Preliminary data on the structural relationships in two lacertid species of the genus Gallotia (Reptilia: Lacertidae) based on the skeleton

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RESUMEN: En el presente trabajo se presentan los resultados de un análisis de regresión que relaciona el tamaño corporal frente a ocho caracteres osteológicos de G. galloti y G. atlantica. Se observa una relación estadística positiva y significativa entre ellas, aunque los coeficientes de determinación ($R^2$) indican niveles de ajuste más elevados en el caso de G. galloti que en G. atlantica. Además, se aportan datos preliminares sobre la relación: tamaño corporal vs. peso. Los distintos modelos propuestos pueden ser utilizados en estudios alimentarios de vertebrados depredadores que incluyen selección tallas (presas) de ambas especies, además de investigaciones paleontológicas.

ABSTRACT: In this paper we present the regression analysis between SVL and eight osteological variables in G. atlantica and G. galloti. Positive significant relationships can be observed among them, although coefficient of determination ($R^2$) indicate better fits in the case of G. galloti than G. atlantica. Furthermore, preliminary data on the weight-length relationships are shown. The proposed models can be used in predator vertebrate alimentary studies that include lizards size selection of both mentioned species and also in paleontological surveys.

INTRODUCTION

Lizards from the genus Gallotia are endemic to the Canary Islands and are represented by four living species: G. atlantica (Peters & Doria, 1882), G. galloti (Oudart, 1839), G. stehlini (Schenkel, 1901) and G. simonyi (Steindachner, 1889) (Machado et al., 1985; González et al., 1996) and at least one extinct species G. goliath (Mertens, 1942) which reached about 358 mm, in snout vent length – SVL (Castanet &
Báez, 1991). Among the extant species, G. atlantica is the smallest (SVL: 60.8 mm; range: 47-96), G. galloti shows an intermediate size (SVL: 70-121 mm depending on the subspecies), and G. stehlini (SVL: 142 mm, range: 88-248) and G. simonyi (SVL: 198 mm; range: 182-199) (Márquez et al., 1997) are the largest ones.

In the Canarian Archipelago, the various species of lizards are common prey of predator birds such as kestrels Falco tinnunculus (L., 1758) (Carrillo et al., 1994), shrikes Lanius excubitor (L., 1758) (Nogales et al., 1998) or buzzards Buteo buteo (L., 1758) (V. Quilis, pers. obs.), and mammals such as feral cats Felis catus (L., 1758) (Nogales & Medina, 1996). Therefore, the study of a series of structural equations would be very useful to predict the total length and weight of the prey eaten by these predator vertebrates. Similar studies have been carried out about insects (Rogers et al., 1976; Díaz & Díaz, 1990) and vertebrates (Morris, 1979; Steenhof, 1983; García-Márquez et al., 1997) as prey. However, generalised regressions made in groups of prey cannot supplant restricted regressions within specific taxa (Rogers et al., 1976).

Furthermore, the knowledge of these equations could also be used in palaeontological surveys. In this respect, bone remains belonging to the different species of the genus Gallotia have been found in palaeontological and aboriginal deposits, as well as in vertebrate droppings and pellets in the Canary Islands.

The aim of the present note is to show the relationships among different lengths of the main skeletal elements, the SVL and the body weight of the two smallest extant species of Gallotia (G. atlantica and G. galloti).

MATERIAL AND METHODS

The studied lizards (adults from both sexes), also used for physiological digestive studies (Valido & Nogales, in prep.) and ecotoxicology (Sánchez et al., 1997), were mainly captured in four localities: G. atlantica in Fuerteventura Island (Valle de Tetir – 400 m a.s.l.) and G. galloti in three other sites in the Island of Tenerife (Barranco de Las Cuevas, in Punta de Teno – 150 m a.s.l.; Barranco de Vargas, in Bajamar – 110 m a.s.l., and Corral del Niño, in Izaña – 2,293 m a.s.l.).

Animals were weighed by using a balance (0.1 mg) and measured by a digital caliper (0.1 mm) after being captured. Length variables taken can be classified in two types: 1) external body feature: Snout Vent length (SVL); and 2) osteological traits: Maxillary length, Jaw length, Parietal length, Parietal width, Pelvic girdle length, Femoral length, Humeral length and Tibial length (Fig. 1). This last variable was only measured in G. galloti due to the extreme weakness of this bone in G. atlantica.

Although dependent and independent variables are subject to random error, structural relations among variables (log-transformed) were calculated by using least square regression (LSR). This method was preferred to others (Radinsky, 1985; McArdle, 1988; LaBarbera, 1989), since the majority of the relationships presented high correlation and determinant coefficients (Table 1). These structural equations permit estimations of the snout vent length (SVL) and the weight from the length of the most frequent bones found in paleontological deposits and vertebrates droppings. In this regard, it is interesting to note that characters such as weight can be very variable and subject to environmental factors which can influence physical condition in the animal.
RESULTS AND DISCUSSION

Results of the regression analysis among SVL and the different osteological variables are presented in Table 1 showing positive relationships among them with high significance levels. However, the coefficients of determination ($R^2$) indicate better fits in the case of *G. galloti* than of *G. atlantica*. While all relationships showed values higher than 0.80 for *G. galloti*, three of the main osteological variables were lower than 0.50 for *G. atlantica*. This fact could be due to the different sample sizes.

The weight-length regression model has a high significance level ($P < 0.01$), the determination coefficients ($R^2$) being 0.62 for *G. atlantica* and 0.77 for *G. galloti* (Figure 2).

Despite the lack of contributions on weight-length relationships in other species of the genus *Gallotia*, some authors as García (1978), Mateo & López-Jurado (1992) and Rodríguez-Domínguez et al., (1998), have found some positive relationships among the length of several morphological variables from *G. goliath*, *G. stehlini* and *G. simonyi* respectively.

In conclusion, our analyses revealed that the bones studied in this work can be considered as good predictors of the size and weight of *G. atlantica* and *G. galloti*, and the proposed models can be used in future studies on lizards size selection by different predator species and paleontological surveys.

ACKNOWLEDGEMENTS

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BIBLIOGRAPHY


Table 1. Regression models found between the SVL and the main osteological variables measured in *Gallota atlantica* and *G. galloti*. Pearson correlation coefficients ($r_p$) are included and data were log-transformed. * $P<0.05$; ** $P<0.01$.

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Species</th>
<th>Regression models</th>
<th>$R^2$</th>
<th>$r_p$</th>
<th>$N$</th>
<th>$P$</th>
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</thead>
<tbody>
<tr>
<td>Maxillary length</td>
<td><em>G. atlantica</em></td>
<td>$Y = 1.32 + 0.52X$</td>
<td>0.48</td>
<td>0.69</td>
<td>18</td>
<td>**</td>
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<tr>
<td></td>
<td><em>G. galloti</em></td>
<td>$Y = 1.11 + 0.80X$</td>
<td>0.88</td>
<td>0.94</td>
<td>41</td>
<td>**</td>
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<tr>
<td>Jaw length</td>
<td><em>G. atlantica</em></td>
<td>$Y = 1.43 + 0.35X$</td>
<td>0.30</td>
<td>0.55</td>
<td>19</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td><em>G. galloti</em></td>
<td>$Y = 1.04 + 0.83X$</td>
<td>0.91</td>
<td>0.95</td>
<td>41</td>
<td>**</td>
</tr>
<tr>
<td>Parietal length</td>
<td><em>G. atlantica</em></td>
<td>$Y = 1.48 + 0.36X$</td>
<td>0.43</td>
<td>0.65</td>
<td>19</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td><em>G. galloti</em></td>
<td>$Y = 1.37 + 0.60X$</td>
<td>0.89</td>
<td>0.94</td>
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<td>Parietal width</td>
<td><em>G. atlantica</em></td>
<td>$Y = 1.30 + 0.61X$</td>
<td>0.68</td>
<td>0.82</td>
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<td><em>G. galloti</em></td>
<td>$Y = 1.26 + 0.73X$</td>
<td>0.84</td>
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<td>Pelvic girdle length</td>
<td><em>G. atlantica</em></td>
<td>$Y = 1.18 + 0.58X$</td>
<td>0.75</td>
<td>0.86</td>
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<td></td>
<td><em>G. galloti</em></td>
<td>$Y = 1.32 + 0.54X$</td>
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<td>Femoral length</td>
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<td>$Y = 1.21 + 0.58X$</td>
<td>0.64</td>
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<td><em>G. galloti</em></td>
<td>$Y = 1.00 + 0.82X$</td>
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<td>Humeral length</td>
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<td>Tibial length</td>
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<td>0.89</td>
<td>0.94</td>
<td>43</td>
<td>**</td>
</tr>
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</table>
Fig. 1. Principal measures taken from the different studied bones: Maxillary length (ML), Jaw length (JL), Parietal length (PL), Parietal width (PW), Pelvic girdle length (PGL), Femoral length (FL), Humeral length (HL) and Tibial length (TL).

Fig. 2. Relationships between weight and body length (SVL) in Gallotia atlantica and G. galloti. Triangles indicate individuals of G. galloti and dots G. atlantica. Confidence interval levels at $P = 0.05$ are shown.