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Ontogenic differences and sexual dimorphism of the locomotor performance in a nocturnal gecko, *Tarentola mauritanica*

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Abstract

Locomotion performance in reptiles is deeply associated with habitat use, escape from predators, prey capture, and territory defense. As ectotherms, this trait in lizards is extremely sensitive to body temperature (BT). However, most studies rarely look at locomotion patterns in an ontogenic perspective. The *Moorish gecko*, *Tarentola mauritanica*, was used to investigate the possible effects of distinct BTs on the locomotor performance within juveniles and adults. Not surprisingly, adult individuals significantly outperform the juveniles in speed at every BT. Moreover, except in the 30-day-old juveniles, there is a general trend for an increase of speed with BT. The comparison of these speed values with the ones obtained for diurnal lizard species, corroborates the premise that because nocturnal species are subject to low thermal heterogeneity, little selection for behavioral thermoregulation, but strong selection for high performance at relatively cool temperatures are expected. Furthermore, the higher locomotor performance in adults at 29°C, roughly coincides with previously obtained preferred BTs. However, further studies need to be conducted to build the full performance curve, and to validate the existence of coadaption between behavioral thermoregulation and thermal sensitivity of physiological performance. Finally, this study has found that adult males run significantly faster than females at the highest BTs, highlighting the importance in understanding sex differences, and its potential to drive sex-specific behaviors, ecology, and ultimately fitness.

KEYWORDS
locomotor performance, ontogeny, sexual dimorphism, *Tarentola mauritanica*

1 | INTRODUCTION

Behavioral responses in ectotherms are concurrently influenced by multiple different factors, such as habitat complexity (e.g., Gifford et al., 2008; Pennings, 1990), body size (e.g., Martín et al., 2005), and temperature (e.g., Cooper, 2000). In lizards, individuals may experience large fluctuations in body temperature (BT) since they mainly depend on external heat sources for thermoregulation (Besson & Cree, 2010; Sepúlveda et al., 2008).

Not surprisingly, the effects of environmental temperature on organismal traits are very common in the study of lizard behavior, with locomotor performance as one of the most generally studied functional traits (e.g., Gomes et al., 2016; Herrel et al., 2000; Kaliontzopoulou et al., 2013; Massetti et al., 2018, 2017). Locomotor performance is deeply associated with habitat use, escape from predators, prey capture, and territory defense (Herrel et al., 2000). Moreover, in reptiles this trait is highly sensitive to changes in BT (Bauwens et al., 1995; Huey & Kingsolver, 1989); it usually increases with rising temperature, and rapidly declines as temperature

approaches the critical thermal maximum (Angilletta Jr, Niewiarowski, et al., 2002; Braña & Ji, 2000; Huey & Kingsolver, 1989). However, most locomotion studies on reptiles are usually concerned in unraveling the patterns in adult individuals, and less investigation has been dedicated to the ontogenic changes (e.g., Tang et al., 2013; Van Berkum et al., 1989; Xu & Ji, 2006). In the particular case of geckos, studies on the functional morphology have been mainly focused on the biomechanical particularities of the adhesive system used for locomotion (e.g., Collins et al., 2015; Higham & Russell, 2010; Johnson & Russell, 2009), and little attention has been given to their locomotor performance.

In many species where, body size changes substantially during ontogeny, the strength and type of intraspecific ecological interactions experienced by each individual during its lifetime, may also change (e.g., cannibalism and asymmetrical behavioral interactions in Keren-Rotem et al., 2006; Rudolf, 2007, 2008). Since the ability of individuals to respond to environmental variables may also change as they mature, behavioral responses to environmental temperature might also vary among age classes. This could lead to changes in relevant organismal traits during the ontogeny, such as locomotion performance. Not surprisingly, many studies have demonstrated that adults and juveniles may differ not only in morphological traits but also in habitat choice, behavioral regulation, and functional capacities (e.g., de Barros et al., 2010; D. Irschick, 2000; D. J. Irschick et al., 2000; Tang et al., 2013; Xu & Ji, 2006). A common trend found in many of these studies is a concurrent increase in both adult and juvenile sprint speed as temperature rises, and a decrease in speed in both age groups at lower temperatures. Furthermore, young animals often move and forage in the same environment as adults, and consequently, they will compete for the same resources (e.g., microhabitats, food, etc.), and also face the same predators. Because juveniles are often at a performance and competitive disadvantage relative to adults, mainly due to their smaller absolute size (La Barbera, 1989; Siqueira & Rocha, 2008; Werner & Gilliam, 1984), selection on the performance of this age group is likely strong (Carrier, 1996). However, changes on different aspects of locomotor performance (e.g., sprint speed and endurance) throughout the ontogeny do not appear to be uniform in terrestrial ectotherms (reviewed in Herrel & Gibb, 2006). In some cases, juveniles tend to employ more of their maximum locomotor potential during escapes when compared to adults, demonstrating higher values of sprint speed or acceleration capacity (e.g., Garland, 1985; Husak & Fox, 2006; Marsh, 1988; Toro et al., 2003). However, in some lizard species, young individuals display markedly lower levels of sprint performance in comparison to adults (e.g., D. Irschick, 2000; D. J. Irschick et al., 2000). These results suggest that adults and juveniles from distinct lizard groups seem to adopt alternative behavioral strategies to confront predators or compete for resources, to achieve higher chances of survival.

Moreover, locomotor performance might vary according to the type of foraging mode; in species that often wait for prey, selection may favor morphological adaptations that enhance rapid acceleration (Herrel et al., 2002; Losos, 1990; Zaaf & Van Damme, 2001). In a comparison between the geckos *Eublepharis macularus* (active

forager) and *Coleonyx brevis* ("sit-and-wait"), Miles et al. (2007) observed that *C. brevis* geckos attained greater speed values than *E. macularus*.

Here, we explore the locomotor performance in both juvenile and adult individuals of the *Moorish gecko*, *Tarentola mauritanica*, subjected to distinct BTs. Although this member of the family Phyllodactylidae (Gamble et al., 2008) is classically considered as having a crepuscular activity, there are populations (POPs) known to be active during the day (Fulgione et al., 2019; Rato, C. personal observation). To thermoregulate, this gecko has been seen basking during the first 2–3h after sunrise near the refugium, and once the selected temperature is achieved, it returns to the retreat (Martínez-Rica, 1974). As observed in many other nocturnal and crepuscular geckos (Arad et al., 1989; Huey & Kingsolver, 1989), *T. mauritanica* selects also a wider and lower range of preferred BTs compared to diurnal lizards (mean 29.80°C in Rato & Carretero, 2015). This most likely reflects the low environmental temperatures available and limited opportunities for behavioral thermoregulation at night (Porter & Gates, 1969). Also, this gecko species is known to be a "sit-and-wait" predator (Martínez-Rica, 1974) hence, high speed values in adults are expected in comparison to "active foraging" lizard taxa.

Apart from being carried out solely on adult individuals, the only available studies on performance of the *Moorish gecko* (Massetti et al., 2018, 2017) have also not explored the effects of distinct BTs on locomotor performance.

Hence, in this study we intend to understand (1) if thermal sensitivity changes locomotion performance across the ontogeny in *T. mauritanica* geckos, and (2) if that same change is also observed between different adult sexes, which might potentially drive to sex-specific fitness. For that, we used 15- and 30-day-old hatchlings plus adult females and males subject to three distinct BTs (25°C, 27°C, and 29°C), and measured their maximum sprint speed.

2 | MATERIALS AND METHODS

2.1 | Specimens examined

We collected a total of 158 adults of *Tarentola mauritanica* (73 females and 85 males) from four different localities in the Iberian Peninsula (Ayamonte [40], Portimão [37], Évora [38], and Torres Vedras [43]) between April and June 2019. Individuals were caught with a lasso (García-Muñoz & Sillero, 2010) or by hand, and were sexed by placing a red laser light against the skin, dorsally to the tail base (Atzori et al., 2007). All animals were taken to the laboratory at BIOPOLIS-CIBIO, placed in individual terraria in couples (matching POP origin), in order for them to mate. The resulting eggs were incubated at 28°C in RCOM Juragon Pro egg incubators. After they hatched, the juveniles were kept in individual terraria and fed with small crickets and water. From the 33 eggs that were hatched, only 14 hatchling lizards survived and grew to be included in the dataset.

2.2 | Morphological characters recorded

Linear biometric traits and weight were measured to describe the variation in the hatchlings' (measured at 15- and 30-day-old) and adults' total body size and body mass. Snout–vent length (SVL) was used as a measure of body size, measured to the closest 0.01 mm using an electronic calliper. Body mass was measured with a digital scale (precision 0.1 g). All measurements were taken by the same person (Riaño, G.) to eliminate interobserver error.

2.3 | Functional performance analysis

To quantify variation in functional traits, locomotor performance was measured in all adults, and when the hatchling lizards were 15- and 30-days-old. All experiments took place between September and October 2019, mismatching the species' breeding season (April–August) and undesirable interactions with locomotor performance (Martínez-Rica, 1974). The tests were performed by making the lizards run on a 1 m vertical surface (45° slope) covered with a cork mat. Geckos were stimulated to run by touching them gently on the back or tail with our finger. Runs were recorded at a filming speed of 50 frames/s using a digital camera from a fixed position (Canon EOS 60D). Runs were performed at three different environmental temperatures (25°C, 27°C, and 29°C, following Marques et al., 2022; Rato & Carretero, 2015), enabled by an incubator (BINDER^{TM}) where animals were placed to achieve the set temperature. The incubator had an accuracy of a tenth of a degree with respect to the temperature indicated in the outside screen. Runs were repeated three times per individual (standard number of trials following Dematteis et al., 2021; Gomes et al., 2022) per temperature, and performed at a random order, allowing at least 30 min of resting and acclimation time between trials. In total, the experiments were conducted for at least 15 not consecutive days, since we had to wait until the 15-day juveniles reached 30 days old. For each group (15-day-old juveniles, 30-day-juveniles, and adults), the experiments were performed for 3 days (one day per temperature).

The position of the geckos across each trial was digitized using Tracker v.5.1.3 (Open Source Physics, 2019). Each individual's maximum speed capacity (in cm/s), was considered as the highest instantaneous speed recorded across the three trials (following the procedure from Gomes et al., 2017).

2.4 | Data analysis

All statistical analyses were performed using R v.3.6.3 (R Development Core Team & Team, 2019). All data were checked for normality, using the Shapiro–Wilk's test ($p > 0.05$), and for extreme outliers. To assess the effects of different predictors on speed performance response, several linear mixed models (LMMs) were conducted with distinct combinations of the predictors, using the *lme* function from the nlme R package (Pinheiro et al., 2020). The LMMs were performed considering the following predictors: POP, BT, adult sex (females vs. males; SEX), and juvenile age (15- and 30-day-old; AGE), and their interactions, with SVL and weight (W) as covariates. Since we're dealing with repeated measures, the individual was always considered as a random factor.

The LMMs were compared using the Akaike's information criterion corrected for small samples (AICc), implemented with the *aictab* function from the AICcmodavg R package (Mazerolle, 2020). The models were ranked using AICc weights, which can be interpreted as the probability that the model is the best among the set of candidate models (Burnham & Andersen, 2002). Graphical representation of the relationships depicted from the LMMs' results was performed using the *effect* function from the effects R package (Fox, 2003), where speed means and standard errors were derived from the model's parameters estimates.

One-way analysis of variances (ANOVAs) for repeated measures were performed to assess the effect of SEX and AGE on speed at each BT, considering the individual as sample identifier. *p*-values were adjusted using the Bonferroni multiple testing correction method (Haynes, 2013). This analysis was performed using the *anova_test* function from the package rstatix (Kassambara, 2021).

Assessment of statistical changes of both SVL and weight across the different juveniles' age classes was carried out with the R function *pairwise_t_test* from the stats package.
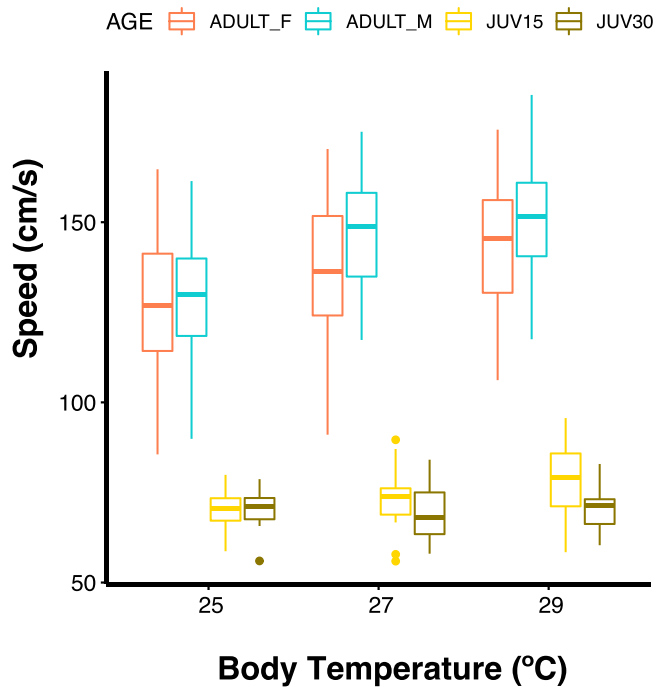
3 | RESULTS

A total of 353 and 2550 videos were digitized frame by frame using tracker for juveniles and adults, respectively. According to the Shapiro–Wilk's test, the speed data has a normal distribution ($p > 0.05$; Supporting Information: Table S2), and no extreme outliers were found.

The juvenile's SVL ranged from 21.60 to 28.22 mm, and in adults varied between 48.72 and 73.92 mm (females) and 53.75 and 84.08 mm (males). In both juveniles and adults, the SVL was significantly different between AGE classes ($t = -6.35$, $df = 41$, $p < 0.001$, Supporting Information: Figure S2) and SEX ($t = -9.5923$, $df = 472$, $p < 0.001$).

In juveniles, the mean speed ranged from 69.59 to 78.40 cm/s when they were 15 days old, and between 69.24 and 70.57 cm/s with 30 days of age (Supporting Information: Table S1). Regarding the adults, the mean speed in females varied between 127.65 and 143.43 cm/s, and in males from 127.80 to 150.81. Likewise, except in the 30 days old juveniles, all groups show a clear tendency of increasing speed with BT (Figure 1), with adults attaining higher speed values compared to juveniles.

Results from model choice according to the AICc (Supporting Information: Table S3), indicate that for juveniles the best fitting model is BT × AGE + SVL, and in adults, the model BT × SEX + W is the best explaining the obtained speed data.

The best LMMs (Table 1 and Figure 2) show that in general, juveniles run significantly faster as their BT increases ($p = 0.01$). However, this trend is unequal between juveniles of different ages

FIGURE 1 Distribution of both adult and juvenile (JUV) speed datasets, in response to distinct body temperatures. For details on sample size, consult Supporting Information: Table S1. F, female; M, male.

TABLE 1 Results of the linear mixed models performed on locomotor performance, considering the best combination of predictors (see Supporting Information: Table S3)

	χ^2	df	p-Value
Between juveniles			
BT	9.72	2.00	**0.01**
AGE	9.50	1.00	**<0.00**
SVL	3.17	1.00	0.07
BT × AGE	4.05	2.00	0.13
Between adults			
BT	179.79	2.00	**<0.00**
SEX	6.11	1.00	**0.01**
W	2.05	1.00	0.15
BT × SEX	9.65	2.00	**0.01**

Note: Predictors: BT; SVL; W; AGE, 15 and 30 days juveniles; and SEX, females and males. Statistically significant values marked in bold. Graphical representation in Figure 2.
Abbreviations: BT, body temperature; df, degrees of freedom; SVL, snout–ventral length; W, weight.

($p < 0.001$), with 15-day old juveniles running faster than the older ones at 29°C (Table 2 and Figures 2 and 3). Results from body weight and size variation within juveniles, demonstrate that the individuals have grown significantly in size ($t = -6.35$, $df = 41$, $p < 0.001$, Supporting Information: Figure S1), but weight gain was not significant with age ($t = -1.42$, $df = 41$, $p = 0.164$, Supporting Information: Figure S2).

Adult geckos also demonstrate an increased speed at higher BTs ($p < 0.001$), but a different pattern between males and females ($p = 0.01$). Significant differences between sexes are only observed at 27°C and 29°C (Table 2), with males attaining higher speeds than females at these temperatures (Figures 2 and 3). Females present a roughly more linear increase of speed with BT.

4 | DISCUSSION

Ectotherm phenotypes including locomotion may fluctuate remarkably at different ontogenic stages or sexes (Angilletta Jr, Niewiarowski, et al., 2002). Due to their usual difference in size, distinct ontogenic stages frequently occupy singular ecological niches and experience different selective pressures (Bowler & Terblanche, 2008; Werner & Gilliam, 1984). The study of the relationships between ontogenic stages and the environment is therefore of paramount importance to understand how ecological communities are structured (Werner & Gilliam, 1984).

According to the results obtained in this study, adult individuals of *Tarentola mauritanica* clearly outperform the juveniles in speed at every BT (Figure 1). This ontogenetic pattern is also observed in other phylogenetically distant lizard species (e.g., D. Irschick, 2000; D. J. Irschick et al., 2000; Tang et al., 2013), whereas in some other taxa, juveniles may present full compensation in sprint speed to near-adult levels of performance (e.g., de Barros et al., 2010; Garland, 1985; Marsh, 1988; Toro et al., 2003). Curiously, in the *Correlophus ciliatus* geckos there are simply no differences between juveniles and adults in running speed, suggesting that size-driven differences between age classes in competitive ability or access to microenvironments have not resulted in the evolution of stage-specific running performances (Aparicio Ramirez et al., 2021).

Moreover, except in the 30-day-old juveniles, there is a general trend for an increase of speed with BT (Table 1 and Figures 2 and 3). This lack of signal in the 30-day-old juveniles apart from their speed values lower than younger juveniles, is most likely related to a loss of body condition throughout the experiment. After 15 days in captivity, most juveniles stopped eating the crickets, and although they continued growing significantly ($t = -6.35$, $df = 41$, $p < 0.001$), they have not gained significant weight ($t = -1.42$, $df = 41$, $p = 0.16$), suggesting a most likely loss of body condition (Supporting Information: Figures S1 and S2).

When comparing the adult speed values obtained in this study with the ones observed in other lizard species (e.g., *Sceloporus undulatus* in Angilletta Jr, Hill, et al., 2002; *Eumeces elegans* in Du et al., 2000; *Eremias brenchleyi* in Xu & Ji, 2006), it is not only clear that at 29°C adult *T. mauritanica* run faster, but to attain similar speed values, the other species have to be under higher BTs. Being a nocturnal species (Martínez-Rica, 1974), the *Moorish gecko* is
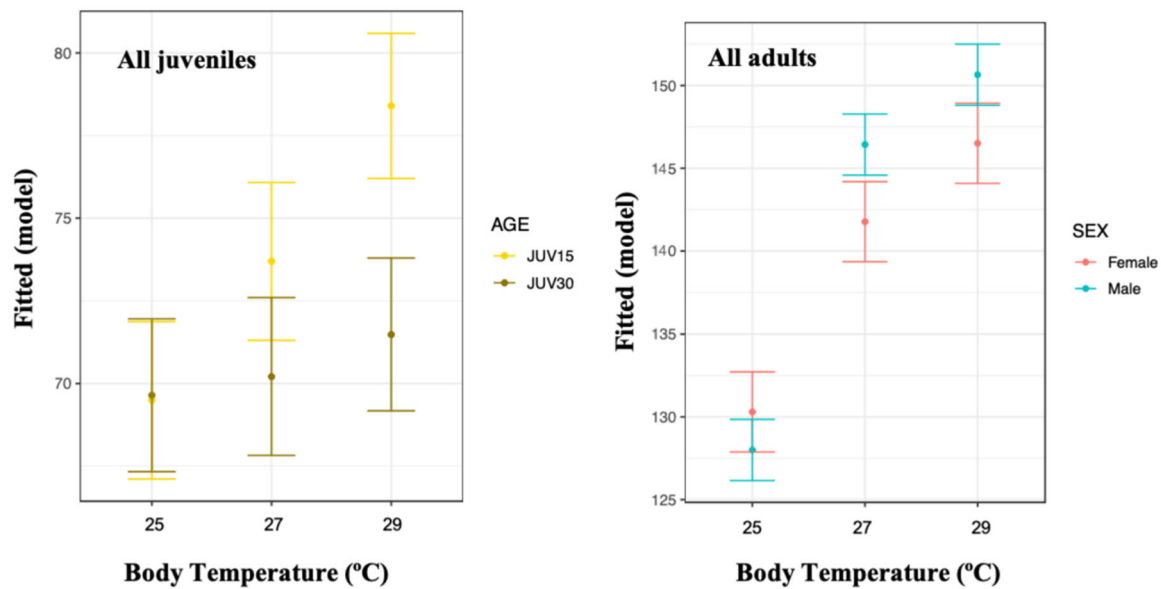
FIGURE 2 Graphical representation of the linear mixed models results denoting the statistically significant relationships among the different predictors and locomotor speed, within juveniles (JUV) and adult geckos. The y-axis represents the fitted values of the model, that is, the sum of the estimated fixed effect coefficient and the predicted random intercept (see Table 1 for exact p-values). For details on sample size, consult Supporting Information: Table S1.

TABLE 2 Results of the one-way ANOVAs to assess the effect of AGE (in juveniles) and SEX (in adults) on speed, at each body temperature

	Body temperature	DFn	DFd	SSn	SSd	MSn	MSd	F	p-Value
AGE	25°C	1	10	0.01	225.30	0.01	22.53	0.00	0.98
	27°C	1	10	66.77	540.03	66.77	54.0.0	1.24	0.29
	29°C	1	11	269.14	523.77	269.14	52.38	5.65	0.04*
SEX	25°C	1	72	0.19	17416.85	0.19	241.90	0.00	0.98
	27°C	1	72	3340.81	18498.45	3340.81	256.92	13.00	<0.001**
	29°C	1	72	1647.60	18507.21	1647.60	257.04	6.41	0.01*

Note: p-values were adjusted using the Bonferroni multiple testing correction method (Haynes, 2013). Graphical representation in Figure 3.

Abbreviations: ANOVA, analysis of variance; DFd, degrees of freedom of the denominator; DFn, degrees of freedom of the nominator; F, F-statistic; MSd, mean square of the denominator; MSn, mean square of the nominator; SSd, sum of squares of the denominator; SSn, sum of squares of the nominator.

*p < 0.05.

**p < 0.001.

expected to experience little thermal heterogeneity, and possibly cooler temperatures than some diurnal species (Gunderson & Stillman, 2015). In fact, Rato and Carretero (2015) observed that *T. mauritanica* selects a wider and lower range of preferred BTs in comparison to diurnal lizards, which is most likely related to the low environmental temperatures and limited opportunities for behavioral thermoregulation at night. These same thermal constraints occur as well in cold-adapted diurnal geckos living in high altitudes, such as the Atlas day geckos, *Quedenfeldtia trachyblepharus* and *Quedenfeldtia moerens* endemic to the Atlas Mountains of Morocco (Bouazza et al., 2016; Mouadi et al., 2020), with both species selecting quite high BTs across a thermal gradient (30.7 ± 0.6°C and 33.3 ± 0.3°C, respectively). Hence, strong selection for high performance at relatively cool temperatures are expected.

Nevertheless, there are POPs of *T. mauritanica* known to be active during the day (Fulgione et al., 2019; Rato, C. personal observation). Moreover, due to its frequent association to human settlements and capacity for long-distance dispersals, this species has been introduced and is thriving in multiple mainland and island regions across the Mediterranean basin, Macaronesia, Caribbean, as well as North and South America (Carranza et al., 2000; Harris, Batista, Carretero, et al., 2004; Harris, Batista, Lymberakis, et al., 2004). The genomic analysis from Fulgione et al. (2019) suggests that the diurnal POPs of *T. mauritanica* are under positive selection, most likely because they are able to fit in a greater variety of available niches. On the contrary, the nocturnal POPs seem to be under balancing selection due to the narrow niche in which they live. In fact, in a recent study in Madeira Island to assess the most
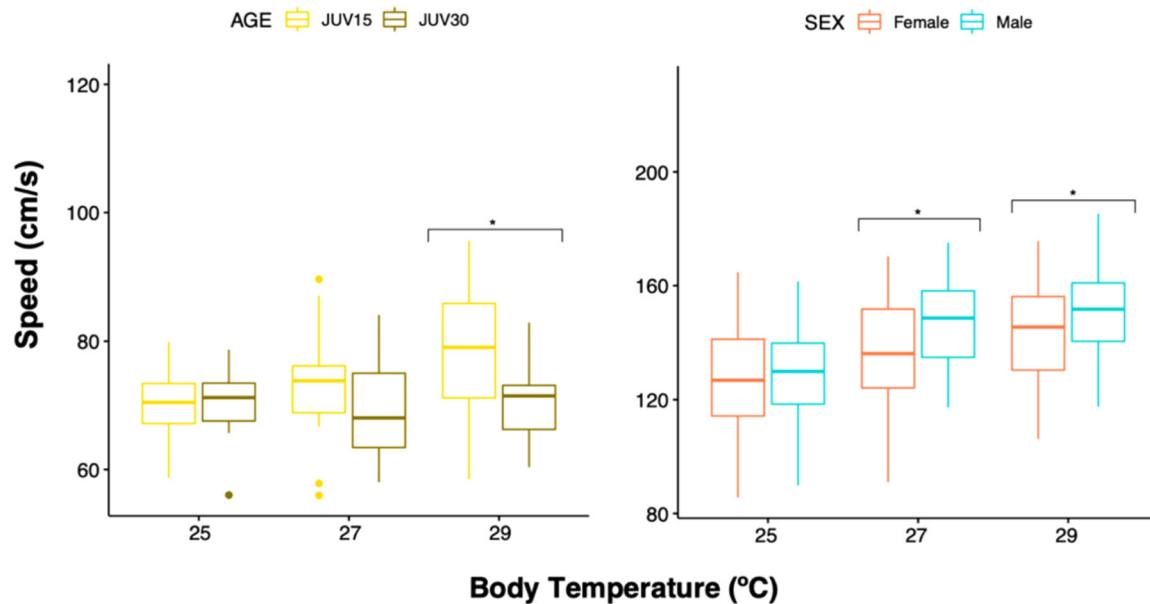
FIGURE 3 Graphical representation of the one-way analysis of variance's results for speed, according to SEX (adults) and AGE (juveniles [JUV]) at each body temperature. Statistically significant results ($p < 0.05$) are represented by an asterisk. Exact p-values are depicted in Table 2. For details on sample size, consult Supporting Information: Table S1.

important bioclimatic variables on the occurrence of the introduced nocturnal POPs of the *Moorish gecko* (Silva-Rocha et al., 2022), the authors observed a clear preference for Mediterranean-like climates. Therefore, if nocturnality seems to limit the species' capacity to explore new environments, its ability to shift to a diurnal activity might be behind the success of the several widespread alien POPs.

The speed values attained by the *Moorish gecko* are quite similar to the ones in the "sit-and-wait" gecko *Coleonyx brevis* (153 cm/s), and higher than what it is observed in the active foraging gecko *Eublepharis macularus* (66 cm/s) (Miles et al., 2007), suggesting a "sit-and-wait" foraging behavior, already described for the focal species (Martínez-Rica, 1974). Nevertheless, the latest results on *T. mauritanica*'s diet analysis using a Next-Generation Sequencing approach, suggests that this "sit-and-wait" foraging mode may not be that strict in this gecko species (Martins et al., 2022). In fact, many authors agree that this strict dichotomy between foraging modes is artificial and more likely extremes in a continuum (references in Miles et al., 2007).

The straight link between behavioral thermoregulation and thermal sensitivity of physiological performance has led to the hypothesis that these two traits have evolved together in a process known as coadaptation (Angilletta Jr et al., 2006; Huey & Bennett, 1987). Thus, the behaviorally selected temperatures by ectotherms should influence fitness via their direct effects on physiological performance, that is, the preferred BT should match with the optimal temperature of performance (Huey & Bennett, 1987). The study from Rato and Carretero (2015) observed that 29.8°C was the average preferred BT of the adult *Moorish gecko*, and in fact, here the highest performance was achieved at 29°C. Certainly, higher temperatures than 29°C should be tested in subsequent locomotor

performance studies on *T. mauritanica*, not only to build the complete performance curve and detect at which point speed starts to decline when approaching the critical thermal maximum, but also to validate the coadaptation hypothesis. This same approach should also be implemented in *Moorish gecko* juveniles.

Consistent with previous studies on both nocturnal and diurnal lizard locomotor performance, temperature was found here to significantly affect sprint performance in juveniles (e.g., Braña & Ji, 2000; Tang et al., 2013; Xu & Ji, 2006), as well as in adult male and female *T. mauritanica* (e.g., Angilletta Jr, Hill, et al., 2002; Cameron et al., 2018; Huey et al., 1989; Marsh & Bennett, 1986; Van Damme et al., 1989). Moreover, a sexual divergence was found only at 27°C and 29°C and not at the lowest temperature (25°C), with adult males exhibiting higher speed values than females (Figures 2 and 3). These results contrast with the ones obtained in the studies on the highly sexually dimorphic lizard *Eremias multiocellata* (Tang et al., 2013), or the European wall lizards *Podarcis muralis* (Zajitschek et al., 2012), where no differences were found between males and females in their locomotor performance.

Also, in Massetti et al. (2018, 2017) no sexual dimorphism was found in the speed performance of adult *T. mauritanica*. In both these studies, the evaluation of speed performance was carried out on a 90° vertical wall, while here the surface had a 45° slope. Nevertheless, the lack of sexual divergence found in Massetti et al. (2018, 2017) may not be related to the slope of the racing track but instead, because environmental temperature was not considered during the experiments, with both males and females having BTs most likely below 27°C.

On the contrary, Lailvaux et al. (2003) found that male *Platysaurus intermedis wilhmi* were faster than females at all

temperatures. More similar to the results obtained in this study, is the one performed on another nocturnal gecko, *Hemidactylus frenatus*, where males from a single POP were found to significantly outperform the females only at the upper temperatures (Cameron et al., 2018). The authors suggest that optimal sprint speeds observed only in males at higher BTs are likely driven by their need to keep territories for mating opportunities and food resources. On the other hand, females may be more restricted due to the thermal requirements of oviposition.

Indeed, functional performance, such as speed reflects the interaction of several underlying physiological processes that are important during tasks relevant for natural and sexual selection, such as competition for food, predator avoidance, territory defense, and mate choice (Arnold, 1983; Garland & Losos, 1994; Huey & Stevenson, 1979; Irschick & Garland, 2001; Oufiero & Garland, 2007). The higher speed values obtained here for adult males clearly reflect how each sex may benefit from possessing different thermal performance capacities that would allow them to maximize their fitness relative to their different reproductive roles. At least during the mating season, *T. mauritanica* males are highly aggressive towards other males, engaging frequently in combat to defend territories and gain mating opportunities (Lozano-Del Campo & García-Roa, 2014). Therefore, males are expected to be under strong selection, which is reflected by their greater overall sprint speed and higher performance in comparison to females.

5 | CONCLUSION

To conclude, there are ontogenic differences regarding the locomotor performance in *T. mauritanica* with adults significantly running faster than juveniles. These results suggest that selection on juveniles must be acting on some other behavioral trait to ensure this age class is able to survive to adulthood. Moreover, this study has found different performance speeds between adult males and females, with males being significantly faster than females at the highest BTs. This highlights the importance in understanding sex differences, and its potential to drive sex-specific behaviors, ecology, and ultimately fitness, but also in delivering a wider insight into the precise mechanisms involved in sexual dimorphism evolution within taxa.

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SUPPORTING INFORMATION

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