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SHORT NOTE

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Exercise-wheel enrichment for a captive leopard gecko *Eublepharis macularius*: An assessment of distance travelled

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ABSTRACT - Environmental enrichment is an understudied aspect of reptilian welfare. The daily distance travelled (DDT) by a captive leopard gecko on an exercise wheel was investigated for 12 months. The gecko used the wheel voluntarily and the overall mean DDT was 161.25 m but varied widely with mean monthly temperature. Behavioural observations indicated a preference for access to the wheel, as evidenced by exploratory behaviour upon its removal and immediate resumption of use upon reintroduction. This suggests that exercise wheels can serve to increase leopard gecko locomotor activity and thereby enhance welfare.

INTRODUCTION

Environmental enrichment can improve captive animal welfare, providing stimuli that promote behavioural diversity and well-being (Wolfensohn et al., 2018). Previous research has shown that enrichment items increase behavioural diversity in leopard geckos (Bashaw et al., 2016; Krönke & Xu, 2023; Zieliński, 2023). Understanding the behavioural needs of leopard geckos is essential for improving husbandry practices and is of importance given that across the globe they are very popular as pets (Valdez, 2021; Digirolamo, 2025), and are the most commonly used squamates in laboratory research (Agarwal et al., 2022).

A challenge to captive care is the limited size of enclosures. Enrichment can stimulate activity but cannot fully compensate for the restricted space compared with life in the wild (Mendyk & Augustine, 2023). A detailed understanding of leopard geckos' behavioural requirements, particularly their daily distance travelled (DDT), is lacking, which makes it difficult to establish appropriate enclosure size benchmarks. Currently, many captive leopard geckos are housed in small terraria, often equivalent area of around 1,650 cm^2 (55 cm x 30 cm) (De Vosjoli et al., 2017). Anecdotal evidence and a preliminary study of leopard gecko play behaviour (Digirolamo, 2024) suggest that they use rodent-designed exercise wheels spontaneously, potentially indicating a natural inclination for greater locomotor activity. Building on earlier findings (Digirolamo, 2024), this study investigates the distance travelled by a leopard gecko on an exercise wheel over 12 months. The long-term aim is to establish a benchmark for DDT, providing valuable insights for optimising enclosure design and enhancing the captive welfare of leopard geckos.

MATERIALS & METHODS

The study was conducted from May 2023 to June 2024. The subject, an adult female leopard gecko weighing 52 grams with a snout-vent length (SVL) of 12 cm, was weighed monthly (on the first day of the month) using digital scales with a precision 0.01 g (bought from a local store which can also be found on Amazon: ASIN: B097PMDPVM). The gecko is the author's companion animal.

A commercially obtained exercise wheel (Amazon.co.jp ASIN B08WJWZ175 SANKO Silent Wheel Flat 19 Clear) equipped with a cycle counter (diameter: 190 mm, width: 70 mm, circumference: 597 mm, weight: 390 g) was used to measure daily distance travelled (DDT). The wheel was placed within an enclosure measuring 45 cm x 45 cm x 30 cm (L x W x H). Dry-bulb temperature was maintained at 24–28 °C during the day and 20–26 °C at night, with relative humidity between 30–50%. Temperature and humidity were measured twice daily using a commercially available thermo-hygrometer (temp. range -20–50 °C, humidity range 0~100%, Daiso Japan) placed 1 cm above the enclosure floor. There was a 12-hour light/dark cycle using artificial LED light (Amazon: ASIN: B09F9F48MF). The gecko was fed LEOPA DRY (a commercially available meal replacement pellet, manufacturer: Kyourin Co., Ltd. which can be found on Amazon: ASIN: B07SCRY8BN) once every seven days. Prior to feeding, the individual pellets were weighed. Fresh water was provided daily via a water bowl. A video was recorded during the study (BHS video, 2026).

The cycle counter was checked every 24 hours to record DDT. To account for the small sample size, a correlation test by randomisation with 10,000 iterations was conducted to evaluate possible relationships between dry-bulb temperature, DDT, gecko weight and pellet consumption. This involved repeatedly randomising the data points and calculating a correlation coefficient for each iteration, creating a distribution under the null hypothesis. The observed correlation coefficient (referred to as 'r_{rm}') was then compared to this distribution to determine the p-value, indicating the significance of the observed relationship (Dugard et al., 2012). The analysis was performed in RStudio using base R functions (R Core Team, 2024).

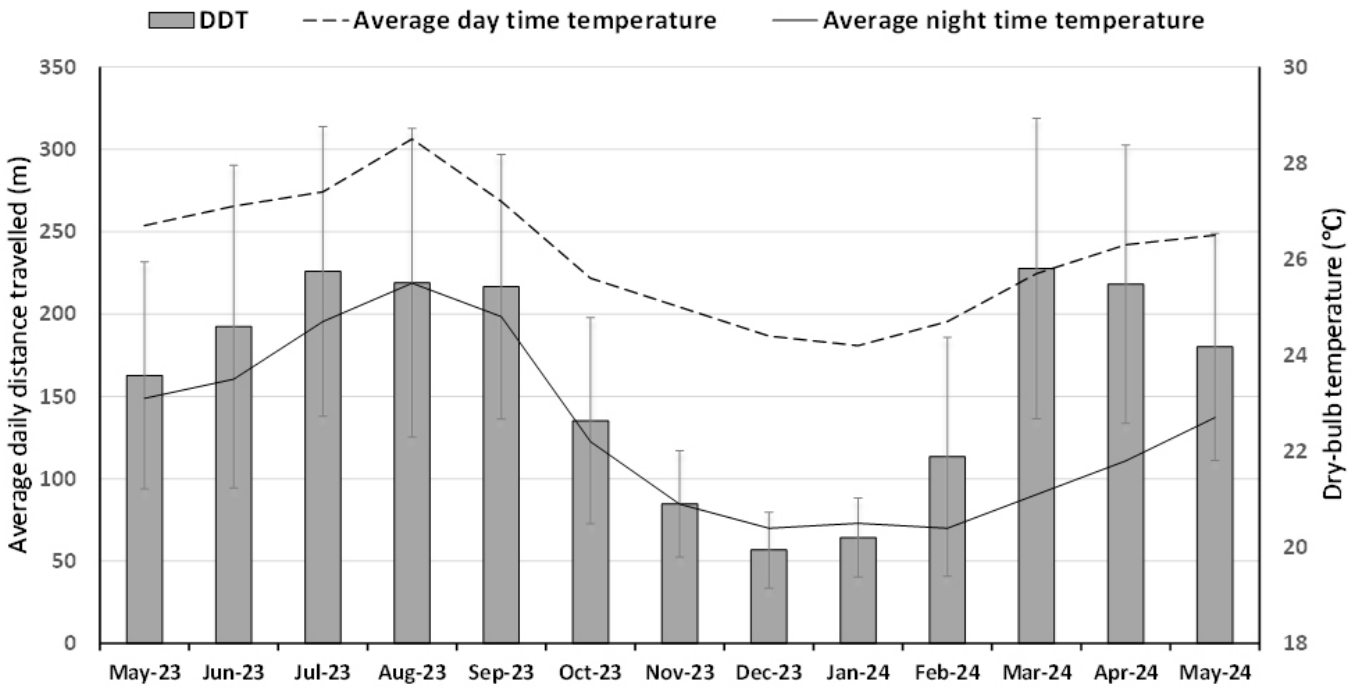

Figure 1. The mean daily distance travelled, by month, by a gecko on an exercise wheel (±sd) plotted against monthly mean daytime and nighttime temperatures

From 1 June 2024, the exercise wheel was removed from the enclosure for 14 days and then reintroduced to qualitatively assess behaviour.

Ethical approval was not required for this study. However, the study followed animal research guidelines applicable to all researchers publicly available from the Ministry of Education, Culture, Sports, Science And Technology—Japan (the country where the study was conducted). The gecko was unharmed during this study.

RESULTS

The leopard gecko was an active user of the exercise wheel (BHS video, 2026) with an overall mean DDT of 161.25 m (± s.d. 68.29 m). However, there was considerable variation between months in mean DDT (Fig. 1). The mean DDTs were greatest for the months of July to September (220.40 m), they fell in the period November to January (68.57 m), but then rose again March to May (208.57 m). This variation is consistent with seasonal reptile activity and there was a statistically significant positive correlation between mean day monthly temperature and monthly mean DDT (r_{rm} = 0.84, p = $0.4e^{-04}$).

The monthly mean DDT, gecko weight, total pellet consumption and average monthly temperatures are summarised in Table 1. Statistically significant, positive correlations were found between monthly mean DDT and pellet consumption (r_{rm} = 0.73, p = 0.006), between gecko body weight and pellet consumption (r_{rm} = 0.79, p = 0.002) and between gecko body weight and average temperature (r_{rm} = 0.75, p = 0.005). Also observed was a particularly strong, statistically significant, positive correlation between pellet consumption and mean temperature (r_{rm} = 0.92, p < $1e^{-04}$).

Table 1. Leopard gecko monthly mean values for daily distance travelled (DDT) on the exercise wheel, body weight, pellet consumption and temperature

Month	DDT (m)	Body weight (g)	Pellets consumed (g)	Mean temperature (°C)
May	162.70	52.0	3.16	26.7
Jun	192.40	51.9	3.26	27.1
Jul	225.80	53.4	3.51	27.4
Aug	218.90	53.1	3.43	28.5
Sep	216.50	54.1	3.23	27.2
Oct	135.20	52.3	2.80	25.6
Nov	84.70	49.0	1.68	25.0
Dec	56.70	51.2	0.90	24.4
Jan	64.30	49.6	0.53	24.2
Feb	113.30	49.5	0.61	24.7
Mar	227.60	50.1	1.64	25.7
Apr	218.10	50.3	2.09	26.3
May	180.00	50.4	2.82	26.5

After the exercise wheel was removed from the enclosure, the gecko did not leave its hide for the first seven days except to drink water. The gecko showed signs of shedding during these seven days. On day eight of wheel removal, the gecko came out of its hide, approaching the wheel's former location. The gecko then moved around the enclosure. This behaviour persisted daily until the wheel was reintroduced 14 days after removal. Upon reintroduction, the gecko resumed its typical wheel engagement behaviour, and the exploratory behaviour ceased.

DISCUSSION

The gecko's daily distance travelled (DDT), food consumption and weight changes were correlated with variation in dry-bulb temperature. These findings are consistent with the known dependency of ectotherm metabolism on ambient temperature. However, no prior study has evaluated variation in leopard gecko activity with ambient temperature. Popular pet guidebooks recommend maintaining temperatures at 24–31 °C and not dropping below 18 °C at night (Vosjoli et al., 2017; Pulsifer & Johnson, 2018). Previous studies on leopard geckos digestion, growth rate and responses to enrichment have typically maintained the geckos in a narrow temperature range of 28–30 °C, thereby minimising any temperature variation effects (Gauthier & Lesbarreres, 2010; Boykin et al., 2020; Zielinski, 2023). Only one study was found applying seasonal temperature changes when examining sensory stimulation and behaviour (Krönke & Xu, 2023). The study used a temperature range of 17–26 °C at night and collected body temperature data. Although their primary objective was not to correlate temperature changes with activity levels, the study reported no significant correlation between body temperature and activity level (no results shown for association with dry-bulb temperature). The geckos hibernated during winter (dry-bulb temperatures 10–16 °C), showing that the geckos' activity fell below 16 °C.

In one of the leopard geckos' natural habitats (Punjab, Pakistan) (Khan, 2009), night time temperatures are between 14–27 °C during the geckos' active season (March–October) (Source: WorldData.info, retrieved on 10 December 2024). The dry-bulb temperature range used in the current study fits within this range. Future studies on feeding, enrichment or activity in leopard geckos should consider seasonal temperature variations to better simulate their natural environment. This could lead to improved practical husbandry methods and deeper understanding of their biology.

Wild rodents and non-mammalian species, such as frogs, have been observed using exercise wheels when placed in nature (Meijer & Robbers, 2014), suggesting that this behaviour is non-stereotypic and elective, potentially occurring across a wide range of taxa. Some laboratory rodents exhibit stereotypic wheel-exercise behaviours under stressful conditions, such as running excessively while starving themselves (Routtenberg & Kuznesof, 1967). The current study did not observe such behaviour, and the gecko's continued voluntary wheel use suggests a lack of boredom and a preference for this behaviour. The gecko's apparent search for the wheel upon removal of the wheel suggests it retained the memory of its presence, and the immediate resumption of wheel use upon reintroduction suggests that the wheel is an enrichment item for the gecko that is contributing positively to its well-being and therefore enhancing its welfare.

The maximum DDT recorded in this study surpassed those of similarly sized diurnal lizards (Hertz et al., 1988 as cited in Garland, 1999). While direct comparison is limited due to differing measurement methods and environmental conditions, this is the first long-term study to measure DDT in a leopard gecko using an exercise wheel. Although the wheel-recorded distance may not directly translate to field walking distance due to friction and wheel weight (White et al., 2016), the distance is unlikely to be achievable within typical enclosure sizes or with other enrichment items. Exercise has been shown to provide physiological benefits in the case of the green anole lizard *Anolis carolinensis* (Husak et al., 2015), and the use of exercise wheels could lead to studies using leopard geckos as a model organism for adaptation to and the effects of exercise in squamates.

Further research is needed to explore these findings for a larger sample of leopard geckos, including both sexes and immatures.

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