

Flightless versus winged - Colonization and Speciation Processes of Orthoptera on the Canary Islands

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Why Islands are wonderful

Old volcanic archipelagos represent excellent areas for the study of colonization and speciation processes, but also for examining the genetic diversification of morphological conserved taxa. The Canary Islands are known for their high biodiversity, containing a fauna mixed of Afrotropical, Mediterranean and endemic elements. The phylogeography of two Orthoptera genera with Canarian radiations have been studied and compared. The Canarian endemic genus *Arminda* is flightless and morphologically conserved, containing seven species, each of which is endemic to a single island. The fully winged genus *Sphingonotus* (s.l.) occurs with approximately ten species of three genera on the Canary Islands, five of which are endemic.

Trying to resolve genetic data

For the genus *Arminda* two mitochondrial (12s rRNA, ND5) and two nuclear (ITS2, 28s rRNA) gene fragments were sequenced to gain phylogenetic information in order to infer a gene tree (2843 bp). The phylogenetic inference was obtained by three methods, UPGMA, neighbor joining and maximum parsimony. The sister genus *Pezotettix* (*P. giornai*, Italy) was used as outgroup. For the genus group *Sphingonotus* the mitochondrial gene ND5 (1050 bp) was analysed. Several other Oedipodinae were used as outgroups (*Acrotylus insubricus*, *Locusta migratoria*, *Oedipoda caerulea*).

Nice ancient radiations ...

The species of the flightless genus *Arminda* are comparatively old and represent a typical example for stepwise colonization and speciation from east to west. This example shows, that DNA barcoding could be very useful for such old but morphologically conserved species. A new endemic species from La Palma has been discovered by DNA sequencing.

... and terrible young lineages

The winged species of the genus *Sphingonotus* and its allies show multiple independent colonization events. The genera *Wernerella* and *Pseudosphingonotus* turn out to be polyphyletic. Two main lineages within the *Sphingonotus* group could be resolved. One lineage consists of the Gran Canarian endemic *S. sublaevis*, *W. pachecoi* from Lanzarote, Fuerteventura and Morocco, the widespread species *P. savignyi*, the northwest African *S. finotianus* and *W. rugosa*, which is endemic to Lanzarote and Fuerteventura. The two species *S. sublaevis* and *W. pachecoi* show only minor genetic divergence. The species rank is rather doubtful, since the morphological differences are also minimal - although they have been assigned even to different genera. A second lineage includes the ancient relicts *W. picteti* (endemic to Tenerife and La Gomera), *W. guancha* (endemic to Gran Canaria) and the young *S. caeruleus* group, with a high number of Mediterranean taxa (*S. rubescens*, *S. uvarovi*, *S. corsicus*, several subspecies of *S. caeruleus* and the Tenerifan endemic *S. willemsei*). This latter group could not be clearly resolved, although a fast evolving gene has been used (ND5).

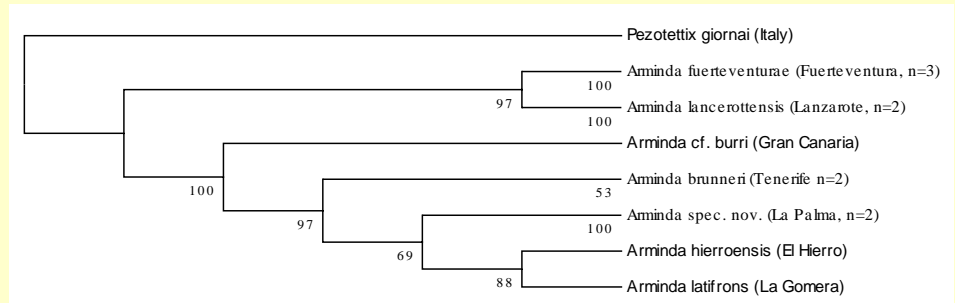


Fig. 1: Most Parsimonious Tree for the flightless grasshopper genus *Arminda* (mtDNA: ND5, 12s; nDNA: 28s, ITS2, 2843 bp), which is endemic to the Canary Islands.



Fig. 2: *Arminda latifrons*, endemic to La Gomera (male, 07.04.2004)

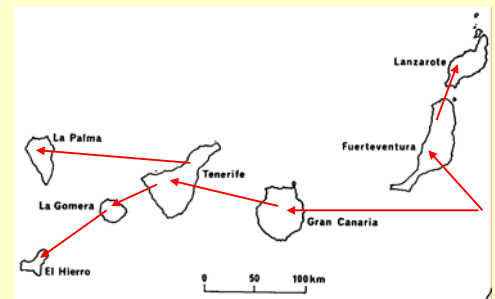


Fig. 3: Stepwise colonisation of the Canary Islands within the genus *Arminda*

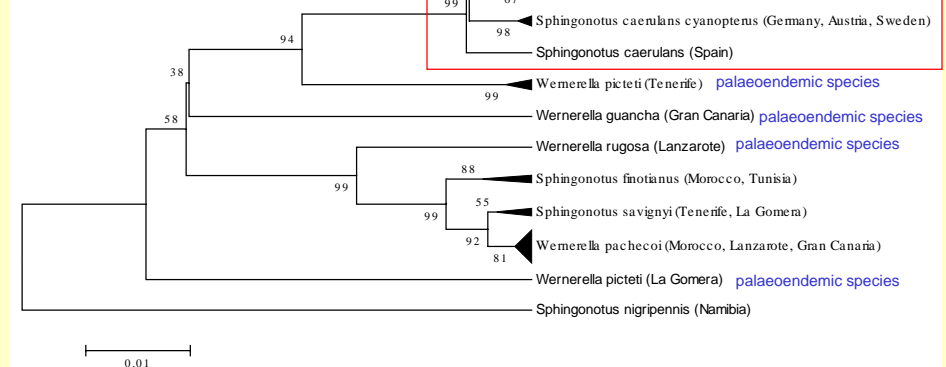


Fig. 4: UPGMA-Phenogram for the winged genus group *Sphingonotus* (mtDNA: ND5, 1050 bp), Photo: *Wernerella picteti*, endemic to Tenerife (female, 21.02.2004)

Multiple invasions

The *Sphingonotus* species have probably reached the Canary Islands independently, without any stepwise colonization of other islands. *S. willemsei*, a species endemic to the Cañadas on Tenerife, represents a very young branch of the *S. caeruleus* group. Its affinities to *S. rubescens* or *S. caeruleus* remain unresolved. *S. sublaevis* from Gran Canaria is closely related to *W. pachecoi* (possibly only a subspecies). The other three endemic species (*W. guancha*, *W. picteti*, *W. rugosa*) represent ancient relicts. The populations of *W. picteti* from La Gomera probably represent a new species.

Is sequencing not enough?

Apparently, the *Sphingonotus* group represents a young radiation with clear bioacoustic differences, but poor genetic resolution, comparable to the *Chorthippus biguttulus* group. This example shows, that DNA barcoding could be difficult in some young radiations. Sequencing of nuclear genes is planned to test the mtDNA data of *Sphingonotus* for introgression. In acoustic communicating insects, combinations of molecular and bioacoustic studies are needed in order to understand the pattern of radiation, mechanisms of reproductive isolation and the genesis of biodiversity.