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Retreat site characteristics and body temperatures of *Saurodactylus brosseti* Bons & Pasteur, 1957 (Sauria : Sphaerodactylidae) in Morocco

by

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Summary - Observations of retreat site characteristics of the ground living lizard *Saurodactylus brosseti* have been made in southern Morocco. The dimensions of retreat site rocks were significantly larger than randomly selected rocks. Diurnal substrate temperatures inside retreat sites were in good agreement with lizard body temperatures, although both retreat site and body temperatures were lower when sea mists were present, increasing as the environment warmed up. A regression equation of substrate temperatures inside the retreat site against body temperatures indicated partial thermoregulation. Relative humidity under retreat site rocks was significantly higher than exterior relative humidity. These results indicate that *S. brosseti* in general operates as a partial thermoconformer and avoids dangerously high daytime temperatures and low relative humidity by selecting appropriate retreats sites.

Key-words: *Saurodactylus brosseti*, retreat sites, body temperatures, relative humidity.

Résumé - Caractéristiques des sites de retraite et températures corporelles du lézard *Saurodactylus brosseti* Bons & Pasteur, 1957 (Sauria : Sphaerodactylidae) au Maroc. Des observations ont été faites dans le sud du Maroc sur les caractéristiques des sites de retraite du lézard *Saurodactylus brosseti.* La taille des rochers des sites de retraite effectivement occupés par ce gecko était plus grande que les tailles issues d'une sélection aléatoire de rochers. Les températures diurnes à l'intérieur des sites de retraite étaient idéales par rapport aux températures corporelles du lézard, bien que les températures du site et du corps diminuaient lors de brouillards marins, puis augmentaient au fur et à mesure du réchauffement de l'environnement. Une équation de régression des températures du substrat à l'intérieur du site de retraite par rapport aux températures corporelles indique une thermorégulation partielle. L'humidité relative présente sous les rochers des sites de retraite est nettement plus élevée que l'humidité relative extérieure. Ces résultats montrent que *S. brosseti* fonctionne comme un '*thermoconformer*' partiel, et qu'il choisit des sites de retraite appropriés afin d'éviter les températures du jour dangereusement élevées et une sécheresse trop importante.

Mots-clés : *Saurodactylus brosseti*, site de retraite, températures corporelles, humidité relative.

I. INTRODUCTION

The sphaerodactylid *Saurodactylus brosseti* is found in southern and western Morocco, mainly to the west of the High Atlas Mountains. Recently re-classified, it was formerly regarded as a subspecies of *S. mauritanicus*, but is now thought to be sufficiently different in population characters to warrant species rank (Bons & Geniez 1996) although further reclassification is a possibility (Rato & Harris 2008). A small species with a maximum length of around 35mm it is a crepuscular ground dweller that operates as a sit-and-wait predator but sometimes actively forages. The daylight hours are spent under rocks or rock piles (Schleich *et al.* 1996).

In common with other reptiles that live in hot arid environments *S. brosseti* faces two potential hazards, excessive body temperatures and dehydration. Small size and consequent high surface to volume geometry, exacerbates the problem (Mautz 1982) and so utilizing areas in the environment that minimises these effects are important as the costs of making poor retreat site selection are high; for example, a lizard risks mortality if the temperatures in a retreat site become lethal. The populations occurring in the coastal areas of northwest Africa inhabit a climate that is arid and hot for most of the year but is occasionally subject to sea mists that, among other things, may influence reptile behaviour and body temperatures (Meek & Jayes 1982). However, despite its common occurrence in such areas, very little is known about *S. brosseti* ecology; much of the present information is derived from captive animals (Schleich *et al.* 1996). This paper presents baseline data on this species giving information about retreat site characteristics and body temperatures of a population living in an area of Morocco next to the Atlantic coast.

II. MATERIALS AND METHODS

Field work was carried out from May 29 to June 6, 1980 in an area just north of Agadir, on the Atlantic coast. The area is coastal succulent steppe, which during the summer months is dry with little or no rain and moderate to high temperatures (Schleich *et al.* 1996). The dominant plant species providing cover for reptiles in general were *Euphorbia sp.* and *Rhus tripartitum*. Forty-two geckos, all of which were less than 45-50 mm total length were found in retreat sites. Additional lizards were sometimes found under the same rock but body temperatures of the first individual only were measured to minimise the potential for error due to delay in measurement. This only occurred 3 times and all were gravid females usually with two eggs easily visible through the translucent skin. The lizards were located at a mean rate (with standard deviation) of 3.24 ± 1.67 lizards per man/hour searching (range 1.7-7 per man/

hour) based on just over 21 hours searching; this included lizards located but not measured for body temperatures, etc. Body temperatures described here were skin surface temperatures recorded with a Whitley Digital thermometer that had an error of ± 0.5°C (Meek 1983). The probe was sensitive at the tip and hence useful for skin surface temperature measurement and relatively quick acting reaching a stable reading within 5-10 seconds. Skin surface temperature was preferred primarily because it was quicker to measure than cloacal temperatures – crucial in small species, and is usually in good agreement with cloacal temperature (Alberts & Grant 1997) particularly in small (Meek *et al.* 2005) or medium sized reptiles (Meek 1999). Simultaneously, substrate temperatures were taken by inserting the probe around 2-3 mm into the soil with shaded air temperatures taken 30 cm above the soil surface. To record maximum and minimum temperatures, a max/min thermometer was left on the site during the study period. Dimensions of rocks were approximate and simple linear measurements of length, width and height in centimetres (cm). The method of random rock selection was for one worker to select a rock in his immediate vicinity for measurement (*i.e.*, within a metre or so of his location) directly a second worker had located a lizard retreat site. This avoided most visual bias in random rock selection since rock selection was determined by discovery of a lizard retreat site. Relative humidity under rocks was recorded before overturning using a small plant soil humidity meter with a 150 mm long probe, and was also used to measure outside home-site relative humidity taken 30 cm above the ground.

III. RESULTS AND DISCUSSION

Sea mists were a common occurrence when the data were gathered, being present both in the morning and late afternoon. Relative humidity was highest during these periods (up to 96% recorded at 1800 hrs) and over the daily period was negatively correlated with changes in temperature (Pearson correlation coefficient with relative humidity treated as dependent on temperature, $r = -0.65$, $p < 0.0001$, $n = 42$). The maximum recorded air temperature was 36°C and minimum overnight temperature 15°C. Body temperatures were lower when the mists were present – usually to just before midday (*mean* ± *standard deviation* = 25.7 ± 2.1°C) increasing to 28.5 ± 1.5°C when the sun was shining, with the difference significant between sunny and misty weather (two sample *t*-test, $t = 4.25$, $p < 0.0001$, $d.f. = 30$). Figure 1 shows body temperature changes with time of day, and includes data under misty as well as

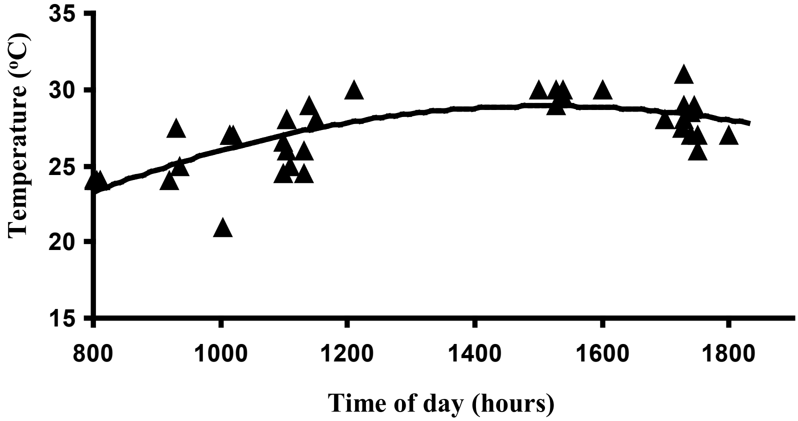

Figure 1: Body temperatures of *S. brosseti* plotted against time of day.

Figure 1 **:** Températures corporelles du *S. brosseti* selon les heures de la journée.

sunny weather. In general body temperatures of *S. brosseti* were in good agreement with those found for other ground living species of gecko – *i.e.*, the Australian species *Christinus marmoratus* (Kearney 2002). Substrate temperatures (27.9 ± 3.1°C) under retreat site rocks were not significantly different from associated body temperatures, mean of all body temperatures = 27.2 ± 2.5°C; $t = 1.24$, $p = 0.22$, *d.f.* = 82, indicating good general agreement of body temperatures with substrate temperatures. However, a test for thermoconformity employing regression analysis of body temperatures (T_b) with substrate temperatures (T_s), with T_b as the dependent variable gave:

$$T_b = 0.54T_s + 11.9,\ r^2 = 0.54.$$

The regression coefficient is significantly different from 1 ($t = 4.6$, $p < 0.001$), the value required for a hypothetical thermoconformer (Bailey 1981). However, the regression coefficient is also significantly different from 0, the coefficient required for perfect thermoregulation, $t = 6.89$, $p < 0.0001$. These results and the moderate r^2 value, indicate partial thermoregulation under rocks in *S. brosseti*, which has been observed in other gekkos (*e.g.* Bustard 1967; Dial 1978). Figure 2 is a graph showing this relationship with the continuous line running though the data based on the regression equation. For comparison, the broken line represents that of a hypothetical thermoconformer with a regression coefficient of 1.

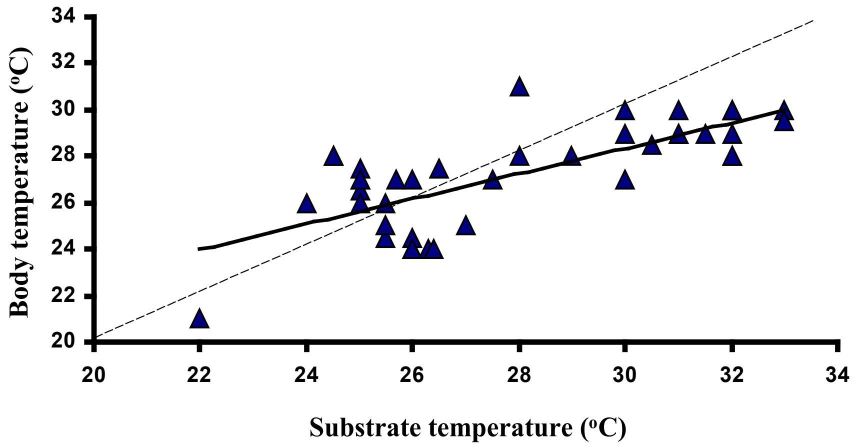

Figure 2: Body temperatures of *S. brosseti* plotted against substrate temperatures. The line running through the data set represents the regression equation given in the text; the broken line represents that expected from a hypothetical thermoconformer.

Figure 2 **:** Températures corporelles du *S. brosseti* en fonction de la température du substrat. La ligne en gras représente l'équation de régression indiquée dans le texte et la ligne discontinue représente le profil hypothétique d'un "thermoconformer".

Schleich *et al.* (1996) commented that retreat sites under rocks "offer relatively high humidity in the sometimes extremely arid biotopes where *S. brosseti* is found". Measurements here confirm this observation; relative humidity under retreat site rocks (*mean* = 78%) was significantly higher than exterior relative humidity (*mean* = 52%; Mann Whitney *U*-test $w = 2229.0$, $p < 0.0001$). Retreat site humidity generally followed a linear trend – it changed very little as the day progressed, whereas exterior humidity followed a polynomial, declining during the middle of the day then increasing towards evening. These trends are shown in Figure 3. The dimensions of retreat site rocks were significantly greater than randomly chosen rocks in respect to length (*median* retreat = 36 cm versus *median* random = 27cm; $w = 862$, $p = 0.039$), and to width (*median* retreat = 23 cm versus *median* random width = 20 cm; $w = 893.5$, $p = 0.009$). Retreat stone height was also greater but the difference was not significant (*medians* = 18 versus 14, $w = 848$, $p = 0.07$). Rock dimension selection and location has been found in other ground dwelling geckoes and are usually larger than random selected rocks (Schlesinger & Shine 1994); this may influence thermal characteristics under rocks (Kearney 2002).

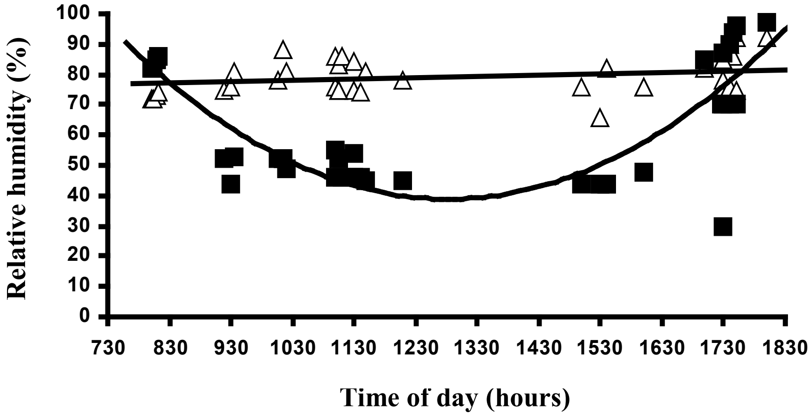

Figure 3: Relative humidity (R_h) inside *S. brosseti* retreat sites (open triangles) and corresponding exterior relative humidity (solid squares) plotted against time of day (T_m). The lines running through the data are lines of best fit for each data series. Retreat site humidity followed a linear trend, $R_h = 0.005T_m + 73.5$; exterior humidity a polynomial, $R_h = 0.0002T_m^2 - 0.48T_m + 347.4$.

Figure 3 **:** Humidité relative (R_h) intérieure aux sites de retraite de *S. brosseti* (triangles vides) et humidité relative extérieure correspondante (carrés pleins) en fonction des heures de la journée (T_m) Les lignes joignant les points sont les lignes de meilleure concordance pour chaque série de données. L'humidité des sites de retraite suit une droite de régression : $R_h = 0.005T_m + 73.5$; l'humidité extérieure correspond à un polynôme, $R_h = 0.0002T_m^2 - 0.48T_m + 347.4$.

This paper provides tentative evidence for retreat site selection in *S. brosseti*, which is in good agreement with data found for other reptiles in similar environments (*e.g.* Schlesinger & Shine 1994; Webb *et al.* 2004). This might be expected due to the potentially lethal diurnal temperatures and very low humidity under non-suitable rocks. In addition, a reptile could experience a thermoregulatory constraint even under selected rocks and possible evidence for this in *S. brosseti* can be seen in the very small standard deviation in body temperature (all data standard deviation = 2.2°C) which was significantly smaller than the general standard deviation of outside air temperature of 3.5°C (variance ratio test, $F = 16.7$, $p = 0.02$). However, reptiles that are active nocturnally with limited thermoregulation may thermoregulate diurnally and in several ways; microhabitat selection and diurnal basking are among the methods employed (Avery 1982). No diurnal basking or above ground activity was seen in *S. brosseti*, which might suggest they thermoregulate by microhabitat selection, a method observed in other gekkos (*e.g.* Bustard 1967; Werner & Whitaker 1978; Sievert & Hutchison

1988 ; Stokes & Meek 2003). Dial (1978) indicated gecko thermoregulation under rocks by subtle movements and this has also been reported under bark (Bustard 1967).

Retreat site selection could have influences other than thermoregulatory, for example social behaviour and predator avoidance are often important and indeed Downes & Shine (1998) have indicated that in certain species the latter has priority over thermoregulation (although both are potentially lethal). Scorpions (*Buthus sp.*) in addition to various species of ants and beetles were found under other rocks at the study site and an interesting future study might compare the characteristics of retreat sites of invertebrates and reptiles. Lizards were never found in association with any other species and indeed scorpions could predate on the lizards although in a recent review snakes, e.g. *Malpolon monspessulanus* and *Macroprotodon cucullatus*, have been cited as the major predators (Schleich *et al.* 1996).

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