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INTRODUCTION TO A FAUNAL STUDY OF THE
CANARY ISLANDS' LAURISILVA WITH SPECIAL
REFERENCE TO THE GROUND-BEETLES

by

A. MACHADO



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XIII. INTRODUCTION TO A FAUNAL STUDY OF THE CANARY ISLANDS' LAURISILVA, WITH SPECIAL REFERENCE TO THE GROUND-BEETLES

(Coleoptera, Caraboidea)

by

ANTONIO MACHADO

Introduction

The laurisilva has usually been dealt with from a strictly botanical point of view, without taking into account its certainly rich and interesting fauna. The global study of the fauna of this vegetal formation is far from being realizable even today, due to the present state of the knowledge of the different zoological groups present in the Archipelago. We have nevertheless wished to approach this line of work for we consider it of great ecological, biogeographical and evolutionary interest.

We may think, for example, on the old problem of how the Macaronesian Archipelagos were colonized: by land? by sea? ... The answer would be simple if only we knew the origin of these islands, greatly debated even by geologists. But principally there are zoologists who, in order to explain some faunistic coincidence or the other, have devised a series of land bridges between the islands or with the continents, when they have not been dedicating themselves to the sinking or rising of lands that existed, at least in their imaginations, at some time in the past.

The origin of the islands only concerns, strictly speaking, the geologists, in so far as it treats of a geological process, but without doubt detailed knowledge of the terrestrial biota that inhabits the different islands can help greatly in the sense of supporting or confronting the diverse hypothetical aspects that geology can offer. What does not seem correct is the devious handling of geology to explain the biogeographic phenomena, rather it is in the fauna and flora where one should reestablish and try to find the ecological, palaeobiogeographical or evolutionary explanations in order to adapt them to the geological facts.

The laurisilva plays an important role in this context in that, excepting the Salvages, it may be considered as the 'common denominator' of Macaronesia (see fig. 1). The careful study of its fauna will bring about the establishment of some faunistic interrelations that can say a lot about the evolution of the whole group.

In a first approach, for example, it is observed that the greatest percentage of the so called 'macaronesian elements' are inhabitants of the

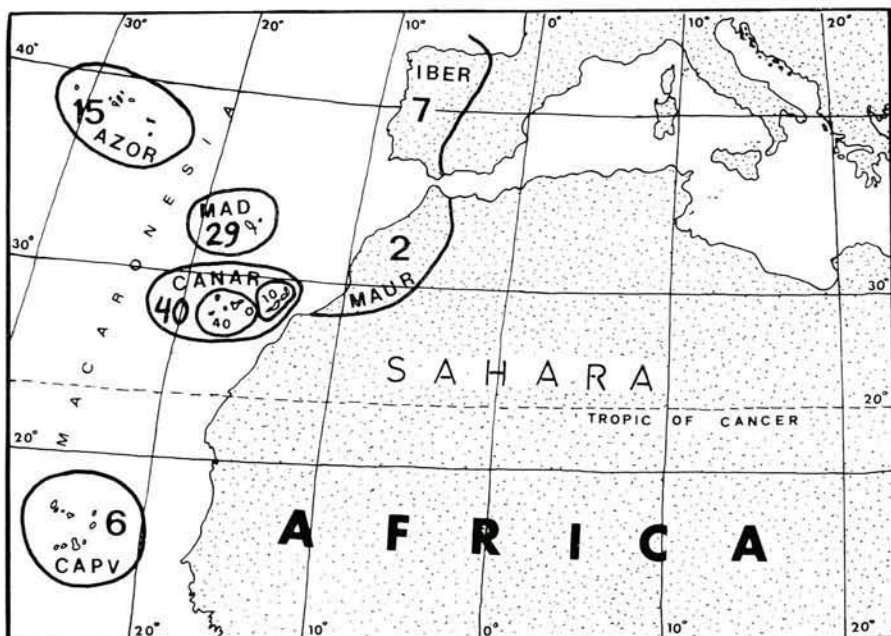


Fig. 1. Map of the numerical distribution area of the *Pruno-Lauretea* Oberdorfer (see the species list on page 352). Only the areas shown are taken into account = Macaronesia sensu lato. The Salvages are not considered as the class *Pruno-Lauretea* does not exist there. (Taken from Voggenreiter, 1974, simplified).

laurisilva. Likewise, the greatest percentage of the palaeoendemic fauna is bound to this formation that is – par excellence – a vegetal relict ('Paleoflora vivente', Ciferri 1962). The laurisilva also represents the stratum where many groups reach their maximum of endemism, and in fact, some cases exist where all the forms present are endemic, and almost without exception exclusively of the laurisilva.

Another evolutionary aspect of the insects that live in the laurisilva which deserves notice is the frequent coexistence of closely related species, even without apparent ecologic barriers. These cases of sympatry, often multiple, may be explained by repeated invasions of a same original line, with the corresponding intermediate periods of isolation, or perhaps consider that the laurisilva could also have acted, in some cases, as a center of secondary sympatry. In order to understand this idea it must be noted that not only different populations exist among the laurel forests of the various islands, but also within the same island; in Tenerife for example, differences between the fauna of formations located in distinct zones may be found. These laurisilva 'islands' may contain exclusive forms that have been displaced by some means to the dominion of its vicariant.



Fig. 2. Aspect of the laurel forest at Agua Garcia, Tenerife. 'Viñátigo' = *Persea indica* (L.) Spreng. in the foreground, with its trunk covered by lichens. Photo A. Machado.

The role that vulcanism could have played in this phenomenon should not be neglected. Lava flows, very common in these islands, can isolate (in certain zoological groups) small populations (c.f. Thiele 1971) in which genetic drift facilitates differentiation so that, when communication is reestablished in the course of time, they coincide in secondary sympatry with the descendents of their ancestors.

This is, of course, speculative terrain, but there is no doubt that careful study of the fauna (components, distribution, ecologic preferences, etc.) is more than justified because it is basically the only way to try to solve some of the problems – sometimes characteristic of this ecosystem – and to be able to understand evolution that in islands such as these becomes strikingly complicated.

Difficulties encountered

The botanical aspect does not entail great difficulties. An extensive bibliography on the laurisilva is available (see in Sunding 1973), and apart from taxonomic and floristic investigations some structural studies of great interest have been made (Dansereau 1968). The problem resides in zoology.

In the introduction we have already commented on the impossibility of realizing a complete faunistic study of the laurisilva. Works on the fauna of the Canary Islands are fairly numerous – especially those referring to the entomological fauna – but this does not imply that an exact knowledge of this fauna has been achieved. On the contrary, we believe that the present state of our knowledge is very unsatisfactory. Whole gaps exist in certain groups, and even most of the studies already made need to be thoroughly revised and complemented by more intensive field work.

Unfortunately there are few recent works. If we add to this, the total dispersion of publications dedicated to the theme, and at the same time, take into account the numerous collections with their corresponding type species, one may then have some idea of the difficulties concerning the fauna of these islands, particularly in relation to any vegetation level of the islands.

Another problem, difficult to remedy, adds to this lack of scientific framework (principally in taxonomy). Here we refer to the present state of conservation of the laurisilva in the Canary Islands (even more disastrous in the Azores, Madeira and Cape Verde). Ceballos & Ortuño (1951) give a rather illustrative map of the existing forest relicts conserved at that time in the Islands of Hierro, Gomera, La Palma and Tenerife, even though the limits of the natural forest dominion do not appear very correct. Voggenreiter (1974) has recently published an extensive work on the vegetation of Tenerife, that treats the syntaxonomic class *Pruno-Lauretea* Oberd. 60 em. 65 with some detail, concerning the Maca-

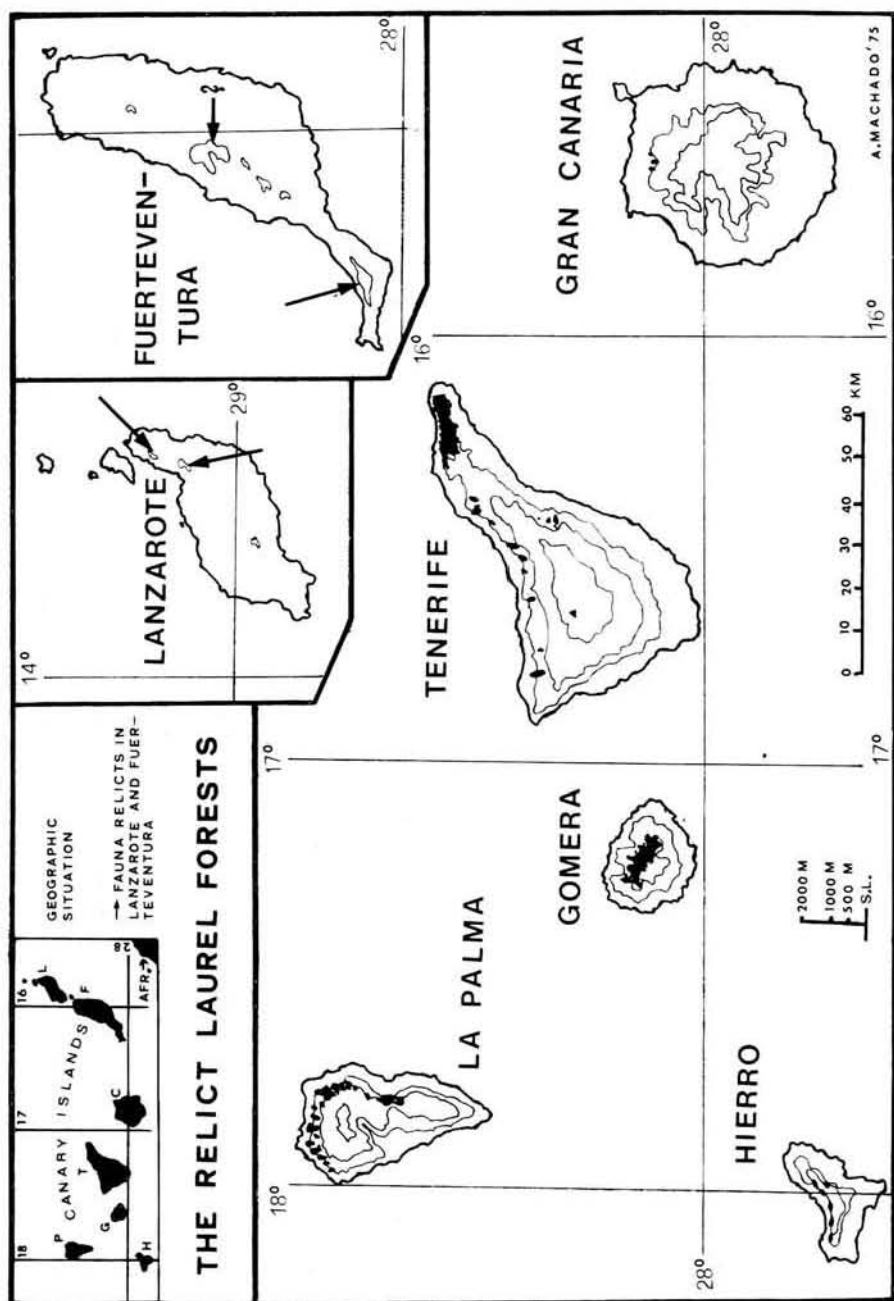


Fig. 3. Approximated distribution of the laurel forest relicts, mainly of secondary character.

ronesian laurisilva. This autor dedicates special attention to the recent destruction of these forests. Reading this chapter (*ibid.*, pp. 107-161), along with the references given by Webb & Berthelot (1840), will give the zoologist an impression of the magnitude of the regression that the laurisilva has suffered at the hands of man and his activities. This leads to the impossibility of perfectly reconstructing the original fauna, and it is very probable that more than one animal species may have disappeared owing to the reduction or destruction of its habitat.

Along with the intrinsic difficulties of this region we have those classical problems confronting faunistic studies that have been fully commented on by Leclercq (1964). Both qualitative (species present in a region and absent in another) and quantitative (species abundant in a region and rare in another) differences are of interest in a faunistic study. If we analyze the bibliography or the existing collections concerning the Canaries, we see that these fundamental aspects, above all quantitative, have scarcely been taken into account. The following comment by Leclercq (*op. cit.*, p. 372) serves to illustrate our case: «A cause du même culte des trophées de chasse, les entomologistes ont pris l'habitude de ne publier que des captures de raretés alors que ce sont des inventaires complets par biotope, par commune, par région, qu'il faudrait pour caractériser valablement le paysage zoologique.»

The Potential Distribution of the Laurisilva and its Faunistic Importance

«Avant la conquete des Canaries, la région laurifière devait s'étendre jusque dans le voisinage du littoral, partout où l'exposition et les autres causes influentes étaient venues favoriser le développement des arbres. Les premiers navigateurs que visitèrent ces îles en ont parlé comme d'un pays boisé jusqu'à la mer; mais aujourd'hui les forêts sont loin du rivage.» (Webb & Berthelot 1840, p. 111).

It is necessary for the zoologist to know the potential distribution of the laurisilva in the Archipelago. The distribution of an animal species of the laurisilva may be affected in different ways by the regression or degeneration of its habitat. For the phytophags or xilophags, often specifically bound to only one plant or group of plants, the alteration of the environmental conditions may or may not be so decisive and they will be found where their food plant persists. The numerical distribution area map of the *Pruno-Lauretea* in Tenerife (fig. 4) presented by Voggenreiter (1974) gives an excellent idea of the repartition-persistence of the forty vegetal species considered¹.

¹ *Athyrium umbrosum*, *Erica scoparia* ssp. *platycodon*, *Ixanthus viscosus*, *Rubus bollei*, *Laurocerasus lusitanica* ssp. *hixa*, *Ardisia bahamensis*, *Myosotis macrocalycina*, *Geranium canariense*, *Senecio populifolius*, *Hypericum glandulosum*, *Cedronella canariensis*, *Smilax* (genus), *Ilex perado* ssp. *platyphylla*, *Woodwardia radicans*, *Rhamnus glandulosa*, *Ocotea foetens*, *Arbutus canariensis*,

The principal limiting factors for other animals are those of an abiotic type (usually humidity or lack of) and, according to their ecologic valence, they may or may not resist a notable injury to their habitat. Certain species of insects have been relegated to real 'sanctuaries' out of which they are not found (these are in great danger of extinction!!), while others persist in the substitute biotopes, taking refuge in certain microenvironments that satisfy their ecologic necessities. There are also others that adapt themselves perfectly to new conditions and even those that take advantage of it to increase their distribution area.

Water utilization will cause aquatic or riparian species to disappear in places suitable in other respects. The edaphic species usually persist for a certain time even after the most radical modifications in the atmobios. Clearly, one must know in a broad sense the ecologic necessities of the group under consideration, as dependent on them, we must consider the potential distribution of the laurisilva in some detail for a better judgement of the repartition of said animals.

In an inverse sense, the fauna can provide new data to botany. Thus, the presence of 'typical' laurisilva species in places no longer inhabited by this plant community can suggest the existence of the latter in the not too distant past. If some day we could know the distribution of certain insects, it would not be surprising that it would coincide quite well with the limits of the potential distribution of the laurisilva.

According to Dansereau (1968) the animal dispersal diaspores are extremely abundant in the tree layer, and Voggenreiter (1974) notes the imperative necessity of making ornithological investigations, concerning bird distribution and the possibility that interisland migrations exist.

The Laurisilva as an Ecosystem; Subtypes

It is easy for the zoologist to recognize the environmental diversity that the laurisilva offers to large and small animals. Referring to insects, the most diverse and best represented group, we find them under bark, in the dry leaves hanging from the *Aeonium*, in dead wood, under stones or fallen trunk of trees, in the green parts of plants, in water, soil, fallen fruits, etc. The richness of ecological niches in this vegetal formation is really great, but to this primary division one of a second order is superimposed. Marked differences exist between the entomological population of a rocky area and that of the forest interior or the border of a path, almost always

Convolvulus canariensis, *Picconia excelsa*, *Canarina canariensis*, *Ilex canariensis*, *Myrica faya*, *Hedera canariensis*, *Gesnouinia arborea*, *Apollonias barbujana*, *Semele androgyna*, *Persea indica*, *Viburnum rugosum*, *Cytisus canariensis*, *Phyllis nobla*, *Laurus azorica*, *Galium ellipticum*, *Visnea mocanera*, *Asplenium hemionitis*, *Asplenium adiantum-nigrum*, *Ranunculus cortusaeifolius*, *Pteridium aquilinum*, *Hypericum grandifolium*, *Erica arborea*, *Brachypodium silvaticum*.

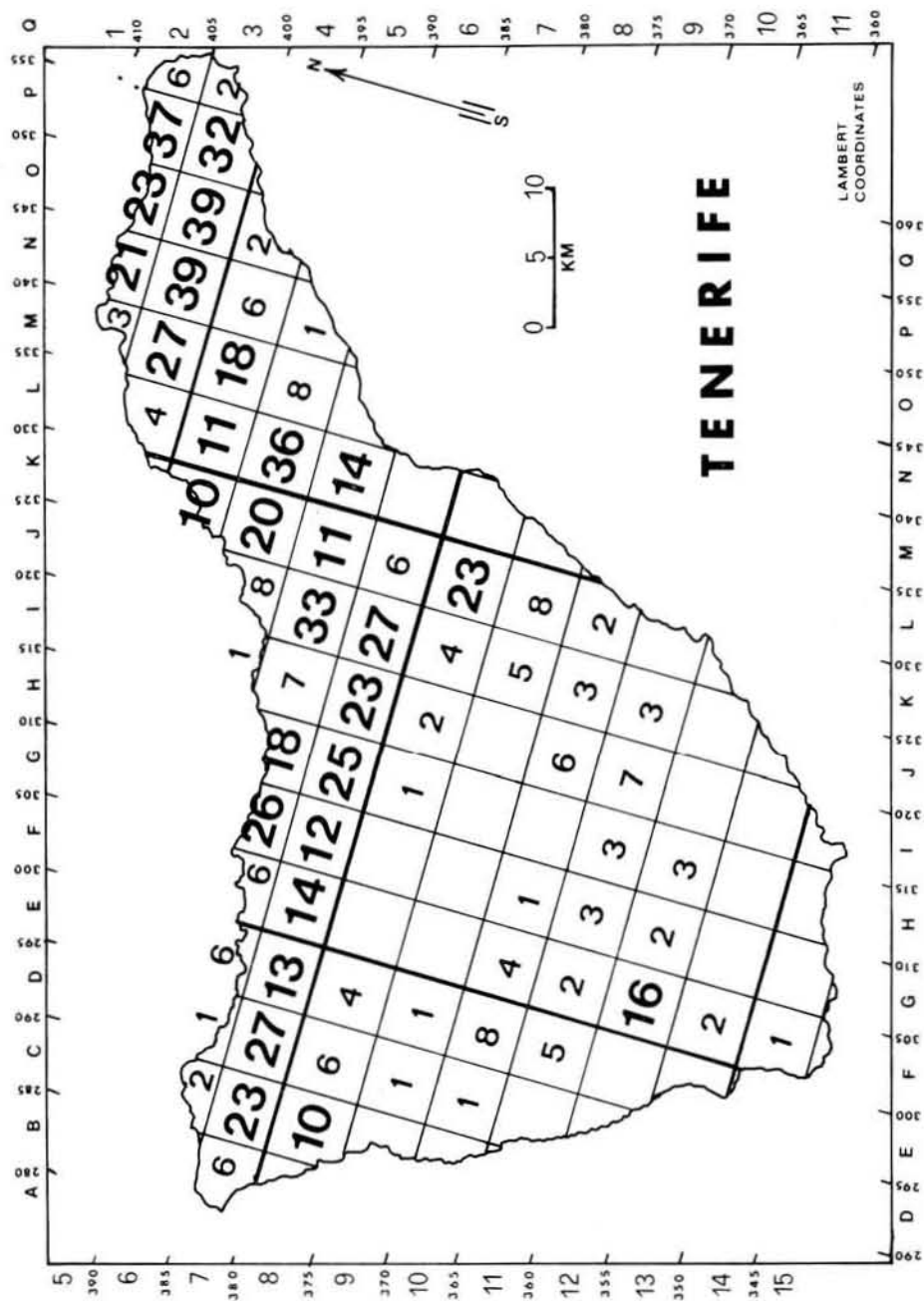


Fig. 4. Map of the numerical distribution area of the syntaxonomic class *Pruno-Lauretea Oberdorfer* in Tenerife, after Voggenreiter, 1974 (simplified).

corresponding to the different vegetal composition or to hygrothermic differences.

We believe that it would be more correct to consider the laurisilva at a higher level, as an ecosystem, that is to say, including the faunistic components in the concept. For greater ease in the study of the fauna it is better to consider the laurisilva, as applied in a botanical sense, as a habitat in which the fauna is established. For this reason we shall frequently refer to the fauna that inhabits the laurisilva, and not the fauna that constitutes it.

But even within botany one must establish the true scope of the term 'laurisilva', and the ecologic variants (that would be subecosystems) encompassed within it.

Kämmer (1974), in a recent study on Tenerife, points out the confusion existing between the concepts 'laurisilva', 'fayal-brezal' and 'monte-verde', and proposes a new division for what he calls the 'laurel forests in the broadest sense' into the following subtypes²:

- *Erica scoparia* shrub-forests
- Epiphyte-rich laurel forests
- Epiphyte-poorer 'normal' laurel forests
- Shrub-rich laurel cliff-forests
- Formations in the dry marginal zone of laurel forests

At the same time this author emphasizes that the potential inferior forest limits have usually been placed very high above sea level. He also mentions the little consideration that other authors have given to the *Pinus canariensis*-laurel mixed forests ('Pinar con sotobosque de laurisilva'), that are very extensive in certain zones (e.g., in La Palma). In this formation (ecotone type), which he includes as a subtype of the *Pinus canariensis*-forests (= woodlands, after Dansereau 1968), the environmental factors of water and radiation (light + temperature), and probably also soil, differ from those prevailing in the pure pine forest and true laurel forest. On Kämmer's map (fig. 5) it can be observed how the laurisilva of the extreme West of the Island (Teno), for example, is 'isolated' by this mixed formation from the rest of the laurisilva of the N-NW side of the Island. It may have some influence on the 'laurisilva islands' mentioned in the introduction.

A superposition of the numerical distribution area maps for the syntaxonomic classes *Pruno-Lauretea* Oberd. 60 em. 65 and *Cytiso-Pinetea canariensis* Rivas Goday & Esteve Chueca 1965, presented by Voggenreiter (*op. cit.*), reveal the coincidence between both, though without many details referring to the limits. The natural potential vegetation maps of Ceballos & Ortuño (1965) or Voggenreiter (*op. cit.*) do not

² We abstain from including the characteristics of the subtypes, and recommend the reading of pp. 16-22 in the work of Kämmer, (*op. cit.*).

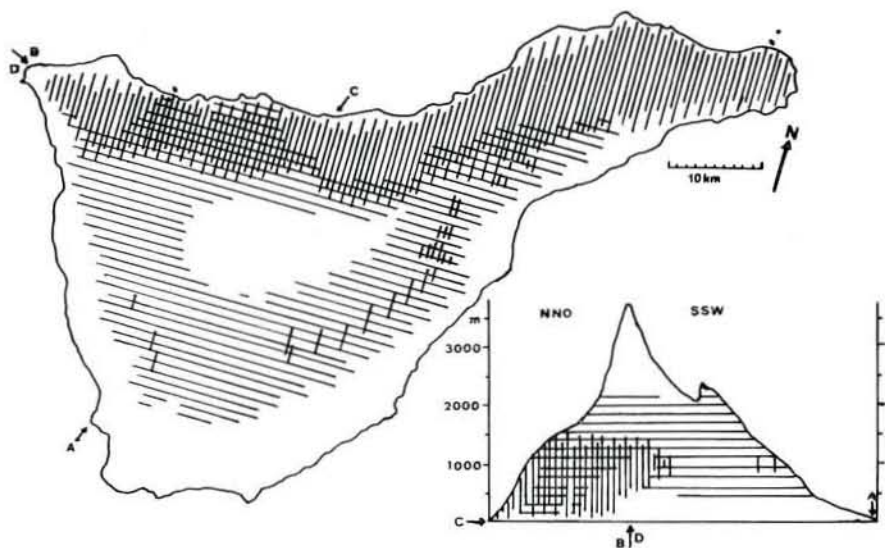


Fig. 5. Potential natural vegetation of Tenerife, after Kämmer, 1974. Vertical lines: Laurel forests in the broadest sense; Horizontal lines: *Pinus canariensis*-forests; White: Few or no trees.

consider this peculiarity and, in our opinion, can lead to erroneous faunistic interpretations.

Both the potential vegetation map of Kämmer (lamentably only of Tenerife), as well as the division into subtypes of the 'laurel forests in the broadest sense' are, in our judgement, of great accuracy in that they coincide with our empirical knowledge of the fauna, the fruit of various years of field work in the Archipelago.

Nevertheless, we believe that the problem of terminology is not resolved. A term is needed which not only designates the laurel forests but also takes in account the laurel components of the mixed forest. We have elected the term 'laurisilva' because it has been used frequently in this sense and because it is rather versatile. One may speak also of the Tenerife, Canary, Macaronesian or Chilean laurisilva, for example (c.f., Rübél 1930). The term 'laurel forest' could be used to refer to the forest manifestations.

The fayal-brezal considered by many authors as a natural formation, does not represent more than a degradation state of the laurisilva due to the effect of lumbering (Melville & Bramwell 1972; Santos Guerra 1973; Sánchez García 1973; Voggenreiter 1974) except when appearing as marginal formations, sotoforest of pine woods, etc. The present extent of these former 'artificial' formations is very much superior to that of the real laurisilva and the Canary peoples do not distinguish between one and the other, designating them as 'monte-verde'. (green wood).

Faunistic Analysis

Until the present time no complete analysis of any group of the laurisilva fauna has been made. Some general, more or less detailed commentaries do exist³ on coleopterans (Wollaston 1865; Palm 1967, etc.). Lindberg (1953), in his monograph on the Canary hemipterans, presents an ecological classification⁴ of the species of the cloudbelt zone ('*Wolkenzone*'); Frey (1936) studied the zonal distribution of the Tenerife dipterans, and gives lists (with number of specimens) of the species collected at certain localities in the cloud-belt zone, later dividing the species into characteristic and secondary or casual species, presenting also their frequency as a percentage.

Gangwere *et al.* (1972) recently made a lengthy study of the Orthopteroïd distribution in Tenerife, in which they pay special attention to the orthopteroïds unique and exclusive (marked *u*) to the important zones (among these, the 'tropical forest zone or laurisilva') and those so commonly encountered there as to be considered to be typical of them (marked *t*).

An ecological division, as well as a classification according to abundance, are of great interest, but in order to represent the real character of the laurisilva fauna, it is necessary to make – whenever possible – a faunistic analysis that reflects the source, zoogeographic value, etc. of the species. For future studies, we propose the following classification and symbols:

Forms present in the laurisilva. –

Autochthonous	{	Exclusive	{	of stenoecious character	W'
				of euryoecious character	W
		Not exclusive			Y
Introduced	{	from neighboring biotopes			R
		by human means.			X
		(adventitious species)			X'

Some dipteran examples will help to understand this classification. The autochthonous forms of the laurisilva may be exclusive or not to this formation; thus the syrphid *Chrysotoxum triarcatum* Macq. lives in the Inferior Zone as well as in the Middle Zone, and would be a Type Y species. Among the exclusive forms it is interesting to differentiate between those that, due to their reduced ecologic valence (stenoecious), remain intimately bound to the laurisilva and are only found in forest relicts,

³ Usually on the Island of Tenerife, being the most representative and best studied.

⁴ 1. Ground species ('*bodenbewohnende Arten*') of the forests. 2. Species from the trees and shrubs from the laurel forests. 3. Species from the *Erica-Myrica* forests. 4. Species from the *Cytisus proliferus*-stands. 5. Pine-inhabiting species. 6. Species from the xerophytic formations of the cloud-belt zone.

as in the case of *Calliphora splendens* Macq. (Type W'), while others, due to their more euryoecious character, have also maintained themselves in the former laurisilva domains (see figs. 29 and 30). In the helomyzids, whose larvae feed on decomposing vegetal material (wood, leaves, etc.), *Suillia oceana* Beck. is one of Type W, present in the true forests as well as in the fayal-brezal or posterior degraded states. These are very interesting 'typical' laurisilva species in that, in certain groups, they may be used to indicate the past existence of laurisilva.

We may also frequently collect many forms in the laurisilva that are not proper to this formation. We are then dealing with forms that were recently introduced through human activities. Road-building, for example, has permitted the settlement of numerous weeds, coming from the Inferior Zone that are frequently accompanied by their animal cohort. The number of these Type X forms will be greater as more 'contamination' enters the laurisilva. We also include here the adventitious species ('Adventivarten', Freude, Harde & Lohse 1965) of our fauna, that is to say, those that have been introduced into the Islands by man or his activities (among these, the synanthropical species), and which because of their great ecologic valence (eurytopes), and/or while not encountering opposition, extend themselves through numerous island biotopes - including the laurisilva - and settling in them. These members of our allochthonous fauna should be distinguished as Type X'. Livestock activities in the laurisilva domain, for example, permit the existence of species bound to domestic animals, as in the case of *Stomoxys calcitrans* L. (Muscidae).

In this section of 'introduced' forms we have included those (Type R) coming from neighboring biotopes that make sporadic but frequent incursions. We cite, for example, the solvid *Solva nigrifibialis* Macq., whose larval stage develops on the succulent plants of the Inferior Zone and is relatively frequent in the laurisilva (Baez, pers. comm.).

Although it only gives us an empirical idea of little statistical value (see Leclercq 1964) it is interesting to note whether the species is rare (*r*), occasional (*o*), common (*c*), or abundant (*a*). The finding of a species may be due to totally fortuitous circumstances and it would be convenient to designate it as casual(*s*). If a not exclusive species presents its maximum abundance in the laurisilva it would be a typical species *in*, but not typical *of* the laurisilva. Finally we believe that it is of great interest to designate, by means of an asterisk (*) or two (**), whether endemic or Macaronesian (at least Madeira and the Canaries) forms, respectively, are being treated.

This proposed scheme will not resolve all of the cases that present themselves. Nature is not easily forced to comply with human concepts, especially when aspects that are so variable are being considered. Groups exist which are better fitted than others for doing chorologic or genemic studies. Likewise, the proposed scheme may be used in some groups,

while for the analysis of others we find ourselves obliged to make certain modifications in order to better adapt it to peculiarities of the group in question (feeding regime, phenology, local fidelity, etc.). Thus, this scheme does not pretend to be more than a guide.

Reflexions on the Ground-Beetle Fauna

In the present work we have wanted to comment – although not exhaustively – on a group that would be representative to a certain degree. We have selected the ground-beetles (Col., Caraboidea *sensu* Jeannel 1941–1942) because we have dedicated some years to their taxonomic study. Nevertheless, as we have not finished their revision, and many data have not been published, we have chosen to rely on the antecedent taxonomy, that established by authors who have worked on this group in the Archipelago: Wollaston, Bedel, Alluaud, Lindberg, Mateu, Colas, Jeannel, Bolivar y Pieltain, Israelson, etc.

The bibliographic study, that of the collections of the Museo Insular de Ciencias Naturales (Santa Cruz de Tenerife) and our own (La Laguna), as well as our contacts with some colleagues (J. M. Fernández, Dr. Th. Palm, Dr. Oromí, etc.), have permitted the confection of the following list. In it we have employed the symbols proposed above (page 357). The distribution of the forms in the Archipelago is also indicated by means of capital letters (**H** for Hierro, **G** for Gomera, **P** for La Palma, **T** for Tenerife, **C** for Gran Canaria, **F** for Fuerteventura and **L** for Lanzarote). The heavy-typed letters (e.g. *Demetrias atricapillus* (L.) **T**) mean a new record for said Islands, and that it is presently at the publishers or that it will be duly published in the near future.

FAUNISTIC LIST

Fam. CARABIDAE

X' <i>Campalita maderae</i> (F.)	(o)	G P T C F L
W' <i>Carabus faustus</i> Brull.* s.l.	(r)	T
W <i>Carabus interruptus</i> Dej.*	(c)	T
W? <i>Carabus coarctatus</i> Brull.*		C

Fam. NEBRIIDAE

W <i>Leistus nubivagus</i> Woll.*		T
W <i>Nebria dilatata</i> Dej.*		T
W? <i>Nebria currax</i> Woll.*	(r)	C
Y <i>Notiophilus geminatus</i> Dej.		H G P T C F L

Fam. APOTOMIDAE

Y? <i>Apotomus angusticollis</i> Müll.	(r)	T C
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Fam. BROSCIDAE

W' <i>Brosicus crassimargo</i> Woll.*	(c)	G
W <i>Brosicus rutilans</i> Woll.*		T
W? <i>Brosicus glaber</i> (Brull.)*		C

Fam. TRECHIDAE

Y	<i>Perileptus nigrutilus</i> Woll.*		G	T	C			
Y	<i>Thalassophilus whitei brevicornis</i> Jeann.*		G	P	T	C		
W	<i>Trechus detersus</i> Woll.*	(r)	F	L				
W'	<i>Trechus laureticola</i> Jeann.*		G					
W'	<i>Trechus fortunatus</i> Jeann.*		T					
W'	<i>Trechus uytenboogaarti</i> Jeann.*		T					
W	<i>Trechus felix</i> Jeann.* s.l.	(a)	T					
Y	<i>Trechus flavocinctus flavocinctus</i> Jeann.*	(a)	T					
Y	<i>Trechus flavocinctus gomeræ</i> Jeann.*	(c)	H	G				
W?	<i>Trechus flavolimbatus</i> Woll.*	(a)	C					
Y	<i>Trechus flavocircumdatus</i> Jeann.*	(c)	P					
Y	<i>Trechus atlantis</i> Paw.*		P					
W'	<i>Anchotrechus punctipennis</i> Jeann.*		T					
W'	<i>Anchotrechus cabreræ</i> Jeann.*		T					
W'	<i>Limnastis gaudini gaudini</i> Jeann.*	(r)	T					
W'	<i>Limnastis gaudini gomerensis</i> Franz.*	(r)	G					
Y	<i>Eotachys bistriatus</i> (Dfts.)		G	C				
Y	<i>Tachyura parvula</i> (Dej.)		G	P	T	C	F	L
Y	<i>Tachyura haemorrhoidalis</i> (Dej.)		G	T	C			
Y	<i>Philochtus iricolor</i> Bed.		T	C				
Y	<i>Bembidion fortunatum</i> Woll.*	(t)	H	G	P	T	C	L
Y	<i>Bembidion schmidti subcallosum</i> (Woll.)*	(t)	H	G	P	T	C	
Y	<i>Bembidion inconspicuum</i> Woll.*	(r)	T					
Y	<i>Bembidion c. crotchii</i> Woll.*	(r)	P					
Y	<i>Ocydromus a. atlanticus</i> (Woll.)		H	G	P	T	C	F
Y	<i>Princidium laetum</i> (Brull.)		H	G	T	C	F	L
Y?	<i>Asaphidion delatorrei</i> Uytt.*	(r)	C					

Fam. HARPALIDAE

W?	<i>Nesarpalus fortunatus</i> (Woll.)*	(c)	C					
Y	<i>Nesarpalus uytenboogaarti</i> (Van Emden)*		C					
Y	<i>Nesarpalus micans</i> (Woll.)*	(t)	G					
Y	<i>Nesarpalus sanctae-crucis</i> (Woll.)*	(t)	T					
Y	<i>Harpalus schaumii schaumii</i> Woll.*		H	G	P	T		
Y	<i>Harpalus schaumii grancanariensis</i> Van Emden*		C					
X'	<i>Harpalus tenebrosus</i> Dej.		P	T	F	L		
Y	<i>Stenolophus teutonius</i> Schr.	(o)	G	P	T	C	F	
W	<i>Bradycellus ventricosus</i> Woll.*		T					
Y	<i>Acupalpus dorsalis</i> (F.)		G	T	C	L		

Fam. PTEROSTICHIDAE

R	<i>Orthomus barbarus berytensis</i> R. & S.	(o)	P	T	C	F	L	
W'	<i>Paraeutrichopus harpaloides harpaloides</i> (Woll.)		H					
W'	<i>Paraeutrichopus harpaloides pecoudi</i> Mat.*	(a)	G					
W'	<i>Eutrichopus fernandezi</i> Mat.*	(a)	T					
W	<i>Eutrichopus gonzalezi</i> Mat.*		T					
W'	<i>Gomerina calathiformis</i> (Woll.)*		G					
W?	<i>Gomerina nitidicollis</i> (H. Lind.)* [see page 380]	(r)	C					
W'	<i>Pseudoplatyderus amblyops</i> C. Bol.*	(r)	G					
Y	<i>Platyderus languidus alticola</i> (Woll.)*		T					
W'	<i>Pseudomyas doramensis</i> Uytt.*	(r)	C					
W	<i>Calathidius acuminatus</i> (Woll.)*		T					
W'	<i>Calathidius sphodroides</i> (Woll.)*	(r)	T					
W'	<i>Calathus rufocastaneus</i> Woll.*		T					

W?	<i>Calathus rectus</i> Woll.*	(c)	T				
W	<i>Calathus freyi</i> Colas*		T				
W	<i>Calathus depressus</i> Brull.*	(a)	T				
W	<i>Calathus ciliatus</i> Woll.*	(r)	T				
W	<i>Calathus auctus</i> Woll.*		T				
W	<i>Calathus abacoides</i> Brull.*	(c)	T				
W'	<i>Calathus amplius</i> Esc.*		T				
W'	<i>Calathus carinatus</i> Brull.*	(r)	T				
W	<i>Calathus angustulus</i> Woll.*	(a)	T				
Y	<i>Calathus ascendens</i> Woll.*	(a)	T				
W	<i>Calathus cognatus</i> Woll.*	(c)	G				
W'	<i>Calathus laureticola</i> Woll.*	(c)	G				
W	<i>Calathus obliteratus</i> Woll.*	(c)	G				
W	<i>Calathus marcellae</i> Colas*		G				
W	<i>Calathus gomerensis</i> Colas*		G				
W'	<i>Calathus apicerugosus</i> H. Lind.*	(r)	G				
W'	<i>Calathus appendiculatus</i> Woll.*		C				
W	<i>Calathus canariensis</i> Har.*	(c)	C				
W?	<i>Calathus angularis</i> Brull.*	(a)	C				
Y	<i>Calathus spretus</i> Woll.*	(t)	H				
W	<i>Calathus simplicicollis simplicicollis</i> Woll.*	(r)	L				
W	<i>Calathus simplicicollis gonzalezi</i> Mat.*		F				
Y	<i>Licinopsis alternans</i> (Dej.)*		T				
W'	<i>Licinopsis bucheti</i> Alluaud*	(r)	G				
W'	<i>Licinopsis gaudini</i> Jeann.*	(r)	P				
W'	<i>Licinopsis picescens</i> (Woll.)*	(r)	H				
Y	<i>Amaroschema gaudini</i> Jeann.*		T				
X	<i>Laemosthenes complanatus</i> (Dej.)		P	T	C	F	
Y	<i>Olistophus glabratus</i> Brull.*		H	G	T	C	
Y	<i>Olistophus palmensis</i> Woll.*	(c)	P				
X'	<i>Anchus ruficornis</i> Gze.		T				
W'	<i>Agonum nicholsii</i> (Woll.)*		G	T?			
W'	<i>Agonum debile</i> (Woll.)*	(r)	C				
Y	<i>Agonum marginatum</i> (L.)		G	T	C		
X'	<i>Amara aenea</i> De Geer	(o)	P	T			
Y	<i>Zabrus laevigatus</i> Zimm.*		G	T	C		
Y	<i>Zabrus crassus</i> Dej.*		T				

Fam. LICINIDAE

W	<i>Zargus crotchianus</i> Woll.*		G				
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Fam. MASOREIDAE

Y	<i>Masoreus alticola</i> Woll.*		T				
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Fam. LEBIIDAE

X'	<i>Demetrias atricapillus</i> L.		T				
W'	<i>Cymindis velata</i> (Woll.)*	(a)	G				
W	<i>Cymindis amicta</i> (Woll.)*		G	C			
W?	<i>Cymindis cincta</i> (Woll.)*		C				
W	<i>Tarulus zargoides</i> (Woll.)*	(c)	T				
W	<i>Dicrodontus separandus</i> H. Lind.*		T				
W'	<i>Dicrodontus alluaudi</i> Mat.*	(r)	C				
W'	<i>Dicrodontus aptinoides</i> (Woll.)*		G				
W?	<i>Dromius angustus brittoni</i> Mat.*	(r)	F				
W'	<i>Dromius angustus plagipennis</i> (Woll.)*		H	G	T	C	

W'	<i>Dromius strigifrons strigifrons</i> Woll.*	(r)	G
W'	<i>Dromius strigifrons tinerfensis</i> Mat.*		T
W'	<i>Dromius amoenus</i> Woll.*		T
Y	<i>Philorhizus l. tongicollis</i> (Woll.)*		T
Y	<i>Philorhizus atlanticus atlanticus</i> Mat.*	(c)	C
Y	<i>Philorhizus atlanticus fortunatus</i> Mat.*		T P
W'	<i>Philorhizus parvicollis parvicollis</i> (Woll.)*	(r)	G
W?	<i>Philorhizus parvicollis fumatus</i> Mat.*	(r)	T
W	<i>Philorhizus elliptipennis elliptipennis</i> (Woll.)*	(a)	T C
W'	<i>Philorhizus elliptipennis bravoii</i> Mat.*		G
Y	<i>Syntomus foveatus inaequalis</i> (Woll.)*	(c)	H G P T C
W?	<i>Syntomus lanzarotensis</i> (Woll.)*		C F L
Y	<i>Metadromius pervenustus</i> (Woll.)*		G P T C
?	<i>Apristus hololeucus</i> H. Lind.*	(r)	C
W	<i>Microlestes negrita</i> Woll.		T C
Y	<i>Microlestes corticalis</i> Duf.		G T C F L
W'	<i>Microlestes gomerensis</i> H. Lind.*		G
Y	<i>Microlestes maurus</i> Sturm.		P T
X'	<i>Microlestes luctuosus</i> Hold.	(o)	T C

H	G	P	T	C	F	L
13	45	21	74	47	14	13

In this list we have considered the polytypic species subdivided, but only if they present inter-island subspecies (geographic island races). The cases of intra-island subspeciation are excluded, figuring the species s.l. as a unity. We believe that in a comparative faunistic study between islands, as in this case, subspecies has enough value to be considered as a unit, as a 'faunistic element' to which we shall refer as a 'form' throughout the text for more agility. Also, when we present faunistic considerations within the same island, the intra-island subspecies will have this same unit value. If a more profound study is to be made, then it would be fitting to give a distinct category to the polytypic and monotypic species.

STATISTICAL ANALYSIS

We begin by analyzing this list from the point of view of the carabids, comparing the laurisilva fauna with that of the total present in the Islands.

The laurisilva fauna contains 130 forms, being 70% of the total forms (186) present in the Archipelago (see table I). It is curious that this 70% found for the forms (= faunistic elements) repeats itself for the genera and species. Of the 76 genera present in the Archipelago, 53, and of the 171 species (that we know) 120, are found in the laurisilva. This high percentage explains itself in the function of the more or less marked hygrophylic character that this group presents. The humidity is probably the most decisive limiting factor for most of the carabids. Since the laurisilva is the most humid vegetation level in the Islands, it is not surprising that the better part of the carabid fauna is bound to it.

Table 1. Comparative Analysis of the Carabid Fauna of the Canary Archipelago with that of the Laurisilva

	Archipelago Fauna		Laurisilva Fauna		Laur/Arch. × 100
Number of Families	15		10		
Number of Genera	76		53		70%
endemic	10	13%	10	19 %	100%
Macaronesian	2	3%	2	4 %	100%
Number of species	171		120		70%
endemic	97	57%	92	77.5%	96%
Macaronesian	2	2%	2	2.5%	100%
Total Number of Faunistic Elements ¹	186		130		70%
Total Number of Endemic Elements ¹	120	65%	108	83%	90%

¹ The polytypic species are found broken down into their different subspecies, but only if geographic island races are being treated.

The fauna of the Archipelago contains 15 families of carabids (sensu Jeannel 1941-1942), and only 5 of these are not represented in the laurisilva. These are: Siagonidae, Cicindelidae, Scaritidae, Callistidae and Brachynidae. The first has only one species, probably introduced and settled in the Inferior Zone of some Islands (T, C y F).

In the Cicindelidae, only three specimens of *Cicindela nilotica* Dej. are known, having been collected in the sands of Maspalomas (C). Much discussion has been made as to whether this species is autochthonous or not, since its presence in the Canaries would mean a clear disjunction in its distribution area. We do not believe that this is a serious objection since many similar cases are known within the Canary entomological fauna, even within the carabids (*Apotomus angusticollis* Müll., *Crassodactylus punctipennis* Guérin, etc.)

In the Scaritidae we have a *Scarites* and various *Dyschirius* bound to the littoral and sublittoral sands. The three species of Callistidae form a part of the riparian fauna of the lower zone, and the Brachynidae are represented by only one species, *Pheropsophus hispanicus* (Dej.), perhaps introduced.

Aside from the ecologic reasons (hygrophyilia), the fact that most of the carabids are in the laurisilva is also due to evolutionary and palaeobiogeographic reasons.

The Canary Islands are about 30-35 million years old (Bravo, pers. comm.), and the laurisilva (a flora proper to the Tertiary) along with

the pine woods, must constitute one of the oldest island environments. Thus it is logical that, apart from being one of the richest faunal layers, its level of endemism would be very high in function of this antiquity. On one hand we have the palaeoendemisms, forms that disappeared on the continent but that have persisted in the Islands bound to environments more or less constant throughout time, in an almost perfect orthogenetic evolution. They are forms frequently marked by the presence of archaic or ultraevolved characteristics. On the other hand we have the neoendemisms, or forms that reached the Archipelago and have differentiated themselves under the effects of insularity *sensu lato*, showing a manifest divergent evolution in various cases.

In this process, a great number of species can originate from a few initial forms. Zimmerman (1948, taken from Franz 1970) for example, estimates that the 5000 species of the insect fauna of Hawaii have been formed from some 250 stock forms by extreme splitting.

From this it can be deduced that it is of great interest to observe the level of endemism of the carabid fauna and its representation in the laurisilva. Above all we consider the endemic genera, although the legitimacy of this and other supraspecific categories has been much argued by various authors as to their subjectivity. In this respect we would like to attract attention to the opinion given by Alston & Turner (1963) in a treatise on systematic biochemistry: «What is often overlooked here is that the subjectiveness is in applying terminology; the objectiveness of the category under consideration, from a biological point of view, is real» (taken from Leclercq 1964).

The Canary carabid fauna consists of 10 endemic genera, all of them in the laurisilva: *Anchotrechus*, *Gomerina*, *Pseudomyas*, *Pseudoplatyderus*, *Eutrichopus*, *Paraeutrichopus*, *Calathidius*, *Licinopsis*, *Amaroschema* and *Dicodontus*. Actually only 7 of these are exclusive to the laurisilva, but it is very probable that in the beginning all of them pertained to it. The genus *Dicodontus* is the only one that has a species totally absent from the laurisilva, *D. brunneus* (Dej.), endemic to Las Cañadas (T), but this is a species that must have originated recently because Las Cañadas is only about 200,000 years old (Bravo, pers. comm.). In *Gomerina* and *Licinopsis* are Type Y species, that probably originated in the laurisilva, but have extended their distribution to other biotopes. The two Macaronesian genera (*Zargus* and *Nesarpalus* *sensu* Puel 1836) are also bound to the laurisilva, at least partially in *Nesarpalus*.

Of 97 endemic species, 92 (96%) are found in the laurisilva, but this percentage is reduced somewhat, to 90%, if we consider the total endemic forms. As will be seen below, 76 forms are exclusive endemisms of the laurisilva, which implies about 2/5 of the total fauna.

We should note that the numbers referring to the fauna of the Archipelago, although corrected, do not have to be considered with extreme rigor. Nevertheless the proportions are extremely high and indicate to us



Fig. 6. The Anaga Massif, Tenerife (seen from Pico del Inglés at an altitude of 1,000 m), which has the richest flora of laurisilva. Photo A. Machado.

Table 2. Quantitative analysis according to character, endemicity and distribution of forms in the different families (*sensu* Jeannel, 1941-1942).

Families	$\frac{W'}{W''}$	$\frac{W}{W''}$	$\frac{Y}{Y''}$	$\frac{R}{R''}$	X'	$\frac{?}{?''}$	Total	$\frac{\% \text{ of } 130}{\% \text{ of each total}}$
CARABIDAE	$\frac{1}{1}$	$\frac{2}{2}$			1		$\frac{4}{3}$	$\frac{3}{75}$
NEBRIIDAE		$\frac{3}{3}$	$\frac{1}{0}$				$\frac{4}{3}$	$\frac{4}{75}$
APOTOMIDAE			$\frac{1}{0}$				$\frac{1}{0}$	$\frac{0.8}{0}$
BROSCIDAE	$\frac{1}{1}$	$\frac{2}{2}$					$\frac{3}{3}$	$\frac{2.3}{100}$
TRECHIDAE	$\frac{7}{7}$	$\frac{3}{3}$	$\frac{17}{11}$				$\frac{27}{21}$	$\frac{20.7}{77.7}$
HARPALIDAE		$\frac{2}{2}$	$\frac{7}{5}$		1		$\frac{10}{7}$	$\frac{7.7}{70}$
PTEROSTICHIDAE	$\frac{18}{18}$	$\frac{18}{18}$	$\frac{10}{9}$	$\frac{1}{0}$	3		$\frac{50}{45}$	$\frac{38.5}{90}$
LIGINIDAE		$\frac{1}{1}$					$\frac{1}{1}$	$\frac{0.8}{100}$
MASOREIDAE			$\frac{1}{1}$				$\frac{1}{1}$	$\frac{0.8}{100}$
LEBIIDAE	$\frac{10}{10}$	$\frac{9}{8}$	$\frac{7}{5}$		2	$\frac{1}{1}$	$\frac{29}{24}$	$\frac{22.3}{82.7}$
Total	$\frac{37}{37}$	$\frac{40}{39}$	$\frac{44}{31}$	$\frac{1}{0}$	7	$\frac{1}{1}$	$\frac{130}{108}$	
$\frac{\% \text{ of } 130}{\% \text{ of each total}}$	$\frac{28.5}{100}$	$\frac{30.8}{97.5}$	$\frac{33.8}{70.5}$	$\frac{0.8}{0}$	5.4	$\frac{0.8}{100}$		

that practically all of the endemic carabid fauna is found concentrated in the laurisilva.

In Table I we have cited 2 Macaronesian species. These are *Thalassophilus whitei* Woll. s.l. with the typical form in Madeira, and the ssp. *brevicornis* Jeann. in the Canaries, and *Philorhizus longicollis* (Woll.) s.l. with 2 subspecies in the Canaries (see page 378) and the ssp. *vieirai* Mat. in Madeira.

The number of Macaronesian species (in this case, common to Madeira and the Canaries) is really very small, but this has its explanation.

If the distinct Macaronesian Archipelagos really received a similar colonization in the past, as appears from botanical deductions⁵ (source of the biogeographic concept of Macaronesia), in zoology these affinities at the specific level have been lost almost completely under the incidence of time and insularity, and if an interrelation persists, it must be looked for at generic or population level.

We abstain from treating these interesting Macaronesian biogeographic and evolutionary aspects here, considering that they demand a separate study that we hope to do some day.

In Table II a more detailed analysis of the laurisilva carabid fauna, attending to the character and endemism of the forms and their distribution in the different families is made. 93.1% (= W' + W + Y) of the forms are autochthonous, which indicates that a very 'pure' fauna is being treated, having few introduced forms (6.2%). The proportion of W', W and Y varies greatly according to the peculiarities of each Island (if they present another forest formation type, or according to the regression level of the laurisilva), but in the general computation give 28.5%, 30.8% and 33.8% respectively.

It is interesting to note that 100% of the W' forms are endemic (see the interior circle of the Faunistic Diagram on page 383). Only one case of a non endemic W is found, *Microlestes negrita* Woll. (perhaps introduced??), 97.5% of the remaining W being endemic. As could be expected, the percentage of endemisms in Y is reduced (70.5%).

The most representative family of the laurisilva is the Pterostichidae (38.5% of the total), followed by the Lebiidae (22.3%) and the Trechidae (20.7%). The same order kept with respect to the percentage of endemisms within each Family (90%, 83% and 78%, respectively), if we do not consider the Families with little representation. None the less, the Broscidae should be noted, having 3 species in the Archipelago, all of which are endemic and exclusive (?) to the laurisilva. The Lebiidae (the Genera *Dromius* and *Philorhizus*) are even more promising, giving further field studies.

⁵ After Dansereau (1968), of the 68 vegetal species of the laurel forest, no less than 64.7% are endemic to Macaronesia, at least at the specific level.

THE INTRODUCED SPECIES

We have disregarded certain species from the faunistic list. Knowing their habits and the localities where they were found, makes one think that they are fortuitous introductions, which is not rare in these Islands where seaports are abundant and international commerce is intensive.

Such cases are: *Elaphrus riparius* L. («A dead and damaged specimen, ... in the neighbourhood of a shed with imported material for packing bananas», Uyttenboogaart 1930 p. 211), *Perigona nigriceps* Dej. and *Carterus cordatus* Dej. The introduced forms considered in the list are (except one R, from the Inferior Zone) adventitious species, some of recent introduction as *Demetrias atricapillus* (Machado 1975), and others known since the time of the earlier authors (e.g., Wollaston, in 1865). Three of them, *Amara aenea*, *Anchus ruficornis* and *Laemosthenes complanatus* (synanthropic) are known as European introductions in North America (Lindroth 1960). The carabid fauna of laurisilva lacks any Type X forms (perhaps *Microlestes luctuosus*); these are found more often in the phytofagous groups (in hemipterans, for example).

Only the Type-specimen of *Apristus hololeucus* is known. From the locality (Valle de Tejada), very little can be deduced about its possible adhesion or faunistic character, but we have included it in the list as ? based on the considerations that will be made in treating the Island of Gran Canaria.

CARABID FAUNA OR FAUNULA?

Is it correct to apply the term 'fauna' in a strict sense to the carabids of the laurisilva? Mac Arthur & Wilson (1967) defines a Fauna as «the animal species of a particular region», but indicates that «a fauna can also be somewhat more precisely defined as a set of species in a region isolated enough so that the set is more or less peculiar to it, as opposed to faunula (= a set of animal species found in a relatively small, poorly isolated region and not peculiar to it)». After this definition, and taking into account the above mentioned numbers, we hope that no doubt will remain as to the legitimacy of the carabid fauna of the laurisilva. On the concept of 'region' in faunistics, see Leclercq (1964, p. 372).

ETHOLOGY

The greater part of the carabid beetles are predators and hunt at night. Nevertheless numerous species or groups exist that present a more varied food regimen (e.g., several Harpalidae), also eating grain, shoots, etc. There are also species (*Cicindela*, *Notiophilus*, *Demetrias*, etc.) that hunt by day, but these cases are very infrequent. Generally, the carabids lead a nocturnal life, remaining hidden during the day in very diverse places.

In order to collect these beetles one must know their habits. In the Islands, these habits are usually the same as that of their parents on the continent, but some variations are observed.

Only two endogeous species are known: *Limnastis gaudini* s.l., wingless and eyeless, present in the soils of the laurisilva of Teno (T) and Gomera (ssp. *gomerensis*), and rather rare. Even more rare is *Pseudoplatyderus amblyops*, of which only the type is known, seemingly lost (Mateu in litt.), and which was collected, according to the author of the genus and the species in breaking up an enormous trunk in an advanced state of decomposition. The degeneration of its eyes is notable, being reduced to a small nucleus of depigmented cornea facets, the pigment having emigrated and is now placed irregularly around the eyes, useless for vision (Bolivar y Pieltain 1940).

The greater part of the laurisilva carabids are epiedaphic and we find them hidden under stones and fallen trunks, or if their size is not very large, among the leaf-litter.

In the zones that are little or not altered (?), where the vegetal layer reaches its maximum, the sotoforest is deep shade (Rübel 1909, measured 43 BE within the forest of Agua García in Tenerife, compared to 1,000 BE in the exterior; taken from Rübel 1930). Among the leaf-litter the darkness is more manifest, and many small carabids (e.g., *Trechus*) show activity also in the daylight hours.

In this layer we find the best represented and most typical genera of the laurisilva: *Trechus* and *Calathus*, and also *Broscus*, *Carabus*, *Zargus*, *Cymindis*, *Nesarpalus*, *Bradycellus*, etc. and most of the Pterostichidae. It is frequent that the same stone is shared as a refuge by representatives of very different genera. Colonies of *Calathus* are also frequently found (often mixed, of two or three species), and those of *Olistophus*, *Cymindis* and *Eutrichopus* are not rare. The relative frequency with which this phenomenon is observed, above all in *Calathus*, makes one think that a truly social phenomenon is being presented, rather than crowding behaviour motivated by humidity in periods of relative dryness.

It is frequent that the borders of the roads form almost vertical banks in the laurisilva (see fig. 7). When the earth is loose or the rock has many crevices, it is easy to dig with a spade and find diverse arthropods (arachnids, tisanurids, myriapods, etc.) with insects predominating, above all the carabid beetles. The *Carabus*, *Nebria*, etc. use this exceptional refuge, and the *Calathus* also appear here forming colonies.

A great number of laurisilva carabids having somewhat less hygrophilic tendencies exist, being found in more exposed spots, such as the leaf-litter or beneath the stones on roadsides, clearings or in the mixed forest that exhibits zones, in relation, somewhat more xerophitic. Among these forms (most of which are Type Y') we should cite: *Zabrus*, *Nesarpalus*, *Cymindis* (*cincta* and *amicta*), *Leistus nubivagus*, *Masoreus alticola*, etc. This last species shows a clear divergence from the habits of its fellows



Fig. 7. Eroded path-way crossing the laurel forest of Llano de los Viejos, Anaga/Tenerife. Of special interest is the small vertical earth bank at right. Photo A. Macado.

which are proper to unplowed land areas or coastal brackish zones.

The arboricolous forms are par excellence *Dromius* and *Philorhizus*, being found under bark, between epiphytic mosses, in the semidry foliage of fallen branches, etc. They are rather rare among leaf-litter.

In the bark we also find some *Calathus* (e.g., *C. laureticola*) and *Trechus* (*T. felix*, *T. laureticola*, etc.), among others which are less common, but we believe that this is, in the most cases, only a refuge niche.

The loose and hanging bark of *Erica scoparia* constitutes a unique habitat, housing the richest bark-fauna. In addition to its proper fauna, numerous terricolous species climb through it (*Calathus angustulus*, abundant, *C. auctus*, *Calathidius*, *Eutrichopus*, etc.). Sifting at *Erica scoparia* ('tejo' in Spanish) is a gratifying experience for any entomologists.

The dead leaves which remain attached to the branches of some plants (several *Aeonium* – see fig. 8 – and *Sonchus*) maintain a microclimate that



Fig. 8. Epiphytic *Aeonium cuneatum* Webb & Berthelot on *Laurus azorica* (Seub.) Franco trunk, a refuge of certain carabids. Photo J. M. Fernández.

is made use of by many insects. Carabids use it as a simple refuge or source of moisture. From here we have frequently obtained *Dicrodontus separandus*, *Tarulus zargoides*, *Calathus rectus*, *C. freyi*, etc.

THE RIPARIAN FAUNA

(The term 'riparian' is used in the meaning of the French's 'ripicole'.) We have separated the riparian fauna in order to present some characters worthy of comment and analysis in greater detail.

In the past, numerous streams must have existed that maintained their flow throughout the year. Intensive water use and lumbering has reduced these streams to only two, the one known as 'El Rio' that cuts through the El Cedro Forest of La Gomera (fig. 9), and that which runs through the Iguana ravine at Anaga (T), though even this sometimes dries out. It



Fig. 9. 'El Rio' at the Cedro forest, Gomera, which is the only remaining stream of laurisilva. Photo: J. M. Fernández.

follows that the general riparian fauna would have dwindled greatly since those earlier times.

The laurisilva still contains a good representation of riparian carabids, not only found in these two streams but also in wet rocky spots and small springs. Most of the riparian carabids are represented by Bembidiidae (*Bembidion*, *Philochtus*, *Ocydromus*, *Princidium*, *Asaphidion*, *Tachyura* and *Eotachys*). They are all Type Y forms, present in aquatic media both in the lower and upper regions, justified not only by their high hydrophile level but also by their great flight capacity. Nevertheless, some are typical in the laurisilva, as *B. fortunatum*. The most abundant form is *B. schmidti subcallosum*, also frequent in the wet rocky spots.

Some cases of anomalous behaviour are also found. *Philochtus iricolor* is a species from the seacoast of Western Europe and the Western Mediterranean; it has been found only in the inland waters of the Canaries (300 and 700 m.a.s.l.) On the other hand, *Ocydromus atlanticus*, which Franz (1970) includes as a xerophilic faunistic element, shows a most curious chorologic phenomenon. In the Eastern Islands (F and L) it is found in its xerophilic environment and with its normal light colouration, but in the Western Canaries (H, G, P, T and C) its colouration is totally dark blue and it is of typical riparian habit, bound to the waters of the Inferior Zone (pond borders, for example) and the streams of the Mountain or Middle Zone. The blue individuals have been differentiated as var. *phobon* Netol. Perhaps it is a true subspecies and not just a simply variety.

Further riparian forms are *Thalassophilus whitei* (in spite of its name, it is not a seashore form), *Perileptus nigrifulus*, *Acupalpus dorsalis*, *Stenolophus teutonius* (o), *Agonum marginatum* (o) and *Apotomus angusticollis* (see page 398). Only three (?) exclusively riparian carabids are encountered in the corresponding laurisilva environments. May be that in the past there existed more. Actually we have: *Agonum nichollsii* (fig. 10, B) very common in El Rio (fig. 9) and of which only one doubtful reference exists for Tenerife; *A. debile* (fig. 10, A), from Gran Canaria, a species that we are not familiar with in natura and perhaps now extinct; and *Anchotrechus punctipennis*, of the Anaga Massif (T), for which some old references state its localization under stones in forests zones rich in leaf mold, but we have only collected it in typical riparian media (The other species of this endemic genus, *A. cabrerai*, coexists in Anaga, living in leaf-litter). The *Nebria* are sometimes found near springs or small water-falls, but it is wrong to consider them exclusive of this environments. We shall return to the riparian fauna in dealing with the Island of Tenerife, but would like to take note of a very interesting fact.

Of the 44 Type Y forms present in the laurisilva, 11 are not endemic, and of these 11, 10 belong to the riparian fauna. The riparian environment is probably the least specific habitat of the laurisilva, and with the exception of two cases (*Notiophilus geminatus* and *Microlestes negrita*), all of the autochthonous non-endemic fauna of the laurisilva is bound to it.

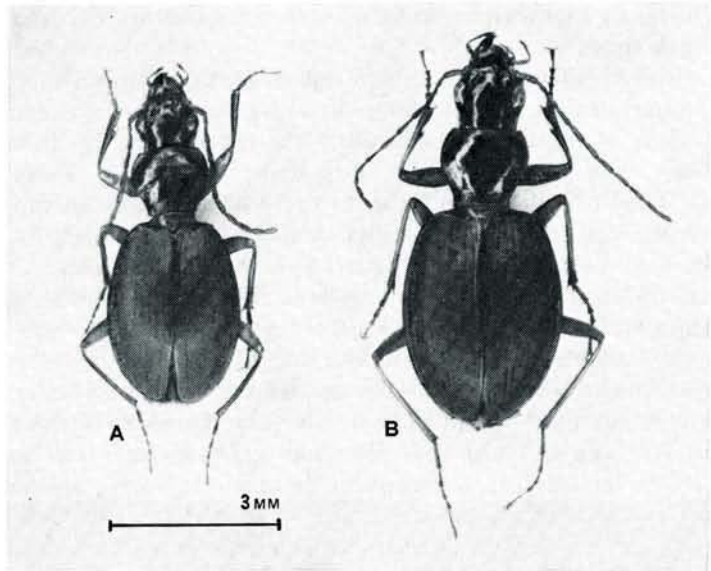


Fig. 10. A. *Agonum debile* (Woll.), B. *Agonum nichollsii* (Woll.), Photo A. Machado.

The three (?) exclusively riparian forms of the laurisilva (Type W') must depend on some factor other than water; probably on reduced light conditions (photophobic). We have always found them in extremely dark places (streams and springs).

PHENOLOGY

Data on the phenology of the Canary carabids does not exist. As observed in dates of collection and our own impressions, we doubt that there are many cases in which the distinct development stages present a seasonal synchronization such as occurs in Europe, where the seasons are much more marked and rigorous. The laurisilva is perennial, and given the generally uniform climatic conditions encountered in the Islands, the changes are very mild. The leaf-litter, the foliage and the cloud layer (NE-trade wind) prevent the floor of the laurel forest from drying out. However if partial drying occurs, sufficient humid places remain to permit the continued development of the organisms. Most of the carabids can be found throughout the entire year, which makes one think that population overlapping occurs if the species is not a very long-lived one, not rare for the carabid beetles (for example, *Carabus* lives at least two years, Lindroth 1974). Thus we do not believe that many species exist in which the larvae estivate. The only notable variation observed is a qualitative and quantitative faunal increase in the humid periods, but this does not signify a typical seasonal synchronization, as we have stated above, since

the precipitation pattern is rather variable. Last year (1974), for example, the laurisilva exhibited its 'summer' aspect in January (dry paths, ant activity, etc.) and the rains began to fall in late March.

Amaroschema gaudini, for example, appears after the first rains bring forth grass shoots and mosses on the road margins or exposed zones. It is collected beneath little stones in these areas.

ECOLOGY

It is not possible to assess the faunistic differences among the diverse laurisilva subtypes without a deeper understanding of the environmental and biocenotic conditions of a given area. Empirically, it is observed that the fauna is richest in the first three Kämmer subtypes (see page 355). The epiphyte-rich laurel forest (fig. 11), which is a climax formation, presents

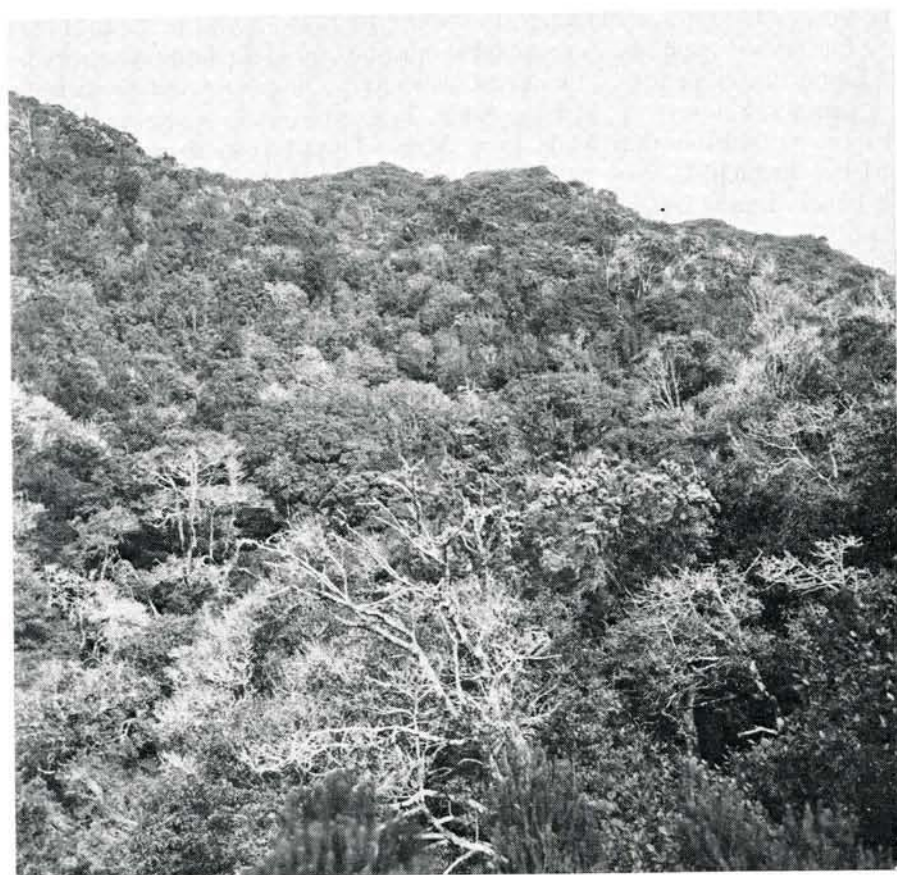


Fig. 11. Aspect of the epiphyte-rich laurel forest at the Anaga Massif (Tenerife).
Photo J. M. Fernández.

the maxima of carabid endemics; we have already mentioned the *Erica scoparia*-shrub forest by dealing with the bark-fauna of *Erica* trees. The 'normal' laurel forest is probably the richest in variety (abundant Type Y forms), while the fauna decreases considerably in the cliff-forest and in the drier marginal zones of the laurel forests. It is an ecological fact that marginal biotopes contain a relatively low diversity of species.

The mixed forest is rather rich in carabids, without noticing the 'edge effect' (Dajoz 1974) while the other component, the pine woods, are very poor in carabid fauna (possessing almost no exclusive forms). Thus the mixed forest has less species diversity as compared to the true laurel forest.

Concerning the carabids, the fauna of the former is typically that of the laurisilva and should simply be considered as another subtype of this formation (laurisilva as undergrowth in the pine woods). This does not mean that its inclusion as a subtype of Kämmer's *Pinus canariensis*-forests is wrong. In other zoological groups the picture may be very different.

The fayal-breza which results from the cutting of the laurisilva presents a fauna that depends on the forest character. The product of the first cut is usually a forest of *Myrica*, *Erica*, *Ilex* and some noble species. Its successive exploitation leads to a *Myrica-Erica* forest, then to a *Erica-Myrica* bushland, *Erica* bushland, ending in a *Cistus* brake, pasture or bedrock. Soil is lost by erosion, the relative humidity decreases notably, and the accumulation of *Erica arborea* (Spanish 'brezo') bristles all contribute to the progressive faunal decrease as the cutting continues.

The fayal-breza is rather interesting in some zones where no manifestation of the pure laurisilva remains because that is where the surviving fauna finds refuge. On the other hand if true laurel forest exist in the vicinity, the carabids must have emigrated there, while only few are found in the fayal-breza, although it may not have been cut for a long time. From the carabid point of view, the fayal-breza can be considered as a degenerate laurisilva.

The absence of carabids in apparently healthy zones of laurisilva, floristically speaking, is usually due to the activity known as 'rastrillados' (= rakings) which consists in the removal of the leaf-litter for agricultural use. This is catastrophic for the ground-dwelling carabids because even if they withdraw to their refuges, they are now left with almost no food: snails, worms, microarthropods, etc, that are normally abundant in this biotope.

THE HISTORIC-INDICATOR FORMS

In a strict synecological sense, the indicator forms would be some of those that we have designated as W' (37 in all), although in the carabids, because of their mobility, their quality as an indicator is not as good as that in other biological groups (amphipods, for example). The Type W

forms would not fit the ecological concept of indicator, but they are highly useful, for being found outside the forest zones, they do indicate to us the former existence of laurisilva in said zone. In reality, these forms should more correctly be called historic-indicators.

Concerning *Syntomus foveatus inaequalis*, Wollaston (1864, p. 16) commented: «It is eminently a sylvan insect, the few specimens which I have observed in comparatively open spots being probably the remains of a fauna which has more or less died-out since the timber has been destroyed.» This is not a typical (exclusive) laurisilva form as it also inhabits the pine woods, but as a typical sylvan insect it is the only form that lives in the five Western Islands.

Knowledge of the distribution of the W forms is very useful when one wishes to establish the potential limits of the laurisilva. A serious study of this aspect should be attempted and not only from a botanical standpoint as is usually the case. The laurisilva as an ecosystem is the result of a plurality of interacting components. Therefore its study should thus be interdisciplinary, taking into account the botany, zoology, climatology, edaphology, geology, etc. of the system. In addition to these natural sciences, historical sources can provide data of very valuable interest (c.f. Dansereau 1968, p. 232).

CONSIDERATIONS OF SINGLE ISLANDS

Until now we have treated the carabid fauna of the laurisilva as a whole, without considering the personality of each island.

The differences at this level are considerable, not only because of the distinct geographic situation, climatology, topography, etc., but also due to the different states of preservation of the laurisilva in each of them, and because of certain palaeozoogeographic factors that will be duly commented on.

To discuss each of the Islands to the required extent would vastly augment the subject matter in this work. We thus shall limit ourselves to the inclusion of a faunistic diagram in which the distinct faunistic composition of the carabid fauna of each Island may be observed, and cite only those general aspects as well as those singular or interesting due to their newness.

Hierro

This is the smallest (278 km²) of the Canary Islands, the westernmost, and until recently, the least accessible. A few laurel forest remains (e.g., Jinamar) are seen on the cliff sides of the Valley of El Golfo (fig. 12). The fayal-brezal formations are more abundant, and sometimes persist in the zones of the center and NE. Mixed forests and some magnificent pine woods exist. A small forest of enormous *Myrica* trees (Spanish 'faya'),



Fig. 12. Characteristic cloud layer at El Golfo (Hierro), touching the cliffs occupied by remains of laurisilva. Photo Baeza.

called El Fayal, is found on the southern slope, with an almost complete absence of brezos. We do not know if it is a natural formation, but it is the only one of its kind.

The total number of laurisilva carabid beetles is very low (13), which may be connected to the Island's small size or to the above mentioned isolation, and it is probable that it is the least studied Island in this respect. To this must be added the difficulty encountered in collecting specimens. A great part of the zones where the laurel forest persists is ground covered by a thick layer of small pebbles and stones (sometimes more than 1 m thick) on which the fallen leaves rest. The carabids take refuge among these stones and escape faster than one can dig for them.

Only 2 Type W' species are known proper to this Island: *Licinopsis picescens* y *Paraeutrichopus h. harpaloides*, both extremely rare. *Dromius angustus plagipennis* is also W', but it is also present in Gomera, Tenerife and Gran Canaria. It is curious that *Philorhizus longicollis* s.l. that inhabits the laurisilva of Tenerife (*longicollis* s.str.) is present in Hierro (ssp. *ferranius* Mat.) but only being known from the pine woods. There is only one *Calathus*, *C. spretus*, which represents *C. ascendens* (Type Y) of Tenerife, inhabiting the pine woods and the laurisilva and being typical in the fayal-brezal. Also the only one *Trechus* known, *T. flavocinctus gomerae*, is Type Y.

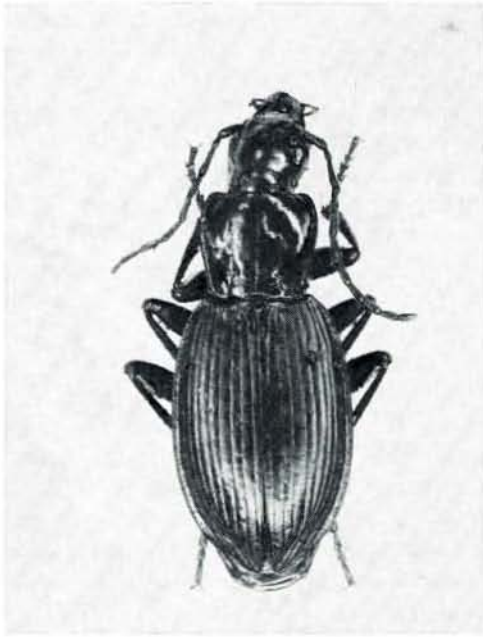


Fig. 13. *Licinopsis picescens* (Woll.) endemic from Hierro (specimen loaned by Dr. H. Franz), 2 cm approx. Photo A. Machado.

The greater part of the carabid fauna of the Hierro laurisilva is Type Y, corresponding to forms which are not proper to the Island, (see the faunistic diagram). The greater affinity has it to the laurisilva fauna of Gomera, having *T. flavocinctus gomerae* and an endemic and monospecific genus (*Paraeutrichopus*) in common, along with their corresponding two vicariant subspecies.

N.B. After completing this study, Dr. H. Franz (Vienna) sent to us one specimen of *L. picescens* (fig. 13) and one of *P.h. harpaloides* captured in La Restinga (S-coast), locality where laurisilva does not exist nor seems ever to have existed. Nevertheless we believe that they are laurisilvan species, but if the locality is correct, then they would be not W'. Maybe they are simply a casual find or, perhaps, they have immigrated from a once-forested locality nearby.

Gomera

With its 380 km² and maximum altitude of 1,480 m, it is probably the Island that had the greatest proportion of its surface covered by laurisilva. Natural pine woods are lacking, and thus also mixed forest (*Pinus radiata* D.Don have recently been planted in great extensions of the upper parts of the Island). It is also the Island that has not experienced volcanic

activity for the longest period of time (about two million years), which has a repercussion in the richness of its fauna. The last cone – trachytic – known as 'La Caldera', is located in the South and is of Quaternary age.

Gomera conserves magnificent laurel forests, that from a forest mass standpoint, are the best in Macaronesia (the qualitatively best laurisilva is to be found in the Anaga Massif – see fig. 6 –, in Tenerife). Some forests have been very slightly altered in comparison with other islands, which has logically influenced the purity of the fauna. With 45 laurisilva carabids, it occupies the third place in spite of its being the second smallest Island of the Archipelago. The richness of this fauna does not therefore appear to be connected to its surface area.

In this context we wish to call to mind a reference by Lindroth (1971, p. 68): «A study of the small Westman Islands showed a good correlation between the distribution of insects and plants but almost none between number of species (beetles) and distance from the main island. The area of an island, involving variety of habitat, as a rule, has apparently greater importance».

In our Islands, another factor (antiquity and vulcanism) establishes itself as highly influential in the richness of the fauna. This aspect will be noted in detail in treating the Island of Tenerife.

The Gomeran laurisilva shows the maximum percentage (51%) of exclusive forms (23) in relation to its proper fauna, surpassing even Tenerife. This is due in part to the great extent of the laurel forest in the Island and the absence of pine woods, thus the sylvan Y forms hardly exist. In turn, the greater part of the exclusive forms ($W' + W$) are proper to the Island (which makes a general rule in the Archipelago), while the non-proper forms predominate in the non-exclusive autochthonous forms (Y), in turn present in two or more Islands. We should recall that all of the exclusive forms (except one, see page 367) are endemic. Thus, the laurisilva of each Island contains its particular forms.

Five endemic genera are present in the Gomera laurisilva, and one, monotypic, is exclusive to it, *Pseudoplatyderus*, which has been discussed above. (page 369) The genus *Gomerina* had been considered until recently as monotypic and proper to Gomera. We have been able to confirm that *Platyderus nitidicollis* H. Lind. of Gran Canaria is really a *Gomerina* (the new combination will be published shortly). Six *Calathus* are also notable in this small Island, compared with three in Gran Canaria which quadruples the former's surface area. Also found, among others, 2 *Trechus* (only one is proper), a *Brosicus* (see fig. 26), a *Licinopsis*, a *Dicrodontus*, a *Nesarpalus*, 2 *Cymindis* (only one being proper), and as a unique case, an endemic *Microlestes*, *M. gomerensis*.

The riparian (see p. 372) and arboreal fauna is also well represented. If to this number of proper endemic forms, high percentage of palaeo-endemisms and good representation in the three strata, we add the fact that Gomera is the only place where the genus *Zargus* (Macaronesian)

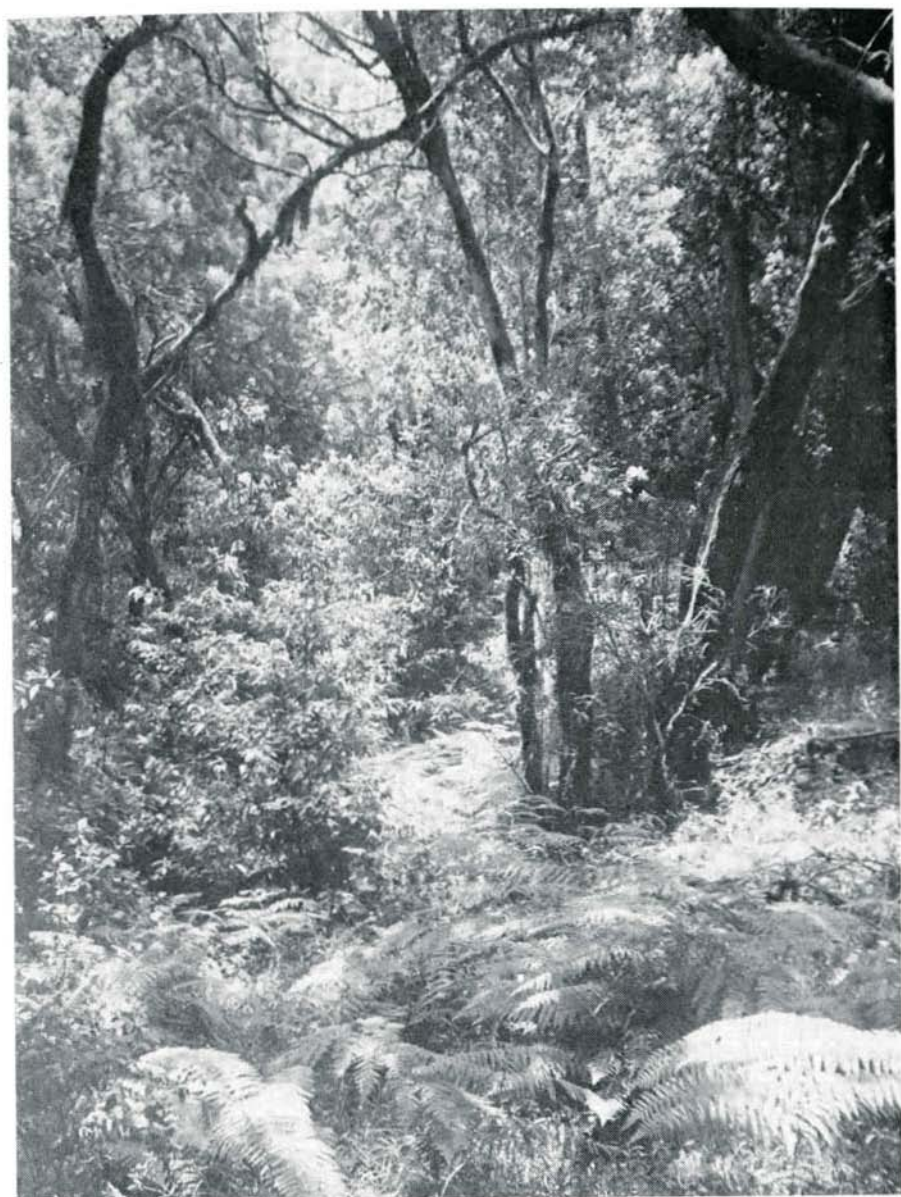


Fig. 14. Laurel forest at Raso de la Bruma (Gomera). The ground covered by ferns (*Pteris* and *Dryopteris*). Photo A. Machado.

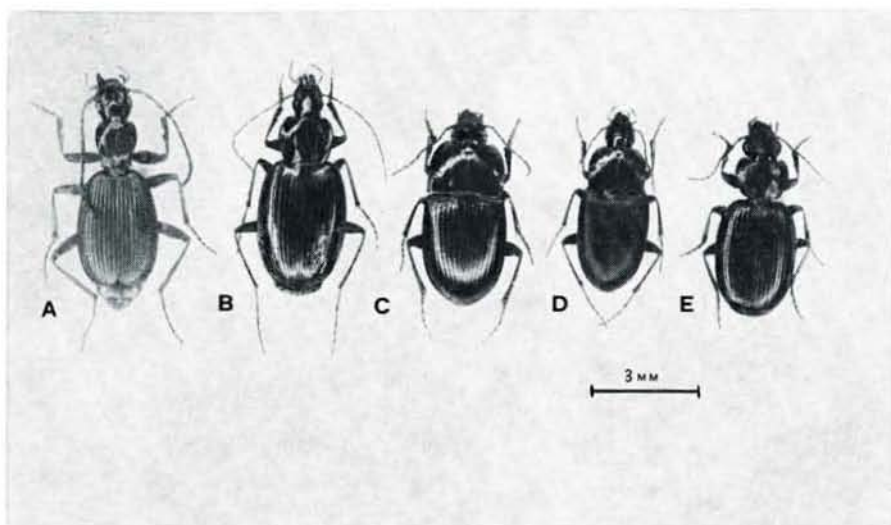


Fig. 15. Some endemisms from the Gomera laurisilva: **A.** *Dicrodontus aptinoides* (Woll.), **B.** *Zargus crotchianus* Woll., **C.** *Paraeutrichopus harpaloides* ssp. *pecoudi* Mat., **D.** *Gomerina calathiformis* (Woll.), **E.** *Cymindis velata* (Woll.). Photo A. Machado.

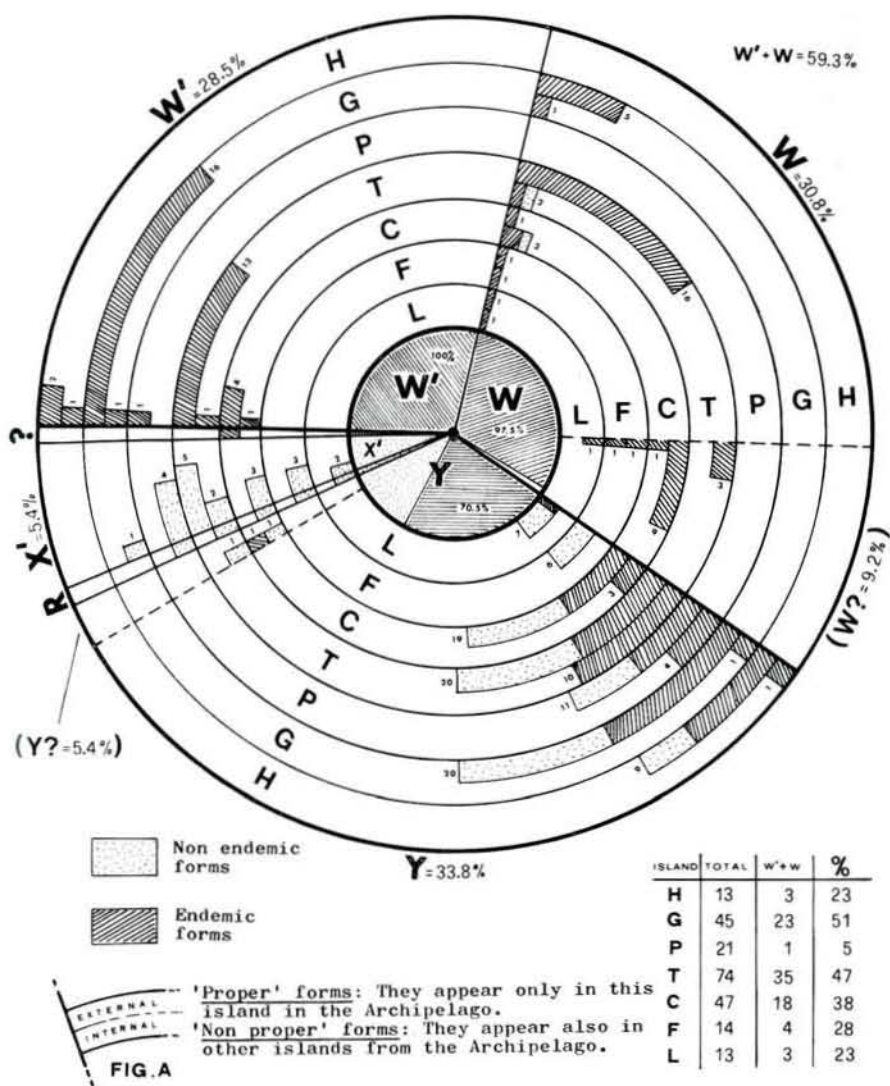
is found, this laurisilva fauna turns out to be one of the richest, most complete and oldest; only Tenerife exceeds it in this regard. The absence of *Carabus*, *Nebria* and *Bradycellus* (or *Leistus*) in this Island is curious.

It has multiple affinities. Principally it shares an endemic genus with Hierro (see p. 379): *Dicrodontus* and *Broscus* with Tenerife and Gran Canaria (fig. 31); *Gomerina* and a species of *Cymindis*, alone with Gran Canaria; alone with Tenerife, *Limnastis gaudini*, though not an endemic genus (Jeannel 1929, admits the possibility), as a hypogeous and very specialized form, has a great zoogeographic value. The genus *Licinopsis* is the only one that unites the four westernmost Islands (H, G, P and T), see fig. 16.

Thus, Gomera presents a rich and most interesting laurisilva carabid fauna, very complete and the purest. For this reason it is urgent that it be studied more thoroughly before man's interference upsets yet further the forest structure.

La Palma

Surface area 730 km², maximum altitude 2,423 m. The extension of the laurisilva was very considerable (fig. 18 A), and a great part of the laurel forests still exist but as secondary formations. The accessible zones have been continually cut resulting in a wider extension of the fayal-brezal,



Faunistic diagram. (Showing the composition of the Ground-Beetle fauna of the Canary Islands laurisilva). The inner circle shows the character and endemism of the global fauna (the percentages shown outside the diagram). The outer circle is subdivided into seven circular bands, each of which corresponds to an island (represented by their initials); it is also divided (fig. A) into an external and an internal portion. For the key to the symbols see page 357.

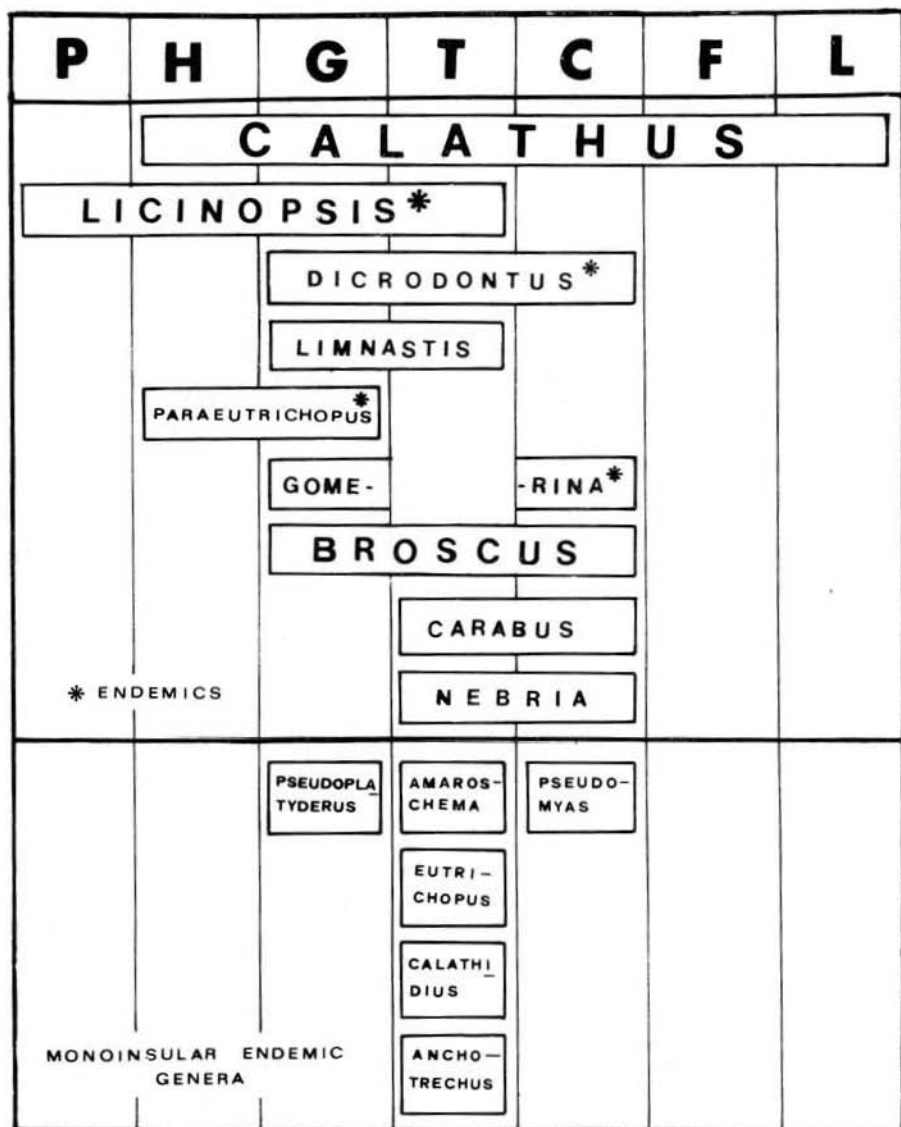


Fig. 16. Inter-island distribution of some genera of faunistic interest.

the greatest of the Archipelago. It is actually the Island most affected by lumbering.

This Island is a true enigma from a laurisilva carabid standpoint. A quick glance at the faunistic diagram reveals that an exclusive fauna is practically lacking. Only one extremely rare species is known, *Licinopsis gaudini*. This represents but 5% of the autochthonous fauna of the

laurisilva, an astonishing datum if we compare it with those of the other Islands. Even the total fauna (21) is relatively small, above all if we consider the enormous extent of the laurisilva. Only in the Y forms do we find some proper endemics. It is the second Island after Tenerife (7 X' forms) in presenting the most adventitious forms (4).

The faunistic discordance is certainly surprising if we do a brief analysis (fig. 16). The *Calathus*, by far the most typical representatives of the laurisilva (including at least Madeira), are totally absent. Gomera has 6, Gran Canaria 3, Hierro and the Eastern Islands 1 and Tenerife 11. Also absent are all of the endemic genera excluding *Licinopsis*, and the rest of the typical laurisilva genera, such as *Broscus*, *Nebria*, *Cymindis*, *Nesarpalus*, etc. Only *Trechus* is represented by two species, but they are shared with the pine woods, the formation that attains a splendid development (the mixed forests are very extensive). The only carabid that we can consider typical in laurisilva is *Olistophus palmensis*, also surprising in that the rest of the Western Islands share another species, *O. glabratus*.

The riparian fauna is very poor contrasting with the humidity present on the Island, termed 'la Isla Verde' (= Green Island). The absence of *Agonum* is also strange. The only fauna somewhat represented is the arboreal, *Dromius* and *Philorhizus*, unfortunately very little studied, but they do promise to allow some faunistic interrelations to be established (We are presently studying some of this material). Only *Ph. atlanticus fortunatus* is presently known to be shared with teneriffan laurisilva. *Ph. lindbergi* Mat. has been collected until now only from pine woods.

Apart from this connection with Tenerife, the carabid fauna of the La Palma laurisilva is seen as closed and very poor. We do not know the reasons for this phenomenon. From a botanical and edaphologic point of view if the La Palma laurisilva presents certain peculiarities (c.f. Lohmeyer & Trautmann 1970, Voggenreiter 1974), these are not so marked as to justify such a manifest discordance. We thought of a possible shortcoming in the entomological field-work that, although more frequent than in Hierro for example, could have been very superficial.

This brought us to undertake a personal expedition, because of the present study, to La Palma in order to visit the best conserved zones of laurisilva and set pit falls in them. This little campaign (see fig. 18 B) took place between February 1-9, 1975. We wish to express our gratitude to Dr. Oromí, who helped set the falls, as well as to the botanist specialist of La Palma, Arnaldo Santos, who aided us to withdraw the pit falls and had previously marked the most interesting zones on a map. We employed molasses mixed with beer as bait. The lack of time, and the orography only permitted us to set 150 pit falls (the project called for 500). We did not catch any new forms, only the *Trechus* and *Olistophus* that were already known. *Licinopsis gaudini* was not caught, in itself rather rare, but this could be due to a secondary factor. In El Cubo de la Galga (fig. 17), locality where this endemism is known (Palm, in litt.),



Fig. 17. Interior view of the laurel forest at Cubo de La Galga (La Palma). At the left, see a channel deviating the water of this particular ravine. Photo A. Machado.

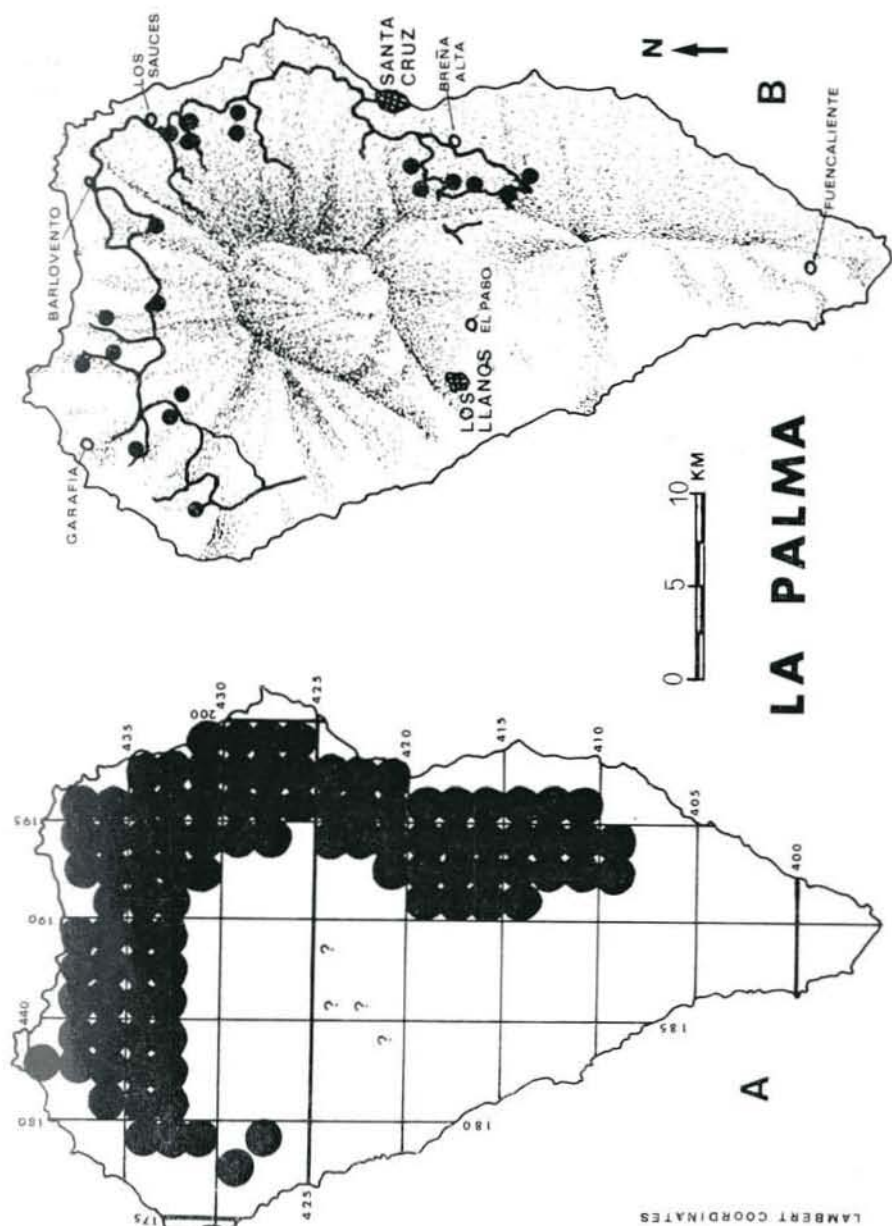


Fig. 18. **A.** The potential natural distribution area of the *Pruno-Lauretea* class in La Palma (based on Voggenreiter, 1974). **B.** Itinerary of the La Palma Expedition February-1975. Black circles: Zones where pit falls were placed.

the plague of rats which has been scourging La Palma was very intense, as could be deduced from the great quantity of tree branches with dried tips. Many pit falls were gnawed, drunk dry, or found with insect remains.

Are the typical representatives of the laurisilva absent from La Palma? Does *Calathus* 'palmensis' exist? The negative value of the expedition undertaken is not absolute, though it remains to be a datum to take into account. If this faunistic poverty is certain, we believe that it could be due to the relative geologic youth of the surface of the Island of La Palma.

Tenerife

This is the largest (2,058 km²) and highest (Teide Peak, 3,715 m) Island. The potential extent of the laurisilva was treated above (fig. 5), and it is important to keep it in mind because the forests have suffered very marked regression. It is difficult to believe today, for example, that the laurisilva reached to below La Laguna (La Cuesta) at the time of the Conquista (XV cent.). Viera y Clavijo (1774) cites that the first contact that the Spanish had with the 'guanches' (the aborigines of the Islands) took place in the midst of a forest between Santa Cruz and La Laguna.

Some of the few present-day manifestations are conserved in an acceptable state (though very endangered), and house the richest laurisilva flora (Anaga Massif). Since the times of Wollaston (second half of the XIX century), some of the magnificent laurel forests have disappeared, such as that of Agua García often cited by this author (today only a few remains are seen, fig. 2) and the typical locality of not a few of the endemic forms of our fauna. Another forest, already absent in those times, was that of Agua Guillén⁶, where Alluaud made very interesting collections of the surviving fauna.

The abundant references of the earlier authors permit a partial reconstruction of the distribution of the carabid fauna of the laurisilva.

Apart from the 74 laurisilva carabids, with 35 exclusive forms and a very high percentage of proper forms, the interesting of Tenerife is the presence of distinct zones and types of distribution for the carabid fauna of the laurisilva. In fig. 20 we have marked these areas with letters, even though we have not wished to place the limits, always difficult to draw.

Zone A. – Includes the Anaga Massif (Aguirre and Las Mercedes forests, Vueltas de Taganana, Barranco de Iguana, etc.); its limit would fall approximately at the 'Laguna belt' (c.f. Gangwere *et al.* 1972)

Zone B. – Includes the forest of Agua García, La Esperanza, Las Lagunetas (mixed forest), etc.

Zone C. – Including Agua Mansa, Barranco de San Antonio, Monte de Icod, as far as Erjos.

⁶ «Station 125, Tenerife, 8 Juin 1889. Source et ruisseau de Agua Guillen, emplacement d'une ancienne foret de Lauriers, aujourd'hui détruite, 750 m» (Alluaud, 1891).

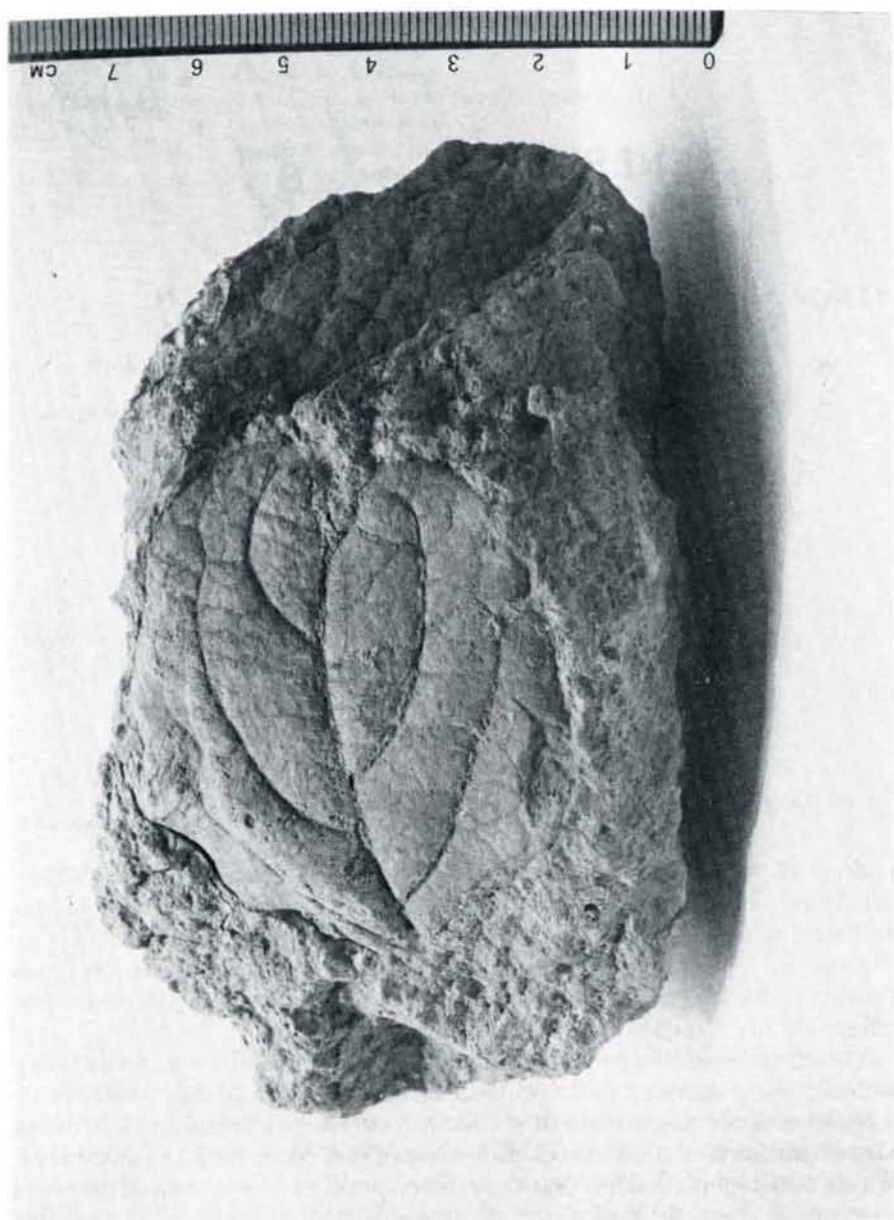


Fig. 19. Print of a leaf of laurisilva (*Viburnum?*) in puzolanic material, found at 30 m depth in the Lomo de Mena (950 m a.s.l.), at Güimar, Tenerife, and for which Dr. T. Bravo estimates an age of 400,000–600,000 years. Photo A. Machado.

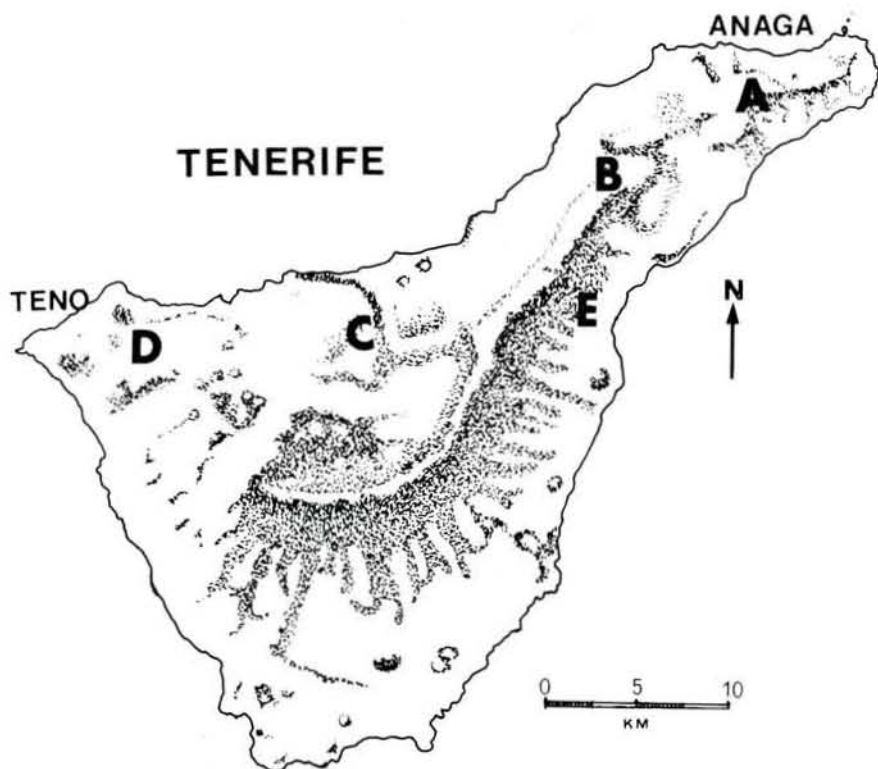


Fig. 20. Distributional areas of the laurisilva carabids in Tenerife.

Zone D. – Includes the Teno Massif, with Los Silos forest (= Monte de Agua). It appears that the limit between C and D lies in the Monte de Erjos, where we have been able to observe some mixtures.

Zone E. – Including the laurisilva of the S-E side (Monte de Agua Guillén †, Barrancos de Güimar, Adeje, etc.). Unfortunately, very few references are available from this zones.

The distribution types are indicated according to the zones that they include, for example, A-B, or D-C-B, and we group them into three categories according to whether they are or are not found in the Anaga Massif and/or in the Monte de Los Silos (Teno Massif). The importance of this two regions lies in that they correspond to the principal zones of outcrops of the 'Old Series' (c.f. Fuster *et al.* 1968). As we shall see, this has a very interesting evolutionary repercussion.

1. Present in Anaga, absent in Monte de los Silos (Teno).

Distribution Type	<i>Trechus uytenboogaarti</i>
A	<i>Trechus felix felix</i>
	<i>Trechus felix faustus</i>
	<i>Trechus felix tahodiensis</i>

	<i>Anchotrechus punctipennis</i>
	<i>Anchotrechus cabrerai</i>
	<i>Eutrichopus fernandezi</i>
Distribution Type	<i>Carabus faustus</i> 'typus faustus' (today only A)
A-B	<i>Bradycellus ventricosus</i>
	<i>Calathus carinatus</i> (today only A)
Distribution Type	<i>Carabus interruptus</i> (today extending also to upper regions)
A-B-C	<i>Nebria dilatata</i>
	<i>Leistus nubivagus</i>
	<i>Calathus rufocastaneus</i>
	<i>Calathus auctus</i>
	<i>Dromius amoenus</i>

2. Present in Anaga and Monte de los Silos (Teno)

Distribution Type	<i>Calathidius acuminatus</i>
A-B-C-D	<i>Calathidius sphodroides</i>
	<i>Calathus depressus</i>
	<i>Calathus abacoides</i>
	<i>Calathus angustulus</i>
	<i>Tarulus zargoides</i>
	<i>Dicrodontus separandus</i>
	<i>Philorhizus e. elliptipennis</i>
	<i>Philorhizus l. longicollis</i>
Distribution Type	<i>Trechus f. flavocinctus</i> (also in Adeje)
A-B-C-D-E	<i>Calathus ascendens</i>
	<i>Calathus rectus</i>
	<i>Calathus freyi</i>

3. Present in Monte de los Silos (Teno), absent in Anaga.

Distribution Type	<i>Carabus faustus</i> 'typus cabrerac'
D	<i>Trechus fortunatus</i>
	<i>Limnastis g. gaudini</i>
	<i>Calathus amplius</i>
Distribution Type	<i>Broscus rutilans</i>
D-C-B	<i>Trechus felix antonii</i>
	<i>Eutrichopus gonzalezi</i>
	<i>Calathus ciliatus</i>

In this list it is noted how the Anaga laurisilva and that of Teno have a peculiar yet similar carabid fauna. It is interesting to observe the phenomenon present in various forms, which extend from Teno toward the East, but not reaching Anaga (D-C-B), while others, starting at Anaga, go toward the West without penetrating Teno (A-B-C). The western limit establishes itself, as we have stated, in Erjos.

A faunistic irradiation is observed, starting at both nuclei, Anaga and Teno. Some authors (Simony 1892, Evers 1964) believe that Tenerife formed itself from three separate islands: Anaga, Teno and Adeje (where the Old Series is also exposed, see fig. 21), and that they were united by later eruptions that ended in the formation of the Teide Peak. Bravo and his collaborators (pers. comm.), in subsurface geological investigations,

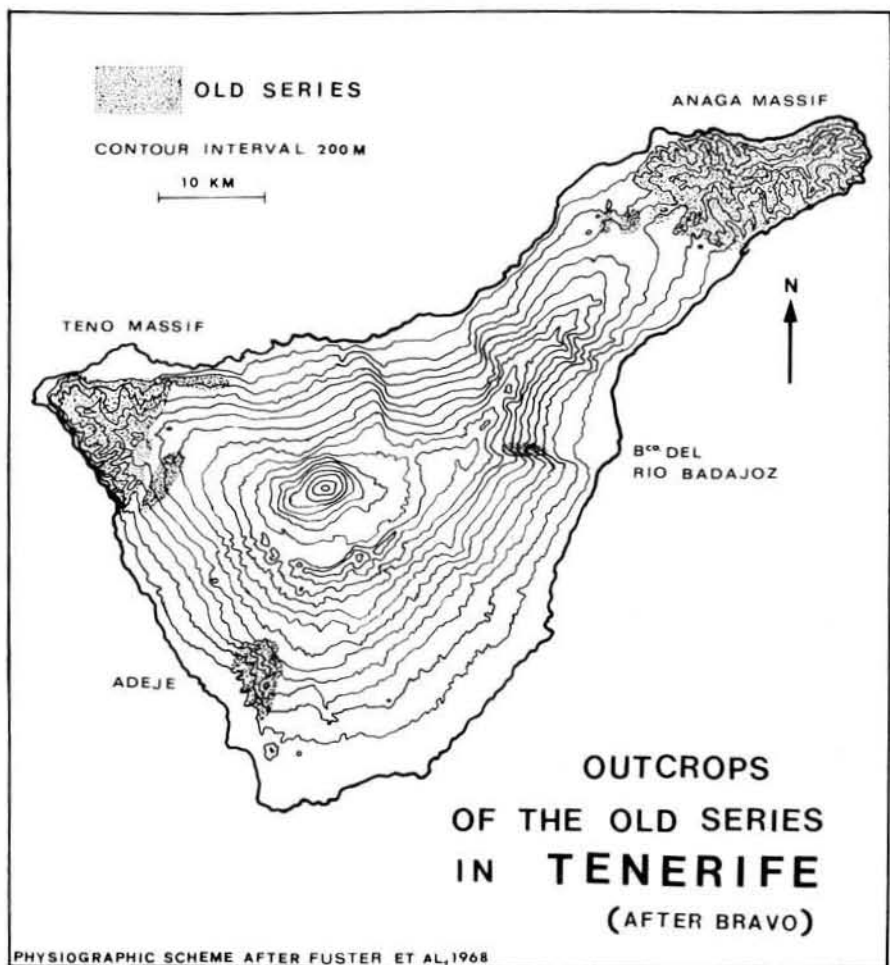
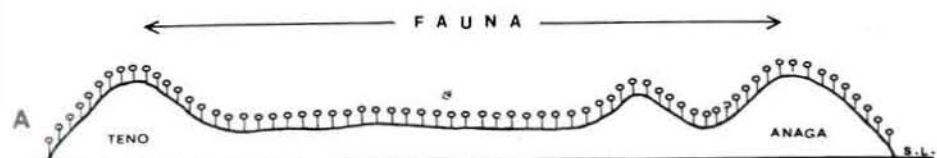


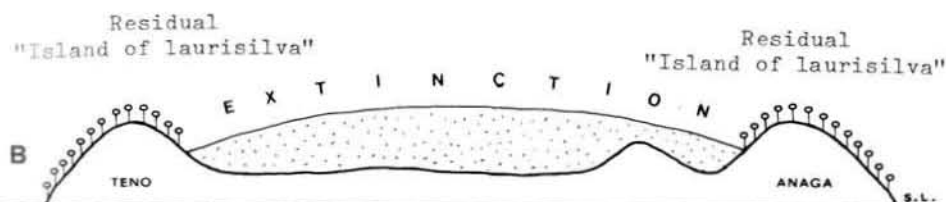
Fig. 21.

have found the Old Series in various zones of the Island, which implies a continuity of this material among the three principal outcropping points; for this reason, the above mentioned hypothesis seem little valid. Besides, other minor zones of outcropping of the Old Series have been localized, after having been exposed through erosion. (fig. 21).

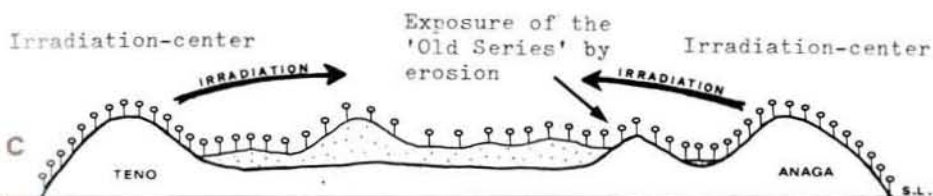
However, if these massifs of Teno and Anaga were not as affected by the later eruptions that sterilized the intermediate regions (see fig. 19), they conserved the existing fauna that afterward, throughout time, colonized the new zones as they transformed themselves and made themselves more adaptable. Thus it is that the laurisilva of Teno and Anaga may be considered as 'faunistic irradiation centers', at least in respect to



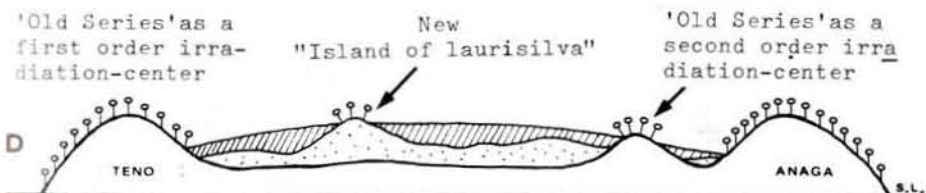
Initial phase starting with the 'Old Series'



Extinction of the fauna of the intermediate zone by the deposition of new volcanic material.



Faunistic irradiation starting from the centers of first order toward the intermediate zone.



Later deposition of volcanic material and the appearance of new irradiation-centers, but of second order.

➡ The process continues...

Fig. 22. Edification process of the Island and its importance in the evolution of the fauna.

the carabids. This could be one explanation of the 'laurisilva islands' mentioned in the introduction. See fig. 22.

The hypothesis would also be valid for the other principal outcrop zone of the Old Series (in Adeje) where today only few relicts of laurisilva

remain, and to a minor degree, for the secondary type exposures. It should also have a repercussion in the other groups bound to the laurisilva.

In the numerical distribution area map of Voggenreiter (fig. 4) it is observed that the squares having the highest number of members of the syntaxonomic class *Pruno-Lauretea* correspond in a general way to the outcrop zones of the Old Series (*c.f.* Fuster *et al.* 1968, p. 11). Thus it seems that botany supports this hypothesis, even though it is necessary to undertake studies that are more concrete and localized in this sense, and investigate the other zones where material of this old type are found.

During this period of isolation, some forms must have become differentiated (*Eutrichopus*, *Calathidius*, *Carabus*, etc.), which later could or could not have extended their range.

Thus, from an ancestral *Eutrichopus*, *E. fernandesi* in Anaga and *E. gonzalezi* in Teno were formed. The former has remained limited to its locality of origin, while the latter extended toward the East, until reaching La Esperanza (Zone B). Nevertheless, it is more abundant in its place of origin, in the Monte de Los Silos, at Teno. Another clear example of the Anaga-Teno disjunctional distribution is that observed in the genus

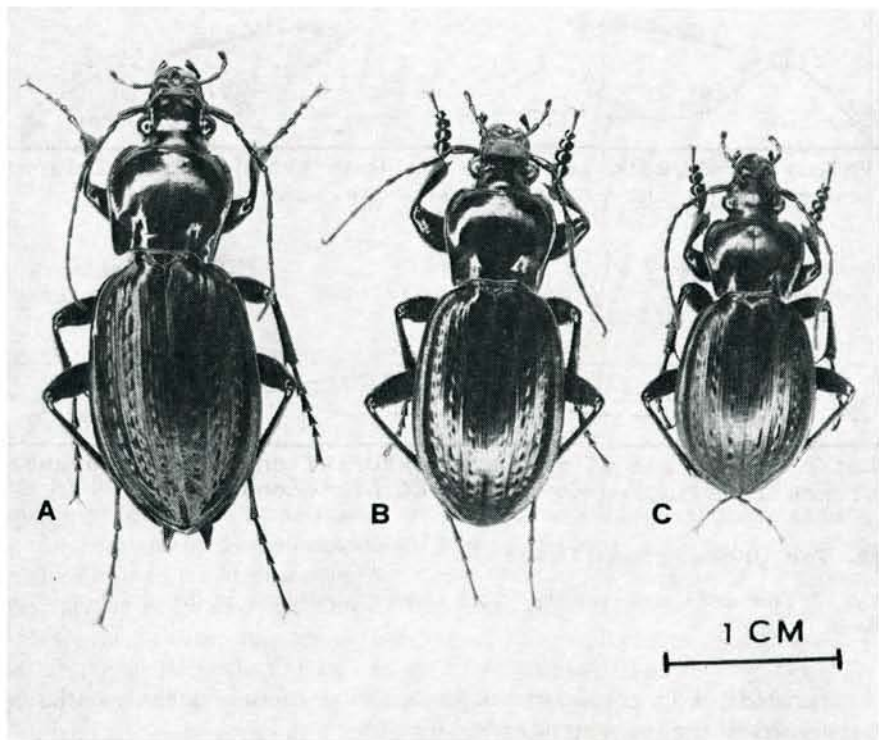


Fig. 23. The genus *Carabus* in Tenerife: **A.** *C. faustus* 'typus faustus', **B.** *C. faustus* 'typus cabrerai', **C.** *C. interruptus* Dej. Photo A. Machado.

Carabus (fig. 23), even though the differentiation level reached is debated among taxonomists. We shall thus speak of a *Carabus faustus* s.l., distinguishing the Teno population as 'typus cabrerai', and that of Anaga as 'typus faustus', without assignating any fixed taxonomic position.

The 'typus cabrerai' is found limited to the Monte de Los Silos, while the 'typus faustus' reached to Agua García (Zone B), where it became extinct. Today it appears only to live in the Anaga Massif, where it is rather rare (it is a coveted entomological 'treasure', which has partly caused its regression). One citation (?) for *Carabus faustus* (Cabrera leg., taken from Lagar 1965) is known from the locality of 'El Río', on the SE side. Dr. A. Cabrera probably referred to the 'Barranco del Río Badajoz' where an outcrop of secondary type of the Old Series is to be found, and that, according to scheme of fig. 22, could be considered as a 'laurisilva island', and even as a second order irradiation-center.

A second (or third) *Carabus*, *C. interruptus* (fig. 23, C), exists in Tenerife, being much more abundant and having certain tendencies to expand its range to upper zones. This is probably a second line which arrived later.

The two *Calathidius* (fig. 24) – an endemic genus of the Tenerife laurisilva – must have evolved in the same way, but we don't know which

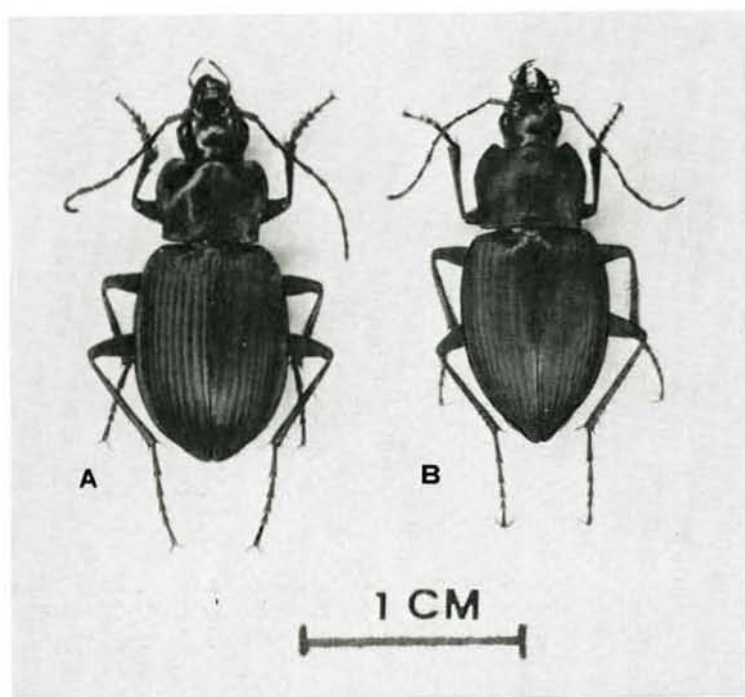


Fig. 24. The Teneriffan endemic genus *Calathidius* Putz.: A. *C. sphodroides* (Woll.), B. *C. acuminatus* (Woll.). Photo: A. Machado.

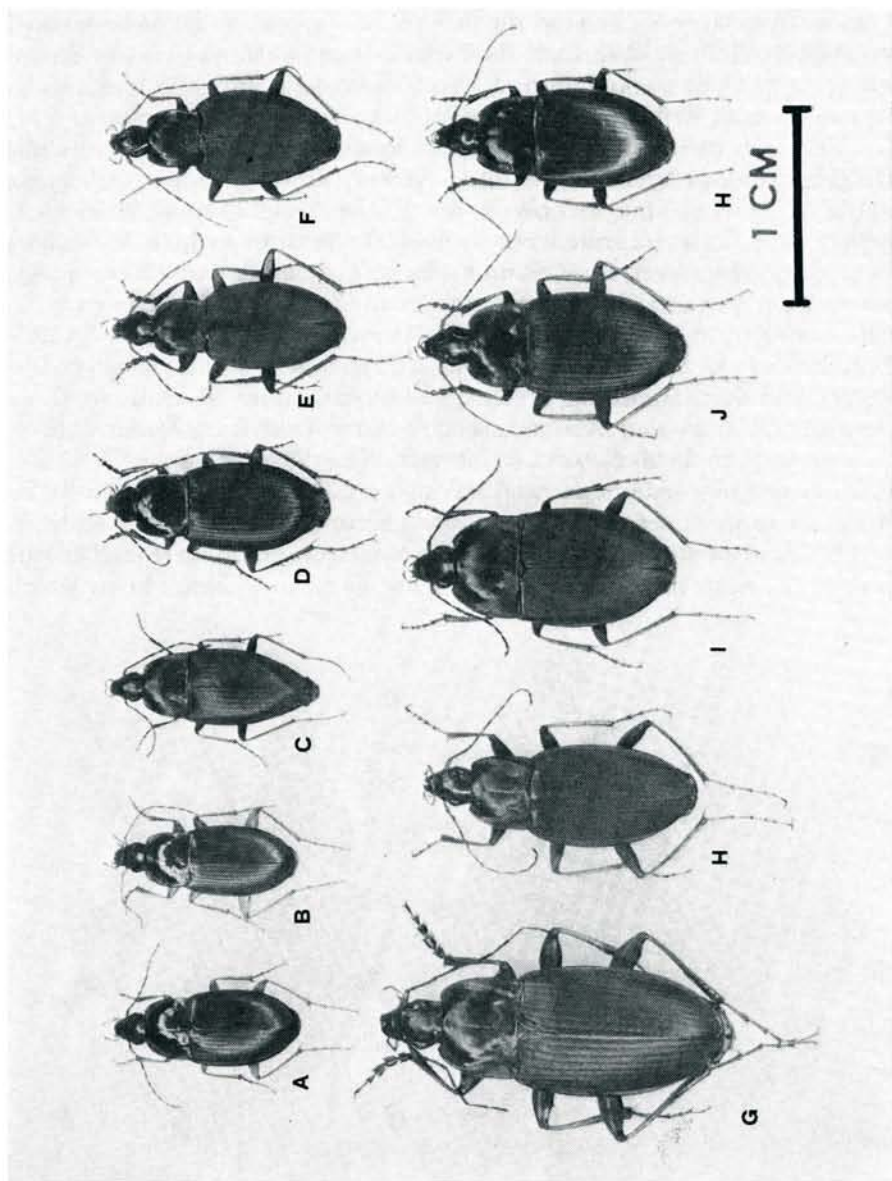


Fig. 25. The genus *Calathus* in Tenerife: **A.** *C. freyi* Colas, **B.** *C. rectus* Woll., **C.** *C. abacoides* Brullé., **D.** *C. ascendens* Woll., **E.** *C. angustulus* Woll., **F.** *C. carinatus* Brullé., **G.** *C. ciliatus* Woll., **H.** *C. auctus* Woll., **I.** *C. amplius* Esc., **J.** *C. rufocastaneus* Woll., **K.** *C. depressus* Brullé. Photo A. Machado.

species originated on which side, now that their expansion has overlapped their distribution areas. *C. acuminatus* is common, while *C. sphodroides* is very rare. This seems to be the known effect of many sympatries of this sort.

The most surprising sympatry presents itself in the genus *Calathus* (fig. 25), which in Anaga alone includes 9 species. Two more exist (11 in all), the *C. amplius* known only from Teno, and *C. ciliatus*, which does not pass the Zone B. According to Mateu (1957), the *Calathus* appear to group themselves in pairs, but to explain the evolution of the eleven forms supposing past Teno-Anaga disjunctions would be very difficult. One might think of isolations in other 'island'-type old sectors, or even in successive invasions as mentioned in the introduction. The most probable would be an interaction of these two processes.

Hypothetically, vulcanism seems to have played a very important role in the evolution of certain groups that show a high fidelity.

In other cases, the isolation factors seem to obey the orography and distinct ecologic conditions. At Anaga we have three subspecies of *Trechus felix*, about which their author comments: «Chaque forêt de Lauriers possède sa race particulière du *T. felix* et il est même très extraordinaire de trouver à quelques kilomètres de distance les unes des autres

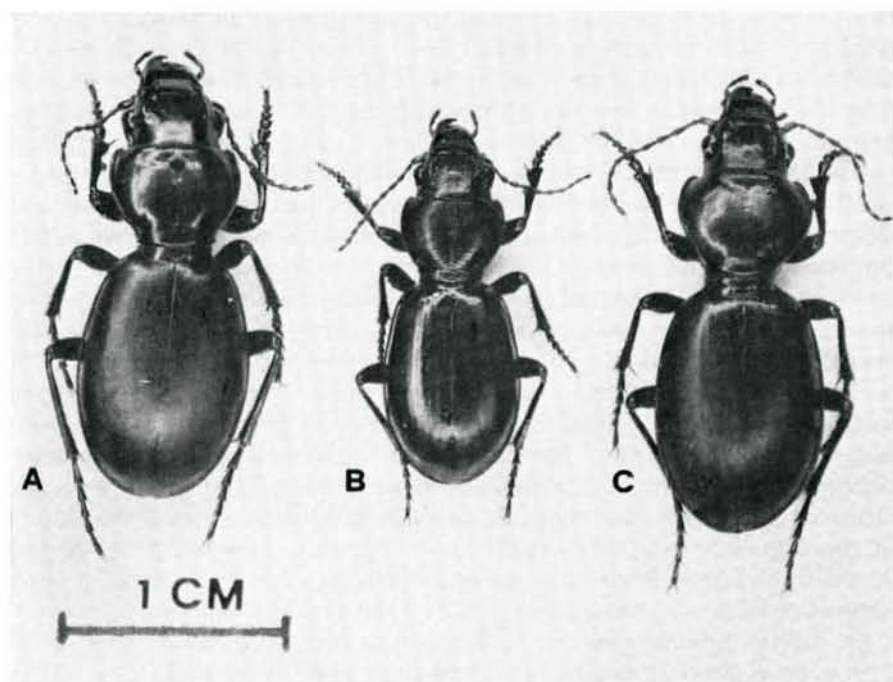


Fig. 26. The three Canarian *Broscus*: **A.** *B. crassimargo* Woll., (Gomera), **B.** *B. rutilans* Woll., (Tenerife), **C.** *B. glaber* (Brull.), (Gran Canaria). Photo A. Machado.

dans l'étroit promontoire que forme la partie orientale de l'île, trois races très individualisées par des différences notables de leurs organes copulateurs.» (Jeannel 1936, p. 18).

One of these three subspecies – *felix* – occupies the centre of Anaga (Cruz de Taganana) at 1,000 m, and the others at lower altitude on the northern side (Cruz del Carmen) – *faustus* –, and on the southern side, *tahodiensis*. This evolution, if it is true, could be linked to the laurisilva subtypes, orography and the different mesoclimatic conditions on one and the other exposure.

The genus *Anchotrechus* constitutes an evolutionary problem; it is a Tenerife palaeoendemism that presents primitive morphologic characters (pubescent elytra) as well as an ultraevolved copulatory organ (Mateu 1961). The two species coexist in the Anaga Sierra. The one with the most reduced area is *A. cabrerai*, living in leaf-litter, while *A. punctipennis* extends to Las Mercedes, and is proper to the riparian media where extreme darkness persists. Successive invasions? Sympatric evolution? Secondary sympatry? ...

Another singular aspect of Tenerife is that it once harbored a lagoon. It is possible that another existed in Gomera, at the locality known as 'Laguna Grande', but the orography of the zone suggests that it can not have been very large, nor persistent. The Tenerife lagoon is from historic times and a map, on which it appears, even exists (Torriani 1590), on which it is seen to be very reduced and lying at one extreme of the city thus called 'La Laguna', the old capital of the Island. Torriani mentioned that it was fed by a stream coming from the North and that it emptied toward the East.

The broad extent of the sediment zone of the Valley of Agueré suggests that the lagoon was much larger in the past, receiving water from the forests of Las Mercedes (not from La Esperanza). Some zones remained muddy in certain periods.

This now nonexistent habitat must have housed a particular laurisilva subtype, as well as a fauna proper to it. The reconstruction of the carabid fauna is now difficult because not even vestiges of the lagoon exist any longer. Nevertheless, some typically hydrophilic forms are predominant in this zone, always linked to humid usually artificial microconditions. Such is the case with *Princidium laetum*, *Agonum marginatum*, *Apotomus angusticollis*, *Acupalpus dorsalis*, *Stenolophus teutomus*, etc. Many of the riparian elements mentioned above (p. 373) must have found an adequate habitat in this lagoon. It should be noted that *Apotomus angusticollis* is likewise found in Bajamar (coast), in a zone where artificial ponds have been abundant for a very long time.

Of the 10 endemic genera, the Tenerife laurisilva contains 4 proper, of which only *Amaroschema* is not exclusive (Type Y). It likewise shares another two (*Dicrodontus* and *Licinopsis*) with other Islands. The affinities with the laurisilvae of Hierro, Gomera and La Palma have already been

treated on discussing these Islands. It exclusively shares the genera *Carabus* and *Nebria* with Gran Canaria, as well as *Broscus* and *Dicrodontus* also present in Gomera (see fig. 31). Some forms are also only known from Tenerife and Gran Canaria: *Apotomus angusticollis*, *Philorhizus e. elliptipennis*, *Philochtus iricolor*, *Microlestes negrita*, etc.

Several genera are present only in the Tenerife laurisilva. Such is the case with *Masoreus*, with *M. alticola* (Type Y); *Bradycellus ventricosus*, representing the *Bradycellus* of Madeira, which are also of the laurisilva; *Tarulus*, with *T. zargoides*, that would come to represent the *Cymindis* of Gomera and Gran Canaria, absent in the laurisilva of Tenerife; *Leistus*, with *L. nubivagus*, related to *L. ellipticus* Woll. of the Madeira laurisilva, and *Platyderus*, with *P. languidus alticola*, Type Y.

We see how the Tenerife laurisilva presents a rich, very characteristic and complete carabid fauna, in which are even found representatives (vicariant forms) of the Madeira laurisilva carabids, absent in the rest of the Canary Islands. One great exception exists, the Macaronesian genus *Zargus*, that lives, as we have seen, only in Gomera.

Its richness is due partially to environmental diversity and in great measure to the mentioned palaeozoogeographic phenomena. The fact that it is the best studied Island also probably has an influence.

Gran Canaria

This is the third Island in terms of surface area (1,532 km²), and in altitude (1,950 m). Within the Canaries, man has reached his 'climax' of the degradation of Nature in this Island. Of the enormous forests which once covered the Island, only a few manifestations of *Pinus canariensis* woods remain. It has been recently reafforested with *Pinus radiata*, and some areas have been planted with *Eucalyptus*, chestnuts, etc., but even so, the forest mass is very small and today, the Island that was once humid and rich in water reserves, now frequently goes thirsty (see Steinert 1975). Kunkel (1975) estimates that the remains of the laurisilva existing today on this Island amounts to less than 1% of its original distribution area.

Today, remains of laurel forest are found in Los Tiles de Moya, El Brezal del Palmital and the Barranco de la Virgen (upper part of the Barranco de Azuaje). Some show an interesting floristic composition (Kunkel & Sventenius 1972, Kunkel 1973c), but their extent is so reduced and the soil conditions are usually so altered that they cannot house a fauna in its natural state (fig. 27). The laurisilva of Gran Canaria is not in a condition to be studied directly for its fauna, and we must base much on extrapolations.

The first difficulty which presents itself is that of not knowing the natural area of the laurisilva. Sunding (1972) presents a map of the actual vegetation and of the potential natural vegetation. The limits that



Fig. 27. Aspect of Los Tiles de Moya, one of the last laurel forest remains in Gran Canaria (considered to become a protected area). In the centre *Ocotea foetens* (Ait.) Benth. et Hook.f. = 'til'. Photo A. Machado.

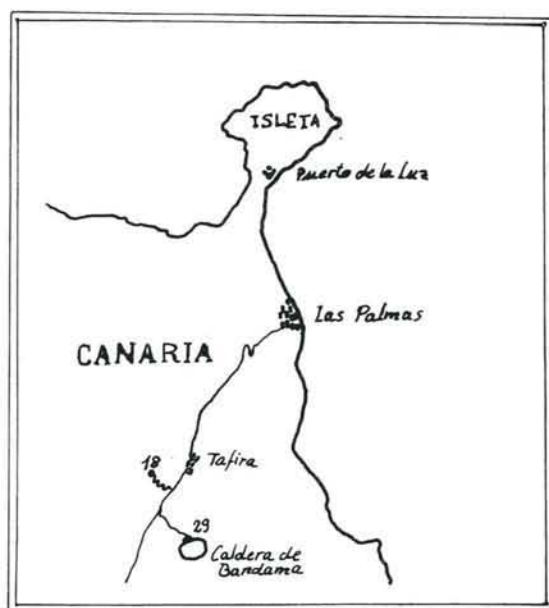


Fig. 28. Detail of the route map of M. Ch. Alluaud, 1891 (see text for explication).



Fig. 29. The original laurel forest zones of Gran Canaria (an attempted reconstruction) and the present day relicts (Kunkel, 1973).

he establishes for the laurisilva (in Sunding = Order *Pruno Lauretalia* + Order *Fayo-Ericetalia arboreae*) do not coincide very much with those of Kunkel (1973b) in his 'Attempted reconstruction' (fig. 29). In our judgement the lower limit of Sunding has been drawn very high, as can be deduced from various earlier authors such as Viera y Clavijo (1866) or Alluaud (1891), who states of his localities 18: «Canaria, 12 Nov. 1889, Los Laureles pres Tafira, Dans l'eau et sur les rives d'un torrent ombragé de lauriers géants, 300m» – and 29 – «Canaria, 8 Janv. 1890, Pic et Cratère de Bandama; (puis comme au n° 18), 450 m.» (fig. 28)

Sunding's upper limit also seems drawn too low. Kunkel, based on small relicts⁷, reconstructs the distribution far more generously (see map, fig. 29).

⁷. «On the other hand the small relicts, often only a few square meters in extent, when they are not located on inaccessible rock cliffs, are only found within farmed areas where they may have been left to provide shade for grazing animals» (Kunkel 1973b, p. 126; translation).

The laurisilva carabids are found very scattered throughout all the N and NE of the Island. Some forms (the W') have remained linked to the small remains of the laurel forest (*Calathus appendiculatus*, for example). Others seem to have become extinct: *Pseudomyas doramensis*, *Asaphidion delatorrei*, *Dicrodontus alluaudi*, or are extremely rare, as *Nebria currax*.

The remainder show clearly disjunct distribution areas, and the major part of which occupy the high and more humid zones of the Island.

We don't know whether these high-lands occupied today by agriculture (e.g., chestnuts) and a formation of high-mountain legumes (perhaps a climax formation of *Chamaecytisus proliferus*, *Teline microphyla*, etc.?), were really once laurisilva or pine woods (cf. Nogales & Schmincke 1969).

It is possible that the carabid fauna would have displaced itself toward a higher zone searching for moisture and adapting to the present formation of legumes and the farming zone. We have thus designated these forms as W?. The study of the edaphic fauna (springtails, par example) could perhaps resolve this question. Personally, we are inclined to think that we are dealing with what used to be a mixed forest.

We include an original map (fig. 30) on which the finds of some frequent forms are noted by letters. It may someday help to reconstruct the real potential distribution map, but in the meantime, and for faunistic studies, we employ that of Kunkel (fig. 29), although we push the inferior limit a little lower in some places.

The e? on the map is a reference to a *Brosicus glaber* captured in 1858 «beneath stones on the dry calcareous hills above Las Palmas» (Wollaston, 1865). We think that this/these specimens found by Wollaston must have been carried by flowing water and deposited at the lower end of the ravine.

Prospections aimed at the discovery of remains of the carabid fauna of the laurisilva, but not to collect in the known localities, promise to result in interesting discoveries. Guided by this intent, during our last trip to Gran Canaria (1974), we discovered several laurisilva species in La Atalaya, at Santa Brigida, among the carabids *Carabus coarctatus* (6 specimens), *Trechus flavolimbatus* and *Calathus angularis*. It was a surprise to collect a *Carabus* at less than 20 m from some 'tabaibas' (*Euphorbia obtusifolia*).

Trechus flavolimbatus, due to its small size and its adaptation to minimal microconditions, could be used as an excellent historic-indicator species.

Compared to Gomera or Tenerife, the Gran Canaria carabid fauna of the laurisilva may be considered as quite complete though poor (impoverished). e.g., it only contains one *Trechus* and three *Calathus*.

Most of the typical genera are present: *Dromius*, *Philorhizus*, *Brosicus*, *Dicrodontus*, etc. Notable are *Pseudomyas*, paleoendemism in this Island, the presence of *Carabus* and *Nebria* relates it to the laurisilva fauna of Tenerife, and of *Cymindis* and *Gomerina*, connecting it with that of Gomera. It is interesting to observe the interrelations among these three Islands, forming something like a unit. At the same time taxa exist which relate

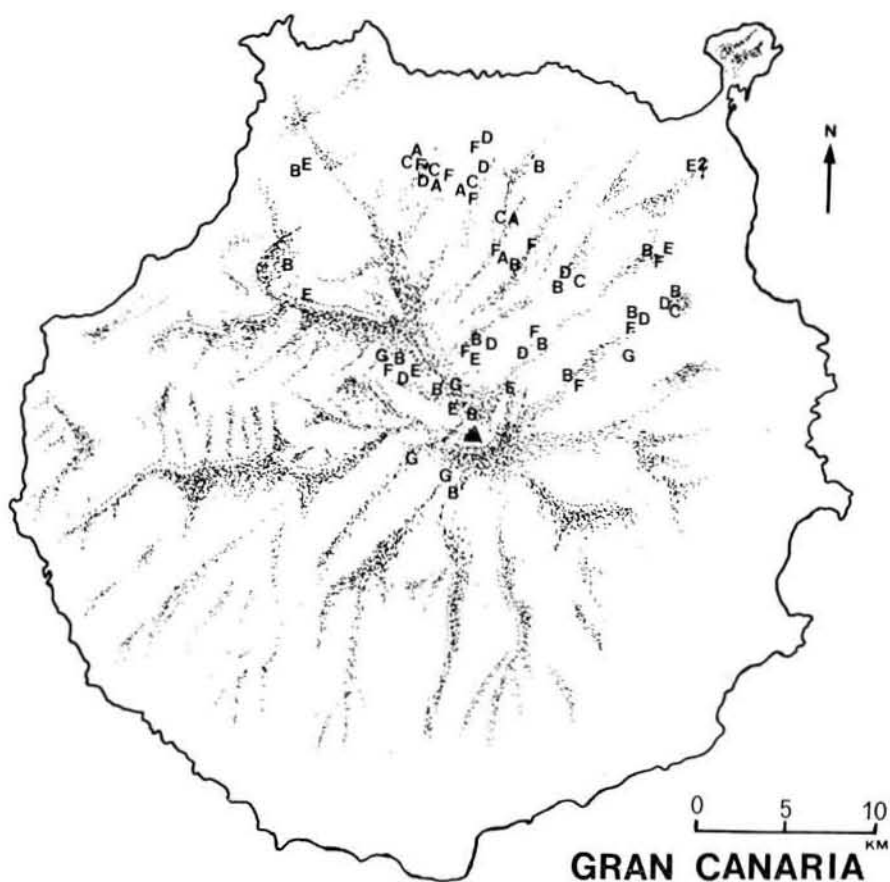


Fig. 30. Distribution of some typical laurisilva carabids of Gran Canaria: **a.** *Calathus appendiculatus* Woll., **b.** *Calathus angularis* Brull., **c.** *Calathus canariensis* Har., **d.** *Carabus coarctatus* Brull., **e.** *Brosicus glaber* (Brull.), **f.** *Trechus flavolimbatus* Woll., **g.** *Cymindis amicta* (Woll.).

each the three Islands, and others that relate them in pairs. We have attempted to summarize these affinities in fig. 31. We have not included the coincidences in *Dromius* and *Philorhizus* because, as noted above, they are very little studied.

Fuerteventura and Lanzarote

These two Islands present some very marked common characteristics that we shall treat them as a unit. The German scientists usually refer to them as the 'Purpurarien'. In reality Lanzarote and Fuerteventura were separated recently (after the last glaciation) and share the same geological

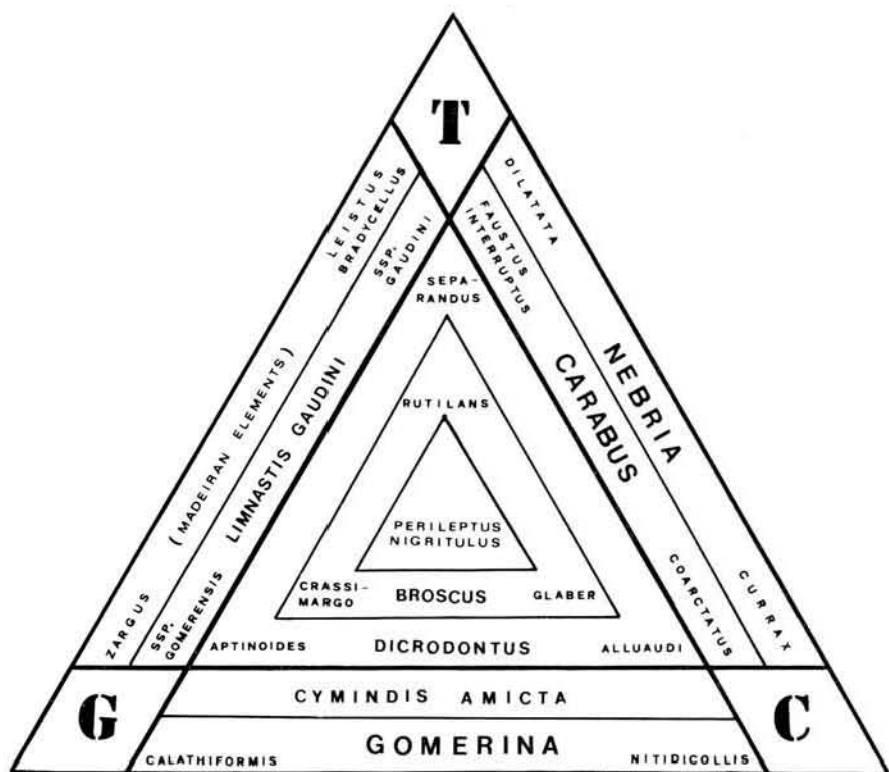


Fig. 31. Faunistic interrelations between the laurisilvae of the three central Islands: Tenerife (T), Gomera (G) and Gran Canaria (C).

base. The La Bocayna Strait separates them by some 11 km, and its depth is not more than 50 m.

Fuerteventura is the longest Island (100 km), and with its 1,725 km² (altitude = 870 m), is the second largest in surface area, after Tenerife. Lanzarote, with its 796 km², is somewhat smaller than La Palma, and with a maximal altitude of 671 m, it is the lowest of the seven main Canary Islands.

According to Dansereau (1968), laurisilva can only have been present on the Western Canaries. Engler (1910) cites some *Laurus* from Lanzarote, as well as several typical accompanying forms from Fuerteventura. Burchard (1929), referring to La Zarza Peak (807 m), states: «Aside from the local peculiarities, I have noted succeeding species that as a whole even point out the partial forestation which existed in far distant times» (translation), and gives a brief list of these plants. Later botanical studies have brought to light (e.g., Kunkel 1974a) other characteristic laurisilva species (*Myrica faya*, *Apollonias barbujuana*, *Erica arborea*, several ferns, etc.), and many present-day botanists differ from Dansereau's opinion when

speaking of 'the last laurel forest relicts' (Voggenreiter 1974), or of the 'perhaps always small' forest zones (Kunkel 1974b).

The present aspect of Fuerteventura and Lanzarote is very different from that of the other Islands. The former are semidesertic, rather flat and without forest formations, having only little stands of *Phoenix*, *Tamarix* (or mixed). But this has not always been the appearance of these Islands.

In the Mid or Late Tertiary, the laurisilva extended from the Atlantic zone, along the Mediterranean region to the Middle East or even further. During the epoch in which the African-facing side of the Canaries was covered with laurisilva⁸, the Lanzarote-Fuerteventura of that time must have enjoyed a similar climate that permitted the covering of a great part of the Island surface by laurisilva (We are considering the Islands as oceanic). The great climatic changes, and the recent desert-forming process suffered by Africa, eliminated the continental laurisilva leaving only a few remains (see Fig. 1). The Eastern Islands, due to their lower altitude and closeness to Africa (110 km), have participated in this desert-formation, although it must have been quite decidedly out of phase due to the moderating action of the Ocean.

It is difficult to evaluate the intensity of this desert-formation to relate it to other factors, volcanic or others of a more artificial type, that must have contributed enormously to the creation of the present arid landscape of these two Islands. Some data conveniently illustrate the desert-formation to which we refer.

According to Torriani (1590), at that time the following existed in Fuerteventura: 60,000 goats and sheep, 4,000 camels, 4,000 donkeys – which came to constitute a plague –, 1,500 horned cattle, 150 pure bred horses «senza infiniti, che sono quasi così boni come quelli di Lanzarote», and 70,000 wild animals (probably domestic animals turned wild). A simple calculation gives us a density of 100 large herbivores per square kilometer!!! (no comments).

Bravo (1964) occupies himself with the desertification of these Islands and notes the presence of *Antophora* (Hymenoptera) nests that are found accumulated by the hundreds in diverse zones (see fig. 32). He has observed (pers. comm.) *Antophora* making this type of nest with mud, near La Orotava (T), which makes him suppose that the Eastern Islands had, until recently, a climate similar to that of the North of Tenerife. The internal shell of a *Limax* (Gastrop. Pulm.) has also been found to be very common, (subfossil). Bravo has collected a living specimen in a spring at Famara (N Lanzarote), and recently we also (1974) in the La Zarza Peak

⁸ «What will probably stand out is the fact that the Canary-laurel forest, far from being an intact relict of Mid- or Late-Tertiary times, is a much impoverished segregate of a richer matrix which has given rise to many other segregates, but remained nowhere in its original undifferentiated state.» (Dansereau, 1968, p. 270).



Fig. 32. *Antophora* nests (subfossil) in sublitoral Fuerteventura. Photo A. Machado.

(F.). The distribution of the *Limax* shells in many zones also speaks of a fairly humid general past climate.

The carabid fauna of the laurisilva of these Islands has disappeared along with the soil and vegetation, and as with the latter, only some vestiges remain in the highest and most humid parts of the Islands (see fig. 3), where the clouds (c.f. Kämmer 1974) have permitted their survival. The most typical relict species is *Calathus simplicicollis*, that has produced a subspecies in each Island (*simplicicollis* in Lanzarote, *gonzalezi* in Fuerteventura). It is extremely localized. The laurisilva of these Islands also contains at least one *Trechus*, *T. detersus*, common to both.

The last laurisilva refuge in Fuerteventura is found in the Cumbres de Jandía, in an almost vertical wall on the N-western side (principally) of La Zarza Peak. Part of the old soil is preserved among the rocks and in the crevices, wherein the remains of the previous fauna are found. It is also observed that many animals take refuge in the hanging leaves of *Odontospermum sericeum* (fig. 33) that characterize the vegetation of the zone. In Lanzarote the refuge corresponds to a vaster region at the Peñas del Chache.

These *Trechus* and *Calathus* are the only carabids that we can consider with some probability as proper to the extinct laurel forests. Of the other forms we only suspect that due to their present localization (they are also to be found in lower zones) not much can be deduced. Such is the case with *Syntomus lanzarotensis*, but Uyttenboogaart (1930) cites it from Los Tiles de Moya on Gran Canaria. This suggests that it is really a sylvan



Fig. 33. *Odontospermum sericeum* (L.f.) Sch. Bip., characteristic species of some cliffs of southern Fuerteventura (Jandía). The persisting dry leaves (arrow!) being a refuge for the remaining laurisilva fauna. Photo A. Machado.

form, adapted to the new conditions of the eastern Islands (as W? in the list).

Dromius and *Philorhizus* should also have existed but we saw that the arboreal stratum has completely disappeared. Nevertheless, some references are known. *Dromius angustus brittoni* was described from a specimen coming from Betancuria (included as W?). *Philorhizus notatus incertus* (Woll.) was collected by its author in Lanzarote (2 specimens) «amongst dry earth and rubbish on some rocks at Ye» (not included at present). We found a *Philorhizus* (?) in the crests of Jandía, among leaves of *Odontospermum sericeum*. It is possible that here this group could give new forms on further investigations, allowing some interrelation with the laurisilva of the other islands to be established. Nevertheless it is evident that the faunal regression is too advanced for it to be reconstructed today.

The high number of laurisilva forms noted for Lanzarote (13) and Fuerteventura (14) is due, as can be observed in the faunistic diagram, to the Type Y forms present in the laurisilva of the other Islands, and also found in the Eastern ones. They must therefore have lived in the laurisilva when this existed.

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