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SELECTED BODY TEMPERATURES OF FOUR LACERTID LIZARDS FROM THE CANARY ISLANDS

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Among the most conspicuous aspects of lizard biology are the interactions between the animals and their thermal environments (Huey & Stevenson, 1979; Avery, 1982). A commonly used variable that may contribute to the characterization of the thermal biology of a species or a population is the selected body temperature (T_b), or the set point range (Pough & Gans, 1982; Hertz, Huey & Stevenson, 1993), which is a measure of the preference zone of body temperatures maintained by behavioural thermoregulation in a thermal gradient, an environment without ecological costs (Huey & Slatkin, 1976) or physiological constraints (Porter & Gates, 1969). When direct measures of physiological performance are unavailable, selected temperatures are the most meaningful measures in the thermal ecology of a given species (Huey, 1982).

The genus *Gallotia* (Sauria: Lacertidae) is endemic to the Canary Islands (Arnold, 1973). According to the latest taxonomic revision, it comprises five species distributed over the seven main islands (López-Jurado, Mateo & Guillaume, 1996). There is some information on the distribution and some aspects of the differentiation of *Gallotia* in the Canary Islands (Thorpe, 1985; López-Jurado, *et al.*, 1986). There is descriptive information about the present-day population and basic general information on distribution and general natural history of the poorly known Giant lizard of El Hierro, *Gallotia simonyi* (Machado, 1985 and references therein). There are also a few behavioural studies on *Gallotia* (Böhme & Bischoff, 1976; Molina-Borja, 1981). However, the only available information about the thermal biology of *Gallotia* is provided by Báez (1985), in a short study of *G. galloti eisentrauti*, and by (Díaz, 1994) in a study of the western Canarian lizard *G. galloti galloti*. Both of these subspecies are endemic to the island of Tenerife.

In this preliminary study we provide the first basic information on selected body temperatures for four species of *Gallotia*: a large species from the island of Gran Canaria, *Gallotia stehlini*; a smaller species from the island of Lanzarote (although there is a population

in Gran Canaria), *Gallotia atlantica*; and two endemic species from the island of El Hierro: the common small *Gallotia caesaris*, and the endangered Giant lizard of El Hierro, *Gallotia simonyi*, a species limited to a relict population which is the subject of a recovery plan based on captive breeding (Pérez-Mellado, *et al.*, 1997).

Gallotia stehlini and *G. atlantica* were tested in the facilities of the Centro de Investigaciones Herpetológicas between 12-22 June 1995 in Galdar, Gran Canaria. Individuals of *G. stehlini* were captured in the vicinity of the testing site (28°7.5' N - 15°40.9' W), and *G. atlantica* were captured in Malpaís de la Corona, Lanzarote Island (29°14.5' N - 13°30' W). Lizards from El Hierro were tested in the facilities of the Centro de Recuperación del Lagarto Gigante de El Hierro (CRLGEH), in Guinea, El Hierro (27°45.4' N - 17°59' W) from 4-29 April 1995. Juveniles of *G. simonyi* were tested between 10-12 January 1996, four months after hatching in captivity. The giant Hierro lizards tested were from the captive breeding stock of the CRLGEH, and *G. caesaris* were collected in the immediate vicinity of the premises. All the lizards collected in the wild were kept in captivity for two weeks to a month prior to testing to allow them to adjust to captive condition. Food and water were provided *ad libitum* to experimental animals.

Lizards were tested in 150 x 50 x 50 cm glass walled thermal gradient chambers floored with gravel. A heat source (250 W infra-red bulb) was suspended at one end, creating a gradient of air temperatures ranging from 17 to 57 °C. In El Hierro, the experiments were carried out mainly during the morning hours (09.00-14.00 hrs) or when air temperatures in the room were cool. In Gran Canaria the tests were carried out between 09.00-18.00 hrs, in an air-conditioned room to ensure that the gradients were not too hot. The cloacal temperature of the tested animals was taken with a Miller & Weber thermometer (0.2°C precision). Three measurements were obtained from each individual, one, two, and three hours after it was placed in the thermal gradient chamber. All lizards captured in the wild were returned to their capture sites at the end of experiments. A maximum of four small-sized individuals or two large-sized lizards were used synchronously. When more than a single individual was tested synchronously the individuals used were selected from similar size and sex classes to minimize agonistic interactions, which were absent in all trials.

For each species and class, we give the grand mean of the averages of individual T_b (see Huey, Niewiarowski, Kaufmann & Herron, 1989 for a similar approach). We also provide set point ranges (T_{set} , Table 1), estimated as the central 80% of all T_b selected in the laboratory (Hertz *et al.*, 1993). All individual measurements (three per individual) were included to calculate T_{set} . We did not detect significant differences in average T_b between classes (males, females, and juveniles) within three species (Table 1, one-way ANOVA, *G. atlantica*, $F = 1.06$, $P = 0.35$; *G. simonyi*, $F = 2.80$, $P =$

TABLE 1. Mean, standard deviation (SD), range and set point (T_{set}) for selected temperature (T_b); and mean, standard deviation and range of snout-vent length (SVL).

	<i>Gallotia caesaris</i>			<i>Gallotia atlantica</i>		
	male	female	juvenile	male	female	juvenile
T_b (C)	35.3	35.7	34.3	33.8	32.9	33.0
SD	1.85	1.46	1.36	1.63	3.36	1.67
Range	26.0-40.5	26.6-40.0	21.8-39.4	24.5-37.5	24.2-38.1	23.6-37.1
T_{set} (C)	32.1-38.0	33.6-38.1	32.5-37.0	30.5-36.4	26.4-36.3	28.6-36.4
SVL (mm)	68.6	66.1	52.1	88.6	70.8	61.2
SD	6.47	5.00	4.76	7.90	5.04	5.54
Range	58-81	58-75	42-61	104-74.5	78-65	66-51
<i>N</i>	33	21	18	25	7	14

	<i>Gallotia simonyi</i>			<i>Gallotia stehlini</i>		
	male	female	juvenile	male	female	juvenile
T_b (C)	35.2	35.6	36.3	33.7	33.5	34.6
SD	1.74	1.35	1.36	1.62	1.96	1.41
Range	26.0-40.0	29.6-39.4	27.0-39.0	27.5-38.3	27.1-39.0	30.4-36.6
T_{set} (C)	32.4-38.3	33.2-37.9	35.0-38.3	30.8-36.4	30.0-36.9	31.7-36.5
SVL (mm)	198.6	182.2	61.3	189.6	155.6	103.4
SD	21.44	12.77	6.78	27.78	18.38	26.02
Range	226-144	204-143	80-52	244-150	195-132	140-75
<i>N</i>	31	24	17	21	12	8

0.07; *G. stehlini*, $F = 1.14$; $P = 0.33$). Only the results for *G. caesaris* yielded significant differences between classes (One-way ANOVA, $F = 3.60$, $P = 0.03$), and the significance was due only to the difference between the most (females) and the least thermophylic class (juveniles), the rest of the pairwise comparisons being non-significant (Tukey-Kramer HSD test). In Gran Canaria, the selected temperatures in the tests performed in the afternoon (14.00-18.00 hrs) did not differ significantly from those obtained in the morning (09.00-14.00 hrs, $t = -1.37$, $P = 0.17$).

A multifactor ANOVA was set up to compare three effects: "island" (the two species present in Gran Canaria vs. the two species endemic to El Hierro), "adult body size" (small species vs. species reaching larger sizes), and "class" (male, female, juvenile). The "island" effect appears to be highly significant, indicating that the lizards from El Hierro (*G. simonyi* and *G. caesaris*) have significantly higher selected temperatures, than the species from Gran Canaria ($F = 53.95$, $P = 0.001$). The selected temperatures of species reaching large adult sizes (*G. stehlini* and *G. simonyi*) were also significantly higher than those of the species not reaching large adult sizes (*G. atlantica* and *G. caesaris*; $F = 6.77$, $P = 0.01$). Finally, the effect of class (male, female, juvenile) was not significant ($F = 1.56$, $P = 0.88$).

In order to determine whether preferred temperatures changed with individual size within each species, the correlations between selected body temperatures (T_b) and body size (SVL) were studied. The two species

that reach larger adult sizes yielded significant correlations (*G. simonyi*: $n = 72$, $r = 0.288$, $P = 0.01$; *G. stehlini*: $n = 40$, $r = 0.372$, $P = 0.01$). However, this effect may be an artifact. Actually, if the data for the juveniles are excluded, the correlations are not significant (*G. simonyi*: $n = 55$, $r = 0.134$, $P = 0.32$; *G. stehlini*: $n = 32$, $r = 0.30$, $P = 0.094$). On the other hand, the smaller species showed positive correlations between SVL and T_b , although the relationship was only significant in the species from El Hierro (*G. atlantica*: $n = 46$, $r = 0.234$, $P = 0.11$; *G. caesaris*: $n = 72$, $r = 0.322$, $P = 0.001$).

We detected significant differences in selected temperatures between islands. This fact could reflect a different thermal regime in these islands (or between a western Island: El Hierro, and two eastern islands: Gran Canaria and Lanzarote) which may act as a selective pressure on thermal preferences of lizards (see Avery, 1982 and references therein). Alternatively, differences in thermal preferences could result from differences in times of activity (Huey & Bennett, 1987). Crepuscular and nocturnal activity has been recorded in *G. galloti* and *G. stehlini* (Böhme *et al.*, 1985; Böhme, pers. comm.) but not in *G. simonyi*. Thus, different thermal preferences could also be linked with different activity cycles, maximizing activity times in each species (Huey & Slatkin, 1976; Huey, 1982).

It is clear that much more research is needed to test these hypotheses, especially on operative temperatures (Bakken, 1992) available in the natural habitats of each

species, and on thermal dependence of digestive efficiency and sprint performance (Huey, 1982). In any case, knowledge of thermal optima is also relevant for the correct design of a captive breeding program, the key factor in the recovery plan of *G. simonyi* (Pérez-Mellado *et al.*, 1997).

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