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Notes on ecological genetics of *Gallotia galloti* populations from Tenerife

by

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The following notes are part of the results of a February 1979 trip (see Pasteur, 1981) sponsored by Muséum National d'Histoire Naturelle, Paris. As the clear-cut climatic and vegetational tiers which altitudinally partition the island of Tenerife are relevant to this study, let us briefly recall that there exist three such tiers (see Bacallado, 1976) that are as noticeable to a person who ascends the island as, spectacularly, to the airborne observer: the below-cloud zone, where the air is warm and rather dry, with tropical vegetation and extensive banana plantations, tending to aridity on slopes facing south; the zone of quasi-permanent clouds, about 300—1500 m high in the north and 600—1800 m in the south, fresh and very humid, with intensive non-banana farming and little primary vegetation left; and the above-cloud zone, the lower part of which is dry and arid and subject to hot temperatures in midday and cold temperatures, even freezing in winter time, at night.

One of us (G. P.), after 1) personal surveying of the island in all directions, 2) conversations with peasants inhabiting the medium tier, and 3) comments from Prof. J. J. Bacallado, Department of Zoology, Universidad de La Laguna, hypothesized that there is little contact, if any, between the above-cloud and below-cloud populations of *Gallotia galloti* on the southern slopes of Tenerife, and none at all on the east, north and west sides.

Thirty-eight protein loci have been investigated through electrophoresis in erythrocyte, plasma, liver, kidney and testis extracts from 36 individuals of *Gallotia* collected in various parts of Tenerife. The specimens can be arranged into four regional samples as follows.

1) Below-cloud tier:
   — Northern coast from Puerto de la Cruz westward — 12 individuals
   — North-west flank (Llano del Moro area) — 4 individuals
   — South slope (Mirador de la Centinela area) — 12 individuals

2) Above-cloud tier:
   — Central mountain range around 2000 m (El Portillo-Izaña area) — 8 Individuals

Two protein loci could not be interpreted with the buffers used. Out of 36 loci left, 15 had more than one allele detectable, and 11 of these had heterozygotes in such frequency that the most common allele did not exceed a 95 %

proportion, yielding an overall polymorphism index of 27.8 % while the gene diversity index* was 8.68 % in 24 fully analysable loci (see Table 1). If the ancestral founding colony was genetically depauperate when it reached the oceanic part of the Canary archipelago, then these relatively high figures imply that a good deal of mutations have been retained since colonization. Little more can be said about this topic as long as we know nothing of genetic variability in continental relatives.

Table I. Electromorph frequencies at polymorphic loci of *Gallotia galloti* Tenerife samples . TR = transferrin; v.f. = very fast . No heterozygotes were observed at the two isocitrate dehydrogenase loci, whose variations were strictly parallel, suggesting similar epistatic action on both from alleles of an extraneous gene.

Locus	Observed alleles	*Gallotia galloti eisentrauti*	*Gallotia g. galloti*	
			'Below-cloud' sample	'Above-cloud' sample
EST-4	90	0.03	0.04	0.06
	100	0.81	0.71	0.81
	110	0.16	0.21	0.13
	120	—	0.04	—
IDH-1	85	—	0.08	0.12
	100	0.93	0.75	0.88
	120	—	0.17	—
	v.f.	0.07	—	—
IDH-2	60	—	0.08	0.12
	100	0.93	0.75	0.88
	115	—	0.17	—
	v.f.	0.07	—	—
MPI-1	90	0.07	0.04	—
	100	0.83	0.75	1.00
	110	0.10	0.21	—
NP-1	100	0.97	0.88	1.00
	180	0.03	0.12	—
PGM-3	40	0.03	—	—
	60	0.03	0.05	0.19
	70	0.16	0.05	0.31
	80	0.25	0.15	0.13
	85	0.12	—	—
	90	0.16	0.20	0.06
	95	0.03	0.20	0.06
	100	0.22	0.35	0.25
TR	100	1.00	—	0.50
	110	—	1.00	0.50

Fully analysed monomorphic loci: Alb, EST-1, EST-2, EST 3, α GPD-1, IDH-3, IPO, LDH-1, LDH-2, MDH-1, MDH-2, NP-2, PGI-2, PGM-1, PGM-2, Pt-2, Pt-3.

* Mean of expected heterozygosities (h) at individual loci, with $h = 1 - \Sigma x_i^2$ where x_i stands for the frequency of the ith allele at the locus.

Of special interest is the first (= controlling more anodal products) locus of mannose phosphate isomerase. This locus presents three alleles, MPI-1^{100}, MPI-1^{90} and MPI-1^{110}, in lowland populations, the samples of which displayed a 32 % average heterozygosity, whereas the high-tier sample is monomorphic for MPI-1^{100}. This suggests that only allele 100 has reached the above-cloud region, but our samples are too small for the difference to be statistically significant. Further investigation of this monomeric enzyme, very easy to study from liver homogenates with tris-citrate buffers, is necessary in above-cloud *Gallotia*.

Unusual diversification is shown by transferrin, a plasma globulin. Plasma extracts from six mountain, two southern and nine northern individuals were available. Two transferrin electromorphs, Tr^{100} and Tr^{110}, were discernible. All northern specimens turned out to be Tr^{100} homozygotes, whereas the two southern ones were homozygous for Tr^{110} and, most remarkably, all above-cloud zone lizards were heterozygous. Probabilities for such differences being due to chance are exceedingly small: the corrected chi-square is 15.8 between north and south low-tier samples (4/0 vs. 0/18 alleles, $P \cong 0.00004$) and 12.9 between above-cloud and below-cloud samples (6/0 vs. 0/11 heterozygotes, $P \cong 0.0003$).

Low-tier *Gallotia galloti* are thus definitely differentiated into two geographical transferrin phenotypes. The extent of their respective distributions remains to be found, but it is noteworthy that all our Tr^{100}/Tr^{100} specimens have apparently been collected in the range of *Gallotia galloti eisentrauti* Bischoff, as this range can be inferred from Bischoff's (1982) distribution map, while the two Tr^{110}/Tr^{110} individuals were taken well within the range of *G. g. galloti* (Oudart).

At the same time, however, both transferrin phenotypes are closely related to the lizards which live above the cloud layer, and the differentiation of these is ecophysiological rather than geographical. The extraordinary situation that all six mountain specimens tested were heterozygous indicates drastic selection against homozygotes, and this suggests a relation with the environmental heterogeneity imposed by the drastic circadinan changes in temperature (and related ecological factors): with two transferrin molecules, an organism is better buffered against environmental fluctuations than with one.

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Zusammenfassung

Proteinloci von 36 Eidechsen der Art *Gallotia galloti* aus Teneriffa wurden untersucht. Der Gendiversitätsindex betrug bei einer Zufallsstichprobe von 24 Proteinloci 0.087. Unter insgesamt 36 untersuchten Loci wurde eine signifikante geographische Variation nur bei Transferrinen von Tieflandeidechsen festgestellt, während eine Stichprobe von *Gallotia* aus Gebirgsregionen oberhalb der Passatwolken ausschließlich Heterozygote aufwies, scheinbar eine Anpassung an drastische circadiane Änderungen der Umweltbedingungen.

Resumen

Loci protéicos de 36 lagartos de la especie *Gallotia galloti* de Tenerife fueron estudiados. El índice de diversidad de los genes de una muestra al azar de 24 loci protéicos fué de 0,087. Entre 36 loci examinados en total pudo constatarse una variación geográfica significativa sólo en las transferinas de los lagartos que habitan las partes bajas, mientras que una muestra de *Gallotia* de la zona montañosa de por arriba de las nubes estaba formada exclusivamente por heterocigotos, lo que aparentemente es una adaptación a la drástica variación diaria de las condiciones ambientales.

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