

# ON THE TAXONOMY AND BIOGEOGRAPHICAL ASPECTS OF THE DERMAPTERA OF MADEIRA

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With 9 Figures and 2 Tables

**ABSTRACT:** After synonymisation of three taxa, of which two were formerly only known from single specimens, and after the description of a further species, 11 species of earwigs inhabit Madeira. The endemic part amounts to 36% (4 out of 11). An analysis of the distribution on the island in relation to the altitude shows, that four distinct distribution patterns can be defined (fig. 8). Except for one the accidentally introduced species are found only in the southern part of the island up to the altitude of 200 m. Distribution maps of the four endemic species are given. Their occurrence is more or less sympatric, exclusively in the laurisilva-zone, beginning at 600 m. up to degraded vegetation areas further up (figs. 1a-c). Biogeographical considerations are discussed.

Competition between newcomers or highly adaptable species and the endemics does not exist, but danger of extinction arises for the endemic species due to the increasing destruction of the relevant living areas.

**Keywords:** Endemism, Dermaptera, Madeira, island biogeography, *Perirhynchus pseudomadeirensis* LANGE spec. nov.

**RESUMO:** Após sinonimizar 3 taxa, dois dos quais descritos apenas por um espécimen, e descrever novas espécies para o Arquipélago, o autor eleva para 11 o número de espécies de dermápteros da Madeira. A percentagem de edemismo é de 36 % (4 em 11). Analisando a distribuição em relação com a altitude podem-se definir 4 tipos de distribuição (Fig. 8). Excepto num caso, as espécies introduzidas acidentalmente são apenas encontradas no sul da ilha e até uma altitude de 200 m. São dados mapas de distribuição das 4 espécies endémicas. As suas ocorrências são mais ou menos simpátricas, exclusivamente nas zonas da Laurisilva, desde os 600 m. até às áreas de vegetação degradada situadas a altitudes mais elevadas (Figs 1a - c). São discutidas algumas considerações biogeográficas.

Não existe competição entre as espécies aparecidas recém chegadas e as endémicas, mas o perigo de extinção das últimas é um facto devido à destruição dos habitats naturais.

**Palavras chave:** Endemismo, Dermaptera, Madeira, biogeografia insular, *Perirhynchus pseudomadeirensis* LANGE nov. esp.

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## 1. INTRODUCTION

The fauna of isolated islands has often attracted biologists because of their interesting evolution in species composition. The most interesting problems are concerned with biogeographical or ecological aspects of settlement, dispersal strategies or the special biological species development often under striking conditions. Occasionally these features result in evolutionary phenomena such as endemism or adaptive radiation.

Earwigs are terrestrial insects mostly unable to fly. However, earwigs are distributed all over the world and occur more or less regularly in retiring habits (POPHAM, 1963, STEINMANN, 1973).

Below the systematics and biogeography of the Madeiran earwigs will be treated. In a further paper the biology and ecological niches of some endemic species will be discussed.

The Madeira archipelago, about 800 km. west of the African continental shelf in the northern Atlantic Ocean at 32.44° N and 16.58° W, arose during the tertiary period from the bottom of the sea up to 1862 m. (Pico Ruivo) by volcanic activities (MITCHELL-THOMÉ 1976). It consists of Madeira proper, Porto Santo (41 km<sup>2</sup>) 45 km. northeast of it and the three Desertas, which are slender, being the considerably high tops of a submarine ridge running southeast from Madeira proper.

The main island has an area of 728 km<sup>2</sup>. The landscape is extremely eroded and surrounded by high cliffs. The warm-humid climate is influenced by trade winds and allows a rich vegetation (1141 species, 11% endemic, after SUNDING, 1979), of which the laurisilva is the most typical and interesting vegetation in the higher altitudes (SJOGREN, 1972).

The fauna is a striking one, rich in endemics and disharmonious in missing typical continental groups, such as snakes, scorpions, and amphibians or freshwater fishes, except of course the eel.

BRINDLE (1969), who published the last résumé and complete paper about the earwigs of Madeira, listed altogether 13 species, 6 of which endemics. He summarizes various papers on the Madeiran fauna written by CHOPARD (1938, 1942) and HINCKS (1938, 1961).

Other authors indicated the poverty of species, and emphasized the high percentage of endemism (CHOPARD, 1937, HINCKS, 1961 and FERNANDES, 1972).

CHOPARD noted a relatively high percentage of earwigs in comparison with the Orthopteran fauna, although this value does not by far reach 74% as on the Canary Islands (BAEZ & GARCIA, 1986).

## 2. MATERIAL AND METHODS

On 3 excursions during August/September 1986, July-September 1988 and April/May 1989 the author collected more than 1900 specimens on the islands of Madeira proper, Porto Santo and Deserta Grande.

The following methods were used:

- barber-traps (10 plastic cups of 7cm. diameter at each locality, which were protected by wide lattice work or flat stones).
- cuffs, 5 pieces per locality, consisting of a single-sided corrugated cardboard (about 40cm. wide), fixed round the trunks at a height of about 1-2 metres.
- 'tree traps': plastic cups, of which the inner surface was roughened with ethyl acetate and sand, packed with woodwool or lichens. 5 traps at each locality were fixed upside down on trees at about a height of 2-4 m.
- netting (30cm.): a series of 20 strokes was usually repeated 10 times at one locality. This method worked exclusively in the broad-leaved vegetation, but never on *Erica scoparia* or *E. arborea*.

The first three types of traps were controlled at intervals of 10-14 days. Supplementary spots were checked: multi-layered bark of *Erica* spp. and the epiphytic moss *Hypnum cupressiforme*, moss-layer on rocks, under stones and in rotten tree trunks.

Additional material for comparison and for examination of the types from the following museums were used:

- Museu Municipal do Funchal, Funchal (MMF)
- Università di Torino, Dipartimento di Biologia Animale (UT)
- Naturhistoriska Riksmuseet, Stockholm (NRS)
- British Museum (Natural History), London (BMNH)
- Zoologisk Museum Kobenhavn (ZMK)
- Naturhistoriska Museet Goteborg (NMG)
- Jardim Botânico da Madeira, Funchal (JBF)
- Muséum National D'Histoire Naturelle, Paris (MNHN)

## 3. LIST OF THE SPECIES

### CARCINOPHORIDAE

#### *Anisolabis maritima* (GÉNÉ, 1832)

*Anisolabis maritima* is recorded from various places on the northern and southern side of Madeira proper, and also from Deserta Grande (MMF). A record from Porto Santo is still missing, but is expected to be recorded presently.

This species lives only in the litoral zone and in estuaries, often together with *Mogoplistes squamiger*, an apterous gryllid.

*Euborellia annulipes* (LUCAS, 1847)

Widespread from the costal region up to 1300 m., common. It occurs also on Porto Santo and Deserta Grande, which are new records for this species. It is probably introduced, as demonstrated by records from various isolated islands (BRINDLE, 1969) and several accidental introductions in Northern Germany (GÜNTHER & HERTER, 1974).

The ecological range seems to be extremely variable: it was found in houses, banana-trees, under stones at the border of the laurisilva but also under cow-dung near the beach on Porto Santo.

LABIDURIDAE

*Labidura riparia* (PALLAS, 1773)

Restricted to dunes and sandy hills only on the Ponta de São Lourenço, the easternmost peninsula of Madeira proper, and the beaches of Porto Santo and Deserta Grande (CHOPARD, 1938). Older records from the environment of Funchal and Santana could not be confirmed (BURR 1912, BORELLI, 1906, CHOPARD, 1938, MMF, JBF).

The occurrence is always correlated with sandy ground, often without vegetation.

LABIIDAE

*Labia curvicauda* (MOTSCHULSKY, 1863) and *L. minor* (L., 1758)

Both species are cosmopolitan and most likely introduced, because they were never found outside the cultural zone. BRINDLE (1969) mentioned no further records of these species from any other oceanic islands.

*L. minor* was often observed flying, a great exception in Dermaptera (own observations). *Labia curvicauda* was caught in leaf sheathes of banana plants.

FORFICULIDAE

*Forficula auricularia* L., 1758  
(=*Forficula laeviforceps* CHOPARD, 1938 syn. nov.)

The most common earwig. The records reach from 300 m. to 1810 m. alt., except

for one striking record of one male cercus on the Ponta de São Lourenço (PIEPER *leg.*). Normally the species avoids hot and arid areas of the lowest coastal region.

*F. laeviforceps* was described from one male, collected on the plateau of Paul da Serra (1600 m.). The male type specimen in the Muséum National d'Histoire Naturelle Paris differs from *F. auricularia* only in the morphology of the cerci. It possesses no caudally directed tooth on the basal extension, the cerci are taller and less curved. In the comprehensive work of KUHLE (1928) the variability of the abdominal appendages and their anomalies of *F. auricularia* is described in detail. The cerci of the type specimen fit quite well to KUHLE's figures. The only other known specimen of this species, a female labelled *F. laeviforceps* in the Museu Municipal do Funchal, which was found in Fajã da Nogueira in 1979, belongs to *F. auricularia*.

These differences in the cercus morphology, combined with the fact, that only one specimen is known, leads to the conclusion, that *F. laeviforceps* is an aberration of *F. auricularia*.

*F. auricularia* was found almost exclusively under stones, under dried cow dung or in rotten bark.

It was often assumed that *F. auricularia* replaces the endemic species as a result of competition or occupying new habitats (BRINDLE, 1969). *F. auricularia* and the endemic species, however, have different demands on the biotopes. Therefore an interspecific competition on the same food- and habitat-resources can be excluded. *F. auricularia* settles in areas, which were influenced by urbanisation or agriculture (for example: wasteland or short grazed slopes as a result of goat- and sheepgrazing). It never occurs sympatric with endemic species of the genus *Perirrhynchus* or *Anechura*. Consequently *F. auricularia* is only able to expand after the destruction of natural vegetation, formerly settled by endemics.

### *Forficula barroisi* BOLIVAR, 1893

Only CHOPARD recorded 5 specimens from Caniçal, which are deposited in Paris (MNHN). These have been examined, and show well developed elytra with light coloured tips on the alae and pronota. This species probably was once introduced and became extinct after a short period of time.

*F. barroisi* has a palaearctic distribution in Northern Africa, South-eastern Asia and Iran. According to HARZ & KALTENBACH (1976) *F. barroisi* is synonymous with *F. lucasi*, but HARZ (in HARZ & KALTENBACH, 1976) added a question mark to his comments. Since this taxonomic problem is not solved, *F. barroisi* is still recorded as a valid taxon.

*Anechura schmitzii* (BORELLI, 1906)  
(=*Forficula brevitarsis* CHOPARD, 1942 *syn. nov.*)

Endemic to Madeira, between 600 m. and 1620 m. (fig. 1a). The genus is distributed over the palaearctis, moreover there exist some species, which are also restricted to extremely small islands, for example São Tomé, Tonkin, Sokotra (GÜNTHER & HERTER 1974).

Description:

The antennae consist of 13 joints, beginning to be hairy at the third article. Head dark brown to almost black, always darker than pronotum and elytron. Pronotum elongate, the hind margin rounded. Elytron shortened, but longer than pronotum (fig. 2a). Abdomen yellowish to dark brown, often along the parallel margins with a dark streak, especially in the light coloured specimens, but the tip of the abdomen is always dark or shiny black. Pygidium of the males very broad, standing up with a bulging grooved border. Male cerci strong, inserted diverging, on the inner side softly serrated; sometimes with a flat tooth behind the first quarter (fig. 3a). Female cerci short, broad at the basis, straight and tapering (fig. 3b).

Genital apparatus (fig. 7a): Virga twice as long as the parameres, at the extended basis a hooklike curve.

CHOPARD described *F. brevitarsis* after one specimen, now stored in the MNHN. This specimen is a female of *A. schmitzii* (BORELLI, 1906). The colouration pattern of the cerci and the last sternite correspond to that of *A. schmitzii*, and the metatarsi are not shortened, as CHOPARD (1942) has mentioned in his description. CHOPARD's figure (6, p. 12) of the cerci is not in congruence with the specimen: They are drawn too broad.

*Perirrhytus edentulus* (WOLLASTON, 1858)

The genus *Perirrhytus* is endemic on Madeira proper and includes three species, which are brachypterous and provided with simple cerci. *Perirrhytus edentulus* is restricted to few localities between 720 and 1450m. (fig. 1c), but there it is common. Some older records before 1936 from lower altitudes on the southern side, where the laurisilva is destroyed now, show that the distribution area must have been greater formerly (see blank spots in fig. 1c). GANGWERE, MARTIN & MORALES AGACINO (1972) mention one record of *Perirrhytus edentulus* from Tenerife in a short footnote, the specimen of which has still to be examined.

### Description:

Body dull, dark reddish-brown, surface strongly punctured, especially the abdomen. Pronotum transverse, the margins bent upright. Elytron shortened oblique, broad, always shorter than pronotum length, the side margins curved (fig. 2b). Abdomen more or less oval shaped. Cerci weakly curved, basis round in the crossing section without border or teeth, but sometimes in the distal half an inner ledge (fig. 4a). Female cerci more or less straight, only the tips are curved, inner margin serrated (fig. 4b).

*Perirrhytus madeirensis* (BORELLI, 1908)  
(= *Perirrhytus lundbladi* HINCKS, 1938 *syn. nov.*)

Widespread from 605 m. to 1750 m. alt. being the most common endemic species (fig. 1b).

FERNANDES (1972) published one record from Deserta Grande, but this note is rather doubtful for a species, which is adapted to a life on trees in a forest with high moisture. Deserta Grande offers the most unfitting conditions, where trees are completely missing and a desert-like, dry climate is predominant in general.

### Description:

Antenna with 13 joints, beginning with the third or sometimes the fourth joint darker and hairy. Head dark brown, hind margin light, shiny as the whole body. Pronotum rectangular or elongated, bent up at the side margins, often with a typical colouration of two broad streaks along a yellowish brown ground. Elytron shortened oblique,  $\pm$  as long as pronotum (fig. 2c). Abdomen shiny, surface weakly punctured; light brown and at the sides with dark stripes or completely maroon. The side margins are formed parallel. Hind margin of the male pygidium straight, sometimes with two acute corners, in the middle of the pygidium a flat triangular curvature, ending in an outstanding tip. Cerci of the males long and tender, at the basis extended with a curved border on the inner side. If a tooth is present, then near the basis at the underside. There exist all variations from a marked tooth to its complete absence (fig. 5a). Female cerci straight, slender, only the tips curved, inner side serrated (fig. 5b).

The descriptions of HINCKS (1938) and BRINDLE (1969) of *P. madeirensis* are quite incorrect, because both noted, that the tooth of the male cercus is inserted on the upper side, without an inner border. Obviously both interpreted the original description of BORELLI (1908) wrongly.

Accordingly the holotype of *P. lundbladi* (HINCKS, 1938) (NRS) completely fits the holotype of *P. madeirensis* (BORELLI, 1908)(UT). Therefore the name of the species *P. lundbladi* has to be rejected as a synonym. Neither CHOPARD nor HINCKS, nor BRINDLE

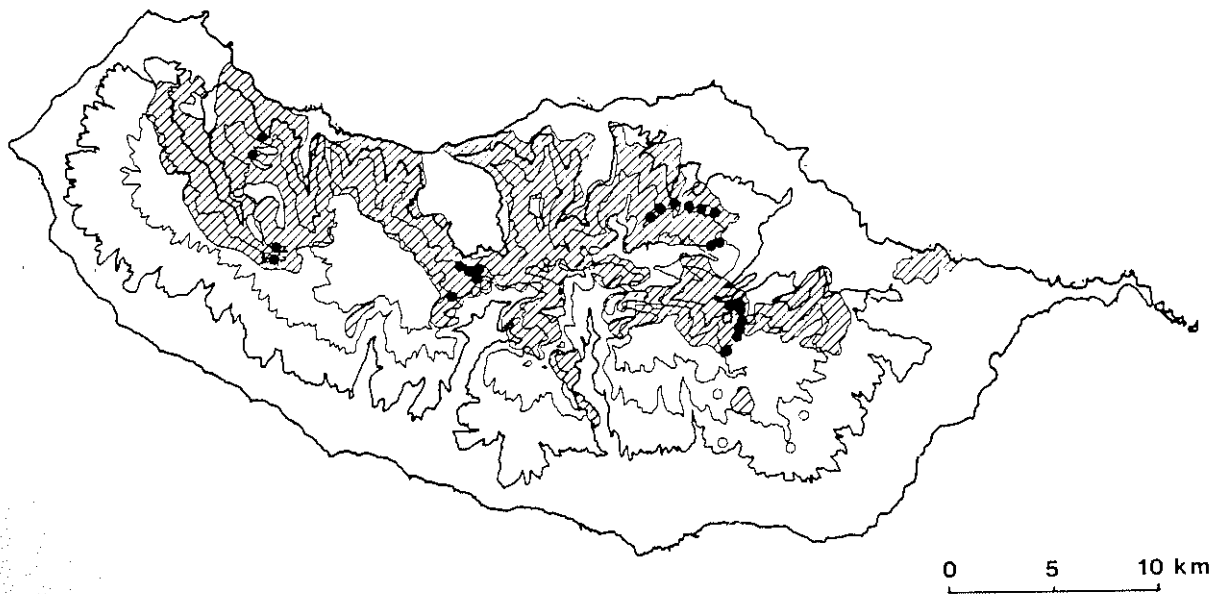


Fig. 1.(a) -- Distribution map of *Anechura schmitzii*. Contour lines: 500, 1000 and 1500 m. Hatching: indigenous vegetation. (After RIBEIRO 1985).



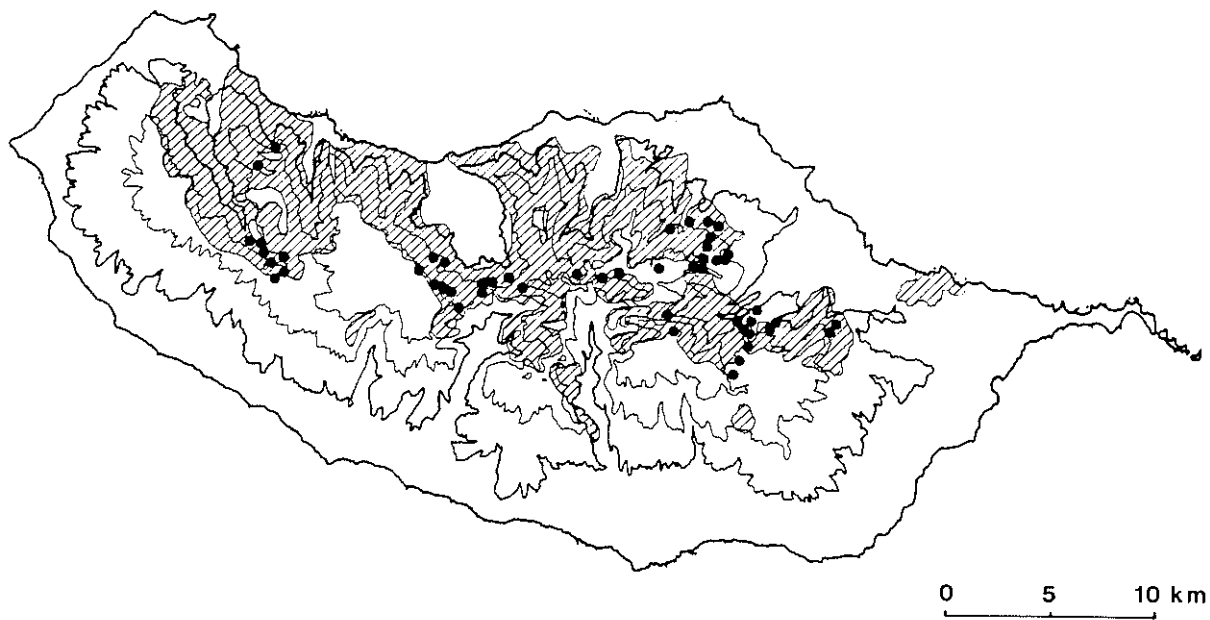


Fig. 1(b) -- Distribution map of *Perirrhytus madeirensis*. Contour lines: 500, 1000 and 1500 m. Hatching: indigenous vegetation. (After RIBEIRO 1985).

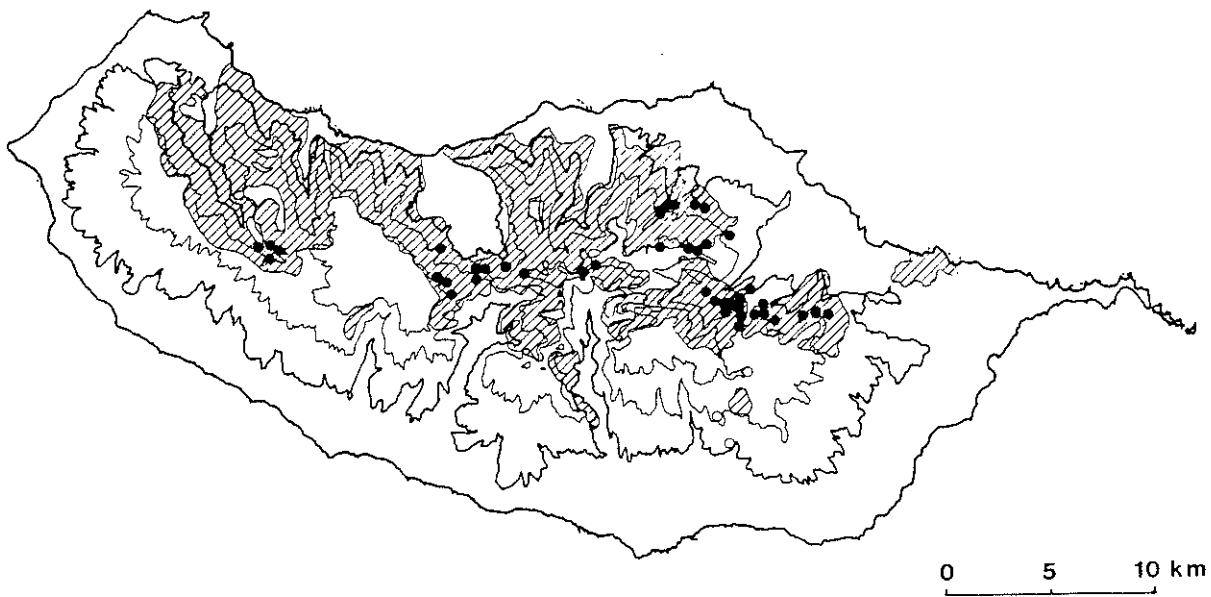


Fig. 1(c) -- Distribution map of *P. edentulus* and *P. pseudomadeiraensis* n. sp. (square). The blank spots represent records before 1936 of *P. edentulus*. Contour lines: 500, 1000 and 1500 m. Hatching: indigenous vegetation. (After RIBEIRO 1985).

have ever compared their specimens with BORELLI's holotype.

*Perirrhytus pseudomadeirensis* LANGE spec. nov.  
(= *Perirrhytus madeirensis sensu* HINCKS, 1938)

Similar to *P. edentulus*, but larger (see tab. 1), somewhat more shiny and more reddish coloured. The virga is very long and resembles that of *A. schmitzii*.

Description:

Antenna hairy, beginning with the third joint, yellowish-brown. Head reddish, silky. Pronotum somewhat broader than long, side margins and the front corners bent upright, hind margin strongly curved, yellow reddish-brown like antenna, legs and elytron. Elytra obliquely cut, side margins parallel, almost as long as pronotum (fig. 2d). Abdomen moderately punctured, silky, reddish light brown. Pygidium flat, the hind margin concave, without any incurvation. Cerci large and robust, slightly curved with a strong tooth on the upper basis, which is rounded and not extended (fig. 6). Male genitalia (fig. 7d): Virga about 1.5 times as long as parameres, basis of the virga slightly curved, the extension of the virga is inserted straight.

Body length	Diameter of head capsule	Pronotum width	Pronotum length	Length of cerci
5.70	2.40	2.52	2.24	5.70
5.11	2.48	2.71	2.36	5.11

Tab. 1 - Measurements of *Perirrhytus pseudomadeirensis* n. sp. (in mm.).

Distribution:

Madeira proper, only one locality between Balcões and Fajã da Nogueira, 810 m. (fig. 1c). *P. pseudomadeirensis* occurs sympatric with the other endemic species.

HINCKS must have found specimens resembling those of the description given above in the material of LUNDBLAD, which he worked on, but unfortunately he assigned them to *P. madeirensis* as a result of a misinterpretation. He gives a redescription of *P. madeirensis* in his work of 1938, which does not fit to the holotype of *P. madeirensis* BORELLI (1908), but completely fits to the two specimens, found near Balcões. HINCKS restored no type according to his redescription and can not be regarded as an introduction of a new name in conformation with the taxonomical nomenclature.

Nothing is yet known about the ecology. Interestingly the two males were found in the same 'tree-trap' of the same locality, which points to an arboricolous mode of life. In consideration of the fact, that extensive research in the vegetation was made with different methods, this species must be declared as very rare, or perhaps it is restricted to a limited area. Females have not yet been found.

#### 4. IDENTIFICATION KEY

BRINDLE (1969) published an identification key for the Dermaptera of Madeira. According to the new results, his key had to be modified in some points:

- 1) Elytra completely absent ..... 2  
 Elytra present ..... 3
- 2) Small, less than 12mm.; basal and some distal segments of the antennae lighter in colour than the others; femora with a dark ring; lateral margins of pronotum not sinuate .....  
 ..... *Euborellia annulipes*
- Larger, more than 16mm; antenna segments and femora uniformly coloured; lateral margins of pronotum sinuate ..... *Anisolabis maritima*
- 3) Hind wings longer than elytra, the tips being visible ..... 4  
 Hind wings reduced and covered by the elytra, or totally absent ..... 8
- 4) Small, less than 7mm.; body surface, especially elytra and wings, pubescent ..... 5  
 Larger; body smooth, never pubescent; male cerci more or less strongly dentate or irregularly serrate at inner margins ..... 6
- 5) Head, pronotum, elytra and wings dark; cerci in male and female short, strongly broadened at base ..... *Labia curvicauda*
- Body uniform brown, at least head darker; legs and antennae pale, the last 1-3 apical segments sometimes light-yellow; male and female cerci more slender, not strongly broadened at base ..... *Labia minor*
- 6) Second tarsal segment simple; antennae with more than 20 segments; elytra glabrous; colouration of body light yellowish brown ..... *Labidura riparia*
- Second tarsal segment bilobed; antennae with less than 15 segments; colour of elytra and body reddish brown to dark brown ..... 7

- 7) Each elytron with a yellow spot; basal extension of male cerci at least as long as the distal part, flattened, inner side blackish with small regular tubercles . . . . . *Forficula barroisi*

Elytron without clear spots; basal extension of male cercus shorter than half the complete cercus, in most cases one large tooth on the inner side of the distal end of the basal extension . . . . . *Forficula auricularia*

- 8) Head always darker than thorax and abdomen; pygidium of the males exceptionally broad; cerci inserted wide apart, strong and straight (fig. 3a); cerci of females short and strong (fig. 3b) . . . . . *Anechura schmitzii*

Pygidium small and narrow; cerci slender . . . . . 9

- 9) Body shining, light to dark brown: sides of the abdomen often darkened and pronotum with a broad dark streak; pronotum parallel-sided; elytra longer, the margins outside straight (fig. 2c); male cerci with a short inner border of upper side; if a tooth present, then inserted at the bottom on the inner side, near the basis (fig. 5a) . . . . . *Perirrhynchus madeirensis*

Body surface dull or silky, colouration different . . . . . 10

- 10) Body surface dull, dark maroon; pronotum transverse, elytra short, the margins outside slightly curved (fig. 2b); male cerci without teeth and not widened at base (fig. 4a); very rarely in the middle of the male cerci an inner ledge . . . . . *Perirrhynchus edentulus*

Body surface silky, light reddish brown; posterior margin of pronotum curved (fig. 2d); male cerci on the upper side always with a strong tooth (fig. 6) . . . . . *Perirrhynchus pseudomadeirensis* n. sp.

## 5. DISTRIBUTION OF THE SPECIES IN RELATION TO ALTITUDE AND VEGETATION

The biotic and abiotic factors change with increasing altitude. These parameters determine the occurrence of the different species in distinct regions.

Especially the abiotic factors such as temperature, humidity or precipitation seem to have an important influence on Dermaptera (GÜNTHER & HERTER 1974). Biotic factors such as food supplies have no considerable influence, because Dermaptera are otherwise generally oligo- or polyphagous. Distinct preferences to special habitats can be recognized in some cases and there the distribution is limited according to the occurrence of the respective biotopes.

After analysis of all recorded localities four distinct distribution patterns can be defined according to their heights and their ranges (fig. 8).

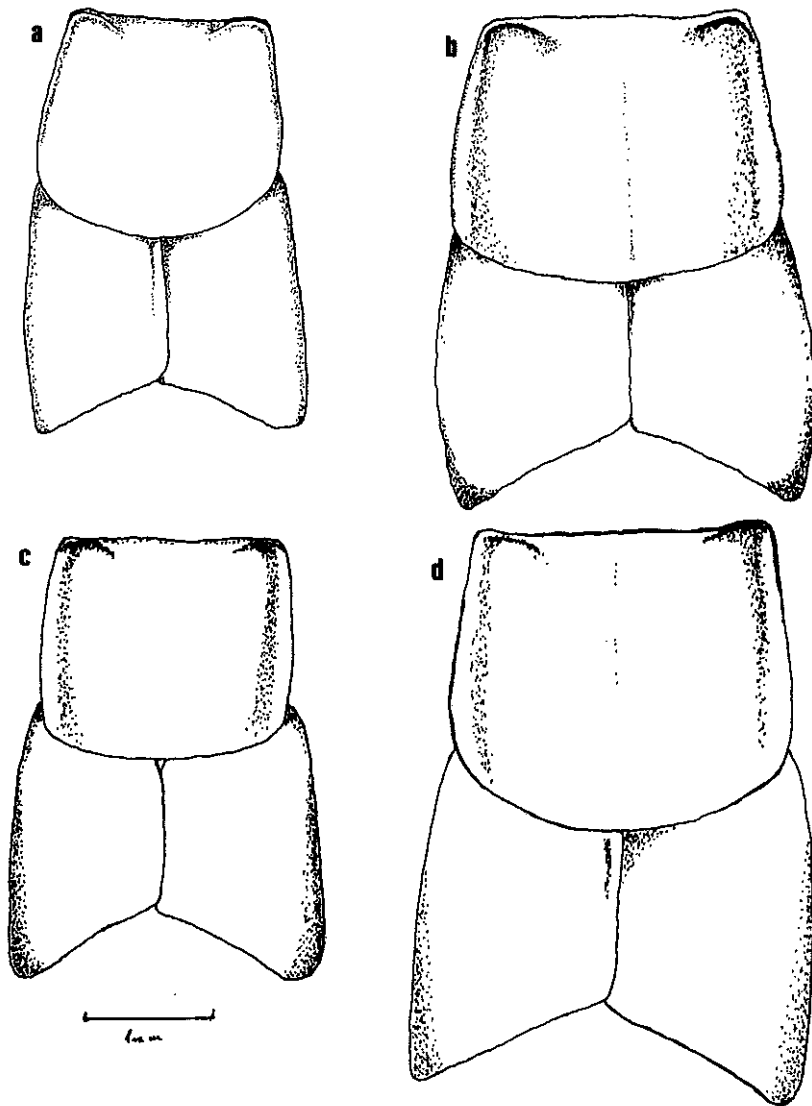
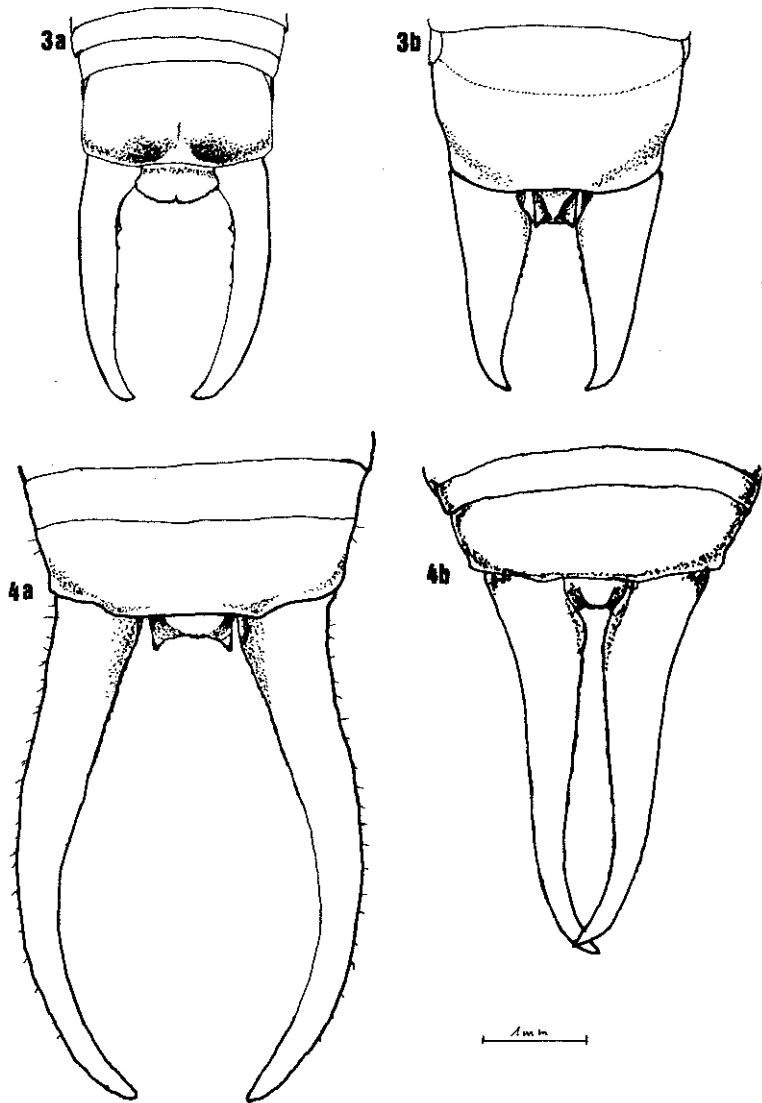
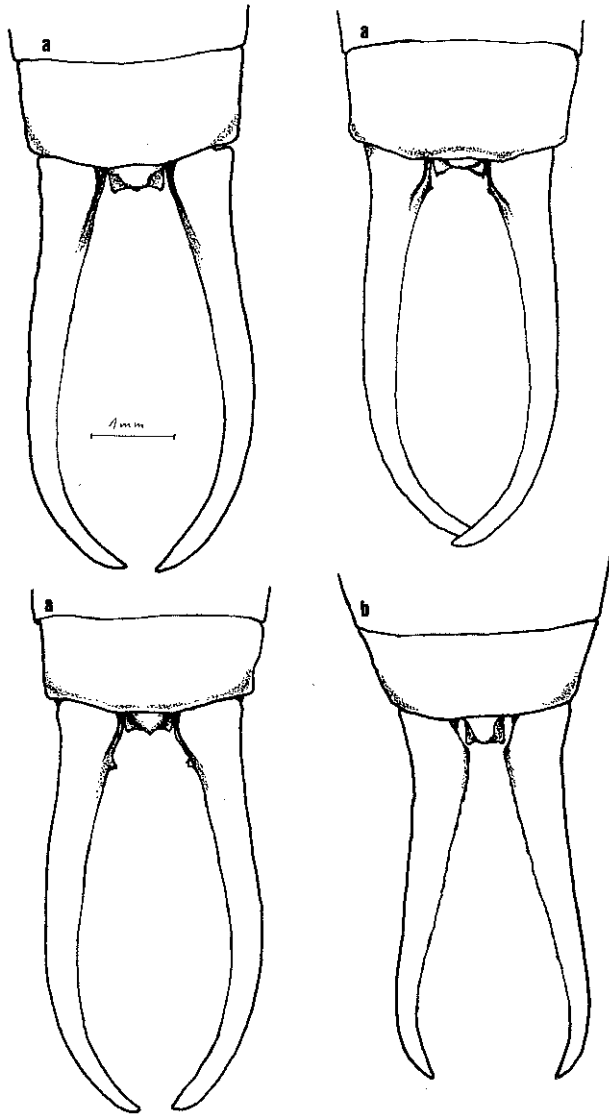


Fig. 2 -- Pronotum and elytra of the males of a) *Anechura schmitzii*, b) *Perirhytus edentulus*, c) *P. madeirensis*, d) *P. pseudomadeirensis* n. sp.



Figs. 3-4 -- 3) Cerci of *Anechura schmitzii* a) male b) female.

4) Cerci of *Perirrhynchus edentulus* a) male cerci b) female cerci.



Figs. 5 -- *Perirhytus madeirensis* a) Three male cerci, showing the variability  
b) female cerci.



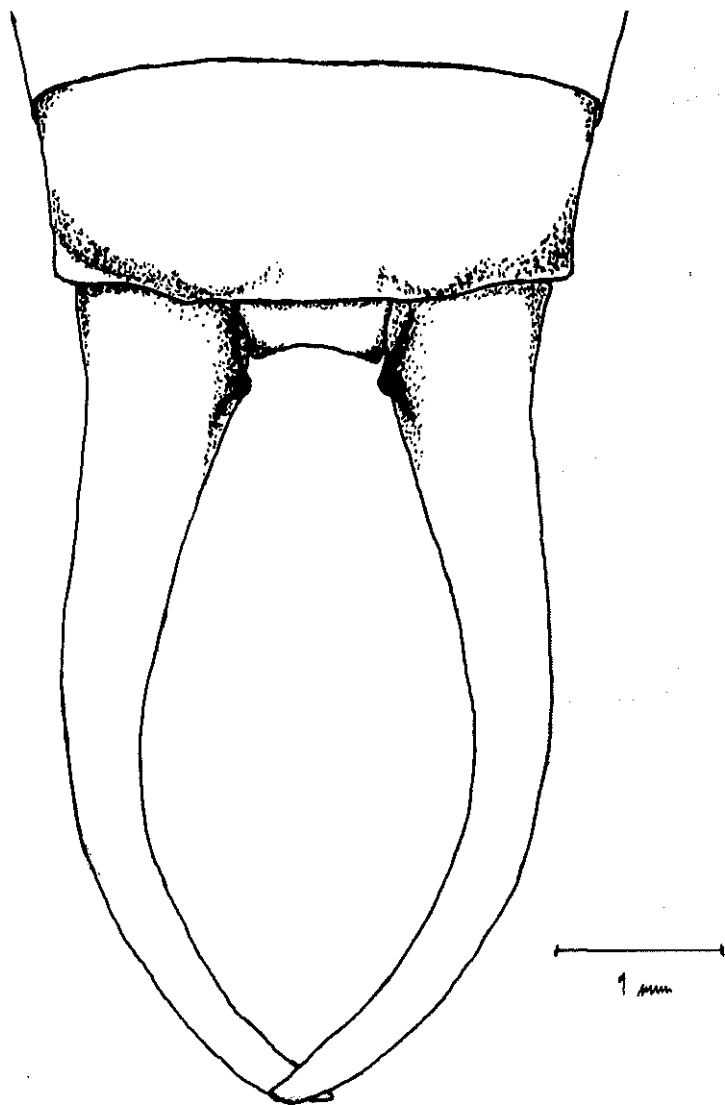


Fig 6 -- Male cerci of *P. pseudomadeirensis* n. sp.

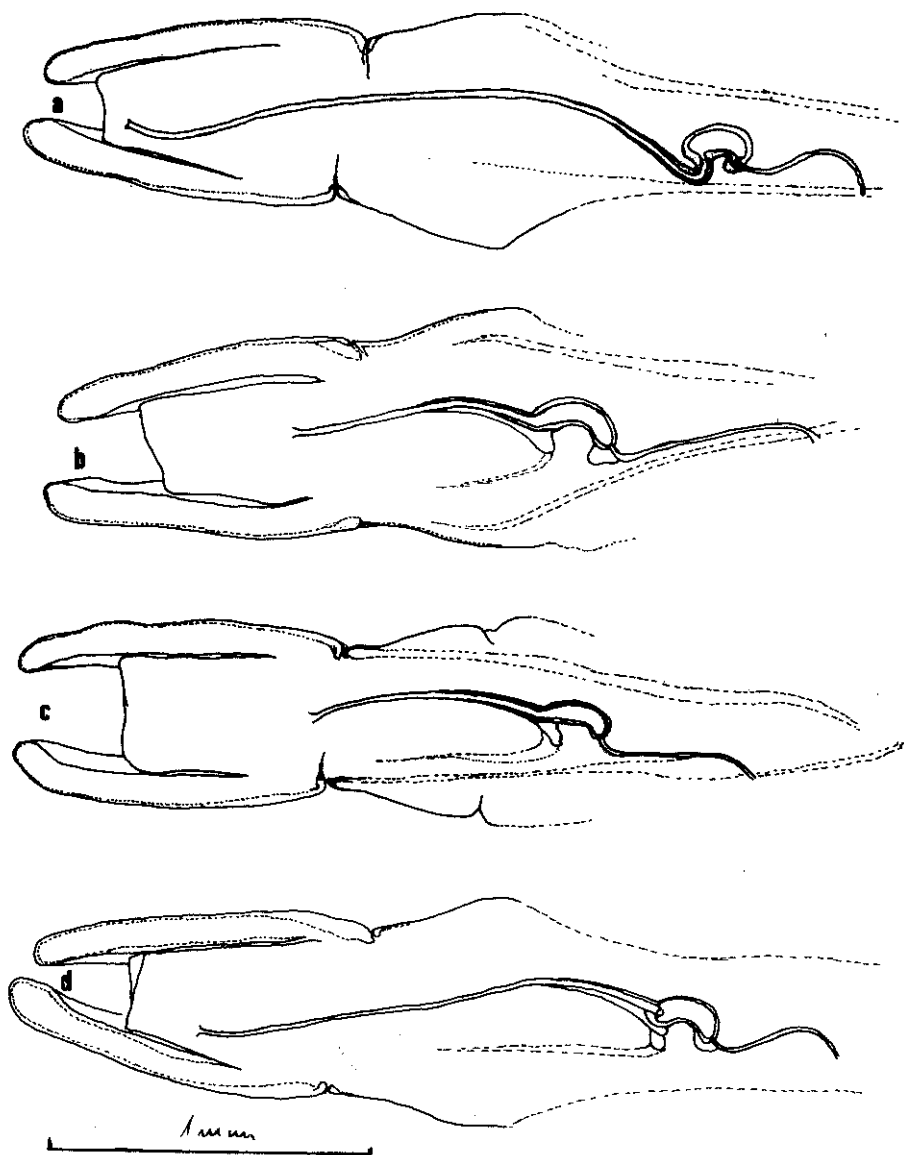


Fig. 7 -- Inner male genitalia-complex of a) *Anechura schmitzii*, b) *Perirhynchus eden-  
tulus*, c) *P. madeirensis*, d) *P. pseudomadeirensis* n. sp..

One distribution pattern is defined by species, which are restricted to the littoral zone. This is the case only in *Anisolabis maritima*.

The second type includes one palaeartic and three cosmopolitan species, living from the lowest area up to 200-250 m., especially on the southern and eastern side. *Forficula barroisi* and *Labidura riparia* are found locally near Caniçal and Ponta de São Lourenço, while the two Labiidae are found mostly in the arable region on the southern side.

The third pattern: The occurrence of *F. auricularia* and *Euborellia annulipes* shows an extremely wide range up to more than 1300m.. They live in various kinds of habitats always preferring regions, which were influenced by man.

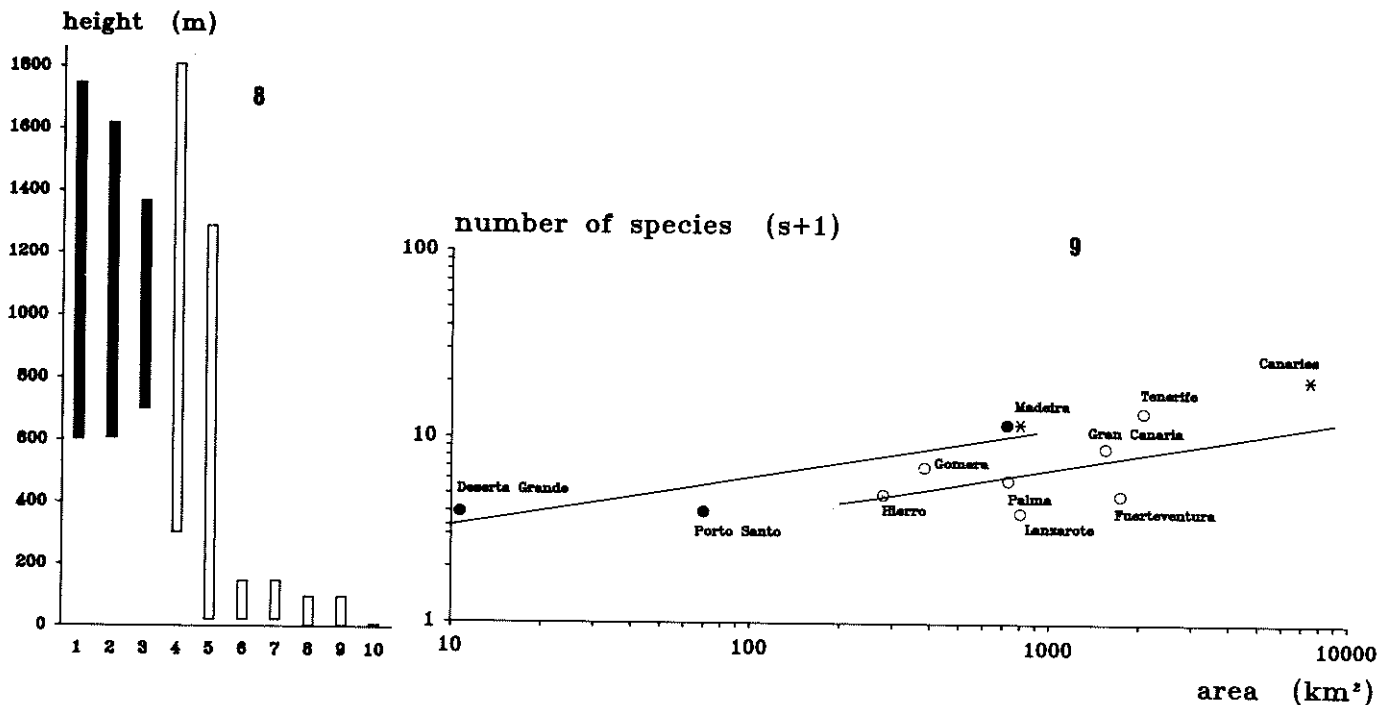
The endemic species, occurring between 600 and 1800 m. (fig. 8, black columns), could be joined in a fourth uniform pattern type. Small differences can be recognised in their ranges. For example *Perirrhytus madeirensis* outlines a range of nearly 1200 m. between 605 and 1750 m., *Anechura schmitzii* between 600 and 1620 m., and *P. edentulus* was found in a region from 720 to 1450m., but generally they are assembled in the primary indigenous laurisilva.

The distribution patterns show a typical order. Especially below 200 m. the cosmopolitan and accidentally introduced species are common, because in the lowest regions the landscape and vegetation had been destroyed or changed since a long time ago. Newcomers first arrived here in a variously shaped and primarily impoverished region. This situation fits to *Labia minor* and *L. curvicauda*.

Besides this the euryecious and highly adaptable species occur at every altitudes in various kinds of habitats, such as *Forficula auricularia* and *Euborellia annulipes*. It is interesting, that both species are missing in the laurel forest. No competition exists there between these faunistic elements and the following species, in contrast with the assumptions of HINCKS (1961) and FERNANDES (1972).

The endemic earwigs live in a more or less limited region, which is located in the zone of trade winds up to the summit region. It completely belongs to the zone of the *Clethro-Laurion* plant community. The limits of the proper *Clethro-Laurion* are from 700-1200 m. (southern side) or 300-1300 m. (northern side) (SJOGREN, 1972). Degradated grass-communities of this formation go up to the summit. RIBEIRO (1985) mapped the actual distribution of the indigenous vegetation, which is mainly composed of laurel forest (figs. 1a-c). There is an obvious coincidence of all localities with this vegetation. Thus the destruction of the laurisilva will lead to a restriction of the endemics, but not to competition with the introduced species (see above).

From the distribution of the endemic earwigs in relation to the autochthonous vegetation the conclusion can be drawn, that the earwigs must have evolved synchronously or later with the formation of the *Clethro-Laurion* and in no case can be older than this plant community.



Figs. 8-9 -- 8) Distribution of 10 species in relation to altitude. 1=*P. madeirensis*; 2=*A. schmitzii*; 3=*P. edentulus*; 4=*F. auricularia*; 5=*E. annulipes*; 6=*L. curvicauda*; 7=*L. minor*; 8=*L. riparia*; 9=*F. barroisi*; 10=*A. maritima*. Ordinate = altitude (m.). Endemics (1-3): black columns, non-endemics (4-10): white columns.

9) Species-area-relation of the Dermaptera on the seven largest Canary Islands (open circles) and the three largest islands of the Madeiran Archipelago (filled circles). The total area and number of species for each archipelago is marked with (\*). The regression-lines were computed; for the Canary Islands:  $S = 0.04 \times C^{0.27}$ , for Madeira:  $S = 0.26 \times C^{0.26}$ . Completed after BAEZ & GARCIA (1986), CHOPARD (1958), JOHNSEN (1974), MARTIN & OROMI (1988). Measurements of areas after MITCHELL-THOMÉ (1976).

## 6. BIOGEOGRAPHICAL ASPECTS OF MADEIRAN DERMAPTERA

Of the 11 species listed above, 6 are cosmopolitan and 4 endemic (tab. 2). The proportion of endemism in the Madeiran Dermapterous fauna is actually 36%, while BRINDLE (1969) still gave a value of 46%.

This percentage is quite typical for insects on Madeira. For example the percentage of endemism for the *Thysanoptera* is given as 20% (Z. STRASSEN, 1984), for the Coleopterous fauna 38.7% (after LUNDBLAD, 1958) and for the *Neuroptera* 43% (OHM & HOLZEL, 1984).

The introduced species live in the lowest parts of the southern coast, while the endemic ones are established in the upper zones of the indigenous laurel forest beginning at 600m. alt. (figs. 1a-c). The percentage of endemism is growing with increasing altitude, a phenomenon one can observe in many mountainous islands, and is totally supported by Madeira (QUARTAU, 1982).

Typically the endemics are not able to fly and possess only shortened elytra (tegmina). [A secondary unfitness of flying on isolated islands is often interpreted as an adaptation against drifting onto the open sea. This explanation is not correct in this case, because the endemic earwigs inhabit only soil and trees in forests and never get into the danger of drifting away (see also QUARTAU, 1982).] The Carcinophoridae, a family with numerous plesiomorph characteristics, have a nearly cosmopolitan distribution, although they are completely apterous and unable to fly (tab. 2).

From the earwigs treated in this paper, observations in sporadic flying was reported only for *Labia minor* and *Forficula auricularia* (BRINDLE, 1969, GÜNTHER & HERTER 1974, MOURIER, 1986, own observations). But in any case earwigs fly quite inadequately.

From *F. auricularia* is known, that only few individuals possess a sufficient musculature for flying, and moreover fly rather clumsily (GÜNTHER & HERTER, 1974). It is unlikely, that such specimens could reach an isolated archipelago such as Madeira in this active way.

This points to other strategies of spreading, for example passive drifting. It can stand for drifting in stormy or constantly blowing winds through the air, drifting on floating wood or parts of plants, or via phoresy on birds. For *L. minor*, *L. curvicauda* and probably for *Euborellia annulipes* and *Labidura riparia* accidental introduction by human transport has been assumed. For biogeographical considerations these species can be set aside.

In which way the autochthonous species settled successfully in Madeira remains an open question.

Perhaps seamounts and shallows, which rise close to the surface from 4000m. depth, situated between Portugal and Madeira, could have acted as stepping stones

Family / species	Status	Character of tegmina	M	P S	D G	1	2	3	4	5	6
<b>CARCINOPHORIDAE</b>											
<i>Anisolabis maritima</i>	Cos.	apter.	x	-	*				x	x	x
<i>Euborelia annulipes</i> *?	Cos.	apter.	x	*	*	x	x	x	x		x
<b>LABIDURIDAE</b>											
<i>Labidura riparia</i> *?	Cos.	winged	x	x	x	x	x			x	x
<b>LABIIDAE</b>											
<i>Labia minor</i> *	Cos.	winged	x	-	-		x				x
<i>L. curvicauda</i>	Cos.	winged	x	-	-	x	x				x
<b>FORFICULIDAE</b>											
<i>Forficula auricularia</i>	Cos.	winged	x	x	-	x	x	x	x	x	x
<i>F. barroisi</i> *?	Pal.	winged	x	-	-		x				
<i>Anechura schmitzii</i>	End.	brach.	x	-	-	x	x	x			x
<i>Perirrhytus edentulus</i>	End.	brach.	x	-	-	x	x	x	x	x	x
<i>P. madeirensis</i>	End.	brach.	x	-	-	x	x	x		x	x
<i>P. pseudomadeirensis</i>	End.	brach.	x	-	-			x			x

Tab. 2 - Survey about the Dermaptera of Madeira and the occurrence on the islands; Cos. = Cosmopolitan, Pal. = Palaearctic, End. = Endemic, \* = Introduced by man, \*? = Probably introduced by man. M = Madeira, PS = Porto Santo, DG = Deserta Grande. Table of records: 1 = BORELLI 1906/1908, 2 = CHOPARD 1938, 3 = HINCKS 1938, 4 = HINCKS 1961, 5 = FERNANDES 1972, 6 = own records.

before increasing sea-level during the Pleistocene. In combination with passive drift a greater part of the insect fauna may have reached Madeira as 'island hoppers', because the shorter the distances the more likely these events can happen. To explain the presence of the rich Dermapteran fauna it is not necessary to claim a landbridge throughout even for a short period.

This brief theoretical scenario can be supported by the following argument: Since MITCHELL-THOMÉ (1976) and KREJCI-GRAF (1961), who studied the geological history of the Azores, Madeira, the Canaries and the Cape Verdes, it is certain, that Madeira is of volcanic origin. Its emergence has to be dated back to the tertiary period and everything points to the fact that the archipelago is completely oceanic, even though a submarine ridge, on which several seamounts rise up to 45m. below the surface (EVERS, 1964) connects Madeira with the Iberian Peninsula. In agreement with the aforementioned also the species composition shows affinities with the European palaeartic fauna.

For the endemic earwigs the possible history of their settling in Madeira can be drawn in the following way: An ancestor of the eastpalaeartic, mainly a mountainous area inhabiting Anechurids reached Madeira via the Iberian Peninsula, where it splits within the genus *Perirrhytus* into three species and one species of the genus *Anechura*. Most *Anechura* species are distributed over the Central- and Eastpalaeartic region, only *Anechura bipunctata* occurring in the Northwest-mediterranean region. No species occur in North-Africa (for a world distribution map of the genus *Anechura* see GÜNTHER & HERTER (1974: 31).

Such affinities were already studied and are well-founded for other Madeiran arthropods, such as the Coleoptera (LUNDBLAD, 1958), Thysanoptera (z. STRASSEN, 1977, 1984) and the Diplopoda (ENGHOFF, 1982).

When McARTHUR & WILSON (1967) proposed their famous theory of Island Biogeography, which stated a dynamic equilibrium of species numbers on a given island, they also studied the dependence of species number in relation to the area size besides the distance of a given island to the next mainland. The species-area relationship is formulated by a mathematical equation in the logarithm of number of species on the logarithm of area, where especially the coefficient  $z$ , which is the slope of the regression line, is a characteristic value for describing the grade of the isolation of an island or an archipelago.

When islands in a group are closely adjacent to each other, the slope is much less pronounced (0.12 to 0.17), because the rate of exchanges is high and thus maintaining a wide variety of species. On the other hand extremely isolated islands, located far away from the next mainland, show a steep slope.

In fig. 9 the regression-line of species-area relation for the Dermaptera-fauna on the three largest Madeiran islands (see tab. 2) and for the Canaries is calculated. In both cases the slope is  $z = 0.26$ . These rather high values can be explained in

different ways. For the Madeira Archipelago the effect of isolation is more evident, which can be sustained in the long distance to the next mainland (700 km.) and therefore allows nearly no exchange. COOK *et al.* (1972) computed for the land molluscs a  $z$ -value of 0.27 and they also emphasized the strong effect of geographical separation.

The Canary Archipelago is situated close to the African continent (the nearest island only 200 km.). The seven islands show extreme differences in their characters and possess a large amount of varying biotopes, which indicates a high variability in species composition independent of the area and is reflected in a low correlation coefficient of 0.48. The most pronounced species-area relation was found on Gomera and Tenerife, both rich in endemic species in accordance with their large laurel forests, especially Tenerife has more altitudinal zones than any other island considered in this paper. On the other hand the desert-like and rather plane islands of Lanzarote and Fuerteventura, still lying on the continental shelf, have a rather poor earwig-fauna. They represent more exceptional habitats, and without these two islands the correlation coefficient for the other Canaries raises to 0.87.

The fauna of the Canaries is rich, with more than 70% endemism, although the grade of isolation is different. There are three striking species of the endemic genus *Anataelia*, which is systematically rather isolated. One species, *A. troglobia* is troglobiont (MARTIN & OROMI, 1988). Two endemic species of *Anisolabis* (BAEZ, 1982 and POPHAM, 1965) are living in coastal regions. The genus *Guanchia* has spread into 11 endemic species. They live exclusively in the laurisilva or in the upper zones of pine-forests like the Genus *Perirrhytus* on Madeira (BAEZ & GARCIA, 1986). Interestingly three *Guanchia* species occur in small enclaves in East-Africa and the Far East: Thus the genus *Guanchia* is obviously not a North-mediterranean element.

Compared to other islands it is obvious, that the Azores and the Cape Verdes have rather low species numbers. The Azores are much more isolated than Madeira, but far-reaching changes in vegetation and fauna through human colonisation led to a distorted picture. No endemics, but only 5 cosmopolitan earwigs live there, on which no considerations can be made. From the Cape Verdes only four specimens are known, but it is assumed, that the archipelago is not explored sufficiently, and the species inventory may be incomplete.

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