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Hypothesis on the reasons for the decline of the large lizards in the Canary Islands

by

Antonio Machado

Introduction

The present fauna of lacertids of the Canary Islands is composed of two groups of lizards, both included in the endemic genus *Gallotia* Boul. 1916 (Arnold 1973). A first group of small lizards is formed by *G. atlantica* s.l., endemic to the eastern islands, and *G. galloti* s.l. which is distributed in the western islands. Both lines have evolved intra- and interinsularly to form subspecific populations ("Rassenkreise") with differences in size and colour. Only the Island of Gran Canaria appears not to be inhabitated by representatives of this group[1].

The second group forms a species of great size whose distribution and systematic knowledge could well present some surprises. *G. stehlini* Schenkel (1901) lives on Gran Canaria and *G.* aff. *simonyi* Stein. (1889) on El Hierro. The first is common, while the Hierro Giant Lizard is in grave danger of extinction.

Besides *Gallotia simonyi* (Steind. 1889), whose only known small population on the Rock of Salmor was exterminated some 50 years ago, the other know forms, also of great size, correspond to the fossil and subfossil material (García Cruz & al. 1980, Bravo 1978). The largest of the species (up to 1.5 meters), *Lacerta (Gallotia?) goliath* Mertens 1942 was described from material from Tenerife whereas other material is known from La Gomera (Hutterer 1985) and La Palma[2]. Also remains of a second large species, although of lesser size, have been found in Tenerife and assigned to *G. simonyi.* However, paleontological research in the Canaries has been very sporadic and superficial. It is hoped that the more organized studies now being conducted will reveal new interesting results that could possibly revolutionize our ideas about past animal colonization of these islands.

1 The population of *G. atlantica* located in the eastern part of Gran Canaria (Arguineguín) is supposedly introduced (Barquín & Martín 1982). This seems quite credible when one considers that the large barges in which the "majoreros" (inhabitants of Fuerteventura) abandoned the Island during years of famine landed in this zone of the coast (v. Roldán 1968).

2 Apart from the remains that Bravo (1954) mentions and which have been lost, Dr. A. Santos has collected new material in Mazo, which is being studied by M. Martín and L. F. López-Jurado.

This work will not discuss the other extinct vertebrates (terrestrial turtles, large rats, wingless birds, etc.), rather, the discussion is limited to the large lizards, concretely to why some populations have become extinct and others not.

As far as we know, *G. goliath* s.l. is considered extinct on Tenerife, La Gomera and La Palma. The same has occurred with *G. simonyi* s.l. on the small Roque de Salmor, its patria typica, and on Tenerife(?). On the other hand, on El Hierro a very reduced population of some 100 individuals of a related large lizards[3] continues to exist. *G. stehlini*, a very similar species, is, nevertheless, a common lizard on Gran Canaria. The same is true for the other small lizards on their respective islands.

In summary, and in light of current knowledge, we are able to state that the situation of the small lizards is normal, as it is with one of the large lizards (*stehlini*) on an island where the small ones do not live. Thus the other large lizards have become extinct or are on the poínt of becoming so.

About the reasons for the decline

Formerly, various authors have treated, more or less superficially, the extinction of the large Canarian lacertids, arguing one or another possible causes but, to me, without giving a reasoned and satisfactory explanation. Instead of expounding the various theses of these authors, it seems more appropriate to present an analysis of the kinds of factors that are argued in one case or another, if not used simultaneously.

Natural biological factors

The extinction of the large form was the consequence of interspecific competition (Mertens 1942, Arnold 1973, Báez 1983). This implies that the small lizard group reached the islands later in a second invasion (Klemmer 1976) and competitively displaced the large lizards which were less well-adapted. Barquín & Martín (1982) believe that perhaps the behaviour of the large adult lizards towards their own young contributed disfavourably when compared to the small sympatric species. Nevertheless, to explain the particular case of Gran Canaria (though small fossil forms have not been found), Mertens (o.c.) simply stated that the reverse occurred there, i.e. the large species survived instead of the small one.

Klemmer (o.c.) writes that the extinction of these large forms could be completely natural, since insular species are usually very sensitive to environmental changes and have a very slow reproductive rate. Báez (o.c.) also considers that the dialectic invasion-extinction is a common natural process on islands.

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3 Until now (Böhme & Bings 1975, 1977, Martínez Rica, 1982), these lizards have been considered as *G. simonyi* (Steind. 1889) — a species described from the nearby Roque of Salmor — but in fact differences exist between them (see Machado 1985).

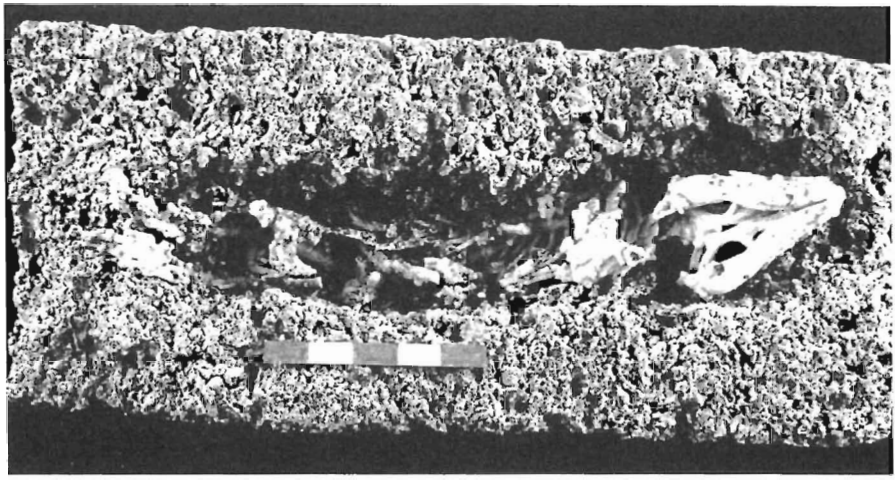

Fig. 1: Fossil giant lizard of Gran Canaria embedded in lapilli from La Isleta. Specimen kept in the Museo Canario, Las Palmas. Scale in centimeters. Photo Museo Canario.

Natural physical factors

Many authors mention the volcanic activity as a factor associated with the extinction of the primitive vertebrate fauna. The majority cite the lapilli and the lava flows as direct causes of mortality, which correlates with the numerous fossil remains found covered by or embedded in these materials (see fig. 1). Klemmer (o. c.) also considers the devastating effect that the eruptions must have had in altering the habitat and limiting food supplies.

It is evident that the eruptions are causes of death in the affected populations. However, as they are a sporadic ecological factor, it does not seem logical that they have the capacity to eliminate a species of wide distribution throughout the island, above all, when there always remain areas unaffected by volcanism for long periods of geological time.

Anthropogenic factors

Nearly all authors, at some time, point to man as a direct or indirect cause contributing to the extinction of the large lacertids. *Gallotia simonyi* s. str. became extinct on the small Roque de Salmor due to scientific and commercial collection. In general, however, these comments are imprecise and, perhaps, in more than one case, just the result of routine speculation.

In the opinion of Salvador (1972), the extinction of *simonyi* on Tenerife and El Hierro[4] occurred in historical times due to human pressure. Bravo (1971) comments on the possibility that the aborigines, the Guanches, ate these lizards and

4 In the same work Salvador includes data regarding the possible survival of the species on the island of Hierro (see footnote 3).

thus contributed to their decline. Báez (1984) believes that the disappearance of these species was accelerated by man and mentions his "intense destructive action."

Speaking of environmental transformations, Klemmer (o.c.) notes the importance of man as a perturbative agent, and Kämmer (1982), with more precision, associates part of the vertebrate fauna extinction with the indirect anthropogenic influence: cultivation, introduced species, goats, etc.

Historical references

Little datation exists related to the fossil and subfossil remains, but enough is found to deduce that these large lacertids did coinhabit the islands with the primitive aborigines (Acosta & Pellicer 1976, Böhme & al. 1981, Hutterer o.c.).

Moreover, the historical register furnishes us with some information of interest. It is probable that the "*Capraria, lacertis grandibus refertam*" of Plinius (*Naturalis historia*, ed. 1624) taken from the lost chronicles of King Juba II expedition (Second Century B.C.), makes reference to the Island of El Hierro[5](Viera & Clavijo 1866, von Buch 1825), and not to Gran Canaria or Fuerteventura as was supposed by other authors (Steindachner 1891, Arribas & Sánchez 1900, Lehrs 1909, Krüss 1976).

There is only one concrete reference to the large lizards in the chronicles of the Conquest of the Canary Islands (XV and XVI Century). In *Le Canarien* the French chroniclers P. Boutier and Jean Le Verrier narrate the arrival of Jean de Bethéncourt at El Hierro in 1404 and comment: ",... and one can find large lizards, like a cat, but they do no harm nor have any poison"[6].Joan dos Barros (1552), in his *Decada primera da Asia,* mentions that the inhabitants of La Gomera eat all manner of things such as "cobras (*sic*), lizards and rats".

Von Fritsch (1870) speaks of large-sized lizards less frequently seen than the common lizard (*G. galloti*) which he has observed on El Hierro, La Gomera and Gran Canaria. To this, one can add other commentaries and stories recollected by various authors (Steindachner 1891, Bings 1980, etc.), but none could be confirmed.

The hypothesis

From this information it can be deduced that the extinction of the large lizards has occurred in recent or very recent times. If the causes of the regression were

5 Saumaise and P. Hardouin (fide Viera & Clavijo 1772, ed. 1982, p. 81) believe that Plinius wrote *Kavrariam*, which means Capraria, instead of *Savrariam*, which means *Lagartaria.* This would also fit better into the context of *lacertis grandibus refertam.* Moreover, the Greek S was written like the Latin C (note of A. Cioranescu; loc. cit.).

6 In the text altered by Bethéncourt (Texto B sensu Cioranescu 1980, p. 161), the end of the sentence has been changed to read: "...cat, but they do no damage and are very repugnant to see".

just natural, these would have been active for a very long time before the arrival of man at these islands. It would be an anthropocentric view to think that this extinction "waited" to happen in the presence of man.

When planning the conservation project of the Hierro Giant Lizard (*Gallotia* aff. *simonyi*), there were various questions that I traced regarding its regression. We know that in the past these large lizards distributed themselves throughout other zones of the island (von Fritsch 1867, Böhme & al. 1981), in addition to the small Roque de Salmor where the form living there was directly eradicated by man.

Why did these large lizards of El Hierro draw the attention of Juba and the Conquistadores more than those of Gran Canaria that are equally as large and much more abundant? Why have these saurians become extinct on Tenerife, La Palma, La Gomera, nearly so on El Hierro, but not on Gran Canaria? So far we have fenced back and forth with arguments that do not explain these discrepancies in a coherent form.

All these questions animated me to develop a hypothesis that tries to give a reasoned explanation of the phenomenon. As every hypothesis, this one does not extend further than its own intellectual limitations, but new hypotheses are perhaps the proper way to stimulate science. The hypothesis presented here gives rise to some questions that could be resolved by experimentation. Experimental results could reinforce the hypothesis or, on the contrary, completely disprove it.

Size segregation

It is a known phenomenon recollected by diverse authors (See Carlquist 1974, cap. 15) that reptiles are usually of larger sizes on islands than on the continent. This tendency towards gigantism can be justified by better usage of the environmental resources and can happen on islands, thanks to the absence of predators.

The large Canarian lacertids fit into this scheme, though opinion exists (Báez 1983) that they are remnants of a giant group now extinct on the continent, and not the result of an insular evolutionary process.

Arnold (1973, p. 317) states that "where more than one lizard species coexist in precisely the same habitat, separation is usually achieved either by hunting at different periods or by selecting different sizes of prey, in which case the coexisting species often differ in size too". This tendency to avoid ecological competition also happens intraspecifically and Heatwole (1976) records various examples where even the different sexes have different sizes (or longer jaws).

One can suppose therefore, that a unique large lizard population (case A), living in a limited environment, tends to adopt a scaled structure of sizes in a manner that achieves the greatest division possible of available, exploitable food sources (fig. 2). The rate of growth will be lower in these cases, and the adults of maximum size will represent only a small portion of the population. The growth is, therefore, slow and progressive.

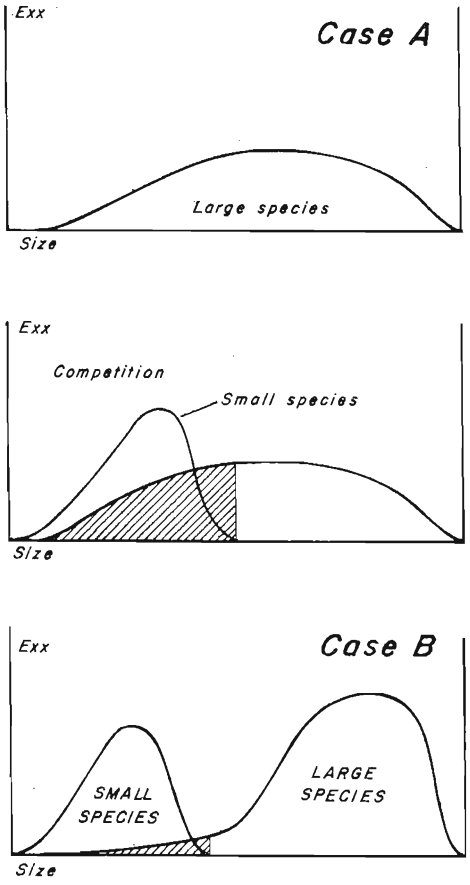

Fig. 2: Population structure development in large lizards. Explanation given in text. Shaded areas refer to population of large species affected by competition.

If we consider two sympatric species (case B), one large and the other small, a conflict arises between the latter and the young individuals of the large species. One form of resolution would be for the large species, to adopt rapid growth, quickly leaving behind the smaller sizes and concentrating its numbers in the larger sizes free from interspecific competition. The adults of maximum size, in this case, would represent the greatest portion of the gene pool.

This is not the only way to segregate the two species of case B. The separation in different hunting periods, as mentioned, or spatial niches (ground/branches) is frequent in reptiles. However, we suppose that it has not happened as such and that the evolutive tendency has hypothetically occurred, at least primarily, according to what has been postulated above.

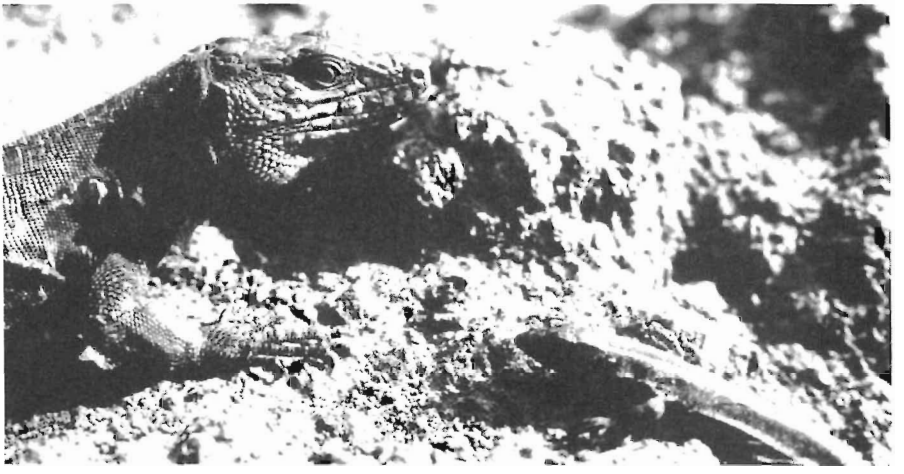

Fig. 3: Adults of *Gallotia* aff. *simonyi* and *Gallotia galloti caesaris* in Gorreta, El Hierro. Both specimens were slightly narcotized to take the picture. Compare sizes. Photo A. Machado.

Case A corresponds to the situation of Gran Canaria where *G. stehlini* exists as the only species. Case B applies to El Hierro where *G.* aff. *simonyi* coexists with *G. galloti caesaris* (fig. 3). Mertens (1942) called attention to the dualism: dwarf form — giant form that exists in all the western islands, maintaining a parallel distance of homologous sizes: the larger the small form, the larger the large form.

It remains to be explained whether the origin of all these forms was common or not, and in the particular case of Tenerife, it is not very clear if there are really two or three phylogenetic lines that coexisted (*galloti — simonyi — goliath*).

Effects of Predators

For a small predator, like a kestrel (*Falco tinnunculus*), a lizard of 200 or 300 grams is a too large prey. However, for a larger predator, like a dog or cat, it would be an adequate prey. Giving that on oceanic islands large predators are normally absent, the gigantism of some island forms can be considered as a favorable adaptation in this sense, thus eluding and minimizing the pressure of small predators.

Valverde (1967), in a still little recognized work, estabilishes the basic relationship that unites a predator with its prey. It is explained in a formula, the Prey Desirability Index (Indice de Apentencia):

$$\text{Desirability Index} = \frac{\text{Energy obtained from eating the prey}}{\text{Energy expended in its capture}}$$

It is evident that a small lizard is not a significant prey for a wild cat or a dog. In fact, it is easy to observe in the field how rarely they pay attention to them. The large lizards, on the contrary, have a higher Desirability Index which increases the bigger the animal is and subsequently attract the attention of predators. Therefore it is only on islands where there are no predators that the species acquire sizes larger than normal.

Cases A and B have been developed with the supposition of an absence of predators. What would occur if we introduce carnivores like those just mentioned? In both situations the predators will only concentrate on large lizards, disregarding the smaller ones. By this manner, in the case of A (scaled sizes), they eliminate an insignificant proportion of the population. Consequently, the larger sizes will be depleted but will continuously be replaced. The population is exploited at one extreme without major consequences.

The effect is different in case B. Practically all the gene-pool is accumulated in the larger sizes, such that the predator pressure acts on nearly all the fertile population causing a progressive regression and ultimate extinction.

I believe therefore, that the biological action, continuously exercised by non-native predators introduced by man, is the causal factor of the regression of the large Canarian lacertids.

This hypothesis implies that the large predators arrived with man on the islands, a species that supposedly landed here not earlier than 2000 B.C. (Castro Alfín 1983). A current revision regarding the presence of dogs and other domestic animals in the times of the Guanches has not been carried out. Furthermore some very interesting and relevant canid remains are known (López-Jurado, pers. comm.) that may pre-date man.

Apparently the existence of dogs on Gran Canaria and Tenerife (Zeuner 1959, Diego Cuscoy 1968) has been confirmed, but doubt exists with respect to Gomera and La Palma. Cats were introduced by the Europeans during and after the 15th Century (Maffiote 1916).

The hypothesis explains why *G. stehlini* has not disappeared on Gran Canaria even though predators exist. It also serves to support the idea that the larger sized individuals are scarce, very timid and retiring and, consequently, difficult to observe.

On Gomera, La Palma and Tenerife (case B), the more prolonged action of dogs and, possibly, the sporadic action of man and later of cats would explain the extinction of the large lizards before those of the Island of El Hierro, where dogs and cats have been present only in recent centuries.

Additional remarks

In spite of some authors that cite generally the presence of dogs in all the islands during prehistoric times (Mercer 1980), I have not been able to find any reference in the chronicles of the Conquest, travel logs, archeological documenta-

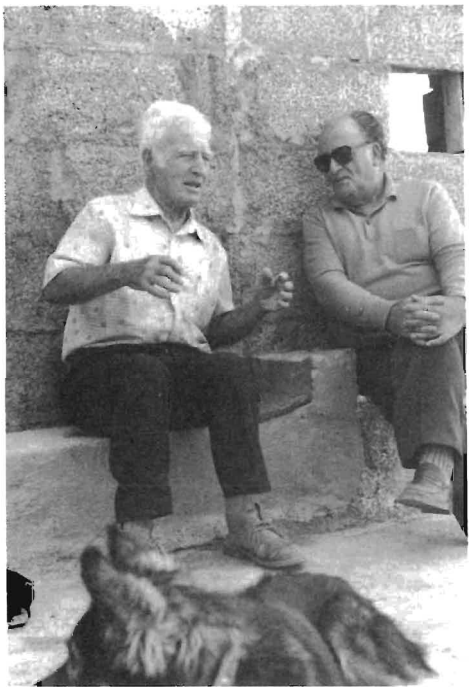

Fig. 4: Mr. Luis Febles (79 years old) explains to a conservancy agent how the first lizard of Gorreta was captured. Photo A. Machado.

tion or data that bear truth to their presence on El Hierro. However, there is documentation of goats, sheep and pigs. This would explain why there was an abundance of large lizards readily seen and that consequently caught the attention of the chaplains of Jean de Bethéncourt in 1404.

The installed people of El Hierro were shepherds practicing little agriculture. The help of dogs had to be important and extensive. Today, there still exists much flock-tending in nearly all parts of the island. Lorenzo Perera (1982), who has extensively addressed these themes, comments that "in the last few years, the insular 'creole dogs' have been substituted by others brought from outside, primarily German sheep dogs and wolf-dogs." (transl.). I have obtained statements of El Golfo inhabitants who recall how the dog (creole) of Petra "la de Guinea" killed no less than 3 large lizards. Guinea is at the foot of the cliff where the lizards live today. Luis Febles (fig. 4), shepherd, (interv. Guinea, Aug. 10, 1984) tells how his dog pointed out a hidden lizard, the first specimen of *Gallotia* aff. *simonyi* that was collected in the Risco de Gorreta, in El Hierro, about 1940. He continues to say that his dog stops and points to only the large lizards in a manner similar to how he points rabbits. His dog does not do this with the small lizards *G. galloti caesaris.*

Definite results have not been published as to whether the Guanches ate lizards. Opinion exists that remains of lizards were found in caves inhabited by Guan-

ches (González & Tejera 1981). More material is available — above all, on the Island of El Hierro — that supports this thesis and the popular saying "the herreño (people of El Hierro) eat lizards" that was cited by Berthelot (1842) and refuted by Verneau (1891). Lorenzo Perera (in Verneau, ed. 1982, note 16) comments, with good criterion, the Berebers eat lizards. Also today, lizards are eaten in zones of Extremadura and Southern Spain (*Lacerta lepida*). Similarly it occurred at Bajamar, Tenerife during the last World War.

It is logical, too, that the aborigines used the natural resources of their environment. The large lizards would be good prey for man. If such a habit was not of normal occurrence, it would seem totally reasonable that during times of famine, which were not rare, they took advantage of this food source. In any case, and as it relates to the discussion here, the pressure of human predation, little specialized, does not seem sufficient cause to explain the decrease of these species, although supporting it.

Note: I like to express my acknowledgment to Marnie E. Knuth and Keith Emmerson for their help with the English translation.

Zusammenfassung

Während die nur fossil bekannte *Lacerta* (*Gallotia*?) *goliath* Mertens, 1942, bis 1,50 m Gesamtlänge erreichen konnte, werden die größten heute lebenden Kanareneidechsen, *Gallotia stehlini* (Schenkel, 1901), 80 cm lang. Die von der Ausrottung bedrohte Hierro-Rieseneidechse, *Gallotia* aff. *simonyi*, erreicht nur etwa 50 cm. Die topotypische Population von *Gallotia simonyi* (Steindachner, 1889) verschwand in diesem Jahrhundert von dem von ihr bewohnten Felseiland, ebenso wie ein fossiler Verwandter von einer anderen Insel.

Die von früheren Autoren geäußerten Überlegungen und Vorstellungen über das Aussterben bzw. den Rückgang dieser Gruppe von Großlacerten werden kommentiert. Es wird postuliert, daß zur Verringerung zwischenartlicher Konkurrenz die Großeidechsen eine von den sympatrischen kleineren Arten verschiedene Populationsstruktur entwickelten, charakterisiert durch eine Anhäufung von Individuen der oberen Größenklassen (durch schnelleres Wachstum).

Die Konzentration von Genen in größeren Individuen bedeutet eine erhöhte Gefahr der Population durch Räuber, da die großen Eidechsen einen höheren „Beuteappetenz-Index" (Indice de Apetencia sensu José Valverde, 1967) haben als kleinere Exemplare. Im Gegensatz zu Populationen mit einem ausgewogenen Größenklassen-Verhältnis, wo es nur einen kleinen Prozentsatz großer Individuen gibt, kann Prädation auf die Populationen der Rieseneidechsen verheerende Auswirkungen haben.

Die Einbürgerung von (für diese Insellebensräume zu großen) Raubtieren, wie Hunden und Katzen, durch den Menschen, und die gleichfalls gegebene Möglichkeit der Ausbeutung der Großeidechsen-Populationen zur Ernährung der Ureinwohner werden diskutiert, wobei einige zusätzliche historische Argumente die hier vorgestellte Hypothese stützen. Biologische Interaktionen mit vom Menschen eingebürgerten Räubern sind der ursächliche Faktor für den Rückgang der großen Kanareneidechsen.

Resumen

En las Islas Canarias se conocen lagartos gigantes fósiles que llegan a medir hasta 1.50 m. Algunas de las especies vivientes alcanzan tallas de 80 cm, como *Gallotia stehlini* (Schenkel, 1901) y algo menos (50 cm) en el Lagarto Gigante del Hierro (*Gallotia* aff. *simonyi*),

que se encuentra en grave peligro de extinción. *Gallotia simonyi* (Steind. 1889) fue exterminado en época histórica del roque donde habitaba, y formas relacionadas con esta especie se conocen como fósiles en otra isla.

Se comentan las ideas y razones que arguyen otros autores referentes a la extinción o regresión de este grupo de grandes lacértidos, a la vez que se aporta una hipótesis más elaborada. Se postula que, con el objeto de evitar la competencia interespecífica con las especies menores coexistentes, las especies grandes han adoptado una estructura de población diferente, que consiste en la acumulación de indivíduos en las tallas mayores (crecimiento rápido). Al ser su Indice de Apetencia (sensu Valverde 1967) mayor que el de los lagartos menores, la acción de los grandes depredadores se concentra y tiene efectos devastadores en casos como éstos, donde la mayoría de los genes de la población están en las tallas mayores. La predación en poblaciones mejor estructuradas (tallas escalonadas), donde los ejemplares mayores sólo representan una pequeña porción del pool-genético, no pone en peligro de extinción al conjunto de la población.

Se discute la introducción de perros y gatos, por el hombre predadores demasiado grandes para el biota insular, la posibilidad de que los aborígenes de la isla comiesen lagartos, así como otros argumentos históricos que soportan la hipótesis. En consecuencia se considera que la acción biológica contínua ejercida por depredadores alóctonos, introducidos por el hombre, es el factor causante de la regresión de los grandes lacértidos canarios.

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Antonio Machado, Instituto Nacional para la Conservación de Naturaleza, Aptdo 619, Santa Cruz de Tenerife, Tenerife, Islas Canarias.