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A Review of the Canarian Sphingonotini with Description of a New Species from Fuerteventura (Orthoptera: Acrididae: Oedipodinae)

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Axel Hochkirch and Martin Husemann (2008) A review of the Canarian Sphingonotini with description of a new species from Fuerteventura (Orthoptera: Acrididae: Oedipodinae). *Zoological Studies* **47**(4): 495-506. The Canarian representatives of the tribe Sphingonotini (Orthoptera: Acrididae: Oedipodinae) are revised, and a molecular phylogeny based on mitochondrial (mt)DNA sequences (ND5) is presented. The genera *Wernerella*, *Pseudosphingonotus*, and *Neosphingonotus* are synonymized with *Sphingonotus*. A new grasshopper species from Fuerteventura, *Sphingonotus fuerteventurae* sp. nov., is described and compared with the Canarian Sphingonotini and some closely related West-Mediterranean species. Some information on the distribution and ecology of the new species is given, and a key to the Canarian species of *Sphingonotus* is presented.
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Key words: Taxonomy, Canary Is., Cryptic species, Sphingonotini, *Sphingonotus*.

The Canarian archipelago is one of the global hot spots of endemism, with 27% of its native flora and 50% of the terrestrial invertebrate fauna endemic (Juan et al. 2000). The insect fauna comprises approximately 2200 endemic species (Oromí and Baéz 2005). About 86 orthopteran (sensu stricto) species are known to occur on the archipelago, including 33 endemics (Bland et al. 1996, Bland 2001, López et al. 2005, Pfau and Pfau 2007). Although the Canary Is. is a major travel destination of European tourists, their faunistic exploration is far from complete. Four new species and subspecies of Orthoptera have been described during the last decade (Bland and Gangwere 1998, Bland 2001, López et al. 2005, Pfau and Pfau 2007), and some species have been recorded for the 1st time from single islands (e.g., Hochkirch 2003, Husemann and Hochkirch 2008).

The genus *Sphingonotus* Fieber, 1852 and its relatives (*Pseudosphingonotus* Shumakov, 1963 and *Wernerella* Karny, 1907) are particularly well represented on the Canary Is., although the identity of some species remains a matter of controversy (Bland et al. 1996, Hochkirch 2003). This has been particularly true for the 3 closely related species *S. rubescens* (Walker, 1870), *S. caerulans* (Linnaeus, 1767) and *S. corsicus* Chopard, 1923 (see also Bland et al. 1996 for discussion). Although Uvarov (1923) long ago stressed morphological differences among these species, uncertainty with their identification still remains, and even experienced taxonomists have argued that these species are difficult to distinguish (e.g., Willemse 1985). Recent studies show that *S. rubescens* can easily be morphometrically distinguished from other species of the *S. caerulans* group (Defaut 2003) and by its characteristic song (Bland 1985, Husemann and Hochkirch 2008). *Sphingonotus rubescens* has a longer and more-slender body and longer wings than *S. caerulans*. Its hindwings are hyaline with blackish vannal veins, whereas *S. caerulans* and *S. corsicus* have bluish hindwings and a denser reticulation of the tegmina. At present, no confirmed records of

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S. caerulans or *S. corsicus* exist from the Canary Is.

Another doubtful record from the Canary Is. is *P. canariensis* (Saussure, 1884). Reexaminations of museum collections (Natural History Museum, London and Zoölogisch Museum, Amsterdam) revealed that this species has often been confused with *S. savignyi* (Saussure, 1884), *S. sublaevis* (Bolívar, 1908), and *S. azurescens* (Rambur, 1838). Uvarov (1930) noted that the epitheton of *P. canariensis* is misleading as the types of this species were collected from Cape Verde and not from the Canary Is. Johnsen (1974) used differences in the stridulatory mechanisms to distinguish between *S. canariensis* and *S. savignyi*, but our own studies show that these traits seem to be rather variable even within *S. savignyi* (MH and AH unpubl. data). We found specimens with serrate intercalary veins, with stridulatory cross veinlets between the radius and media ("knots"), and with both traits combined, which will be addressed in a future paper.

During a field trip in 2006 (Husemann and Hochkirch 2008), we obtained material of a new species of *Sphingonotus*, which we originally identified as *W. pachecoi* (Bolívar, 1908). We incorporated some specimens in a phylogenetic analysis to reconstruct the colonization pattern of the Canary Is. (Fig. 1). Surprisingly, specimens from Fuerteventura represented a genetically distinct lineage, while specimens from Lanzarote were genetically rather similar to *S. azurescens* from northern Africa and *S. sublaevis*, an endemic species from Gran Canaria. As the type locality of *W. pachecoi* is Lanzarote, the individuals from Fuerteventura had to belong to a hitherto undescribed species, which is described below.

MATERIALS AND METHODS

Phylogenetic analysis

In total, 37 specimens of all Canarian *Sphingonotus* species as well as some northwestern African and European relatives were obtained from 2002 to 2007 and stored either in a freezer or in absolute ethanol (Table 1). We chose the Oedipodinae species *Oedipoda caerulescens* (Linnaeus, 1758) and *Sphingonotus scabriculus* Stål, 1876 from Namibia as outgroups. DNA was extracted from thoracic or femoral muscle tissue using the DNEasy tissue kit (Qiagen, Hilden, Germany) following the manufacturer's protocols. A mitochondrial gene fragment (ND5, 1059 bp) was amplified and sequenced using the primers presented by Hochkirch (2001). We used the HotMasterMix (Eppendorf, Hamburg, Germany) and the HotStarTaq Master Mix kit (Qiagen) for amplification. The PCR product was purified using a Qiaex II gel extraction kit (Qiagen) according to the manufacturer's protocol. Sequencing was performed with the Big Dye sequencing kit (Perkin Elmer, Cheshire, UK) for sequencing reactions run on a Perkin-Elmer ABI automated sequencer. DNA sequences were corrected and aligned by eye. We did not include ambiguous data from the beginning and end of the fragment in the analysis, resulting in a 1047-bp-long dataset. Sequences were deposited in GenBank under the accession numbers EU266710-46. We used 3 different methods to infer a gene tree from our data. First, we used Bayesian Inference as implemented in MrBayes 3.1.1 (Ronquist and Huelsenbeck 2003). The best-fitting substitution model was chosen through the Akaike information criterion (AIC) as implemented in MrModeltest 2.2 (Nylander 2004). We ran the Monte Carlo Markov chain for 10^6 generations, sampling every 1000 generations. We discarded 1000 trees as burn-in, after checking that the chains were stationary and convergent. Support of the nodes was assessed by the posterior probabilities of reconstructed clades as estimated by MrBayes 3.1 (Ronquist and Huelsenbeck 2003). Using the Minimum Evolution method, we visualized the phylogenetic relationships among the samples based on their pairwise Kimura 2-parameter distances as implemented in MEGA 3.1 (Kumar et al. 2004). Maximum-parsimony (MP) analysis was performed in PAUP 4.0b10* (Swofford 2002), using a heuristic search (with TBR branch swapping). The confidence of the nodes was evaluated by bootstrapping the matrix 1000 times (Felsenstein 1985).

Morphological analyses

We examined 5 males and 3 females collected from Fuerteventura (see below) and compared them with other Canarian as well as with some North African and European species. We dissected the genitalia of a male of each species according to the method described by Hochkirch (2001). Moreover, we dissected the forewings of some specimen and examined the stridulatory apparatus with a digital scanning electron microscope (SEM; Zeiss DSM 962,

Oberkochen, Germany). Measurements were taken with an ocular micrometer in the microscope. Abbreviations for depositories are as follows: Museum Alexander Koenig, Bonn, Germany (ZFMK); Zoölogisch Museum Amsterdam, The Netherlands (ZMA); Museo de Ciencias Naturales de Tenerife, Santa Cruz de Tenerife, Spain (MCN); Departamento Biología Animal, Univ. de La Laguna, Tenerife, Spain (ULT); Academy of Natural Sciences, Philadelphia, PA, USA (ANSP); and

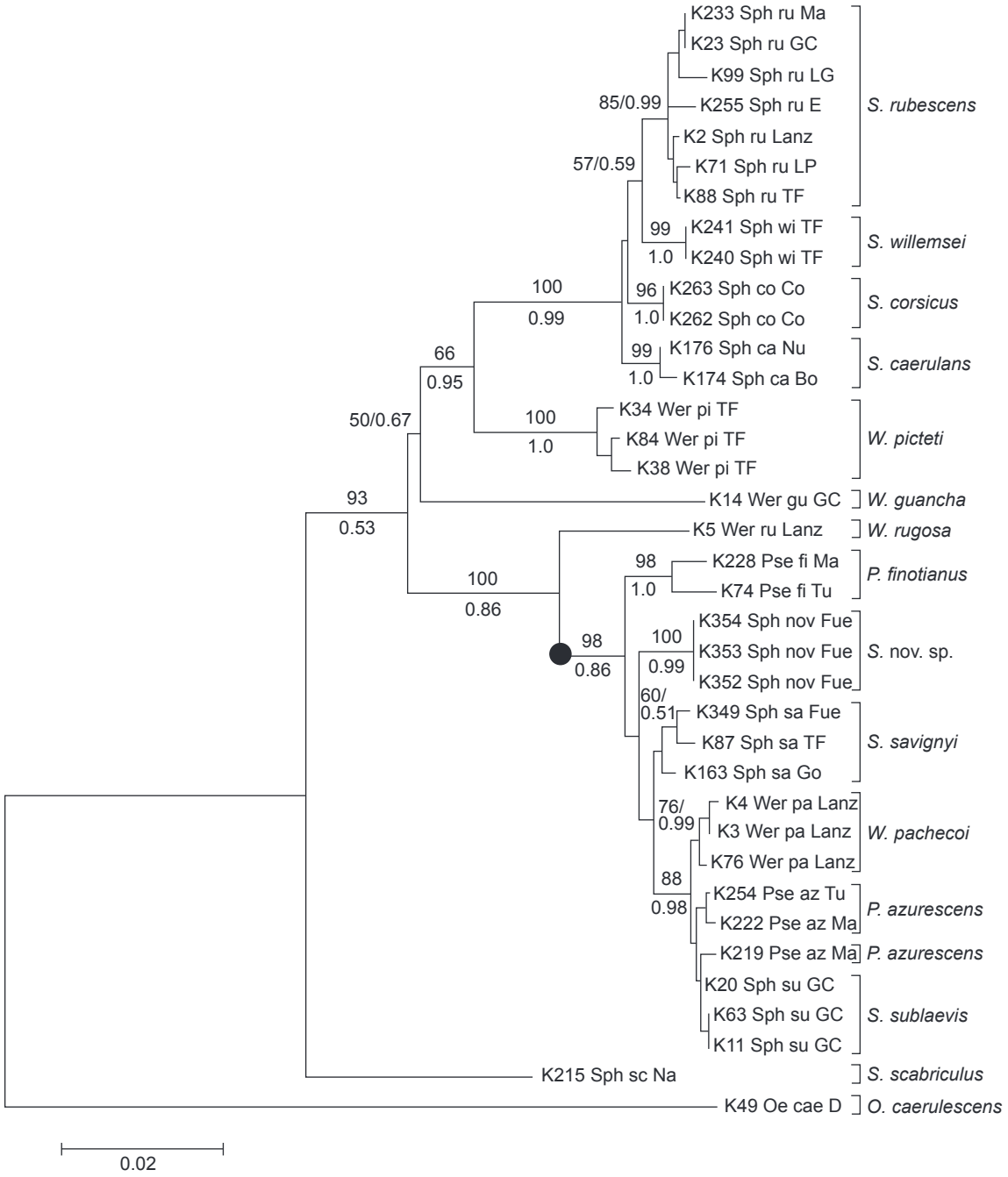

Fig. 1. Minimum Evolution tree based on pairwise Kimura 2-parameter distances of the NADH-dehydrogenase subunit 5. Values above the branches represent bootstrap values based on 1000 bootstrap replicates (only values > 50 are shown). Values behind the slash or below the branches represent percentage posterior probabilities from the Bayesian analysis. The black circle indicates the existence of thickened cross veinlets between the radius and media (but note, that in *S. savignyi* some specimens lacked this trait and possessed a serrate intercalary vein).

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RESULTS

Molecular phylogeny

Our phylogenetic analysis revealed that the Canarian Sphingonotini represent ancient lineages as well as very young groups (Fig. 1). Some taxa belong to recent radiations, which are difficult to disentangle based on the gene fragment examined. This is true for the widespread *S. rubescens* and the Tenerifean endemic *S. willemsei*, both of which belong to a young clade also containing *S. corsicus* and *S. caerulans* (*S. caerulans* group). Moreover, *W. pachecoi* from Lanzarote and *S. sublaevis* from Gran Canaria are close relatives to *P. azurescens* (*S. azurescens* group). However, the low genetic differentiation of these taxa (Hochkirch 2003) is not a sufficient argument for synonymization as

Table 1. Locality information for samples of *Sphingonotus* and *Oedipoda* (as the outgroup) used in the phylogenetic analysis

Nr	Species	Locality	Date
K2	*S. rubescens*	Lanzarote, Charco del Palo	23 May 2002
K23	*S. rubescens*	Gran Canaria, San Nicolás	27 Feb. 2003
K88	*S. rubescens*	Tenerife, Punta de Teno	10 Feb. 2004
K99	*S. rubescens*	La Gomera, Casas de Langrerc	13 Apr. 2004
K71	*S. rubescens*	La Palma, La Fajana	3 May 2003
K233	*S. rubescens*	Morocco, El Feid	9 Mar. 2005
K255	*S. rubescens*	Spain, Extremadura, Monfrague	7 May 1998
K240	*S. willemsei*	Tenerife, Paisaje Lunar	11 June 2005
K241	*S. willemsei*	Tenerife, Canadas Blanca	12 June 2005
K262	*S. corsicus*	Corse, Mafia	Aug. 2005
K263	*S. corsicus*	Corse, Popriano	Aug. 2005
K174	*S. caerulans*	Germany, Borken (Hesse)	Sept. 2004
K176	*S. caerulans*	Germany, Nürnberg (Bavaria)	12 Sept. 2004
K219	*S. azurescens*	Morocco, Zaouira-Sidi-A.E. Moumene	11 Mar. 2005
K222	*S. azurescens*	Morocco, Ahmer	10 Mar. 2005
K254	*S. azurescens*	Tunisia, Djebil NP	1 Sept. 1994
K87	*S. savignyi*	Tenerife, Palm Mar	13 Feb. 2004
K163	*S. savignyi*	La Gomera, Barranco Hondo nr. San Sebastian	6 Apr. 2004
K349	*S. savignyi*	Fuerteventura, La Lajita	18 Feb. 2006
K11	*S. sublaevis*	Gran Canaria, Alto de Pajaritos	9 Feb. 2003
K20	*S. sublaevis*	Gran Canaria, El Lomo	7 Feb. 2003
K63	*S. sublaevis*	Gran Canaria, El Molinoto	3 Feb. 2003
K3	*S. pachecoi*	Lanzarote, Puerto del Carmen	19 May 2002
K4	*S. pachecoi*	Lanzarote, Las Brenas	20 May 2002
K76	*S. pachecoi*	Lanzarote, Macher	20 May 2002
K352	*S.* sp.	Fuerteventura, Morro de Siete Fuentes, Jandia	15 Feb. 2006
K353	*S.* sp.	Fuerteventura, Monte del Mar, Jandia	15 Feb. 2006
K354	*S.* sp.	Fuerteventura, Gran Tarajal	18 Feb. 2006
K5	*S. rugosus*	Lanzarote, Las Hoyas	20 May 2002
K34	*S. picteti*	Tenerife, Los Silos	20 May 2001
K38	*S. picteti*	Tenerife, Chio	18 May 2001
K84	*S. picteti*	Tenerife, Los Gigantes	7 Feb. 2004
K14	*S. guanchus*	Gran Canaria, Barranco Tejada	10 Feb. 2003
K74	*S. finotianus*	Tunisia, Bou Hedma NP	26 Aug. 1994
K228	*S. finotianus*	Morocco, Tour Had-Smimou	12 Mar. 2005
K215	*S. scabriculus*	Namibia, Otjiu	16 Jan. 2005
K49	*O. caerulescens*	Germany, Vörden near Osnabrück	11 July 2003

these might represent young lineages similar to *S. caerulans* and *S. rubescens*, which are genetically very similar but bioacoustically distinct. *Wernerella guancha* from Gran Canaria represents the oldest branch of our phylogeny, although its phylogenetic relationships are not fully resolved. *Wernerella picteti* from Tenerife seems to be an ancient sister species to the *caerulans*-group. *Wernerella rugosa* from Lanzarote and Fuerteventura branches off basally to a group comprising *S. savignyi*, *P. finotianus*, and the *azurescens*-group. Some specimens from Fuerteventura, which were originally identified as *W. pachecoi*, branched off basally to *S. savignyi* and the *azurescens*-group (this new species is described below). The genus *Wernerella* turns out to be a polyphyletic assemblage of ancient and young lineages. The genus *Pseudosphingonotus* is also not monophyletic, but it should be noted that all species with the specialized stridulatory apparatus typical for this genus (the above-mentioned knots formed by cross veinlets between the radius and media, Fig. 5) belong to a monophyletic group (Fig. 1). Only some specimens of 1 species within this group (*S. savignyi*) lack this trait and possess the serrate intercalary vein, which is typical for most of the Oedipodinae.

Synonymy of *Sphingonotus*, *Wernerella*, *Pseudosphingonotus*, and *Neosphingonotus*

The genus *Sphingonotus* is one of the largest grasshopper genera known, comprising 120 species (Eades et al. 2008). The status of some closely related genera is doubtful and the tribe Sphingonotini is obviously in need of revision. Karny (1907) erected the genus *Wernerella* for *Thalpomena picteti* Krauss, 1892 from Tenerife. *Wernerella* includes 10 Canarian and African species, which are characterized by a rugose pronotum with lateral carinae in the metazona (Johnsen 1974). The status of *Wernerella* has frequently been questioned (Uvarov 1923, Johnsen 1985, Bland and Gangwere 1998) and even Karny (1907) noted in his original description that the type species (*W. picteti*) has many similarities with *S. caerulans*. Indeed, our genetic analyses suggest that *Wernerella* represents a polyphyletic group, comprising ancient lineages (e.g., *W. guancha*) as well as very young species (*W. pachecoi*) belonging to recent radiations. As the characters used to identify *Wernerella* are variable in both genera, we synonymize *Wernerella* with *Sphingonotus*.

A 2nd doubtful taxon is the genus *Pseudosphingonotus*, which was erected by Shumakov (1963) for species possessing

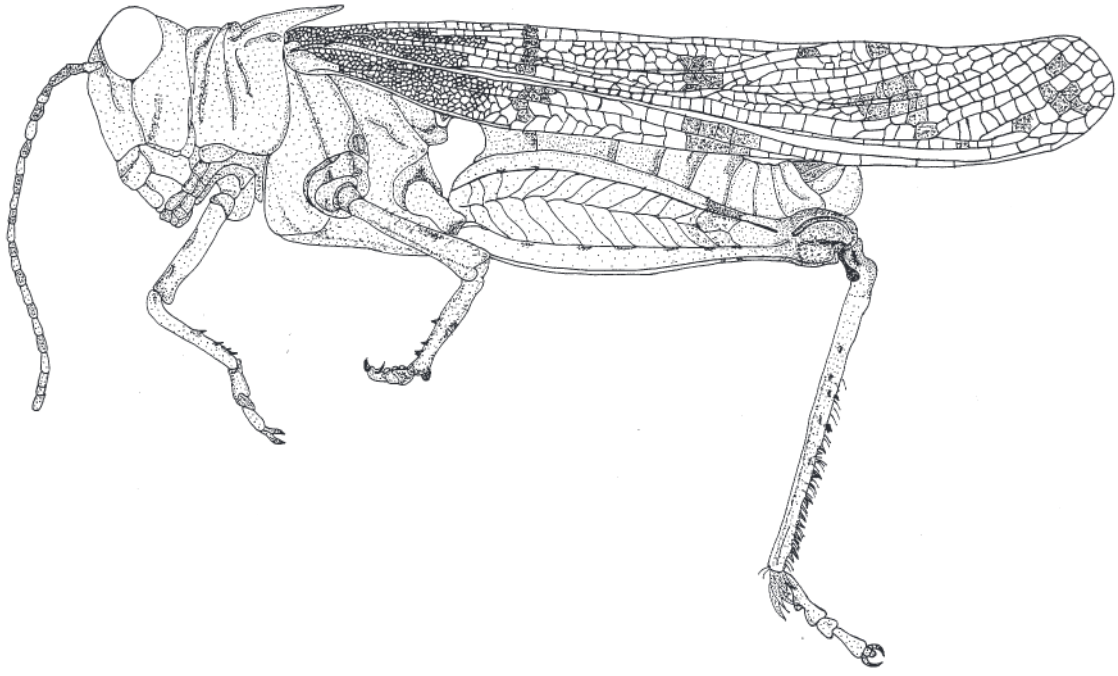

Fig. 2. *Sphingonotus fuerteventurae* sp. nov., lateral aspect of adult male (holotype).

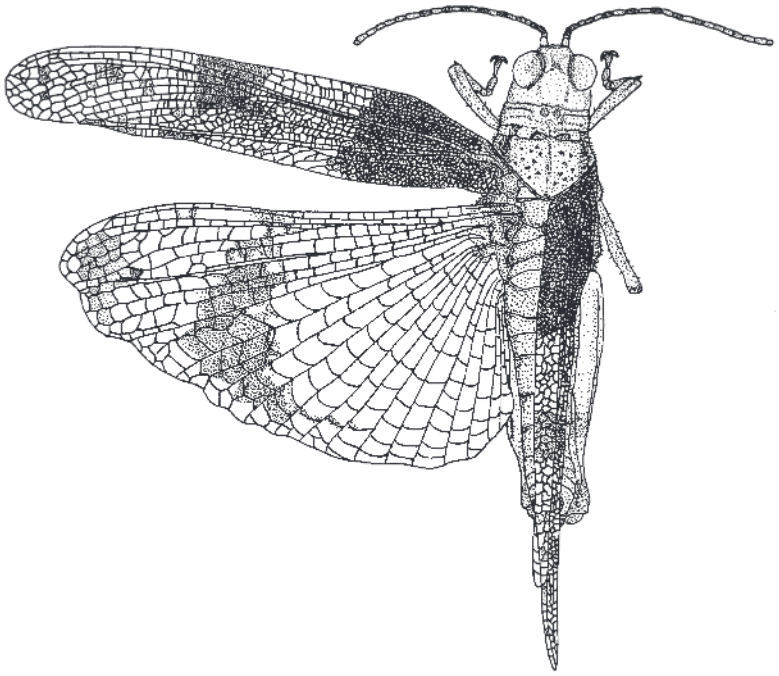

Fig. 3. *Sphingonotus fuerteventurae* sp. nov., dorsal aspect of adult male (holotype).

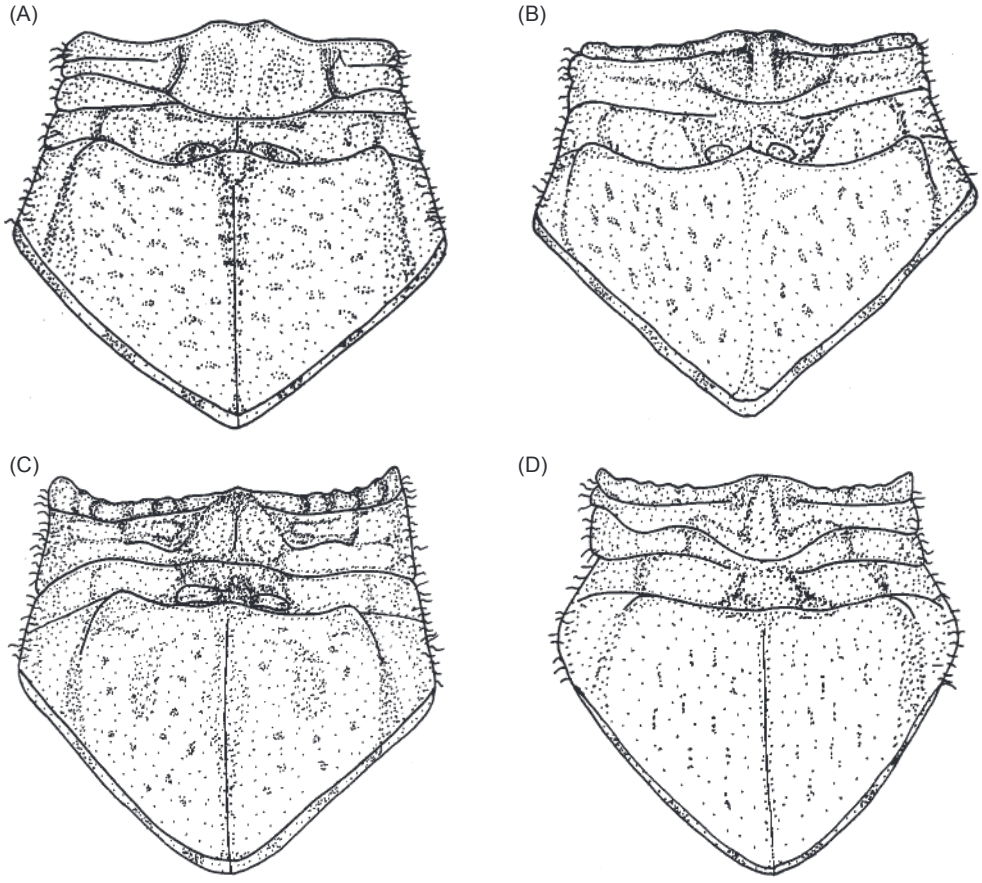

Fig. 4. Dorsal aspect of pronotum of (A) *Sphingonotus fuerteventurae* sp. nov., (B) *S. pachecoi*, (C) *S. sublaevis*, and (D) *S. azurescens*.

thickened cross veinlets between the radius and media (Fig. 5). Indeed, this character seems to be an apomorphic trait (Fig. 1), but unfortunately the type species (*S. savignyi*) is rather variable in this character (see above). Benediktov (1997) stated that the type species does not possess the knots and, therefore, synonymized the genus with *Sphingonotus*. He created a new genus (*Neosphingonotus*) for species with knots and designated *S. paradoxus* Bei-Bienko, 1948 as the type species. Defaut (2005) reestablished *Pseudosphingonotus* and suggested that the confusion was based on a misidentification by Shumakov. Hence, *S. paradoxus* has become the new type species for *Pseudosphingontus* which includes 9 species (Eades et al. 2008). Our genetic analyses confirm the hypothesis that the knots represent an apomorphic trait. Only 1 species within this monophyletic clade (*S. savignyi*) seems to possess both stridulatory mechanisms. For unknown reasons, some species with knots were not assigned to the genus *Pseudosphingonotus* (e.g., *W. pachecoi* and *S. sublaevis*). Although the knots seem to be an appropriate trait for identifying *Pseudosphingonotus*, a synapomorphy for the other *Sphingonotus* species is missing. Most *Sphingonotus* species possess a serrate intercalary vein, which is found in the majority of Oedipodinae species and probably represents a plesiomorphic trait. Hence, the designation of *Pseudosphingonotus* would make *Sphingonotus* a paraphylum (Fig. 1). As our genetic analyses support this scenario, we synonymize *Pseudosphingonotus* and *Neosphingonotus* with *Sphingonotus*. Some other related genera are also not well defined, and their status should be addressed in the future (e.g., *Leptopternis* and *Sphingoderus*).

Description: *Sphingonotus fuerteventurae* sp. nov. Husemann.

Type material: Holotype: 1 ♂, SPAIN, Canary Is., Fuerteventura, Morretes de Lucas, 28°13.923'N, 14°09.010'W, 20 Feb. 2006, leg. M. Husemann and A. Hochkirch, Depository: ZFMK. Paratypes: all from SPAIN, Canary Is., Fuerteventura; 1 ♀, Monte del Mar, Jandia, 28°04.957'N, 14°18.100'W, 15 Feb. 2006, leg. M. Husemann and A. Hochkirch, Depository: ZFMK; 1 ♂, Rosa de Combrillo, 28°41.042'N, 13°53.620'W, 16 Feb. 2006, leg. M. Husemann and A. Hochkirch, Depository: ZMA; 1 ♂, Morretes de Lucas, 28°13.923'N, 14°09.010'W, 20 Feb. 2006, leg. M. Husemann and A. Hochkirch, Depository: MCN; 1 ♀, Canada de Mellian, 28°32.117'N, 13°59.386'W, 17 Feb. 2006, leg. M. Husemann and A. Hochkirch, Depository: ULT; 1 ♀, Morro de Siete Fuentes, Jandia, 28°03.842'N, 14°22.543'W, 15 Feb. 2006, leg. M. Husemann and A. Hochkirch, Depository: ANSP.

Other material examined: SPAIN: Canary Is.: Fuerteventura: 1 ♂, Casas de las Salinas, 28°22.201'N, 13°52.197'W, 14 Feb. 2006, leg. M. Husemann and A. Hochkirch, Depository: UTR; 1 ♂, Monte del Mar, Jandia, 28°04.957'N, 14°18.100'W, 15 Feb. 2006, leg. M. Husemann and A. Hochkirch, Depository: UTR.

Male

General facies: Habitus as typical for genus, but body comparatively stout; medium size: length from fastigium of vertex to end of supra-anal plate 13.5-15 mm (Figs. 2, 3).

Color: Color pattern variable, similar to other *Sphingonotus* species; usually brownish or blackish. Antennae alternating dark and light brown. Outer lower area of hind femora whitish; inner lower area of hind femora bluish. Inner side of hind femora light brownish with dark subapical band. Hind tibiae whitish to bluish with

Table 2. Measurements of 5 males and 3 females of *Sphingonotus fuerteventurae* sp. nov.

Character	Males (*n* = 5) min-max (mm)	Females (*n* = 3) min-max (mm)
Interocular distance	0.6 - 0.7	0.9 - 1.0
Length of pronotal disc (midline)	2.8 - 3.1	3.9 - 4.0
Length of tegmen	15.0 - 15.6	19.8 - 21.9
Maximum width of tegmen	2.6 - 3.1	3.8 - 4.0
Hind femur length	7.5 - 8.4	9.7 - 10.2
Hind femur width	2.2 - 2.5	2.7 - 3.3
Total length (vertex to end of supra-anal plate)	13.5 - 15.0	19.0 - 19.1

brown spines. Tegmina with a dark basal fascia. Hindwings bluish with a brown fascia which is sometimes diffuse and/or interrupted; sometimes with apical dark infumation.

Head: Antennae filiform, longer than head and pronotum together. Frontal ridge slightly concave with lateral carinae, widest part between antennae (above ocellus). Fastigium verticis concave; lateral carinulae missing, medial carinula developed only in frontal part or missing. Fastigial foveolae small, diffuse, triangular.

Thorax: Pronotal disc (Fig. 4A) rugose with 3 complete transverse sulci; median carina present in anterior part of prozona and in metazona, raised in frontal part; posterior 1/2 of prozona (in front of 2nd sulcus) with 2 raised tubercles around median carina; posterior margin rounded to obtuse-angulate; lateral carinae missing or slightly developed in metazona; upper hind angles of pronotum comparatively steep ("shoulders"). Metazona of pronotum 1.8-2.4 times longer than prozona. Mesosternal interspace 2-2.4 times wider than long.

Wings: Tegmina in basal part densely reticulated, 5.1-5.8 times longer than wide. Intercalary vein ± straight or slightly sinuous without serration. Cross veinlets (knots) present between radius and media (Fig. 6A), but only slightly developed (compared to *S. finotianus*). Costal margin expanded, forming widest part of tegmen.

Femora: Hind femora 3.2-3.6 times longer than wide. Spurs of hind tibiae of normal length. Arolium small (less than 1/2 claw length).

Abdomen: Tympanum large, as high as long; ~50% of opening anteriorly covered by ventral lobe. Basal outer areas and apical area of supra-anal plate slightly concave. Cerci short,

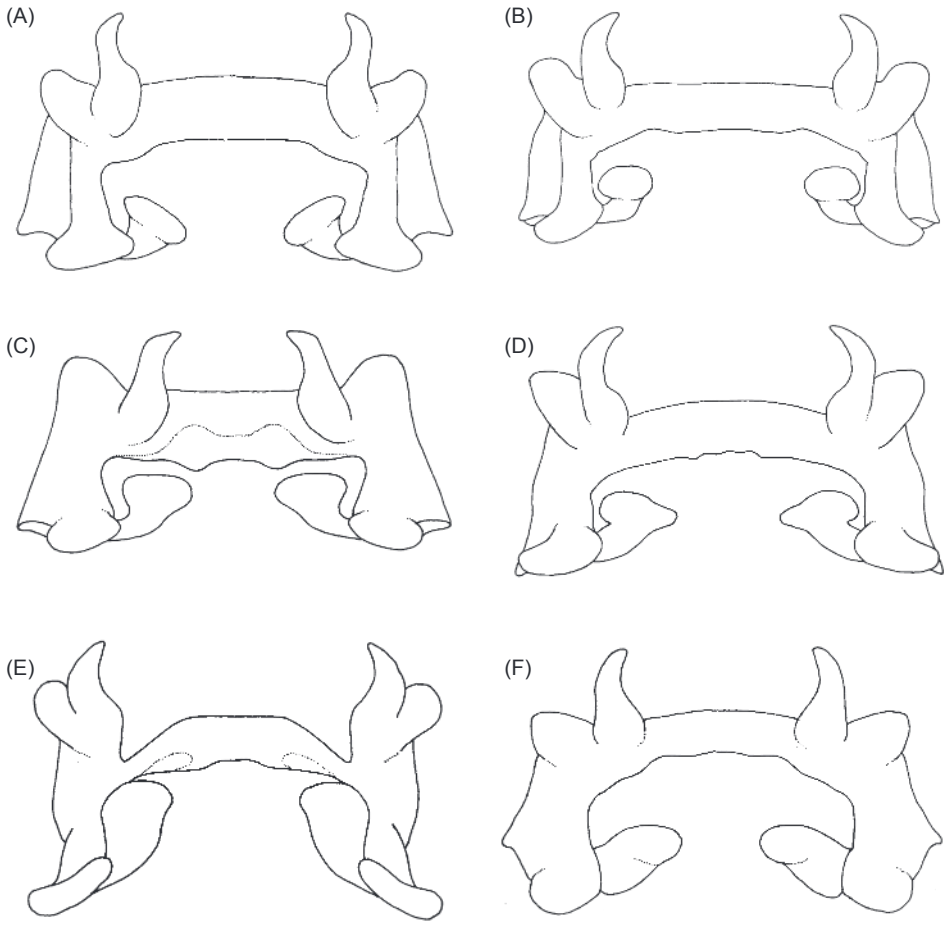

Fig. 5. Dorsal aspect of epiphallus of (A) *Sphingonotus fuerteventurae* sp. nov., (B) *S. pachecoi*, (C) *S. sublaevis*, (D) *S. azurescens*, (E) *S. savignyi*, and (F) *S. picteti*.

approximately as long as supra-anal plate. Subgenital plate slightly pointed.

Inner genitalia: Epiphallic lophi large, bipartite; internal part slightly shorter than external part, triangular to mushroom-shaped; outer part protruding; ancorae in- and downcurved, pointed and anteriorly projecting; epiphallic bridge of medium size; anterior projections short, rounded; posterior projections short; pointed (Fig. 5A). Measurements as in table 2.

Female

General facies: Habitus as typical for genus, but body comparatively stout; medium size: length from fastigium of vertex to end of supra-anal plate ~19 mm.

Color: Color pattern variable, similar to other *Sphingonotus* species; usually brownish or blackish. Antennae alternating dark brown and light brown. Inner side of hind femora brownish with dark subapical band. Hind tibiae whitish with brown spines. Tegmina with a dark basal fascia. Hindwings bluish with a brown fascia which is sometimes diffuse and interrupted.

Head: Antenna filiform, longer than head and pronotum together. Frontal ridge flat with widest part between antennae (above ocellus). Fastigium verticis concave; lateral and medial carinulae missing. Fastigial foveolae diffuse.

Thorax: Pronotal disc rugose with 3 complete transverse sulci; median carina raised in 1st 1/2 of prozona and in 1st 1/2 of metazona; posterior 1/2 of prozona (in front of 2nd sulcus) with 2 raised tubercles around median carina; posterior margin rounded; lateral carinae missing; upper hind angles of pronotum comparatively steep ("shoulders"), but without carinae. Metazona of pronotum 2.1-2.3 times longer than prozona. Mesosternal interspace wider than long.

Wings: Tegmina densely reticulated, 5.3-5.6 times longer than wide. Intercalary vein ± straight or weakly sinuous without serration. Cross veinlets present between radius and media (knots), but only slightly developed (Fig. 6B). Costal margin expanded, forming widest part of tegmen.

Femora: Hind femora 3.0-3.7 times longer than wide. Spurs of hind tibiae of normal length. Arolium small.

Abdomen: Tympanum large, as high as long; ~50% of opening anteriorly covered by ventral lobe. Valves of ovipositor short. Measurements as in table 2.

Differential diagnosis: *Sphingonotus fuerteventurae* has blue hind wings with a dark wing fascia. The majority of the Canarian *Sphingonotus* species possess blue or bluish hind wings with no dark fascia (*S. willemsei*, *S. guanchus*, *S. picteti*, *S. rubescens*, and *S. rugosus*), but in some species the vannal veins are darkened (*S. rubescens* and *S. rugosus*). *Sphingonotus sublaevis* differs from *S. fuerteventurae* by its comparatively smooth pronotum, which lacks any raised structures (Fig. 4C). In *S. sublaevis*, the external parts of the epiphallic lophi are rounded, less protruding and shorter than the inner projections, which are strongly incurved and nearly reach the epiphallic bridge (Fig. 5C). The hind margin of the external part of the lophi is convex, while it is straight in *S. fuerteventurae*. The ancorae are more-closely spaced in *S. sublaevis* than in *S. fuerteventurae*. *Sphingonotus pachecoi*

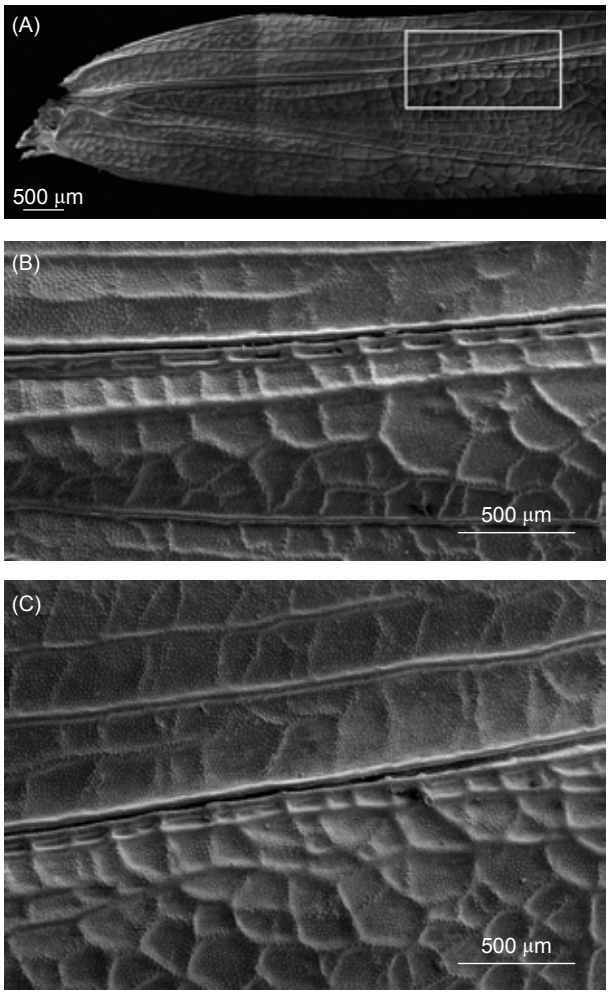

Fig. 6. SEM photographs of the stridulatory apparatus of *Sphingonotus fuerteventurae* sp. nov. (A) Overview male; (B) detail male; (C) detail female.

is a little bit larger than *S. fuerteventurae*. Its pronotum (Fig. 4B) is variable in shape and usually rugose with raised tubercles (rather similar to *S. fuerteventurae*). The internal projections of the lophi are approximately of similar length as the external parts (in *S. fuerteventurae* the internal parts are slightly shorter than the external parts) and strongly incurved, touching the inner margin of the lateral plates (Fig. 5B). *Sphingonotus azurescens* has a smooth pronotum (Fig. 4D, similar to *S. sublaevis*). The inner projections of the epiphallic lophi are longer than the external parts (Fig. 5D) and much longer than in *S. fuerteventurae*. Some band-winged specimens from Spain (usually identified as *S. azurescens*) lack the knots between the radius and media, which are typical for the entire *S. azurescens* group, but possess a serrate intercalary vein (as typical for most of the Oedipodinae). Our genetic analyses suggested that these specimens belong to the *S. caerulans* group and are related to northern and central European lineages, which sometimes also possess a wing band (*S. caerulans caerulans* and *S. caerulans cyanopterus*). *Sphingonotus savignyi* is the most distinct Canarian relative of the *S. azurescens* group. It is a comparatively large species with a narrow wing band, which is strongly curved. The vannal veins are thickened and slightly orange or yellowish. The inner sides of the hind femora are yellowish with a single dark subapical band. The stridulatory apparatus is variable: some specimens possess a serrate intercalary vein, other specimens have knots between the radius and media, and both mechanisms are present in some specimens. The internal parts of the epiphallic lophi are large, rounded, and strongly projecting forwards (Fig. 5E).

Fig. 7. Records of *Sphingonotus fuerteventurae* sp. nov. from Fuerteventura.

Ecological and phenological notes

Sphingonotus fuerteventurae is probably endemic to Fuerteventura, but occurs widespread on this island. During a field trip to Fuerteventura in Feb. 2006 the species was recorded from 54%

Table 3. *Sphingonotus* species of the Canary Is. (e, endemic species; F, Fuerteventura; L, Lanzarote; C, Gran Canaria; T, Tenerife; G, La Gomera; P, La Palma; H, El Hierro)

Species	e	F	L	C	T	G	P	H
Sphingonotus rubescens (Walker, 1870)		x	x	x	x	x	x	x
Sphingonotus willemsei Mistshenko, 1937	x				x			
Sphingonotus picteti (Krauss, 1892)	x				x			
Sphingonotus guanchus (Johnsen, 1985)	x			x				
Sphingonotus sp.	x					x		
Sphingonotus rugosus (Bland, 1998)	x	x	x					
Sphingonotus savignyi (Saussure, 1884)		x	x	x	x	x		
Sphingonotus fuerteventurae sp. nov. Husemann	x	x						
Sphingonotus pachecoi (Bolívar, 1908)		?	x	?				
Sphingonotus sublaevis (Bolívar, 1908)	x			x	?			

of the study sites (Fig. 7, see also Husemann and Hochkirch 2008). It is terricolous and occurs in nearly every habitat with sparse vegetation. Adults have been collected from Feb. to May, but also in Aug., Oct., and Dec. (data from museum collections). It is, therefore, likely that adults occur throughout the year.

Checklist of the Canarian *Sphingonotus* species

Based on our collections and a reexamination of museum material, 10 *Sphingonotus species* seem to occur on the Canary Is. (Table 3). We removed older records of *S. corsicus*, *S. caerulans*, and *S. canariensis* from the list (as outlined in the "Introduction"). We also deleted records of *S. picteti* from Lanzarote, Gran Canaria, and La Gomera. This species seems to be endemic to Tenerife, and records from other islands refer to *S. rugosus* (Lanzarote), *S. guanchus* (Gran Canaria), and an hitherto undescribed species (La Gomera). *Sphingonotus picteti* is restricted to coastal areas of Tenerife, whereas the species from La Gomera was collected at Cumbre Carbonera (630 m, Holzapfel 1970), above Agulo (300 m at the northern coast; 7 July 1966, leg. K.M. Guichard, NHM), Barranco Villa (25 Mar. 1966, leg. C. Holzapfel and K. Lems, Michigan Museum of Zoology), Parque National (25 Aug. 1987, leg. J. McKinney, Michigan Museum of Zoology), 3 km W of San Sebastian (25 Aug. 1987, leg. J. McKinney, Michigan Museum of Zoology), and SW of San Sebastian (Dec. 1982, J. Szijj, ZFMK). These records indicate a different ecological niche of this species in terms of its climatic range. The specimen from San Sebastian also morphologically differs from *S. picteti*, but more individuals should be examined to describe this new species. *Sphingonotus sublaevis* and *S. pachecoi* are genetically difficult to distinguish, but differ in the shape of their pronotum (Fig. 4). *Sphingonotus willemsei* occurs exclusively in the Cañadas on Tenerife. Our genetic data suggest that this species represents a young branch of the *S. caerulans* group. The genetic distance of *S. willemsei* to *S. caerulans* or *S. rubescens* is low, but still higher than between *S. sublaevis* and *S. pachecoi*.

A key to the Canarian species of *Sphingonotus*

1. Hindwings with dark fascia (sometimes diffuse or interrupted).....2
- Hindwings without dark fascia (sometimes with blackish vannal veins).....5
2. Dark fascia of hindwing narrow, strongly incurved in vannal area; vannal veins thickened, orange to yellowish; intercalary vein of tegmen in males sinuous and often serrate; inner side of hind femora yellowish with 1 dark subapical transverse band (all islands except La Palma and El Hierro) .....*savignyi* (Saussure)
- Dark fascia of hindwing short, sometimes diffuse or interrupted; wing disc bluish; intercalary vein of tegmen never serrate; inner side of hind femora brownish.....3
3. Pronotum smooth with a narrow median carina; 2nd 1/2 of prozona only with small tubercles or with no elevations at all (Gran Canaria, Tenerife?).....*sublaevis* (Bolívar)
- Pronotum comparatively rugose; median carina raised in frontal part; posterior 1/2 of prozona with 2 distinct raised tubercles around median carina.....4
4. Pronotum rugose with 2 raised tubercles in central region around median carina, comparatively small insects (males 13.5-15 mm; females -19 mm; Fuerteventura).....*fuerteventurae* sp. nov. Husemann
- Pronotum less rugose, without or with small tubercles in central region around median carina, larger (males > 15 mm, females > 20 mm; Lanzarote, Gran Canaria?).....*pachecoi* (Bolívar)
5. Pronotum smooth.....6
- Pronotum rugose, often with "shoulders" 7
6. Inner side of hind femora dark with 1 complete light band (all Canary Is.).....*rubescens* (Walker)
- Inner side of hind femora dark with 2 complete light transverse bands (Tenerife: Cañadas).....*willemsei* Mistshenko
7. Pronotum very rugose; tegmen comparatively long (6.1-6.6 times longer than broad; Lanzarote, Fuerteventura).....*rugosus* (Bland)
- Pronotum less rugose; tegmen shorter (5.6-6.1 times longer than broad).....8
8. Small insects (males < 14.5 mm); metasternal interspace in males 1.5 times longer than broad, in females 2 times longer than broad (Tenerife).....*picteti* (Krauss)
- Larger insects (males > 14.5 mm); metasternal interspace in males 2 times longer than broad, in females more than 2 times longer than broad.....9
9. Intercalary vein straight or slightly sinuous (Gran Canaria) .....*guanchus* (Johnsen)
- Intercalary vein sinuous (La Gomera).....*S.* sp.

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