European birds. Europe: EURING.

Fry, S. K. (2001). Ecology of the endangered Sandy Cay rock iguana, *Cyclura rileyi cristata*, in the Bahamas (Unpublished doctoral dissertation). California: Loma Linda University.

Frye, F. (1995). *Iguana iguana, guide for successful captive care*. Malabar, FL: Krieger Publishing Company.

Gadsden, H., & Castañeda, G. (2013). Life history of the marbled whiptail lizard *Aspidoscelis marmorata* from the central Chihuahuan desert, Mexico. *Acta Herpetologica*, *8*(2), 81–91.

Gaillard, J., Festa-Bianchet, M., & Yoccoz, N. (1998). Population dynamics of large herbivores: Variable recruitment with constant adult survival. *Trends in Ecology and Evolution*, *13*, 58–63.

Gainsbury, A. M., Tallowin, O. J., & Meiri, S. (2018). An updated global data set for diet preferences in terrestrial mammals: Testing the validity of extrapolation. *Mammal Review*, *48*(3), 160–167.

Galvão, P. E., Tarasantchi, J., & Guertzenstein, P. (1965). Heat production of tropical snakes in relation to body weight and body surface. *American Journal of Physiology-Legacy Content*, *209*(3), 501–506.

Gans, C., & Crews, D. (1992). *Hormones, brain, and behavior* (Vol. 18). Chicago: University of Chicago Press.

Garland, T. Jr., & Albuquerque, R. L. (2017). Locomotion, energetics, performance, and behavior: A mammalian perspective on lizards, and vice versa. *Integrative and Comparative Biology*, *57*(2), 252–266.

Garland, T. Jr, & Else, P. L. (1987). Seasonal, sexual, and individual variation in endurance and activity metabolism in lizards. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *252*(3), R439–R449.

Garstka, W. (1981). Female sex pheromone in the skin and circulation of garter snake. *Science*, *214*, 681–683.

Gates, G. O. (1963). Ecology of the iguanid lizard, *Urosaurus graciosus*, in Arizona. Tucson, AZ: University of Arizona.

Genoud, M., Isler, K., & Martin, R. D. (2018). Comparative analyses of basal rate of metabolism in mammals: data selection does matter. *Biological Reviews*, *93*(1), 404–438.

Germano, D. J. (1994). Comparative life histories of North American tortoises. In R. B. Bury & D. J. Germano (Eds.), *Biology of North American tortoises* (pp. 175–185). Washington, DC: U.S. Dep. Interior, National Biological Survey, Fish and Wildlife Research.

Gibson, S., Penniket, S., & Cree, A. (2015). Are viviparous lizards from cool climates ever exclusively nocturnal? Evidence for extensive basking in a New Zealand gecko. *Biological Journal of the Linnean Society*, *115*(4), 882–895.

Gillespie, G. R. (2011). Life history variation in the spotted tree frog, *Litoria spenceri* (Anura: Hylidae), from southeastern Australia. *Acta Herpetologica*, *67*(1), 10–22.

Goldberg, J., Cardozo, D., Brusquetti, F., Bueno Villafañe, D., Caballero Gini, A., & Bianchi, C. (2018). Body size variation and sexual size dimorphism across climatic gradients in the widespread treefrog *Scinax fuscovarius* (Anura, Hylidae). *Austral Ecology*, *43*(1), 35–45.

Goldsmith, S. (1984). Aspects of the Natural History of the Rough Green Snake, *Opheodrys aestivus* (Colubridae). *The Southwestern Naturalist*, *29*, 445–452.

Gorzula, S., Nsiah, W., & Oduro, W. (1997). Survey of the status and management of the royal python (*Python regius*) in Ghana (Online pdf). Accessed April 23, 2010 at ec.europa.eu/environment/cites/pdf/studies/royal_python_ghana.pdf.

Gray, B. S. (2014). *Carphophis amoenus amoenus* (eastern wormsnake) longevity. *Herpetological Review*, *45*, 256.

Green, B., & Christian, K. (2007). Field metabolic rates (FMRs) and water fluxes in free-living varanid lizards: A review. In H. Horn, W. Buhme, & U. Krebs (Eds.), *3rd Multidisciplinary World Conference on Monitor Lizards* (pp. 1–7). Rheinbach, Germany: Advances in Monitor Research III.

Greer, A. E. (1989). *The biology and evolution of Australian lizards*. N.S.W, Australia: Surrey Beatty and Sons.

Greer, A. E. (2006). *Encyclopedia of Australian reptiles*. Australian Museum Online.

Grenard, S. (1991). *Handbook of alligators and crocodiles*. Malabar, FL: Krieger Publishing Company.

Grimm-Seyfarth, A., Mihoub, J. B., & Henle, K. (2019). Functional traits determine the different effects of prey, predators, and climatic extremes on desert reptiles. *Ecosphere*, *10*(9), e02865.

Grismer, L. L. (2002). *Amphibians and reptiles of Baja California, including its Pacific islands and the islands in the Sea of Cortés* (Vol. 4). Berkeley, California: University of California Press.

Gruber, B., & Henle, K. (2008). Analysing the effect of movement on local survival: a new method with an application to a spatially structured population of the arboreal gecko *Gehyra variegata*. *Oecologia*, *154*(4), 679–690.

Grzimek, B. (Ed.). (1990). *Grzimek's animal life encyclopedia*. Vol. I–IV. *Mammals*. New York, NY: McGraw-Hill.

Grzimek, N. C. B. (Ed.). (1975). *Grzimek's animal life encyclopedia*. Vol. 1–5, *Mammals*. New York, NY: Van Nostrand Reinhold.

Guarino, F. M., Andreone, F., & Angelini, F. (1998). Growth and longevity by skeletochronological analysis in *Mantidactylus microtympanum*, a rain-forest anuran from southern Madagascar. *Copeia*, *1998*(1), 194–198.

Guarino, F. M., de Pous, P., Crottini, A., Mezzasalma, M., & Andreone, F. (2011). Age structure and growth in a population of *Pelobates varaldii* (Anura, Pelobatidae) from northwestern Morocco. *Amphibia-Reptilia*, *32*(4), 550–556.

Guarino, F. M., & Erismis, U. C. (2008). Age determination and growth by skeletochronology of *Rana holtzi*, an endemic frog from Turkey. *Italian Journal of Zoology*, *75*(3), 237–242.

Guarino, F. M., Garcia, G., & Andreone, F. (2014). Huge but moderately long-lived: age structure in the mountain chicken, *Leptodactylus fallax*, from Montserrat, West Indies. *The Herpetological Journal*, *24*(3), 167–173.

Guarino, F. M., Lunardi, S., Carlomagno, M., & Mazzotti, S. (2003). A skeletochronological study of growth, longevity, and age at sexual maturity in a population of *Rana latastei* (Amphibia, Anura). *Journal of Biosciences*, *28*(6), 775–782.

Guggisberg, C. (1972). *Crocodiles: Their natural history, folklore, and conservation*. Harrisburg, UK: David & Charles.

Gül, S., Olgun, K., & Kutrup, B. (2011). Body size and age structure of *Pelophylax ridibundus* populations from two different altitudes in Turkey. *Amphibia-Reptilia*, *32*(2), 287–292.

Gül, S., Özdemir, N., Avci, A., Kumlutaş, Y., & Ilgaz, C. (2015). Altitudinal effects on the life history of the Anatolian lizard (*Apathya cappadocica*, Werner 1902) from south-eastern Anatolia, Turkey. *Turkish Journal of Zoology*, *39*(3), 507–512.

Gul, S., Ilgaz, C., Kumlutas, Y., & Candan, K. (2017). Age structure and growth pattern in an east Anatolian high-altitude population of *Iranolacerta brandtii* (DE FILIPPI, 1863). *Herpetozoa*, *30*(1–2), 3–7.

Gutiérrez, J. A., Piantoni, C., & Ibargüengoytía, N. (2013). Altitudinal effects on life history parameters in populations of *Liolaemus pictus argentinus* (Sauria: Liolaemidae). *Acta Herpetologica*, *8*, 9–17

Hakeem, A., Sandoval, R., Jones, M., & Allman, J. (1996). *Brain and life span in primates*. In J. Birren (Ed.). *Handbook of the psychology of aging* (pp. 78–104). San Diego, California: Academic Press.

Hall, R. J., & Fitch, H. S. (1971). Further observations on the demography of the great plains skink (*Eumeces obsoletus*). *Transactions of the Kansas Academy of Science*, *74*, 93–98.

Hallmann, K., & Griebeler, E. M. (2015). Eggshell types and their evolutionary correlation with life-history strategies in squamates. *PLoS ONE*, *10*(9), e0138785.

Hamann, U. (1987). Zu Aktivität und Verhalten von drei Taxa der Zwerghamster der Gattung Phodopus Miller. *Zeitschrift für Säugetierkunde*, *52*, 65–76 (in German).

Hammerson, G. (2007). *Heterodon simus*. The IUCN Red List of Threatened Species 2007: e.T63821A12718888. Accessed September 11, 2016 at http://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63821A12718888.en.

Harbig, P. (2000). Erste Erfahrungen bei Terrarienhaltung und Zucht des Laos-Kielskinks, *Tropidophorus laotus* Smith, 1923. *Sauria*, *22*, 3–9.

Harding, J. (1997). *Amphibians and reptiles of the Great Lakes Region*. Ann Arbor: The University of Michigan Press.

Harding, J. (2006). *Amphibians and reptiles of the Great Lakes Region*. Ann Arbor: The University of Michigan Press.

Harding, J. H., & Rockafield, K. (2012). *Nerodia sipedon* (northern watersnake). Captive longevity. *Herpetological Review*, *43*, 265.

Hare, K. M., Pledger, S., Thompson, M. B., Miller, J. H., & Daugherty, C. H. (2010). Nocturnal lizards from a cool-temperate environment have high metabolic rates at low temperatures. *Journal of Comparative Physiology B*, *180*(8), 1173–1181.

Harless, M., & Morlock, H. (Eds.). (1979). *Turtles: Perspectives and research*. New York, NY: John Wiley & Sons.

Hasumi, M. (2010). Age, body size, and sexual dimorphism in size and shape in *Salamandrella keyserlingii* (Caudata: Hynobiidae). *Evolutionary Biology*, *37*(1), 38–48.

Hauschild, A., & Gassner, P. (1995). *Skinke im Terrarium*. Hannover, Germany: Landbuch-Verlag.

Hawbecker, A. (1975). *The biology of some desert dwelling ground squirrels*. The Hague, Netherlands: Dr. Junk, b.v.

Hayssen, V. (1991). *Dipodomys microps*. *Mammalian Species*, 389, 1–9.

Heatwole, H., & Taylor, J. A. (1987). *Ecology of reptiles* (2nd ed.). Chipping Norton, UK: Surrey Beatty & Sons.

Hemelaar, A. (1988). Age, growth and other population characteristics of *Bufo bufo* from different latitudes and altitudes. *Journal of Herpetology*, *22*(4), 369–388.

Henderson, R. W., & Powell, R. (2009). *Natural history of West Indian reptiles and amphibians*. Florida: University Press of Florida.

Hews, D. K. (1993). Food resources affect female distribution and male mating opportunities in the iguanian lizard *Uta palmeri*. *Animal Behaviour*, *46*(2), 279–291.

Hill, R. A. (2006). Why be diurnal? Or, why not be cathemeral? *Folia Primatologica*, *77*(1–2), 72–86.

Hirth, H.F. (1963). The ecology of two lizards on a tropical beach. *Ecological Monographs*, *33*, 83–112.

Hoare, J. M., Stephens, C. L., Daugherty, C. H., & Phillpot, P. M. S. (2005). *Oligosoma lineoocellatum* (spotted skink). Longevity, site fidelity. *Herpetological Review*, *36*, 181.

Hofmeyr, M. D. (2009). Chersina angulata (Schweigger 1812) – Angulate tortoise, South African bowsprit tortoise. *Chelonian Research Monographs*, *5*, 030.1–030.6

Hollis, G. J. (2004). Ecology and conservation biology of the Baw Baw frog *Philoria frosti* (Anura: Myobatrachidae): Distribution, abundance, autoecology and demography (Unpublished doctoral dissertation). Melbourne, Australia: University of Melbourne.

Holman, J., Harding, J., Hensley, M., & Dudderar, G. (1999). *Michigan snakes*. East Lansing: Michigan State University Extension/MSU Museum.

Honegger, R. E. (1969). Notes on some amphibians and reptiles at Zurich Zoo. *International Zoo Yearbook*, *9*(1), 24–28.

Hoser, R. (1989). *Australian reptiles and frogs*. Mosman NSW, Australia: Pierson & Co.

Hossie, T. J., Hassall, C., Knee, W., & Sherratt, T. N. (2013). Species with a chemical defence, but not chemical offence, live longer. *Journal of Evolutionary Biology*, *26*(7), 1598–1602.

Houston, D., & Shine, R. (1994). Low growth rates and delayed maturation in Arafura file snakes (Serpentes: Acrochordidae) in tropical Australia. *American Society of Ichthyologists and Herpetologists*, *1994*, 726–731.

Hsu, F. H., Hsieh, Y. S., Wu, S. H., & Kam, Y. C. (2014). Altitudinal variation in body size and age structure of the Sauter's frog *Rana sauteri* in Taiwan. *Zoological Studies*, *53*(1), 62–71.

Huang, Y., Zhu, H. Q., Liao, Y. M., Jin, L., & Liao, W. B. (2013). Age and body size of the toad *Bombina maxima* in a subtropical high-altitude population. *The Herpetological Journal*, *23*(4), 229–232.

Hudson, L. N., Isaac, N. J., & Reuman, D. C. (2013). The relationship between body mass and field metabolic rate among individual birds and mammals. *Journal of Animal Ecology*, *82*(5), 1009–1020.

Huffman, B. (2003). Mountain nyala. *Animal Diversity Web*. Accessed April 30, 2003 at http://www.ultimateungulate.com/Artiodactyla/Tragelaphus_buxtoni.html.

Hughes, B. (1986a). Longevity records of African captive amphibians and reptiles. Part 1. Lizards and amphisbaenians. *Journal of the Herpetological Association of Africa*, *34*, 20–24.

Hughes, B. (1986b). Longevity records of African captive amphibians and reptiles. Part 2. Lizards and amphisbaenians. *Journal of the Herpetological Association of Africa*, *34*, 20–24.

Hughes, B. (1988). Herpetology in Ghana (West Africa). *British Herpetological Society Bulletin*, *25*, 29–38.

Iturra-Cid, M., Ortiz, J. C., & Ibargüengoytía, N. R. (2010). Age, size, and growth of the Chilean frog *Pleurodema thaul* (Anura: Leiuperidae): latitudinal and altitudinal effects. *Copeia*, *2010*(4), 609–617.

Iverson, J. B., Hines, K. N., & Valiulis, J. M. (2004). The nesting ecology of the Allen Cays rock iguana, *Cyclura cychlura inornata* in the Bahamas. *Herpetological Monographs*, *18*(1), 1–36.

Jackson, J. C. (2007). *Reproduction in dwarf chameleons (Bradypodion) with particular reference to B. pumilum occurring in fire-prone fynbos habitat* (Unpublished doctoral dissertation). Stellenbosch University, Stellenbosch.

Jakob, C., Miaud, C., Crivelli, A. J., & Veith, M. (2003). How to cope with periods of drought? Age at maturity, longevity, and growth of marbled newts (*Triturus marmoratus*) in Mediterranean temporary ponds. *Canadian Journal of Zoology*, *81*(11), 1905–1911.

Jeckel, A. M., Saporito, R. A., & Grant, T. (2015). The relationship between poison frog chemical defenses and age, body size, and sex. *Frontiers in Zoology*, *12*(1), 27.

Jennings, M. R., & Hayes, M. P. (1994). *Amphibian and reptile species of special concern in California*. Rancho Cordova, CA: California Department of Fish and Game, Inland Fisheries Division.

Jesus, J. (2012). Evidence of high longevity in an Island lacertid, *Teira dugesii* (Milne-Edwards, 1829). First data on wild specimens. *Acta Herpetologica*, *7*(2), 309–313.

Jin, Y., & Liao, P. (2015). An elevational trend of body size variation in a cold-climate agamid lizard, *Phrynocephalus theobaldi*. *Current Zoology*, *61*(3), 444–453.

Jofré, G. M., Reading, C. J., & Di Tada, I. E. (2005). Breeding behaviour and reproduction in the Pampa de Achala toad, *Bufo achalensis*. *Amphibia-Reptilia*, *26*(4), 451–458.

Johnson, S. R. (1965). An ecological study of the chuckwalla, *Sauromalus obesus* Baird, in the western Mojave Desert. *American Midland Naturalist*, *73*, 1–29.

Johnston, G. (1999). Reproductive biology of the Peninsula dragon lizard, *Ctenophorus fionni*. *Journal of Herpetology*, *33*(4), 694–698.

Jones, K. E., Bielby, J., Cardillo, M., Fritz, S. A., O'Dell, J., Orme, C. D. L., … Connolly, C. (2009). PanTHERIA: A species-level database of life history, ecology, and geography of extant and recently extinct mammals. *Ecology*, *90*(9), 2648–2648.

Jones, L. L., & Lovich, R. E. (2009). *Lizards of the American Southwest: A photographic field guide*. Tucson, Arizona: Rio Nuevo Publishers.

Jones, M. L. (1982). Longevity of captive mammals. *Zoological Garten N. F. Jena*, *52*, 113–128.

Jovanovic, O., & Vences, M. (2010). Skeletochronological analysis of age structure in populations of four species of Malagasy poisonous frogs, genus Mantella. *Amphibia-Reptilia*, *31*(4), 553–557.

Juvik, J. O., Andrianarivo, A. J., & Blanc, C. P. (1981). The ecology and status of *Geochelone yniphora*: A critically endangered tortoise in northwestern Madagascar. *Biological Conservation*, *19*(4), 297–316.

Kalayci, T. E., Altunişik, A., Gül, Ç., Özdemir, N., & Tosunoğlu, M. (2015). Preliminary data on the age structure of *Asaccus barani* (Baran's leaf-toed gecko) from southeastern Anatolia, Turkey. *Turkish Journal of Zoology*, *39*(4), 680–684.

Kalezić, M. L., Cvetković, D., Djorović, A., & Džukić, G. (1996). Alternative life-history pathways: paedomorphosis and adult fitness in European newts (*Triturus vulgaris* and *T. alpestris*). *Journal of Zoological Systematics and Evolutionary Research*, *34*(1), 1–7.

Kamel, S., & Gatten, R. E. Jr. (1983). Aerobic and anaerobic activity metabolism of limbless and fossorial reptiles. *Physiological Zoology*, *56*(3), 419–429.

Kaplan, M. (2003). Melissa Kaplan's herp care collection. Anoles. Accessed March 21, 2003 at http://www.anapsid.org/anole.html.

Karger, D. N., Conrad, O., Böhner, J., Kawohl, T., Kreft, H., Soria-Auza, R. W., … Kessler, M. (2017). Climatologies at high resolution for the earth's land surface areas. *Scientific Data*, *4*, 170122.

Kästle, W., & Schleich, H. H. (1998). Notes on comparative ethology and taxonomy of the genus japalura. In H. H. Schleich, & W. Kästle, (Eds.), *Contributions to the herpetology of South-Asia (Nepal India)* (pp. 233–246). Wuppertal (Veröffentli-chungen aus dem Fuhlrott-Museum), Bd. 4.

Kellner, A., & Green, D. M. (1995). Age structure and age at maturity in Fowler's toads, *Bufo woodhousii fowleri*, at their northern range limit. *Journal of Herpetology*, *29*(3), 485–489.

Khonsue, W., Matsui, M., Hirai, T., & Misawa, Y. (2001a). A comparison of age structures in two populations of a pond frog *Rana nigromaculata* (Amphibia: Anura). *Zoological Science*, *18*(4), 597–603.

Khonsue, W., Matsui, M., Hirai, T., & Misawa, Y. (2001b). Age determination of wrinkled frog, Rana rugosa with special reference to high variation in postmetamorphic body size (Amphibia: Ranidae). *Zoological Science*, *18*(4), 605–612.

Khonsue, W., Matsui, M., & Misawa, Y. (2000). Age determination by skeletochronology of *Rana nigrovittata*, a frog from tropical forest of Thailand. *Zoological Science*, *17*(2), 253–257.

Khonsue, W., Matsui, M., & Misawa, Y. (2002). Age determination of Daruma pond frog, *Rana porosa brevipoda* from Japan towards its conservation (Amphibia: Anura). *Amphibia-Reptilia*, *23*(3), 259–268.

Kidov, A., & Matushkina, K. (2017). Reproduction of the sand lizard, (Lacerta Agilis L.) In the stavropol upland. Timiryazev Agricultural Academy, *93*, 81–89.

Kidov, A. A., Zamaletdinov, R. I., Matushkina, K. A., & Mikhailova, R. I. (2018). notes on study of age and growth of the hyrcanian frog, *Rana pseudodalmatina* Eiselt Et Schmidtler, 1971 in the Talysh mountains. *Russian Journal of Herpetology*, *25*(3).

Kingdon, J. (1979). *East African mammals*. IL: University of Chicago Press.

Kingsbury, B. A. (1995). Field metabolic rates of a eurythermic lizard. *Herpetologica*, *51*, 155–159.

Kivit, R., & Wiseman, S. (2000). *The green tree python & emerald tree boa: Their captive husbandry and reproduction*. Keltern-Weiler, Germany: Kirschner & Seufer Verlag.

Klimkiewicz, M. K., & Futcher, A. G. (1987). Longevity records of North American birds: Coerebinae through Estrildidae (Registros de Longevidad de Aves de Norte América: Coerebinae a Estrildidae). *Journal of Field Ornithology*, *58*, 318–333.

Klimkiewicz, M., & Futcher, A. (1989). Longevity records of North American birds supplement 1. *Journal of Field Ornithology*, *60*(4), 469–494.

Knoepffler, L.-P. (1961). Les Batraciens et principalement le genre Discoglossus dans les îles méditerranéennes. In *Colloques Internationaux du Centre National de la Recherche Sientifique. XCIV. Le peuplement des îles méditerranéennes et le probleme de l'insularité. Banyuls-sur-Mer, 22–27 sept. 1959* (pp. 159–161). Paris, France: Éd. C.N.R.S.

Köhler, G., Pérez, R. G. T., Petersen, C. B. P., & de la Cruz, F. R. M. (2014). A revision of the Mexican Anolis (Reptilia, Squamata, Dactyloidae) from the Pacific versant west of the Isthmus de Tehuantepec in the states of Oaxaca, Guerrero, and Puebla, with the description of six new species. *Zootaxa*, *3862*(1), 1–210.

Kulkarni, J. T., & Pancharatna, K. (1996). Age related changes in ovarian follicular kinetics in the Indian skipper frog *Rana cyanophlyctis* (Schn.). *Journal of Biosciences*, *21*(5), 699–710.

Kumaş, M., & Ayaz, D. (2014). Age determination and long bone histology in *Stellagama stellio* (Linnaeus, 1758) (Squamata: Sauria: Agamidae) populations in Turkey. *Vertebrate Zoology*, *64*, 113–126.

Kumbar, S. M., & Pancharatna, K. (2001). Determination of age, longevity and age at reproduction of the frog *Microhyla ornata* by skeletochronology. *Journal of Biosciences*, *26*(2), 265–270.

Kusano, T., Maruyama, K., & Kaneko, S. (2010). Body size and age structure of a breeding population of the Japanese common toad, *Bufo japonicus* formosus (Amphibia: Bufonidae). *Current Herpetology*, *29*(1), 23–31.

Kutrup, B., Bulbul, U., & Yilmaz, N. (2005). Age structure in two populations of *Triturus vittatus ophryticus* at different altitudes. *Amphibia-Reptilia*, *26*(1), 49–54.

Kutrup, B., Özdemir, N., Bülbül, U., & Çakır, E. (2011). A skeletochronological study of age, growth and longevity of *Rana macrocnemis* populations from four locations at different altitudes in Turkey. *Amphibia-Reptilia*, *32*(1), 113–118.

Kuzmin, S. L., & Ischenko, V. G. (1997). Skeletochronology of *Bufo raddei* from the Gobi Desert. *Journal of Herpetology*, *31*(2), 306–309.

Kyriakopoulou-Sklavounou, P., Stylianou, P., & Tsiora, A. (2008). A skeletochronological study of age, growth and longevity in a population of the frog *Rana ridibunda* from southern Europe. *Zoology*, *111*(1), 30–36.

Labra, M. A., & Rosenmann, M. (1994). Energy metabolism and evaporative water loss of Pristidactylus lizards. *Comparative Biochemistry and Physiology Part A: Physiology*, *109*(2), 369–376.

Lai, Y. C., Lee, T. H., & Kam, Y. C. (2005). A skeletochronological study on a subtropical, riparian ranid (*Rana swinhoana*) from different elevations in Taiwan. *Zoological Science*, *22*(6), 653–658.

Lamar, W. W., Barrio-Amorós, C. L., Dwyer, Q., Abarca, J. G., & De Plecker, R. (2015). The gerrhonotine genus Coloptychon (Sauria: Anguidae). *Mesoamerican Herpetology*, *2*, 88–104.

Lamprecht, I. H. D., Matuschka, F. R., & Schaarschmidt, B. (1991). Microcalorimetric investigations on the energy metabolism of lizards. *Journal of Experimental Biology*, *156*(1), 375–385.

Langerwerf, B. (2006). *Water dragons*. Neptune City, New Jersey: TFH Publications.

Lannoo, M. (2005). *Amphibian declines: The conservation status of United States species*. Berkeley: University of California Press. Berkeley.

Lauck, B. (2005). Life history of the frog Crinia signifera in Tasmania, Australia. *Australian Journal of Zoology*, *53*(1), 21–27.

Laver, R. J., Purwandana, D., Ariefiandy, A., Imansyah, J., Forsyth, D., Ciofi, C., & Jessop, T. S. (2012). Life-history and spatial determinants of somatic growth dynamics in Komodo dragon populations. *PLoS ONE*, *7*(9), e45398.

Le Berre, F., & Bartlett, R. D. (2009). *The chameleon handbook*. Hauppauge, New York: Barron's Educational Series.

Leclair, M. H., Leclair, R. JR, & Gallant, J. (2005). Application of skeletochronology to a population of *Pelobates cultripes* (Anura: Pelobatidae) from Portugal. *Journal of Herpetology*, *39*(2), 199–207.

Leclair, M. H., Levasseur, M., & Leclair, R. Jr. (2006). Life-history traits of *Plethodon cinereus* in the northern parts of its range: Variations in population structure, age and growth. *Herpetologica*, *62*(3), 265–282.

Leclair, R. Jr, & Castanet, J. (1987). A skeletochronological assessment of age and growth in the frog *Rana pipiens Schreber* (Amphibia, Anura) from southwestern Quebec. *Copeia*, *1987*(2), 361–369.

Leclair, R. Jr, & Leclair, M. H. (2011). Life-history traits in a population of the dwarf gecko, *Sphaerodactylus vincenti ronaldi*, from a xerophytic habitat in Martinique, West Indies. *Copeia*, *2011*(4), 566–576.

Lee, J. H., & Park, D. (2008). Effects of physical parameters and age on the order of entrance of *Hynobius leechii* to a breeding pond. *Journal of Ecology and Field Biology*, *31*(3), 183–191.

Lee, J. H., & Park, D. (2009). Effects of body size, operational sex ratio, and age on pairing by the Asian toad, *Bufo stejnegeri*. *Zoological Studies*, *48*(3), 334–332.

Lee, J. H., Min, M. S., Kim, T. H., Baek, H. J., Lee, H., & Park, D. (2010). Age structure and growth rates of two Korean salamander species (*Hynobius yangi* and *Hynobius quelpaertensis*) from field populations. *Animal Cells and Systems*, *14*(4), 315–322.

Lee, J. H., Ra, N. Y., Eom, J. H., & Park, D. S. (2008). Population dynamics of the long-tailed clawed salamander larva, *Onychodactylus fischeri*, and its age structure in Korea. *Journal of Ecology and Environment*, *31*(1), 31–36.

Legler, J., & Vogt, R. C. (2013). *The turtles of Mexico: Land and freshwater forms*. Berkeley, California: University of California Press.

Lemos-Espinal, J. A., & Dixon, J. R. (2013). *Amphibians and reptiles of San Luis Potosí*. Utah: Eagle Mountain Publishing.

Leskovar, C., Oromi, N., Sanuy, D., & Sinsch, U. (2006). Demographic life history traits of reproductive natterjack toads (*Bufo calamita*) vary between northern and southern latitudes. *Amphibia-Reptilia*, *27*(3), 365–375.

Li, C., Liao, W. B., Yang, Z. S., & Zhou, C. Q. (2010). A skeletochronological estimation of age structure in a population of the Guenther's frog, *Hylarana guentheri*, from western China. *Acta Herpetologica*, *5*(1), 1–11.

Liang, S., Li, W., Zhang, Y., Tang, X., He, J., Bai, Y., … & Chen, Q. (2017). Seasonal variation of metabolism in lizard *Phrynocephalus vlangalii* at high altitude. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*, *203*, 341–347.

Liao, W. B., & Lu, X. (2010a). Age and growth of a subtropical high-elevation torrent frog, *Amolops mantzorum*, in western China. *Journal of Herpetology*, *44*(1), 172–176.

Liao, W. B., & Lu, X. (2010b). Age structure and body size of the Chuanxi tree frog *Hyla annectans chuanxiensis* from two different elevations in Sichuan (China). *Zoologischer Anzeiger-A Journal of Comparative Zoology*, *248*(4), 255–263.

Liao, W. B., & Lu, X. (2011). Male mating success in the Omei tree frog (*Rhacophorus omeimontis*): the influence of body size and age. *Belgian Journal of Zoology*, *141*(2), 3–12.

Liao, W. B., & Lu, X. (2011). Variation in body size, age and growth in the Omei tree frog (*Rhacophorus omeimontis*) along an altitudinal gradient in western China. *Ethology Ecology and Evolution*, *23*(3), 248–261.

Liao, W. B., Lu, X., Shen, Y. W., & Hu, J. C. (2011). Age structure and body size of two populations of the rice frog *Rana limnocharis* from different altitudes. *Italian Journal of Zoology*, *78*(2), 215–221.

Liao, W. B., Zhou, C. Q., Yang, Z. S., Hu, J. C., & Lu, X. (2010). Age, size and growth in two populations of the dark-spotted frog *Rana nigromaculata* at different altitudes in southwestern China. *The Herpetological Journal*, *20*(2), 77–82.

Lillywhite, H. B. (1996). Husbandry of the little file snake, *Acrochordus granulatus*. *Zoo Biology*, *15*(3), 315–327.

Lim, K. K. P., & Lim, F. L. K. (1992). *A field guide to the amphibians & reptiles of Singapore*, 160. Singapore: Singapore Science Centre.

Lindquist, E., Redmer, M., & Brantner, E. (2012). Annular bone growth in phalanges of five Neotropical harlequin frogs (Anura: Bufonidae: Atelopus). Phyllomedusa: *Journal of Herpetology*, *11*(2), 117–124.

Liu, W. C., Liu, Y. H., Huang, Y., Mi, Z. P., & Li, C. (2012). Skeletochronological study on age structure of a Chinese endemic frog (*Rana omeimontis*). *Asian Herpetological Research*, *3*(3), 252–257.

Lou, S. L., Jin, L., Liu, Y. H., Mi, Z. P., Tao, G., Tang, Y. M., & Liao, W. B. (2012). Altitudinal variation in age and body size in Yunnan Pond Frog (*Pelophylax pleuraden*). *Zoological Science*, *29*(8), 493–498.

Lovegrove, B. G. (2003). The influence of climate on the basal metabolic rate of small mammals: a slow-fast metabolic continuum. *Journal of Comparative Physiology B*, *173*(2), 87–112.

Loveridge, A. (1942). Scientific results of a Fourth Expedition to forested areas in East & Central Africa: IV, Reptiles. *Museum of Comparative Zoology*, *91*, 237–373.

Ma, X., & Lu, X. (2009). Sexual size dimorphism in relation to age and growth based on skeletochronological analysis in a Tibetan frog. *Amphibia-Reptilia*, *30*(3), 351–359.

MacDonald, D. (Ed.). (1984). *The encyclopedia of mammals* (pp. 1–895). New York, NY: Oxford University Press.

Mahapatra, P. K., Nayak, S., & Dutta, S. K. (2008) Age estimates for a population of the Indian Tree Frog *Polypedates maculatus* (GRAY, 1833). *Herpetozoa*, *21*, 31–40.

Maletzky, A, Pesta, J, Schabetsberger, R, Jehle, R, Sztatecsny, M, & Goldschmid, A. (2004). Age structure and size of the syntopic populations of *Triturus carnifex* (Laurenti, 1768), *Triturus vulgaris* (Linnaeus, 1758) and *Triturus alpestris* (Laurenti, 1768) in the lake Ameisensee (1282 m asl). *Herpetozoa*, *17*, 75–82.

Marais, J. (2004). *A complete guide to the snakes of Southern Africa* (2nd ed.). South Africa: Struik Publishers.

Marangoni, F., Barrasso, D. A., Cajade, R., & Agostini, G. (2012). Body size, age and growth pattern of *Physalaemus fernandezae* (Anura: Leiuperidae) of Argentina. *North-Western Journal of Zoology*, *8*(1), 63–71.

Marchioro, M., Nunes, J. M. D. A. M., Ramalho, A. R., Molowny, A., Perez-Martinez, E., Ponsoda, X., & Lopez-Garcia, C. (2005). Postnatal neurogenesis in the medial cortex of the tropical lizard *Tropidurus hispidus*. *Neuroscience*, *134*(2), 407–413.

Márquez, R., Esteban, M., & Castanet, J. (1997). Sexual size dimorphism and age in the midwife toads *Alytes obstetricans* and *A. cisternasii*. *Journal of Herpetology*, *31*(1), 52–59.

Martell, A., W. Fuller. (1979). Comparative demography of *Clethrionomys rutilus* in taiga and tundra in the low Arctic. *Canadian Journal of Zoology*, *57*, 2106–2120.

Martins, F. I., & Souza, F. L. (2008). Estimates of growth of the Atlantic rain forest freshwater turtle *Hydromedusa maximiliani* (Chelidae). *Journal of Herpetology*, *42*(1), 54–60.

Marunouchi, J., Kusano, T., & Ueda, H. (2002). Fluctuation in abundance and age structure of a breeding population of the Japanese brown frog, *Rana japonica* Guenther (Amphibia, Anura). *Zoological Science*, *19*(3), 343–350.

Marunouchi, J., Ueda, H., & Ochi, O. (2000). Variation in age and size among breeding populations at different altitudes in the Japanese newts, *Cynops pyrrhogaster*. *Amphibia-Reptilia*, *21*(3), 381–396.

Marvin, G. A. (2001). Age, growth, and long-term site fidelity in the terrestrial plethodontid salamander *Plethodon kentucki*. *Copeia*, *2001*(1), 108–117.

Matthews, K. R., & Miaud, C. (2007). A skeletochronological study of the age structure, growth, and longevity of the mountain yellow-legged frog, Rana muscosa, in the Sierra Nevada, California. *Copeia*, *2007*(4), 986–993.

Mattioli, F., Gili, C., & Andreone, F. (2006). Economics of captive breeding applied to the conservation of selected amphibian and reptile species from Madagascar. *Natura–Società italiana di Scienze naturali e Museo civico di Storia Naturale di Milano*, *95*(2), 67–80.

Mattison, C. (1995). *The encyclopedia of snakes*. New York, NY: Facts on File.

Mattison, C. (2007). *The new encyclopedia of snakes*. NJ: Princeton University Press.

Mautz, W. J. (1979). The metabolism of reclusive lizards, the Xantusiidae. *Copeia*, *1979*, 577–584.

Mautz, W. J., & Lopez-Forment, W. (1978). Observations on the activity and diet of the cavernicolous lizard *Lepidophyma smithii* (Sauria: Xantusiidae). *Herpetologica*, 311–313.

McConnachie, S. (2014). The effects of temperature on oxygen consumption in the lizard *Pseudocordylus melanotus* from Suikerbosrand Nature Reserve. *African Journal of Herpetology*, *63*(1), 57–69.

McKechnie, A. E., & Wolf, B. O. (2004). The allometry of avian basal metabolic rate: good predictions need good data. *Physiological and Biochemical Zoology*, *77*(3), 502–521.

McMahon, J.A., (1999). *Smithsonian book of North American mammals*. Washington D.C.: Smithsonian Institution Press, in association with The American Society of Mammologists.

Mehl, K., R. Alisauskas, A. Buerger. (2007). King Eider (*Somateria spectabilis*) brood ecology: Correlates of duckling survival (Écologie d'élevage des couvées de Somateria spectabilis: Corrélations avec la survie des canetons). *The Auk*, *124*(2), 606–618.

Mendyk, R. W. (2015). Life expectancy and longevity of varanid lizards (Reptilia: Squamata: Varanidae) in North American zoos. *Zoo Biology*, *34*(2), 139–152.

Merret, P. K. (1983). Edentates. *Zoological Trust of Guernsey*. Guernsey, Channel Islands, United Kingdom.

Mertz, L. (2009). Alligators and caimans. *Animal Diversity Web*. Accessed November 28, 2009 at http://www.novelguide.com/a/discover/grze_07/grze_07_00439.html#Common_caiman.

Miaud, C., Andreone, F., Ribéron, A., Michelis, S., Clima, V., Castanet, J. … & Guyétant, R. (2001). Variations in age, size at maturity and gestation duration among two neighbouring populations of the alpine salamander (*Salamandra lanzai*). *Journal of Zoology*, *254*(2), 251–260.

Miaud, C., Ūzüm, N., Avci, A., & Olgun, K. (2007). Age, size and growth of the endemic Anatolian mountain frog *Rana holtzi* from Turkey. *The Herpetological Journal*, *17*(3), 167–173.

Minakami, K. (1979). An estimation of age and life-span of the genus Trimeresurus (Reptilia, Serpentes, Viperidae) on Amami Oshima Island, Japan. *Journal of Herpetology*, *13*, 147–152.

Misawa, Y., & Matsui, M. (1999). Age determination by skeletochronology of the Japanese salamander *Hynobius kimurae* (Amphibia, Urodela). *Zoological Science*, *16*(5), 845–851.

Mitchell, J. (1994). *The reptiles of Virginia*. Washington, DC: Smithsonian Institution Press.

Miyata, K. I. (2013). Studies on the ecology and population biology of little known Ecuadorian Anoles. *Bulletin of the Museum of Comparative Zoology*, *161*(2), 45–78.

Møller, A. P. (2007). Senescence in relation to latitude and migration in birds. *Journal of Evolutionary Biology*, *20*(2), 750–757.

Møller, A. P. (2008). Relative longevity and field metabolic rate in birds. *Journal of Evolutionary Biology*, *21*(5), 1379–1386.

Montanucci, R. R. (1997). Captive management, behavior and conservation of chuckwallas, *Sauromalus obesus* (Lacertilia: Iguanidae). *Bulletin of the Chicago Herpetological Society*, *32*, 121–137.

Montanucci, R. R. (2015). A taxonomic revision of the Phrynosoma douglasii species complex (Squamata: Phrynosomatidae) *Zootaxa*, *4015*, 001–177.

Morgan-Richards, M., Hinlo, A. R., Smuts-Kennedy, C., Innes, J., Ji, W., Barry, M., … & Hitchmough, R. A. (2016). Identification of a rare gecko from North Island New Zealand, and genetic assessment of its probable origin: a novel mainland conservation priority? *Journal of Herpetology*, *50*(1), 77–86.

Morrison, C., Hero, J. M., & Browning, J. (2004). Altitudinal variation in the age at maturity, longevity, and reproductive lifespan of anurans in subtropical Queensland. *Herpetologica*, *60*(1), 34–44.

Murphy, C., Burnett, S., Conroy, G. C., Howland, B. W., Lamont, R. W., Sumner, J., & Ogbourne, S. M. (2019). Genetic diversity and structure of the threatened striped legless lizard, Delma impar: Management implications for the species and a translocated population. *Conservation Genetics*, *20*(2), 245–257.

Murray, I. W., Fuller, A., Lease, H. M., Mitchell, D., Wolf, B. O., & Hetem, R. S. (2015). Low field metabolic rates for geckos of the genus Rhoptropus may not be surprising. *Journal of Arid Environments*, *113*, 35–42.

Mussart, N. B., Barboza, N. N., Fioranelli, S. A., Koza, G. A., Prado, W. S., & Coppo, J. A. (2006). Age, sex, year season, and handling system modify the leukocytal parameters from captive Caiman latirostris and Caiman yacare (Crocodylia: Alligatoridae). *Revista Veterinaria*, *17*(1), 3–10.

Nayak, S., Mahapatra, P. K., Mohanty, R. K., & Dutta, S. K. (2008). A Skeletochronological analysis of age, growth and longevity of the Indian green frog, *Euphlyctis hexadactylus* (Lesson, 1834) (Anura: Ranidae). *Herpetozoa*, *20*, 99–107.

Nazan, Ü. Z. Ü. M. (2009). A skeletochronological study of age, growth and longevity in a population of the Caucasian Salamander, *Mertensiella caucasica* (Waga 1876) (Caudata: Salamandridae) from Turkey. *North-Western Journal of Zoology*, *5*, 74–84.

Necas, P. (1999). *Chameleons-Nature's hidden jewels*. Frankfurt, Germany: Edition Chimaira.

Niewiarowski, P. H., & Waldschmidt, S. R. (1992). Variation in metabolic rates of a lizard: use of SMR in ecological contexts. *Functional Ecology*, *6*, 15–22.

Nowak, R. M. (1991). *Walker's mammals of the world* (Vol. I, 5th ed.). Baltimore, MD: Johns Hopkins University Press.

Nowak, R. (1999). *Walker's mammals of the world* (6th ed.). Baltimore, MD: Johns Hopkins University Press.

Olgun, K., Miaud, C., & Gautier, P. (2001). Age, growth, and survivorship in the viviparous salamander *Mertensiella luschani* from southwestern Turkey. *Canadian Journal of Zoology*, *79*(9), 1559–1567.

Olgun, K., Uzum, N., Avci, A., & Miaud, C. (2005). Age, size and growth of the southern crested newt *Triturus karelinii* (Strauch 1870) in a population from Bozdag (Western Turkey). *Amphibia-Reptilia*, *26*(2), 223–230.

Oliveira, B. F., São-Pedro, V. A., Santos-Barrera, G., Penone, C., & Costa, G. C. (2017). AmphiBIO, a global database for amphibian ecological traits. *Scientific Data*, *4*, 170123.

Oppel, S., & Powell, A. (2010). Age-specific survival estimates of King Eiders derived from satellite telemetry (Estimados de la Supervivencia Específicos de la Edad Derivados Mediante Telemetría Satelital en *Somateria spectabilis*). *The Condor*, *112*(2), 323–330.

Ortega-Rubio, A. (1993). Skeletochronology in the mezquite lizard, *Sceloporus grammicus*. *Proceedings of the Oklahoma Academy of Science*, *73*, 31–34.

O'Shea, M. (2005). *Venomous snakes of the world*. NJ: Princeton University Press.

Otero, M. A., Valetti, J. A., Bionda, C. L., Salas, N. E., & Martino, A. L. (2016). Are ploidy and age size-related? A comparative study on tetraploid *Pleurodema kriegi* and octoploid *P. cordobae* (Anura: Leptodactylidae) from Central Argentina. *Zoologischer Anzeiger-A Journal of Comparative Zoology*, *268*, 136–142.

Özdemir, N., Altunışık, A., Ergül, T., Gül, S., Tosunoğlu, M., Cadeddu, G., & Giacoma, C. (2012). Variation in body size and age structure among three Turkish populations of the tree frog *Hyla arborea*. *Amphibia-Reptilia*, *33*(1), 25–35.

Pal, A., Swain, M. M., & Rath, S. (2009). Long bone histology and skeletochronology in a tropical Indian lizard, *Sitana ponticeriana* (Sauria: Agamidae). *Current Herpetology*, *28*(1), 13–18.

Panov, E. N., & Zykova, L. Y. (2016). *Rock agamas of Eurasia*. Moscow, Russia: KMK Scientific Press.

Parker, S. L. (2014). Physiological ecology of the ground skink, *Scincella lateralis* in South Carolina: thermal biology, metabolism, water loss and seasonal patterns. *Herpetological Conservation and Biology*, *9*(2), 309–321.

Pauwels, O., Luis Bonnin, J., Sancho, V., & Wilms, T. (2017). *Uromastyx nigriventris* (Moroccan Spiny-tailed Lizard). Longevity. *Herpetological Review*, *48*, 569.

Pearson, D. J., & Jones, B. (2000). *Lancelin Island skink recovery plan*. Perth, Australia: Department of Conservation and Land Management.

Pernetta, J. C., & Burgin, S. (1983). The status and ecology of crocodiles in the Purari. *Monographiae biologicae*, *51*, 409–428.

Perry, G., & Dmi'el, R. (1994). Reproductive and population biology of the fringe-toed lizard, *Acanthodactylus scutellatus*, in Israel. *Journal of Arid Environments*, *27*(3), 257–263.

Petter, J., Albignac, R., & Rumpler, Y. (1977). *Mammiferes lemuriens* (Primates porsimians). *Faune de Madagascar*, *44*, 287–305.

Petzold, H. G., Murphy, J. B., & Murphy, J. B. (2008). *The lives of captive reptiles*. New York, NY: Society for the Study of Amphibians and Reptiles.

Phillips, L., & Powell, A. (2009). Brood rearing ecology of King Eiders on the North Slope of Alaska. *The Wilson Journal of Ornithology*, *121*(2), 430–434.

Pianka, E., & King, D. (Eds.). (2004). *Varanoid lizards of the world*. Bloomington, Perry Township, Indiana: Indiana University Press.

Pianka, E. R. (2011). Notes on the natural history of the tiny skink *Menetia greyi*. *Western Australian Naturalist (Perth)*, *28*, 12–17.

Pianka, E. R., & Parker, W. S. (1975). Ecology of horned lizards: a review with special reference to *Phrynosoma platyrhinos*. *Copeia*, *1975*, 141–162.

Pianka, E. R., & Pianka, H. D. (1970). The ecology of *Moloch horridus* (Lacertilia: Agamidae) in western Australia. *Copeia*, *1970*, 90–103.

Piantoni, C., Ibargüengoytía, N. R., & Cussac, V. E. (2006a). Growth and age of the southernmost distributed gecko of the world (*Homonota darwini*) studied by skeletochronology. *Amphibia-Reptilia*, *27*(3), 393–400.

Piantoni, C., Ibargüengoytía, N. R., & Cussac, V. E. (2006b). Age and growth of the Patagonian lizard *Phymaturus patagonicus*. *Amphibia-Reptilia*, *27*(3), 385–392.

Platz, J. E., Lathrop, A., Hofbauer, L., & Vradenburg, M. (1997). Age distribution and longevity in the Ramsey Canyon leopard frog, *Rana subaquavocalis*. *Journal of Herpetology*, *31*(4), 552–557.

Plummer, M. (1985). Demography of green snakes (*Opheodrys aestivus*). *Herpetologica*, *41*, 373–381.

Plummer, M. (1997a). Population ecology of green snakes (*Opheodrys aestivus*) revisited. *Herpetological Monographs*, *11*, 102–123.

Plummer, M. (1997b). Speed and endurance of gravid and nongravid green snakes, *Opheodrys aestivus*. *Copeia*, *1997*, 191–194.

Popanoe, H. (1981). *The water buffalo: New prospects for an underutilized animal*. Washington, DC: National Academy Press.

Primate Info Net (2004). The life spans of nonhumans primates. Accessed May 08, 2007 at http://pin.primate.wisc.edu/aboutp/phys/lifespan.html.

Purwandana, D., Ariefiandy, A., Imansyah, M. J., Ciofi, C., Forsyth, D. M., Gormley, A. M., … Jessop, T. S. (2015). Evaluating environmental, demographic and genetic effects on population-level survival in an island endemic. *Ecography*, *38*(10), 1060–1070.

Quillfeldt, P., & Möstl, E. (2003). Resource allocation in Wilson's storm-petrels *Oceanites oceanicus* determined by measurement of glucocorticoid excretion. *Acta Ethologica*, *5*(2), 115–122.

Quiroga, L. B., Sanabria, E. A., & Marangoni, F. (2015). Sexual size dimorphism and age in *Odontophrynus cf. barrioi* (Anura: Odontophrynidae) from the Monte Desert, Argentina. *Journal of Herpetology*, *49*(4), 627–632.

Ramiro, C. N., Junior, M. T., & Rodrigues, M. T. (2017). Reproductive biology of three sympatric species of gymnophthalmid lizards from the sand dunes of the Middle São Francisco River, Bahia, Brazil. *South American Journal of Herpetology*, *12*(1), 76–88.

Rao, M. S., & Rajabai, B. S. (1974). Influence of thermal acclimation on oxygen consumption in the agamid garden lizard, *Calotes nemoricola jerdon*, with reference to size, sex, temperature, season and climatic conditions. *Proceedings of the Indian Academy of Sciences-Section B*, *79*(1), 1–15.

Read, J. L. (1998). The ecology of sympatric scincid lizards (Ctenotus) in arid South Australia. *Australian Journal of Zoology*, *46*(6), 617–629.

Reading, C. J. (2004). Age, growth and sex determination in a population of smooth snakes, *Coronella austriaca* in southern England. *Amphibia-Reptilia*, *25*(2), 137–150.

Reading, C. J., & Jofré, G. M. (2003). Reproduction in the nest building vizcacheras frog *Leptodactylus bufonius* in central Argentina. *Amphibia-Reptilia*, *24*(4), 415–427.

Reagan, D. P. (1992). Congeneric species distribution and abundance in a three-dimensional habitat: the rain forest anoles of Puerto Rico. *Copeia*, *1992*, 392–403.

Reaser, J. K. (2000). Demographic analysis of the Columbia spotted frog (*Rana luteiventris*): Case study in spatiotemporal variation. *Canadian Journal of Zoology*, *78*(7), 1158–1167.

Rebouças, R., Silva, H. R., & Sanuy, D. (2018). Froghood: Postmetamorphic development of the rock river frog *Thoropa miliaris* (Spix, 1824) (Anura, Cycloramphidae). *Acta Zoologica*, *99*(2), 151–157.

Regalado, R. (2006). Reproduction and growth of seven species of dwarf geckos, Sphaerodactylus (Gekkonidae), in captivity. *Herpetological Review*, *37*(1), 13–19.

Ricklefs, R. E. (2000). Intrinsic aging-related mortality in birds. *Journal of Avian Biology*, *31*(2), 103–111.

Riemer, K., Anderson-Teixeira, K. J., Smith, F. A., Harris, D. J., & Ernest, S. M. (2018). Body size shifts influence effects of increasing temperatures on ectotherm metabolism. *Global Ecology and Biogeography*, *27*(8), 958–967.

Ripple, J. (1996). *Sea turtles*. Stillwater, Oklahoma: Voyaguer Press.

Roberts, M. (1994). Growth, development, and parental care in the western tarsier (*Tarsius bancanus*) in captivity: Evidence for a "slow" life-history and nonmonogamous mating system. *International Journal of Primatology*, *15*, 1–28.

Robertson, P., & Coventry, A. J. (2014). *Reptiles of Victoria: A guide to identification and ecology*. Australia: CSIRO Publishing.

Robin, L., Dickman, C., & Martin, M. (2011). *Desert channels: The impulse to conserve*. CSIRO Publishing.

Robinson, R. A., Leech, D. I., & Clark, J. A. (2018). The online demography report: Bird ringing and nest recording in Britain & Ireland in 2017. Thetford, UK: BTO (http://www.bto.org/ringing-report, created on 7-September-2018)

Rodríguez-Romero, F., Smith, G. R., Cuellar, O., & Méndez de la Cruz, F. R. (2004). Reproductive traits of a high elevation viviparous lizard *Sceloporus bicanthalis* (Lacertilia: Phrynosomatidae) from Mexico. *Journal of Herpetology*, *38*(3), 438–443.

Rodríguez-Romero, F., Smith, G. R., Méndez-Sánchez, F., Hernández-Gallegos, O., Nava, P. S., & Méndez de la Cruz, F. R. (2011). Demography of a semelparous, high-elevation population of *Sceloporus bicanthalis* (Lacertilia: Phrynosomatidae) from the Nevado de Toluca volcano, Mexico. *The Southwestern Naturalist*, *56*(1), 71–77.

Rogner, M. (1997). *Lizards: Husbandry and reproduction in the vivarium*. Volume 1. *Geckos*, *flap-footed lizards*, *agamas*, *chameleons*, *and iguanas*. Krieger, Malabar, Florida.

Röll, B. (2005). Variability in a common species: The Lygodactylus capensis complex from southern and eastern Africa (Reptilia, Gekkonidae). In B. A. Huber & K. H. Lampe (Eds.), *African biodiversity – Molecules*, *Organisms*, *Ecosystems* (pp. 237–244). Berlin: Springer.

Rotger, A., Igual, J. M., Smith, J. J., & Tavecchia, G. (2016). Relative role of population density and climatic factors in shaping the body growth rate of Lilford's Wall Lizard (*Podarcis lilfordi*). *Canadian Journal of Zoology*, *94*(3), 207–215.

Rowe, N. (1996). *The pictorial guide to the living primates*. East Hampton, NY: Pogonias Press.

Sagor, E. S., Ouellet, M., Barten, E., & Green, D. M. (1998). Skeletochronology and geographic variation in age structure in the wood frog, *Rana sylvatica*. *Journal of Herpetology*, *32*(4), 469–474.

Sarasola-Puente, V., Gosá, A., Oromí, N., Madeira, M. J., & Lizana, M. (2011). Growth, size and age at maturity of the agile frog (*Rana dalmatina*) in an Iberian Peninsula population. *Zoology*, *114*(3), 150–154.

Sasa, M., Wasko, D. K., & Lamar, W. W. (2009). Natural history of the terciopelo *Bothrops asper* (Serpentes: Viperidae) in Costa Rica. *Toxicon*, *54*(7), 904–922.

Sastrawan, P., & Ciofi, C. (2002). Distribution and home range. In J. Murphy, C. Ciofi, C. De La Panouse, & T. Walsh (Eds.), *Komodo dragons: biology and conservation* (pp. 42–77). Washington, DC: Smithsonian Institution Press.

Schleich, H. H., & Kästle, W. (2002). *Amphibians and reptiles of Nepal*. *Biology*, *Systematics*, *Field Guide*. Koenigstein, Germany: Koeltz Scientific Books.

Schleich, H. H., Kästle, W., & Kabisch, K. (1996). *Amphibians and reptiles of North Africa* (Vol. 63). Koenigstein, Germany: Koeltz Scientific Books.

Seglie, D., Roy, D., & Giacoma, C. (2010). Sexual dimorphism and age structure in a population of *Tylototriton verrucosus* (Amphibia: Salamandridae) from the Himalayan Region. *Copeia*, *2010*(4), 600–608.

Seufer, H. (2017). Eine schier unglaubliche Geschichte oder Anmerkungen zum Lebensalter von Doppelschleichen (Amphisbaenia) *Sauria*, *39*, 17–20.

Seufer, H., Kaverkin, Y., & Kirschner, A. (Eds.). (2005). *The eyelash geckos: Care*, *breeding and natural history*. Rheinstetten, Germany: Kirschner & Seufer Verlag.

Shaw, J. (1959). Salt and water balance in the East African freshwater crab, *Potamon niloticus* (M. Edw.). *Journal of Experimental Biology*, *36*, 157–176.

Shea, G. M. (2010). The suburban terrestrial reptile fauna of Sydney–winners and losers. In D. Lunney, P. Hutchings, & D. Hochuli (Eds.), *The natural history of Sydney* (pp. 154–197). Mosman: Royal zoological society of NSW.

Shekelle, M., & Nietsch, A. (2008). *Primates of the Oriental Night*. West Java, Indonesia: Indonesia Institute of Sciences, Research Center for Biology.

Sherbrooke, W. C. (2003). *Introduction to horned lizards of North America* (No. 64). Los Angeles, California: University of California Press.

Shirose, L. J., Brooks, R. J., Barta, J. R., & Desser, S. S. (1993). Intersexual differences in growth, mortality, and size at maturity in bullfrogs in central Ontario. *Canadian Journal of Zoology*, *71*(12), 2363–2369.

Sieg, A. E., O'Connor, M. P., McNair, J. N., Grant, B. W., Agosta, S. J., & Dunham, A. E. (2009). Mammalian metabolic allometry: Do intraspecific variation, phylogeny, and regression models matter? *The American Naturalist*, *174*(5), 720–733.

Sinsch, U., Leskovar, C., Drobig, A., König, A., & Grosse, W. R. (2007). Life-history traits in green toad (*Bufo viridis*) populations: indicators of habitat quality. *Canadian Journal of Zoology*, *85*(5), 665–673.

Sinsch, U., Martino, A. L., & di Tada, I. E. (2002). Longevity and sexual size dimorphism of the Pampa de Achala copper lizard *Pristidactylus achalensis* (Gallardo, 1964). *Amphibia-Reptilia*, *23*(2), 177–190.

Sittler, B., Gilg, O., & Berg, T. (2000). Low abundance of King eider nests during low lemming years in northeast Greenland. *Arctic*, *53*, 53–60.

Slavenko, A., & Meiri, S. (2015). Mean body sizes of amphibian species are poorly predicted by climate. *Journal of Biogeography*, *42*, 1246–1254.

Slavens, F. L., & Slavens, K. (1993). *Reptiles and amphibians in captivity: Breeding*, *longevity and inventory*. Seattle, WA: Slave ware.

Slavens, F. L., & Slavens, K. (1994). *Reptiles and amphibians in captivity: Breeding*, *longevity*, *and inventory*. Seattle, WA: Slave ware.

Smirina, E. M. (1994). Age determination and longevity in amphibians. *Gerontology*, *40*(2–4), 133–146.

Smirina, E. M., & Ananjeva, N. B. (2007). Growth layers in bones and acrodont teeth of the agamid lizard *Laudakia stoliczkana* (Blanford, 1875) (Agamidae, Sauria). *Amphibia-Reptilia*, *28*(2), 193–204.

Smirina, E., & Ananjeva, N. (2017). On the longevity, growth and reproductive characteristics of Lichtenstein's Toadhead Agama, *Phrynocephalus interscapularis* Lichtenstein, 1856 (Agamidae, Sauria). *Amphibia-Reptilia*, *38*(1), 31–39.

Smith, A. L., Bull, C. M., & Driscoll, D. A. (2013). Skeletochronological analysis of age in three 'fire-specialist' lizard species. *South Australian Naturalist*, *87*, 6–17.

Smith, J. G., Christian, K., & Green, B. (2008). Physiological ecology of the mangrove-dwelling varanid *Varanus indicus*. *Physiological and Biochemical Zoology*, *81*(5), 561–569.

Smithsonian National Museum of Natural History (2014). American Mammals: Urocitellus armatus. Accessed November 14, 2014 at http://www.mnh.si.edu/mna/image_info.cfm?species_id=356.

Snider, A. T., & Bowler, J. K. (1992). *Longevity of reptiles and amphibians in North American collections*. 2nd ed. Society for the Study of Amphibians and Reptiles, Herpetological Circular no. 21. Milwaukee, USA.

Sousa, H. C. D., Soares, A. H. S., Costa, B. M., Pantoja, D. L., Caetano, G. H., Queiroz, T. A. D., & Colli, G. R. (2015). Fire regimes and the demography of the lizard *Micrablepharus atticolus* (Squamata, Gymnophthalmidae) in a biodiversity hotspot. *South American Journal of Herpetology*, *10*(3), 143–156.

Sparreboom, M. (2014). Salamanders of the Old World. In *The salamanders of Europe, Asia, and Northern Africa* (pp. 320–323). Zeist, the Netherlands: KNNV Publishing.

Spotila, J. R., Reina, R. D., Steyermark, A. C., Plotkin, P. T., & Paladino, F. V. (2000). Pacific leatherback turtles face extinction. *Nature*, *405*(6786), 529.

Stafford, P. J., & Meyer, J. R. (2000). *Guide to the reptiles of Belize*. San Francisco, California: Academic Press.

Stalling, D. T. (1997). *Reithrodontomys humulis*. *Mammalian Species*, *565*, 1–6.

Starostová, Z., Konarzewski, M., Kozłowski, J., & Kratochvíl, L. (2013). Ontogeny of metabolic rate and red blood cell size in eyelid geckos: species follow different paths. *PLoS ONE*, *8*(5), e64715.

Starostová, Z., Kubička, L., Konarzewski, M., Kozłowski, J., & Kratochvíl, L. (2009). Cell size but not genome size affects scaling of metabolic rate in eyelid geckos. *The American Naturalist*, *174*(3), E100–E105.

Staub, N. L. (2016). The age of plethodontid salamanders: A short review on longevity. *Copeia*, *104*(1), 118–123.

Stebbins, R. C., & McGinnis, S. M. (2012). *Field guide to amphibians and reptiles of California: Revised edition* (Vol. 103). Los Angeles, California: University of California Press.

Stevenson, D., Dyer, K., & Willis-Stevenson, B. (2003). Survey and monitoring of the eastern indigo snake in Georgia. *Southeastern Natural*, *2*, 393–408.

Stout, B., & Nuechterlein, G. (1999). Birds of North America online. Accessed September 15, 2009 at http://bna.birds.cornell.edu/bna/species/465.

Stuginski, D. R., Navas, C. A., de Barros, F. C., Grego, K. F., Martins, M., & de Carvalho, J. E. (2018). The role of feeding specialization on post-prandial metabolic rate in snakes of the genus Bothrops. *Zoological Science*, *35*(4), 373–382.

Sullivan, B., & Sullivan, K. (2008). Common chuckwalla (*Sauromalus ater*) populations in the Pheonix metropolitan area: Stability in urban preserves. *Herpetological Conservation and Biology*, *3*, 149–154.

Sun, Y., Xiong, J., Lv, Y., & Zhang, Y. (2016). Age, body size & growth in a population of the Asiatic toad *Bufo gargarizans* from central China. *Russian Journal of Herpetology*, *23*(1), 35–40.

Suydam, R. S. (2000). *King eider*: *Somateria spectabilis*. In A. Poole & F. Gill (Eds.), Philadelphia, PA: The Birds of North America.

Svatek, S., & van Duin, S. (2001). *Keeping and breeding leaf-tailed geckos: The genus Uroplatus*. Banteln, Germany: Brähmer-Verlag.

Szczerbak, N. N. (2003). *Guide to the reptiles of the Eastern Palearctic*. Malabar, India: Krieger Publish Compani.

Székely, D., Székely, P., Stănescu, F., Cogălniceanu, D., & Sinsch, U. (2018). Breed fast, die young-Demography of a poorly known fossorial frog from the xeric Neotropics. *Salamandra*, *54*(1), 37–44.

Tacutu, R., Craig, T., Budovsky, A., Wuttke, D., Lehmann, G., Taranukha, D., ... De Magalhaes, J. P. (2012). Human ageing genomic resources: Integrated databases and tools for the biology and genetics of ageing. *Nucleic Acids Research*, *41*, D1027–D1033.

Tanner, W. W., & Krogh, J. E. (1975). Ecology of the zebra-tailed lizard *Callisaurus draconoides* at the Nevada test site. *Herpetologica*, *31*, 302–316.

Tessa, G., Delforno, C., Govindarajulu, P., Tissot, N., Miaud, C., & Andreone, F. (2016). Age and body size in four introduced populations of the American bullfrog, *Lithobates catesbeianus* (Ranidae). *Italian Journal of Zoology*, *83*(4), 497–502.

Tinkle, D. W., & Dunham, A. E. (1983). Demography of the tree lizard, *Urosaurus ornatus*, in central Arizona. *Copeia*, *1983*, 585–598.

Tomašević-Kolarov, N., Ljubisavljević, K., Polović, L., Džukić, G., & Kalezić, M. L. (2010). The body size, age structure and growth pattern of the endemic Balkan mosor rock lizard (*Dinarolacerta mosorensis* Kolombatović, 1886). *Acta Zoologica Academiae Scientiarum Hungaricae*, *56*(1), 55–71.

Towns, D. R. (1994). The role of ecological restoration in the conservation of Whitaker's skink (*Cyclodina whitakeri*), a rare New Zealand lizard (Lacertilia: Scincidae). *New Zealand Journal of Zoology*, *21*(4), 457–471.

Towns, D. R., & Ferreira, S. M. (2001). Conservation of New Zealand lizards (Lacertilia: Scincidae) by translocation of small populations. *Biological Conservation*, *98*(2), 211–222.

Tristan, T. (2010). The aging raptor. *Veterinary Clinics: Exotic Animal Practice*, *13*(1), 51–84.

Tsellarius, A. Y., & Tsellarius, E. Y. (2009). Longevity and factors of mortality in the rock lizard *Darevskia brauneri* (reptilia, sauria) based on long-term observations in the Navagir Ridge. *Zoologichesky Zhurnal*, *88*(10), 1276–1280.

Tsiora, A., & Kyriakopoulou-Sklavounou, P. (2002). A skeletochronological study of age and growth in relation to adult size in the water frog *Rana epeirotica*. *Zoology*, *105*(1), 55–60.

Tuberville, T., Bodie, J., Jensen, J., LaClaire, L., & Gibbons, J. (2000). Apparent decline of the southern hog-nosed snake, *Heterodon simus*. *Journal of the Elisha Mitchell Scientific Society*, *116*, 19–40.

Tucker, A. D., McCallum, H. I., & Limpus, C. J. (1997). Habitat use by *Crocodylus johnstoni* in the Lynd River, Queensland. *Journal of Herpetology*, *31*(1), 114–121.

Üzüm, N., Avci, A., Kumlutaş, Y., Beşer, N., & Ilgaz, C. (2015). The first record of age structure and body size of the Suphan Racerunner, *Eremias suphani* Başoğlu & Hellmich, 1968. *Turkish Journal of Zoology*, *39*(3), 513–518.

Üzüm, N., Avci, A., Özdemir, N., Ilgaz, Ç. & Olgun, K. (2011). Body size and age structure of a breeding population portion of the Urmia salamander, *Neurergus crocatus* Cope, 1862 (Caudata: Salamandridae). *Italian Journal of Zoology*, *78*(2), 209–214.

Üzüm, N., & Olgun, K. (2009). Age and growth of the southern crested newt, Triturus karelinii (Strauch 1870), in a lowland population from northwest Turkey. *Acta Zoologica Academiae Scientiarum Hungaricae*, *55*(1), 55–65.

van der Reijden, J. (2008). *The captive maintenance and breeding of Diporiphora winneckei (Cane grass dragon) at the Alice Springs Desert Park*. Australian Society of Zoo Keeping Special Publication.

Vardon, M. J., & Tidemann, C. R. (2000). The black flying-fox (*Pteropus alecto*) in north Australia: juvenile mortality and longevity. *Australian Journal of Zoology*, *48*(1), 91–97.

Vasey, N. (1997). How many red ruffed lemurs are left? *Primates*, *18*, 207–216.

Vial, J., Berger, T., & McWilliams, W. Jr. (1977). Quantitative demography of copperheads *Agkistrodon contortrix* (Serpentes: Viperidae). *Researches on Population Ecology*, *18*, 223–234.

Vincent, M., & Birkett, J. (1999). The arafura file snake (*Acrochordus arafurae*), *10*, 4.

Wake, D. B., & Castanet, J. (1995). A skeletochronological study of growth and age in relation to adult size in *Batrachoseps attenuatus*. *Journal of Herpetology*, *29*(1), 60–65.

Wapstra, E., Swain, R., & O'Reilly, J. M. (2001). Geographic variation in age and size at maturity in a small Australian viviparous skink. *Copeia*, *2001*(3), 646–655.

Warburg, M. R. (2007). Longevity in *Salamandra infraimmaculata* from Israel with a partial review on other salamanders. *Salamandra*, *43*(1), 21–34.

Weaver, R. E., & Kardong, K. V. (2009). Microhabitat and prey odor selection in *Hypsiglena chlorophaea*. *Copeia*, *2009*(3), 475–482.

Wechsler, D. (2001). *Garter snakes*. New York, NY: The Rosen Publishing Group.

Weigl, R. (2005). *Longevity of mammals in captivity; from the living collections of the world*. Stuttgart, Germany: Schweizerba.

Weir, B. J. (1974). Reproductive characteristics of Hystricomorph rodents. *Symposium Zoological Society of London*, *34*, 265–301.

Werner, Y. L. (2016). The effects of temperature on regeneration speed: A comment on Saccucci et al., 2016. *Journal of Zoology*, *300*(4), 237–238.

Werner, Y. L., Frankenberg, E., Volokita, M., & Harari, R. (1993). Longevity of geckos (Reptilia: Lacertilia: Gekkonoidea) in captivity: An analytical review incorporating new data. *Israel Journal of Zoology*, *39*(2), 105–124.

Werner, Y. L., & Sivan, N. (1994). Systematics and zoogeography of Ptyodactylus (Reptilia: Sauria: Gekkonidae) in the Levant: 2, Taxonomy, with a review of ecology and zoogeography. *Revista Española de Herpetología*, *8*, 105–122.

West, S. (1974). *Post-burn population response of the northern red-backed vole*, *Clethrionomys rutilus*, *in Interior Alaska* (Master's thesis). University of Alaska, Alaska.

While, G. M., Uller, T., & Wapstra, E. (2009). Family conflict and the evolution of sociality in reptiles. *Behavioral Ecology*, *20*(2), 245–250.

Whitaker, A. H., & Sadlier, R. A. (2011). *Skinks and geckos from New Caledonia*. In The IUCN Red List of Threatened Species. Version 2018.7.

White, C. R., Blackburn, T. M., Martin, G. R., & Butler, P. J. (2007). Basal metabolic rate of birds is associated with habitat temperature and precipitation, not primary productivity. *Proceedings of the Royal Society B: Biological Sciences*, *274*(1607), 287–293.

White, C. R., Phillips, N. F., & Seymour, R. S. (2006). The scaling and temperature dependence of vertebrate metabolism. *Biology Letters*, *2*(1), 125–127.

Wieczkowski, J., McGraw, W. S., & Butynski, T. M. (2012). Inferred African crowned eagle (*Stephanoaetus coronatus*) predation on a Tana River Mangabey (*Cercocebus galeritus*). *African Primates*, *7*(2), 218–223.

Wiederhecker, H. C., Pinto, A. C., Paiva, M. S., & Colli, G. R. (2003). The demography of the lizard *Tropidurus torquatus* (Squamata, Tropiduridae) in a highly seasonal Neotropical savanna. *Phyllomedusa: Journal of Herpetology*, *2*(1), 09–19.

Wikelski, M., & Thom, C. (2000). Marine iguanas shrink to survive El Niño. *Nature*, *403*(6765), 37–38.

Williams, T. D, & British Antarctic Survey. (1991). *Penguins*. Cambridge, UK: British Antarctic Survey.

Wilman, H., Belmaker, J., Simpson, J., de la Rosa, C., Rivadeneira, M. M., & Jetz, W. (2014). EltonTraits 1.0: Species-level foraging attributes of the world's birds and mammals: Ecological Archives E095-178. *Ecology*, *95*(7), 2027–2027.

Wilms, T. (2005). *Uromastyx: Natural history, captive care, breeding*. Herpeton Offenbach, 143.

Wilson, D., & Ruff, S. (1999). *The Smithsonian book of North American mammals*. Washington, DC: Smithsonian Institution Press.

Wilson, S. (2012). *Australian lizards: A natural history*. Sydney, Australia: CSIRO Publishing.

Wilson, S., & Swan, G. (2009). *What lizard is that?: Introducing Australian lizards*. Sydney, Australia: Reed New Holland.

Wisconsin Primate Research Center Library. (2004). Primate Info Net. Accessed March 18, 2005 at http://pin.primate.wisc.edu/aboutp/phys/lifespan.html.

Withers, P. C., Aplin, K. P., & Werner, Y. L. (2000). Metabolism and evaporative water loss of Western Australian geckos (Reptilia: Sauria: Gekkonomorpha). *Australian Journal of Zoology*, *48*(2), 111–126.

Woodard, A. E. (1986). Longevity in the Chukar partridge. *Poultry Science*, *65*(4), 815–816.

Wooller, R., Richardson, K., & Bradly, G. (1999). Dietary constraints upon reproduction in an obligate pollen and nectar-feeding marsupial, the honey possum (*Tarsipes rostratus*). *Journal of Zoology*, *248*, 279–287.

Wyrich, L., Hill, R., & Lock, B. (2015). Captive husbandry of the Arakan Forest turtle (*Heosemys depressa*) and its implications for conservation. *Herpetological Review*, *46*, 49–54

Xuan, L., Yiming, L., & McGarrity, M. (2010). Geographical variation in body size and sexual size dimorphism of introduced American bullfrogs in southwestern China. *Biological Invasions*, *12*, 2037–2047.

Yakın, B. Y., Çiçek, K., Koyun, M., Gürkan, M., Hayretdağ, S., & Tok, C. V. (2015). A skeletochronological analysis of a population of the Anatolia Newt, *Neurergus strauchii* (Steindachner, 1887) (Caudata: Salamandridae), in Eastern Anatolia, Turkey. *Zoology in the Middle East*, *61*(4), 332–338.

Yakin, B. Y., Gürkan, M., Hayretdağ, S., & Tok, C. V. (2012). Preliminary data on age estimation and body size of the dwarf lizard, *Parvilacerta parva* (Boulenger, 1887) (Reptilia: Lacertilia) from Akşehir, Konya (Turkey). *Ecologia Balkanica*, *4*(1), 81–85.

Yakin, B. Y., & Tok, C. V. (2015). Age estimation of *Anatololacerta anatolica* (Werner, 1902) in the vicinity of Çanakkale by skeletochronology. *Turkish Journal of Zoology*, *39*, 66–73.

Yıldırım, E., Kumlutaş, Y., Candan, K., & Ilgaz, Ç. (2019). Age structure and body size of the endangered species *Darevskia bendimahiensis* (Schmidtler, Eiselt & Darevsky, 1994) from eastern Turkey (Squamata, Sauria, Lacertidae). *Herpetozoa*, *32*, 159–163.

Young, A. M., Hobson, E. A., Lackey, L. B., & Wright, T. F. (2012). Survival on the ark: life-history trends in captive parrots. *Animal Conservation*, *15*(1), 28–43.

Yu, X., Zhong, M. J., Li, D. Y., Jin, L., Liao, W. B., & Kotrschal, A. (2018). Large-brained frogs mature later and live longer. *Evolution*, *72*(5), 1174–1183.

Žagar, A., Simčič, T., Carretero, M. A., & Vrezec, A. (2015). The role of metabolism in understanding the altitudinal segregation pattern of two potentially interacting lizards. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*, *179*, 1–6.

Zaldívar-Riverón, A., & Nieto-Montes de Oca, A. (2002). Variation in the rare lizard *Barisia rudicollis* (Wiegmann) (Anguidae) with description of a new species from central Mexico. *Herpetologica*, *58*(3), 313–326.

Zari, T. A. (1993). Effects of body mass and temperature on standard metabolic rate of the desert chameleon *Chamaeleo calyptratus*. *Journal of Arid Environments*, *24*(1), 75–80.

Zari, T. A. (2013). Seasonal acclimation in resting metabolism of the skink, *Mabuya brevicollis* (Reptilia: Scincidae) from southwestern Saudi Arabia. *Journal of Thermal Biology*, *38*(7), 449–453.

Zari, T. A. (2016). Seasonal metabolic acclimatization in the herbivorous desert lizard *Uromastyx philbyi* (Reptilia: Agamidea) from western Saudi Arabia. *Journal of Thermal Biology*, *60*, 180–185.

Zhang, L., Guo, K., Zhang, G. Z., Lin, L. H., & Ji, X. (2018). Evolutionary transitions in body plan and reproductive mode alter maintenance metabolism in squamates. *BMC Evolutionary Biology*, *18*(1), 45–53.

Zhang, L., & Lu, X. I. N. (2012). Amphibians live longer at higher altitudes but not at higher latitudes. *Biological Journal of the Linnean Society*, *106*(3), 623–632.

Znari, M., & Brown, R. P. (1999). Skeletochronology and mark–recapture assessments of growth in the North African agamid lizard (*Agama impalearis*). *Journal of Zoology*, *249*(4), 455–461.

Zuercher, G., Roby, D., & Rexstad, E. (1999). Seasonal changes in body mass, composition, and organs of northern red-backed voles in Interior Alaska. *Journal of Mammalogy*, *80*, 443–459.

Zug, G. R., Barber, M. M., & Dudley, J. C. (1982). Gonadal histology and reproduction in *Carlia bicarinata* (Scincidae, Sauria, Reptilia) of the Port Moresby area, Papua New Guinea. *Herpetologica*, *38*, 418–425.

Zúñiga-Vega, J. J., Rojas-González, R. I., Lemos-Espinal, J. A., & Pérez-Trejo, M. E. (2005). Growth ecology of the lizard *Xenosaurus grandis* in Veracruz, México. *Journal of Herpetology*, *39*(3), 433–443.

Zweifel, R. G., & Lowe, C. H. (1966). The ecology of a population of *Xantusia vigilis*, the desert night lizard. *American Museum Novitates*, no. 2247. 1–58.