



The species diversity of the genus *Gallotia* (Sauria: Lacertidae) during the Holocene on La Gomera (Canary Islands) and the Latin names of Gomeran giant lizards

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The importance of appropriate identification of a species prior to the adoption of an effective species conservation plan should not be underestimated. This precondition is not generally problematic. However, erroneous identification leads to unsuitable conservation measures (Daugherty *et al.* 1990) being drawn up. This may be the case of the “critically endangered” gomeran giant lizard (Cox *et al.* 2006).

The unusual tendency to gigantism of some Canary Island lizard species and the apparent size reduction they have undergone since the arrival of human settlers (Pregill 1986; Barahona *et al.* 2000) have generated uncertainty regarding the number of species on some of the islands. In the case of the island of Tenerife, mitochondrial DNA sequencing by Maca-Meyer *et al.* (2003) revealed that three different species coexisted until at least 2500 years ago, when humans settled in the Canary Island archipelago.

According to Hutterer (1985), Nogales *et al.* (2001) and Martín & Rando (2006), the “one island, three species” situation identified in Tenerife would also be applicable to the islands of Hierro, La Palma and La Gomera before the arrival of humans. Bischoff (1998), and Barahona *et al.* (2000) suggest, however, that these three islands were inhabited by only two species. They argue that all the distinguishing features used to differentiate the two supposedly larger species can be explained by growth changes. In other words, they propose that the medium-sized lizards are young individuals of the larger of the two species found there.

Concerning La Gomera, the dispute has also given rise to controversy over taxonomy and nomenclature. In 1985, Hutterer, taking the “one island, three species” hypothesis as fact, described two new and supposedly extinct taxa from subfossil remains. The larger one was named *Gallotia goliath bravoana*, and the medium-sized species *Gallotia simonyi gomerana*. The remains of a small lizard species were assigned to *Gallotia caesaris* (Lehrs), which is still abundant on La Gomera today (Pleguezuelos *et al.* 2002).

Several years later, Bischoff (1998) suggested that the bones of the large and medium-sized lizards found by Hutterer (1985) on La Gomera belonged to a single species. He thus formally synonymised *Gallotia goliath bravoana* and *G. simonyi gomerana*, selected *bravoana* as the valid nomen for the large species from La Gomera and considered it to be conspecific with *Gallotia simonyi*, thus proposing the trinomen *Gallotia simonyi bravoana* to designate the large-bodied taxon from La Gomera.

In 1999, Nogales *et al.* (2001) discovered a relict population of medium-sized lizards (up to 200 mm long body length) on an almost inaccessible cliff on Gomera at La Mérica. The authors found that their morphological features matched those of the smaller taxon described by Hutterer (1985), but thought that they were sufficiently different from *Gallotia simonyi* (Steindachner), still surviving on the island of Hierro, to deserve a specific status. They thus designated the just-rediscovered “giant” lizards from La Gomera as *Gallotia gomerana*.

Since then a series of studies have adopted either *bravoana* (e.g. Bischoff & Bannert 2001; Pleguezuelos *et al.* 2002; Mateo 2007) or *gomerana* (Maca-Meyer *et al.* 2003; Martín & Rando 2006), depending on which hypothesis (two or three species on La Gomera) was regarded as valid.

During systematic exploration of La Gomera to look for populations of giant lizards, numerous lizard skeletal remains were found at over fifty sites (Mateo 2007), including La Vasa, a small ravine in the south-east of the island (28°02'41"N/17°10'06"W). The sheltered sites in this ravine contained remains, waste and other products of human

presence and activity, including ancient carbon remains, pottery shards, mollusc shells, bird eggs, fish, rabbits and medium-sized and large lizards.

The lizard remains included a fragment of a large specimen comprising bones, an irregular section of skin just under 20 cm² with many recognizable scales, and mummified muscle from the trunk and anterior extremities, currently held at the Recovery Centre of La Gomera Giant Lizard (RCGGL). Our aim in this paper is to clarify for good the systematics and nomenclature of the extant taxon of large-bodied lizard of La Gomera based on morphological and genetic analysis of the specimen found in La Vasa and comparison with similar data obtained from the living specimens.

Morphometric study of the bones was conducted in accordance with the methodology followed by Barahona *et al.* (2000). Comparisons were made with material from the collection of *Gallotia* skeletons at the Department of Biology of the University of Las Palmas, and with skeletons of two adult specimens of the extant population of gomeran giant lizard that died in landslides (currently held at RCGGL).

The equations to estimate snout-vent length (svl) based on ulna length, sternal vertebrae, and scapula-coracoides (R^2 values always > 0.9) were obtained from measurements of 18 specimens of *Gallotia stehlini*, a similar large species currently found on Gran Canaria island. Within a 30-cm radius of the site of the mummified tissues, there were 3 sternal vertebrae, 4 sternal ribs, and a complete scapula-coracoides. In addition to the mummified tissue, there was an ulna, half a humerus, several ribs and a left dentary that was complete but fragmented proximally. Bone size suggested that all the bones, including those attached to the mummified soft tissue, probably belonged to the same specimen. Size of the various attached bones yielded an estimated snout-vent length for a live specimen of 360.2 to 378.0 mm, including margins of error at a 95% confidence level. This is much larger than the size of the specimens that survive today on La Gomera (around 200 mm svl, see Nogales *et al.* 2001).

The methodology used to estimate age at time of death was that followed by Barahona *et al.* (2000). Transversal cuts 35 μ deep made on two of the attached sternal ribs, the ulna and the humerus fragment yielded an estimated age at time of death of between 26 (estimate from the smallest of the attached ribs) and 28 years old (estimate for humerus fragment). The patterns of interannual growth on the ribs (attached or not), 11th vertebra, ulna and humerus coincided, thus reinforcing the hypothesis that they all belong to a single specimen.

The left dentary presented 27 dental positions (25 ankylosed teeth + 2 missing), with 3 cuspids on each tooth, which although obvious are less conspicuous than those of the giant lizards on Hierro, Tenerife and La Palma (Barahona *et al.* 2000). Hutterer (1985) regarded these features of dental morphology as diagnostic for the taxon *Gallotia goliath bravoana*. The 27 dental positions in the dentary also point more towards *G. goliath bravoana* (25 to 26 teeth according to Hutterer 1985) than to *G. simonyi gomerana* (21 to 22 teeth according to Hutterer 1985).

Genetic analyses were performed in the labs of the Department of Animal Biology of the University of Barcelona by Dr Salvador Carranza. DNA was extracted from the mummified remains using a Qiagen (Qiagen, Santa Clarita, CA) extraction kit. Special measures were taken to avoid contamination (Carranza *et al.* 1999, 2001). There was no risk of intra-species contamination as no *Gallotia* samples from the Canary Islands had previously been processed at the facilities. After the mummified remains had been sequenced, four specimens of gomeran giant lizards from the breeding colony in RCGGL were also processed for comparison. DNA was extracted from small tissue fragment extracted from the tip of the tail using the same methods as above.

The same PCR amplification and sequencing methods were used for the mummified remains and contemporary samples. A fragment of the mitochondrial ribosomal gene 12S rRNA was amplified for all the samples using the 12Sa and 12Sb primers from Kocher *et al.* (1989). The PCR conditions were described by Maca-Meyer *et al.* (2003).

The 12S rRNA sequences amplified from the mummified remains and from the four living specimens from the breeding colony were 390 base pair in length. All five specimens were identical to each other as well as to the available sequence of "*Gallotia gomerana*" held by Hernandez *et al.* (GenBank accession number AJ272395).

Systematic and nomenclatural conclusions. The analyses of the dental characteristics and the size of the bones all demonstrate that the mummified remains from La Vasa are identical to what Hutterer (1985) described as *Gallotia goliath bravoana* (the largest species under a three-species scenario). For example, the maxillar ZFMK-42392, belonging to its holotype, was from a lizard that must have measured between 381 and 395 mm svl. In addition, our genetic results clearly establish that these mummified remains belong to the same taxon as the lizards that currently survive on the cliffs of La Mérica.

The present results, the findings by Barahona *et al.* (2000), together with the fact that La Vasa is very close (less than 1000 m) to Chiguarime (*terra typica* of *Gallotia goliath bravoana*) all suggest that only two lizard species coexisted on La Gomera before the arrival of humans: the smaller *Gallotia caesaris* and the larger species that still survives at La Mérica. There is thus no doubt that Bischoff (1998) was right and that *Gallotia goliath bravoana* Hutterer, 1985 and *Gallotia simonyi gomerana* Hutterer, 1985 are subjective synonyms.

Since both *bravoana* and *gomerana* were published in the same work and were proposed at the same (subspecific) rank (Hutterer 1985), the precedence of the nomina can only be fixed by the First Reviser (see Article 24.1 and 24.2.2 of the International Code of Zoological Nomenclature, ICZN 1999, designated as “the Code” hereafter). In the present case, “the first author citing in a published work those names or acts and selecting from them” (see Article 24.2.1 of the Code) is to our knowledge Bischoff (1998) who selected *bravoana* as the valid nomen and treated *gomerana* as a synonym of *bravoana* and is thus the First Reviser. The valid nomen for the large lizard species that inhabited La Gomera before human settlement and still survives in a very small population on La Mérica cliffs is thus *bravoana* Hutterer, 1985. Hence, the La Gomera giant lizards should be designated as *Gallotia bravoana* Hutterer, 1985.

The “three lizards, one island” model, which was widely accepted from the first half of the twentieth century for the four most westerly Canary Islands, now appears only to be valid for Tenerife, a large island with a great diversity of habitats. Its more complex geological history might explain its more complex evolutionary processes and greater biological diversity both now and in the past (Brown *et al.* 2000).

Acknowledgements

DNA sequencing was conducted with the invaluable cooperation of Dr. Salvador Carranza. Research was supported by a LIFE European Project (LIFE 02 NAT/E/8614).

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