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Cryptic diversity in endemic *Canarilabis* revealed by a multigene phylogeny (Dermaptera: Anisolabididae)

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Abstract

Earwigs of the genus *Canarilabis* Steinmann, 1985 (Dermaptera: Anisolabididae), which is endemic to the Canary Islands, were sequenced and subjected to molecular phylogenetic analyses for the first time. Molecular phylogenetic analyses confirmed the monophyly of *Canarilabis* and its sister relationship to Eurasian *Euborellia* Burr, 1909, and simultaneously revealed unexpected cryptic diversity among the populations that inhabit individual islands. We confirmed the species

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status of *C. alata* (Johnsen, 1974), which is endemic to La Gomera, but within *C. maxima* (Brullé, 1838), three different species were distinguished, and two of them are described here: *C. canariensis* Kočárek, Bonczek & Kočárková, sp. nov., inhabiting Gran Canaria; *C. hierrensis* Kočárek, Bonczek & Kočárková, sp. nov., inhabiting El Hierro; and *C. maxima sensu novo* associated with Tenerife. A morphologically based identification key is provided for the differentiation of male specimens.

Keywords

Anisolabidinae – Canary Islands – cryptic species – island biogeography – new species – speciation

Introduction

The Canary Islands are important biodiversity hotspots and have become a focal point for evolutionary studies during the past 20 years, largely because of their high rates of endemism and well-known geological history, with times of subaerial appearances well established for most islands (e.g., Cox et al., 2010; Vargas & Zardoya, 2014; Zaczek et al., 2015). The archipelago consists of seven main islands of different ages, from 21 MYA in the case of Fuerteventura to 1 MYA in the case of El Hierro (Carracedo et al., 1998; Zaczek et al., 2015). During the Miocene and Pleistocene, the archipelago was an important refuge for species from continental Africa and Europe when the dry seasons or glacials approached (Vargas & Zardoya, 2014). The islands farther from Africa's mainland are younger, and those closer to the mainland (Fuerteventura and Lanzarote) are older. Older islands are drier and lower in elevation; thus, Fuerteventura and Lanzarote do not contain wet forest habitats. The rest of the islands are, at least partially, covered with evergreen laurel forests and offer similar conditions suitable for inter-island colonization by the same lineages (Shaw & Gillespie, 2016). Unusually high diversity can be found in spiders, beetles, and diplopods, but few phylogenetic studies exist (Vargas & Zardoya, 2014).

In total, the Canary Islands are inhabited by 16 endemic species of Dermaptera from the genera *Guanchia* Burr, 1911 (Forficulidae, 11 spp.), *Canarilabis* Steinmann, 1985 (Anisolabididae, 2 spp.) and *Anataelia* Bolivar, 1899 (Pygidicranidae, 3 spp.). These species inhabit the islands of Gran Canaria, Tenerife, La Gomera, La Palma, and El Hierro (Bivar de Sousa & Sakai, 1997). In contrast, on the islands of Fuerteventura and Lanzarote, only non-native species (*Forficula* Linnaeus, 1758; *Euborellia* Burr, 1909) and species widely inhabiting coastal zones (*Labidura* Leach, 1815; *Anisolabis* Fieber, 1853) are found (Bivar de Sousa & Sakai, 1997). All endemic species are flightless and capable only of passive spread by sea. The spread of endemic *Guanchia* and *Canarilabis* is limited by their close association with habitats in

laurel forests, which occur from 400 to 1,200 m in elevation and are therefore far from the seacoast (Höllermann, 1981).

In 1838, Brullé described an unusually large earwig from the Canary Islands and named it *Forficula maxima* Brullé, 1838. Although Brullé (1838) did not specify the collection site in the description, the type specimens are deposited in Museum National d'Histoire Naturelle, Paris (Burr, 1908). Later, this species was reported from Tenerife, Gran Canaria, La Gomera, and El Hierro (Brindle, 1968), and the opinions on generic placement differed significantly among authors; the species was gradually transferred from one genus to another (*Forcinella* Dohrn, 1862; *Anisolabis* Fieber, 1853; *Euborellia* Burr, 1909; *Gelotolabis* Zacher, 1911; *Gonolabis* Burr, 1900) until the description of *Canarilabis* by Steinmann (1985). Johnsen (1974) described a new related species, *Canarilabis alata* (Johnsen, 1974) (originally *Anisolabis alata*), from La Gomera.

Today, the genus *Canarilabis* is represented by two species, *Canarilabis maxima* (Brullé, 1838) and *Canarilabis alata*. *Canarilabis maxima* is known from the islands of Tenerife, Gran Canaria, and El Hierro, whereas *C. alata* is endemic only to the island of La Gomera. The presence of *Canarilabis* (*C. maxima* or *C. alata*) on La Palma reported by Brindle (1968) remains uncertain because only nymphs were found there (Johnsen, 1974). Brindle (1964) erroneously mentioned the distribution of *C. maxima* in Madeira (Johnsen, 1974), but there is no evidence of the presence of *Canarilabis* in Madeira (Bivar de Sousa & Sakai, 1997).

None of the *Canarilabis* species have been subjected to molecular analyses; therefore, their validity, as well as the validity and position of the genus in the current Dermaptera system, has been unclear for decades. The present study aims for a taxonomic revision on the basis of the molecular phylogenetic evaluation of *Canarilabis* populations from four Canary Islands.

Materials and methods

Taxon sampling

Dermaptera specimens were collected individually under stones, decaying trunks or under the bark of such trunks. The collected specimens were preserved in ethanol until tissue extraction for DNA isolation. For DNA isolation, we used abdominal or thoracic muscles. After that, the studied specimens were dissected and mounted on a label, with male genital armatures mounted in dimethyl hydantoin formaldehyde resin (DMHF, a water-soluble mounting medium) on the same label as each specimen. The specimens used for visualization were photographed with a Leica Z16 APO macroscope (Leica Microsystems, Wetzlar, Germany) equipped with a CANON 6D Mark II camera. Micrographs of 10 to 20 focal layers of the same specimen were combined with Helicon Focus software and finally processed with Adobe Photoshop CS6 Extended (Version 13). The Dermaptera taxa used in the phylogenetic analyses (29 taxa of Anisolabididae as the ingroup and two taxa of Labiduridae as the outgroup) were identified by the senior author (PK) via the identification keys of Steinmann (1989) and by comparison with voucher specimens. The females of the newly differentiated lineages of the genus *Canarilabis* are not morphologically

distinguishable from each other and therefore cannot be assigned to species if their geographic origin is unknown. In the case of females found at localities where males were not also recorded, females were assigned to species based on their geographic occurrence on each island. Based on the same principle, published records for which voucher specimens could not be examined were included in the distribution maps.

Distribution maps are based on published records, records extracted from the GBIF database (GBIF.org, 2024), and new data presented in this study.

The terminology used for morphological characteristics follows that of Steinmann (1989); the terminology used to describe the terminalia and genitalia follows that of Kamimura (2014). The nomenclature used follows that of Hopkins et al. (2024). Voucher specimens were deposited in the entomological collections of the following institutions: the National Museum, Prague, Czech Republic (NMPC); the University of Ostrava, Czech Republic (UNOV); and the private collection of Marion Mantič, Bobrovníky, Czech Republic (MMCO). Details of the analyzed taxa, including voucher deposition, isolation numbers, and GenBank accession numbers, are provided in supplementary table S1.

Extraction, amplification and sequencing

Total genomic DNA was extracted from 31 Dermaptera taxa via the DNeasy Blood & Tissue Kit (QIAGEN, Inc.) following the manufacturer's protocol. Partial sequences of four genetic markers (one nuclear and three mitochondrial) were amplified and sequenced. These include 18S rRNA, cytochrome *c* oxidase subunit 1 (COI), 12S rRNA, and 16S rRNA. Polymerase chain reactions (PCRs) were performed in 20-µl volumes containing 1 µl of DNA template, each primer at 0.4 µM, distilled water, and 1x PCRBIO HS Taq Mix Red (PCR Biosystems, London, UK). For the table with primers and conditions of the PCR cycles, please see supplementary table S2.

The PCR products were visualised via 1% agarose gel electrophoresis with MIDORI Green Advance (NIPPON Genetics EUROPE) to confirm amplification and to test for product contamination. For purification of the amplified DNA, we used a Gel/PCR DNA Fragments Extraction Kit (GENAID, Taiwan). Sanger sequencing was performed via an ABI3730XL DNA Sequencer by Macrogen Europe (Amsterdam, the Netherlands) and Eurofins (Germany). The chromatograms were visually checked via ChromasPro v2.1.9 software (Technelysium, Brisbane, Australia).

Phylogenetic analysis

The sequences were aligned with EMBL-EBI sequence analysis tools (Madeira et al., 2022) via MAFFT with default parameters. For phylogenetic reconstruction, we used partial sequences of four genetic markers: 18S rRNA (~1,804 bp), 12S rRNA (~373 bp), 16S rRNA (~547 bp), and COI (660 bp). The protein-coding gene (COI) was translated into amino acids to check for potential stop codons within the open reading frames. Substitution saturation was tested in DAMBE v6.4 (Xia, 2017) via the index proposed by Xia et al. (2003). The multigene dataset of 3,384 bp was concatenated via Concatenator v0.2.1 (Vences et al., 2022). The best-fitting partitioning schemes and molecular evolution

models were selected under the corrected Akaike information criterion (AICc) via PartitionFinder v2.1.1 (Lanfear et al., 2016). Bayesian inference (BI) and maximum likelihood (ML) analyses were performed to infer phylogenetic relationships, and both analyses were run on the CIPRES Science Gateway v3.3 (Miller et al., 2010). Bayesian analysis was conducted with MrBayes v3.2.7a in XSEDE (Ronquist et al., 2012) via the Markov chain Monte Carlo (MCMC) method. Two independent MCMC runs of four chains were run for 10 million generations. The MCMC parameters were examined in Tracer v1.7.2 (Rambaut et al., 2014). The maximum likelihood analysis based on the GTR+G nucleotide model was conducted via RAxML-HPC BlackBox v8.2.12 (Stamatakis, 2014). The obtained trees were rooted by outgroup taxa from the family Labiduridae and were displayed via iTOL (interactive Tree of Life) v6.8.1 (Letunic & Bork, 2021).

Species delimitation of Canarilabis

On the basis of the results of the phylogenetic analyses, Automatic Barcode Gap Discovery (ABGD) and Assembly Species by Automatic Partitioning (ASAP) were used to determine whether the obtained COI sequences of *Canarilabis* from different Canary Islands constitute separate species. For ABGD, the following settings were used: Kimura (K80) measure of distance, minimum barcode gap width (1.5), and intraspecific divergence minima (0.001) and maxima (0.1). For ASAP, the Kimura (K80) substitution model was used. Pairwise distance analysis was conducted on the COI and 12S alignments via MEGA X v.10.1.7 (Kumar et al., 2018).

Haplotype Network

A haplotype network was created via the COI marker to elucidate the population structuring of *Canarilabis* from Gran Canaria, Tenerife, Gomera, and El Hierro. Nine sequences of COI were analyzed. The TCS haplotype network was created in PopART v.1.7 (http://popart.otago.ac.nz; Leigh & Bryant, 2015).

Results

Phylogenetic relationships and haplotype network analyses

The phylogenetic tree based on four markers (3,384 characters) included 29 Anisolabididae specimens and two Labiduridae taxa used as an outgroup. The BI and ML methods produced identical topologies with comparable support values (fig. 1A). The genus *Canarilabis* forms a monophyletic clade with 100% support in both analyses in a sister position to *Euborellia* species, except for two American species (*Euborellia* sp., *E. caraibea*). The *Canarilabis* clade consists of two supported clades. Clade 1 contains *C. alata* obtained from Gomera, and the sister Clade 2 consists of two subclades in turn. The first *Canarilabis* subclade includes lineage "A" from Gran Canaria and lineage "B" from El Hierro, both in a sister position to the subclade with lineage "C" from Tenerife.

The species delimitation methods based on the COI marker retrieved varying numbers of *Canarilabis* species (fig. 1A). The ASAP analysis revealed four species whose occurrence corresponds to the four individual Canary Islands, i.e., El Hierro, La Gomera, Gran Canaria, and Tenerife.

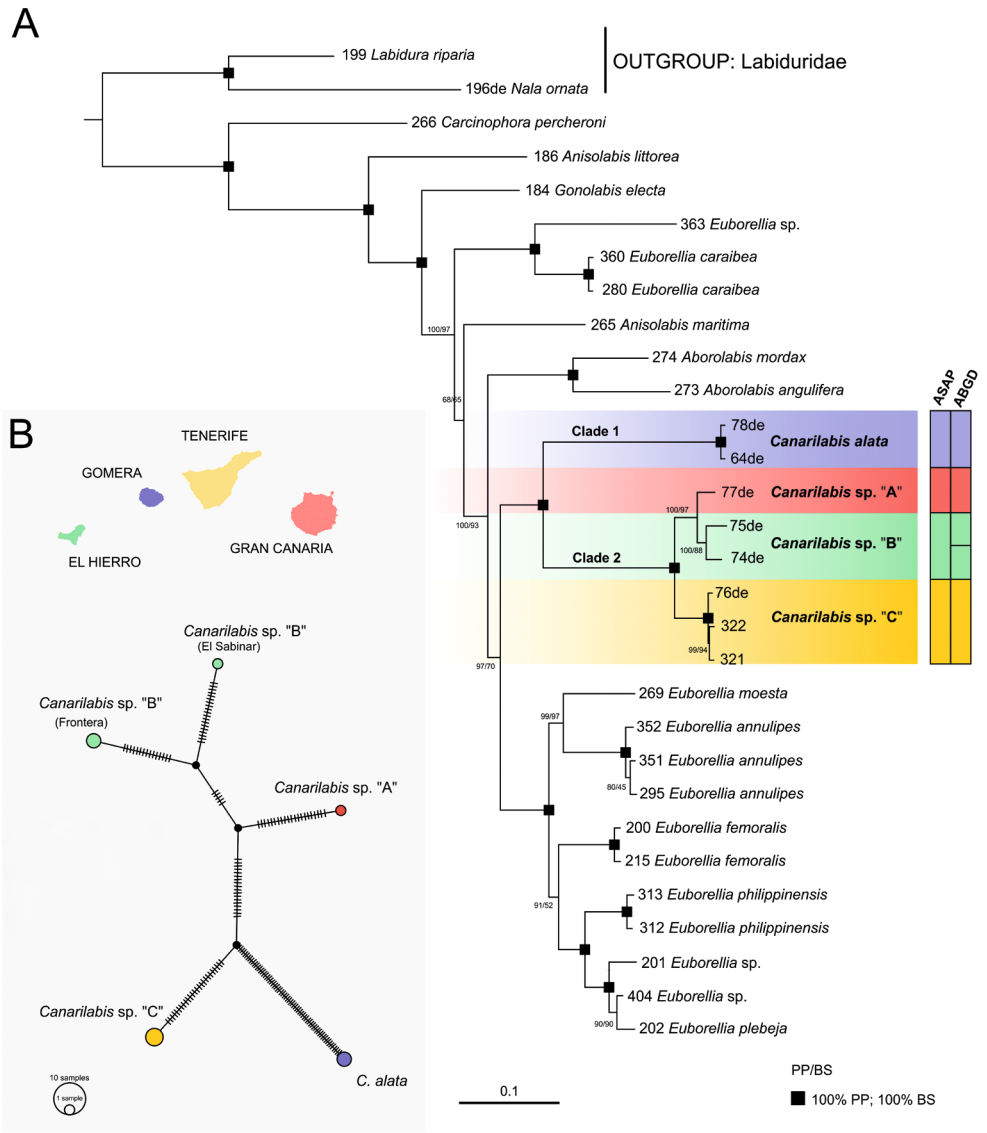


FIGURE 1 (A) Phylogenetic tree resolved by Bayesian inference based on the combined dataset for four molecular markers (18S, COI, 12S, and 16S). The bars to the right of the phylogeny represent the taxon assignments from the species delimitation methods on the basis of the COI dataset. The colour scale corresponds to the colour of the individual islands. The numerical code in the species name corresponds to the DNA isolate number (see table 1 and supplementary table S1). PP, Bayesian posterior probabilities; BS, RAxML bootstrap support; ABGD, Automatic Barcode Gap Discovery; ASAP, Assembly Species by Automatic Partitioning. (B) Haplotype network corresponding to the phylogeny illustrates the interspecific relationship between *Canarilabis* via the COI marker. Notches between haplotypes represent nucleotide substitutions, and the size of the circles represents the number of samples sharing the same haplotype. The colours of the haplotypes show the island origin, since each colour corresponds to the colours indicated for the maps of each Canary Island.

TABLE 1 Sequence divergence (p-distance) of *Canarilabis* species for the examined parts of the mitochondrial markers CO1 (611 bp) and 12S (304 bp). The values of CO1 are below the diagonal. Isolate – DNA isolate number

	Species	Isolate	Locality	1	2	3	4	5	6	7	8	9
1	*C. alata*	64de	Gomera		0.00	0.23	0.23	0.22	0.21	0.21	0.22	0.22
2	*C. alata*	78de	Gomera	0.00		0.23	0.23	0.22	0.21	0.21	0.22	0.22
3	*C. hierrensis* sp.nov.	60de	El Hierro: Frontera	0.16	0.16		0.00	0.02	0.04	0.06	0.07	0.07
4	*C. hierrensis* sp.nov.	74de	El Hierro: Frontera	0.16	0.16	0.00		0.02	0.04	0.06	0.07	0.07
5	*C. hierrensis* sp.nov.	75de	El Hierro: Sabinar	0.18	0.18	0.06	0.06		0.04	0.07	0.08	0.08
6	C. *canariensis* sp.nov.	77de	Gran Canaria	0.17	0.17	0.07	0.07	0.07		0.06	0.07	0.08
7	*C. maxima*	76de	Tenerife	0.15	0.15	0.10	0.10	0.12	0.10		0.01	0.02
8	*C. maxima*	321	Tenerife	0.15	0.15	0.10	0.10	0.12	0.10	0.00		0.01
9	*C. maxima*	322	Tenerife	0.15	0.15	0.10	0.10	0.12	0.10	0.00	0.00	

The ABGD analysis revealed five species. Two specimens from El Hierro (isolate 74de – Frontera and isolate 75de – El Sabinar) were evaluated as different species.

The haplotype network for the CO1 mitochondrial marker (fig. 1B) shows a topology similar to that of the phylogenetic reconstruction, with each lineage occupying a distinct haploclade. The five different haplotypes identified belong to four species of the genus *Canarilabis*. For the island of El Hierro, two different haplotypes were found within lineage "B".

The lineage "A" (Gran Canaria) differed from *C. alata* (La Gomera) and lineage "C" (Tenerife) in terms of high pairwise CO1 and 12S distances (CO1: 17% and 10%, 12S: 21% and 6–8%, respectively).

The lineage "B" (El Hierro) differed in CO1 and 12S from *C. alata* by 16% and from lineage "C" (Tenerife) by 10–12% and 21–22%, respectively. The pairwise distance between the lineages "A" (Gran Canaria) and "B" (El Hierro) reached 7% for CO1 and 4% for 12S. The resulting pairwise distances of the CO1 and 12S markers for all studied *Canarilabis* samples are shown in table 1.

On the basis of phylogenetic analysis, haplotypes and pairwise distances, we have defined four species of *Canarilabis* living on different islands of the Canary Islands: *C. alata* (La Gomera), *C. maxima* (Tenerife), shown as lineage "C" in Fig. 1A, and two new species described here from Gran Canaria (lineage "A") and El Hierro (lineage "B").

Taxonomy

Order DERMAPTERA de Geer, 1773
Family ANISOLABIDIDAE Verhoeff, 1902
Subfamily ANISOLABIDINAE Verhoeff, 1902

Genus *Canarilabis* Steinmann, 1985
= *Forficula* Linnaeus, 1758, partim Brullé (1838: 74); *Forcinella* Dohrn, 1862, partim Dohrn (1864: 288); *Anisolabis* Fieber, 1853, partim Bolivar (1893: 46); *Gelotolabis* Zacher, 1911, partim Burr (1915: 541); *Gonolabis* Burr, 1900, partim Popham & Brindle (1966: 273); *Euborellia* Burr, 1909, partim Brindle (1969: 17)

Type species. Forficula maxima Brullé, 1838

Diagnosis. Large species (17.8–31.2 mm without forceps), colour generally dark brown black, cuticle shiny, antennae reddish brown, and legs ochraceous. Tegmina absent or developed as lateral flaps, wings absent; ultimate tergite broad, tumid, with strong and comparatively straight forceps; male forceps long, strongly trigonal basally and medially, cylindrical, and slightly curved apically. Male genitalia with two penises, V-shaped, median incision deep; paramere 1.6–2.1 times as long as broad, with angular outer margin and concave inner margin; penis approximately 1.5 times longer than the paramere, tip rounded, cuticle finely serrated, virga not observable.

The earwigs of the subfamily Anisolabidinae share a uniform body structure, and the external cuticle provides very few identifying characters to distinguish described genera. Genera diagnoses are therefore based on the male copulatory organs (Steinman, 1989; Srivastava, 1999). The parameters of the male copulatory organs are oval in the genus *Canarilabis*, two times longer than wide, and are shallowly excised on the inner margin, and in most species also on the outer margin. No distinct protuberance or tooth is formed on the parameres (Steinman, 1989; Srivastava, 1999). For the identification of Anisolabidinae genera described so far, the identification key published in the study of Kočárek (2014) can be used.

Comments. Brullé (1838) described *Forficula maxima* without specification of the type locality; the type specimens are stored in Museum National d'Histoire Naturelle, Paris (Burr, 1908). Brullé (1838) also recorded two slightly different females with pale prothorax and described them as *Forficula major* Brullé, 1838. This species was synonymised with *F. maxima* by Burr (1910). Bolivar (1893) studied material of *F. maxima* from Tenerife and Gran Canaria and reevaluated generic placement from *Forficula* Linnaeus, 1758, to *Anisolabis* Fieber, 1853. Burr (1915) used two generic combinations within one study. He moved *Anisolabis maxima* to the genus *Gelotolabis* Zacher, 1911 (Burr, 1915: 541), although in the same study, he used Bolivar's combination *A. maxima* (Burr, 1915: 526), which was used in his previous studies (Burr, 1908, 1910, 1911, 1912). Brindle (1964, 1968) followed the classification of Burr (1915) in the genus *Gelotolabis*, but in his later studies, he used the combination *Euborellia maxima* (Brindle, 1969, 1971). A few years before, Popham and Brindle (1966) used the combination *Gonolabis maxima*. However, the situation in the perception of the species was complicated by Moreira (1932), who described the species *E. maxima* Moreira, 1932 from Brazil. In subsequent studies, Brindle mentioned both *E. maxima* (Brullé, 1838) as an endemic species of the Canary Islands (Brindle, 1969) and *E. maxima* Moreira, 1932 as a species from Brazil (Brindle, 1971). Only Steinmann (1989) distinguished *E. maxima* Moreira, 1932, as a secondary

homonym of *C. maxima* (Brullé, 1838) and created the replacement name *Euborellia tropica* Steinmann, 1989. Johnsen (1974) moved the species back to *Anisolabis* Fieber, 1853, together with the description of a new species, *Anisolabis alata* Johnsen, 1974. Steinman (1985) established a new monotypic genus, *Canarilabis* Steinmann, 1985, for *A. maxima*; however, lately, he moved *C. maxima* again into *Gonolabis* Burr, 1900 (Steinmann, 1989) but neglected to mention the species *Canarilabis/Gonolabis alata*. Srivastava (1999) kept *C. maxima* in *Canarilabis,* but he also did not mention *C. alata*.

***Canarilabis canariensis* Kočárek, Bonczek & Kočárková, sp. nov.**

LSID urn:lsid:zoobank.org:act:C7CD744A-D3C7-47D0-BD66-967C368BEF5F

Figs. 1A (clade 2, lineages "A"), 2, 4A–E, 5A, E

Type locality. Spain: Canary Isl., Gran Canaria, Cruz de Tejeda env., 27 °58′54″N, 15 °34′53″W, 1705 m a.s.l.

Material examined. Holotype: male, "Spain: Canary Isl., Gran Canaria, Cruz de Tejeda env., 27 °58′54″N, 15 °34′53″W, 1705 m a.s.l., under stones, 13.iv.2017, P. Kočárek & I. Horká leg." (NMPC). Paratypes: 1 male, 5 females: "Canary Islands: Gran Canaria, Cruz de la Tejeda env., 4.12.2008, V. Šilha lgt. (NMPC, UNOV); 1 male: "SP-Gran Canaria isl., Sezadero de Cruz Grande, 17.1.2001, lgt. F. Pavel (UNOV); 1 female: "Canary Islands: Gran Canaria, Presa los Niñas, 25.2.2009, V. Šilha lgt. (UNOV).

Diagnosis. Similar to the rest of the species of *Canarilabis* in terms of external morphology, males can be identified by the unique combination of the following characters: tegmina absent; lateral glandular folds not developed or developed only on tergite 4 but slightly visible; tergites 6–9 rugoso-striate at the sides; penultimate sternite with posterior margin narrow, truncate, truncate part as wide as 1/4 of the maximal width of the sternite, with a manubrium approximately 1.5 times longer than the penultimate sternite; and the outer margin of the paramere with a broadly rounded bulging protuberance. The females are indistinguishable.

Description. Male. Body blackish brown, shiny; antennae unicolour, reddish brown; distal half of the labrum yellow; legs unicolour, ochraceous, forceps reddish brown with lateral and dorsal edges black. Cuticle punctured, shiny; tegmina and wings absent. The total body length without forceps: males: 22.6–25.4 mm, holotype 25.4 mm; females: 17.8–22.1 mm. Length of forceps: males: 5.8–7.8 mm, holotype 7.8 mm; females: 4.6–6.4 mm.

Head (fig. 2A) as long as wide; postfrontal and coronal sutures fine but distinct; frons convex. Eyes approximately 0.5 times as long as head length behind eyes. Antennae multisegmented and composed of up to 24 pubescent antennomeres, left antenna of holotype 14 antennomeres, right antenna of holotype 28 antennomeres (both incomplete); antennomere 1 (scape) long, narrowed basally, widened terminally, as long as antennomeres 2–4 combined; antennomere 2 (pedicel) transverse, only slightly longer than wide; antennomere 3 cylindrical, 2 times longer than wide; antennomere 4 slightly longer than wide; the rest of antennomeres conical, each subsequent antennomere slightly longer than the previous antennomere.

Pronotum (fig. 2A) smooth, approximately as long as wide, widened posteriorly;

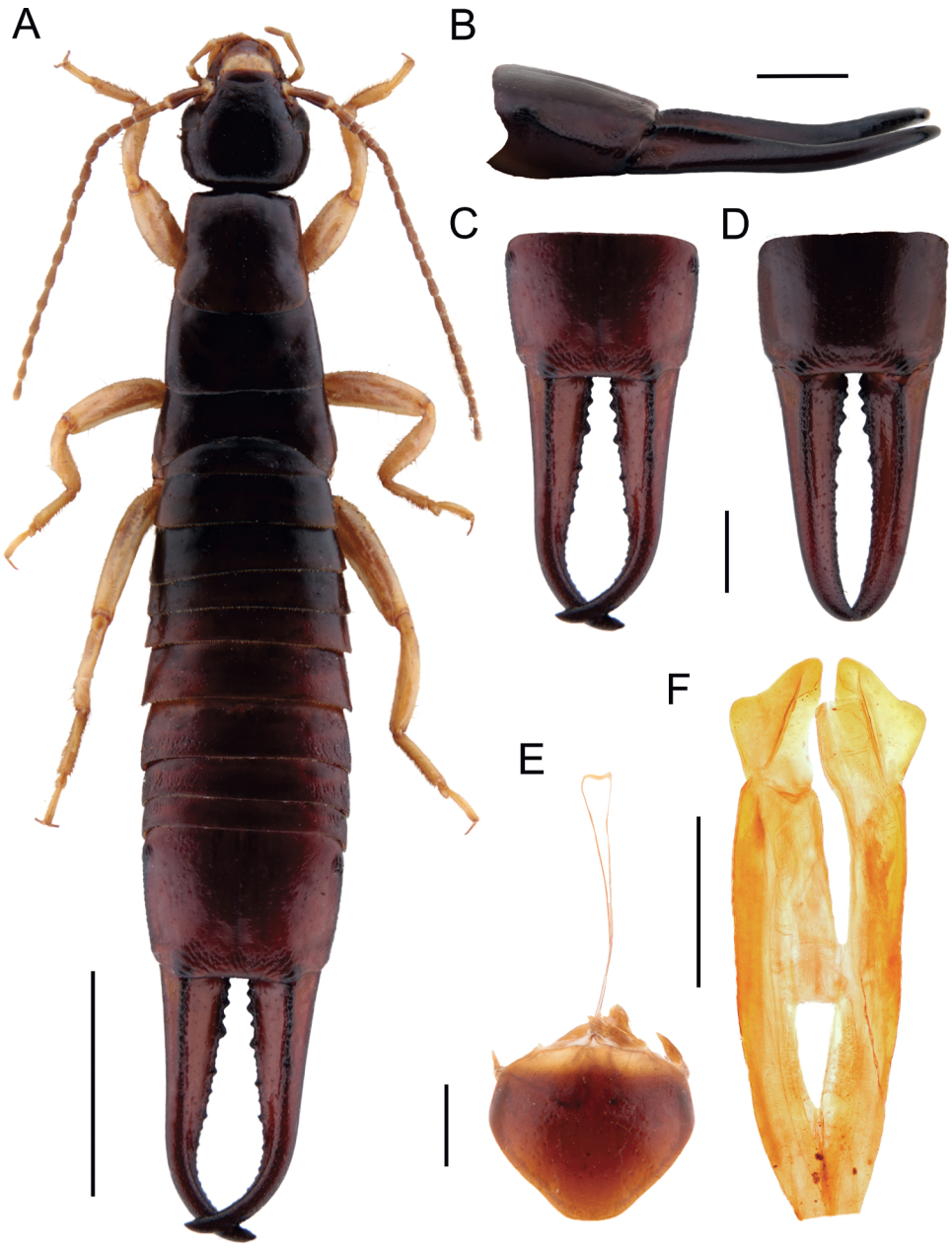


FIGURE 2 *Canarilabis canariensis* Kočárek, Bonczek & Kočárková, sp. nov. (A) Habitus of holotype male from dorsal view; (B) Male forceps from lateral view; (C) Male forceps from dorsal view; (D) Female forceps from dorsal view; (E) Subgenital plate from ventral view; and (F) Male genitalia from dorsal view. Scale bars: A = 5.0 mm; B, C, D, E = 2.0 mm; and F = 1.0 mm.

anterior margin nearly straight, posterior margin rounded and shallowly emarginated in middle, lateral margins concave in middle. Median sulcus fine but distinct. Meso- and metanotum transverse, smooth; mesonotum truncate posteriorly, metanotum broadly emarginated posteriorly; median sulcus visible on both mesonotum and metanotum. Prosternum 1.5 times longer than wide, constricted laterally in posterior third, posterior margin truncate; mesosternum approximately as long as wide, posterior margin broadly rounded; metasternum approximately as long as wide, trigonal, widest at base and tapering to truncate tip. Legs comparatively short; femora stout, covered by sparse long setae; tibiae shorter than femora, with sparse setae, setae longer on outer edge than on inner edge; tarsomeres pubescent laterally and ventrally, smooth dorsally; tarsomere 1 longer than tarsomeres 2–3 combined, tarsomere 2 short, quadratic; claws bent inward, gradually narrowing toward the tip; arolia absent.

Abdomen (fig. 2A) sparsely punctulate, and shiny. Tergites (except for ultimate tergite) convex, and somewhat widened posteriorly; lateral glandular folds developed on tergite 4, but only slightly visible (in holotype), or indistinguishable; tergites 6–9 rugoso-striate at sides. Ultimate tergite transverse; sides convex, narrowed somewhat anteriorly, median part with 8–10 longitudinal, finely dotted stripes; lateral longitudinal ridge rugoso-striate, sinuate, with tuberous projection at the base; posterior margin slightly concave medially. Penultimate sternite narrowed posteriorly, with posterior margin straight, truncate, truncate part as wide as 1/4 of maximal width of sternite (fig. 2E), manubrium approximately 1.5 times longer than penultimate sternite. Pygidium flat, not protruding, trigonal, with oval depression in middle. Forceps symmetrical (figs. 2B, C, 4A–C), or only slightly asymmetrical in distal third; both branches subcontinuous and stout at base, gradually tapering apically, nearly straight in basal two-thirds, and slightly incurved afterward; forceps trigonal in basal half and cylindrical in distal half; inner margin crenulated, teeth irregularly spaced, dorsal edge without teeth, elevated in basal one fourth.

Genitalia (figs. 2F, 4D, E) with two penises, deeply excised, V-shaped, with short parameres; parameres 1.5–1.6 times longer than wide, widest in middle, with external projection broadly rounded, external edge trigonal, convex in basal half and concave in apical half, internal edge broadly concave; apical angle convex. Penis 1.7 times longer than the paramere, tip rounded, cuticle finely serrated; virga not observable.

Female. Agrees with male in most characters except for the following: mesonotum broadly concave posteriorly; lateral glandular folds on tergite 4 not developed; tergites 7–9 smooth, not rugoso-striate at sides; ultimate tergite with lateral longitudinal ridge less developed. Penultimate sternite trigonal, narrowed posteriorly, with posterior margin truncate. Forceps (fig. 2D) with simple and straight contiguous branches, weakly regularly concave from base to tip.

Distribution. Canary Islands: Gran Canaria.

Etymology. The specific epithet is the Latinised adjective derived from the name Canaria with the added suffix -ensis, denoting the place of origin.

***Canarilabis hierrensis* Kočárek, Bonczek & Kočárková, sp. nov.**

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Figs. 1A (clade 2, lineage "B"), 3, 4F–J, 5B, F

Type locality. Spain: Canary Isl., El Hierro, Frontera env., 27 °45′07.0″N 17 °59′32.4″W, 618 m a.s.l.

Material examined. Holotype: male, "Spain: Canary Isl., El Hierro, Frontera env., 24 °45′07.0″N, 17 °59′32.4″W, 618 m a.s.l., under stones and decaying trunks, 1.vii.2014, P. Kočárek & I. Horká leg." (NMPC). Paratypes: 4 males, 3 females, same label data as holotype (NMPC, UNOV); 1 male, 1 female, "Spain: Canary Isl., El Hierro, El Sabinar, 27 °45′08.4″N, 18 °07′10.1″W, 663 m a.s.l., under stones, 5.vii.2014, P. Kočárek leg. & I. Horká leg." (UNOV).

Diagnosis. Similar to the rest of the species of *Canarilabis* in terms of external morphology, males can be identified by the unique combination of the following characters: tegmina absent; lateral glandular folds always present, developed on tergites 3 and 4, or only on tergite 4; tergites 6–9 rugoso-striate at sides; penultimate sternite with posterior margin subtruncate, somewhat concave, truncate part as wide as 1/3 of maximal width of sternite, manubrium approximately 2 times longer than penultimate sternite; outer margin of paramere with angular projection. Females are indistinguishable.

Description. Male. Body blackish brown, shiny; antennae unicolour, reddish brown; distal half of labrum yellow; legs unicolour, forceps reddish brown with lateral and dorsal edges black. Cuticle punctured, shiny; tegmina and wings absent. Total body length without forceps: males: 21.4–26.3 mm, holotype 25.2 mm; females: 18.0–24.7 mm. Length of forceps: males: 6.5–8.8 mm, holotype 8.2 mm; females: 4.3–7.1 mm.

Head (fig. 3A) as long as wide; postfrontal and coronal sutures fine but distinct; frons convex. Eyes approximately 0.5 times as long as head length behind eyes. Antennae multisegmented and composed of up to 28 pubescent antennomeres, left antenna of holotype 18 antennomeres, right antenna of holotype 25 antennomeres (both incomplete); antennomere 1 (scape) long, narrowed basally, widened terminally, as long as antennomeres 2–4 combined; antennomere 2 (pedicel) transverse, only slightly longer than wide; antennomere 3 cylindrical, 2 times longer than wide; antennomere 4 slightly longer than wide; the rest of antennomeres conical, each subsequent antennomere slightly longer than the previous antennomere.

Pronotum (fig. 3A) smooth, approximately as long as wide, widened posteriorly; anterior margin nearly straight, posterior margin rounded and shallowly emarginated in middle, lateral margins concave in middle. Median sulcus fine but distinct. Meso- and metanotum transverse, smooth; mesonotum truncate posteriorly, metanotum broadly emarginated posteriorly; median sulcus visible on both mesonotum and metanotum. Prosternum 1.5 times longer than wide, constricted laterally in posterior third, posterior margin truncate; mesosternum approximately as long as wide, posterior margin broadly rounded; metasternum approximately as long as wide, trigonal, widest at base and tapering to truncate tip. Legs comparatively short; femora

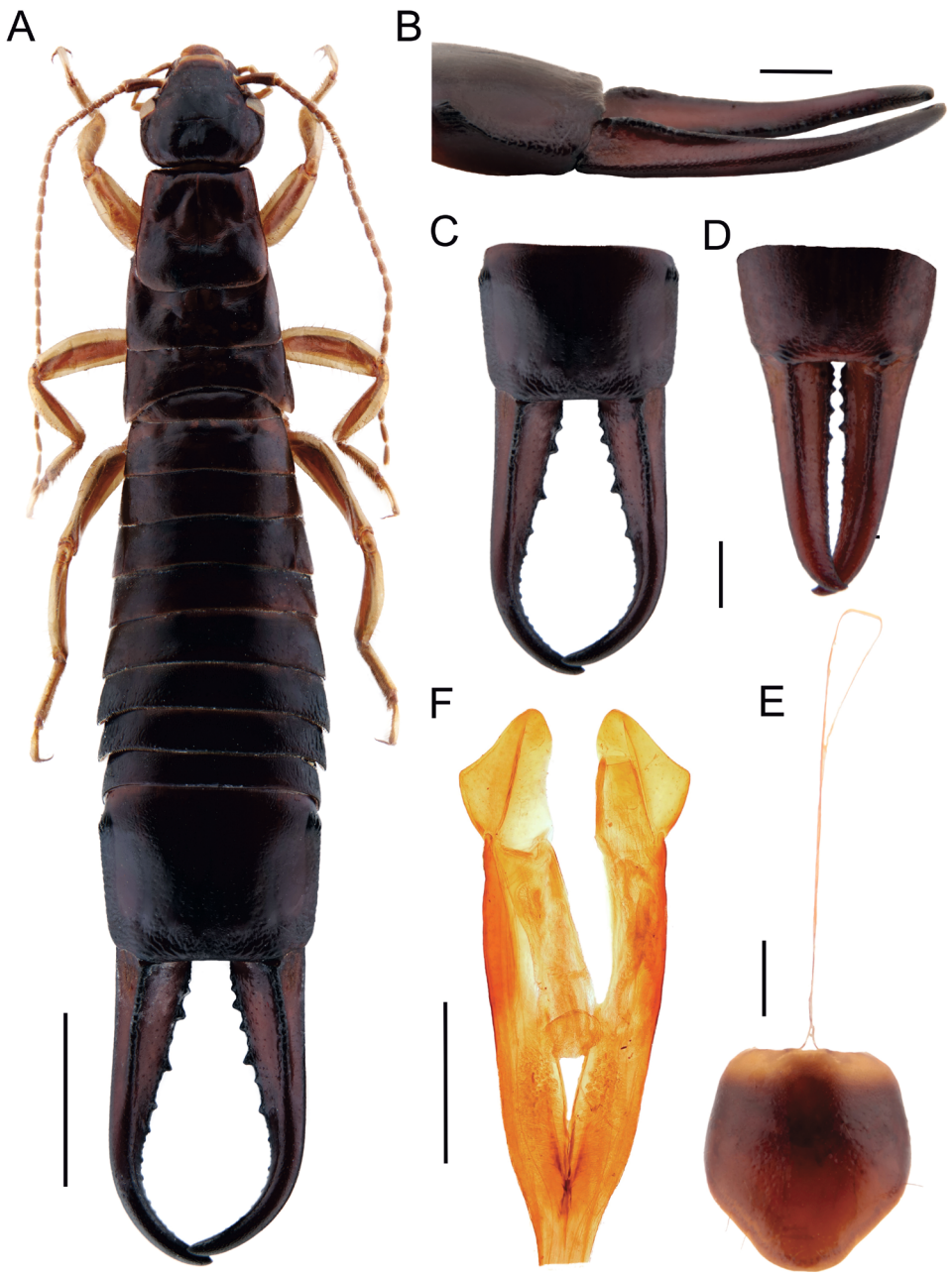


FIGURE 3 *Canarilabis hierrensis* Kočárek, Bonczek & Kočárková, sp. nov. (A) Habitus of holotype male from dorsal view; (B) Male forceps from lateral view; (C) Male forceps from dorsal view; (D) Female forceps from dorsal view; € Subgenital plate from ventral view; and (F) Male genitalia from dorsal view. Scale bars: A = 5.0 mm; B, C, D, E = 2.0 mm; and F = 1.0 mm.

stout, covered by sparse long setae; tibiae shorter than femora, with sparse setae, setae longer on outer edge than on inner edge; tarsomeres pubescent laterally and ventrally, smooth dorsally; tarsomere 1 longer than tarsomeres 2–3 combined, tarsomere 2 short, quadratic; claws bent inward, gradually narrowing toward the tip; arolia absent.

Abdomen (fig. 3A) sparsely punctulate and shiny. Tergites (except for ultimate tergite) convex and somewhat widened posteriorly; lateral glandular folds developed on tergites 3 and 4 or only on tergite 4; tergites 6–9 rugoso-striate at sides. Ultimate tergite transverse; sides convex, slightly narrowed anteriorly, median part with 8–10 longitudinal, finely dotted stripes; lateral longitudinal ridge rugoso-striate, sinuate, with tuberous projection at the base; posterior margin slightly concave medially. Penultimate sternite narrowed posteriorly, with posterior margin subtruncate, somewhat concave, truncate part as wide as 1/3 of maximal width of sternite (fig. 3E), and manubrium approximately 2 times longer than penultimate sternite. Pygidium flat, not protruding, trigonal, with oval depression in middle. Forceps symmetrical (figs. 3B, C, 4F–H), or only slightly asymmetrical in distal third; both branches subcontinuous and stout at base, gradually tapering apically, nearly straight in basal two-thirds, and slightly incurved afterward; forceps trigonal in basal half and cylindrical in distal half; inner margin crenulated, teeth irregularly spaced, dorsal edge without teeth, elevated in basal one fourth.

Genitalia (figs. 3F, 4I, J) with two penises, deeply excised, V-shaped, with short parameres; parameres 1.6–1.7 times longer than wide, widest in middle, with external projection pointed, external edge trigonal, convex in the basal half and concave in the apical half, internal edge broadly concave; apical angle broadly convex. Penis 1.5 times longer than the paramere, tip rounded, cuticle finely serrated; virga not observable.

Female. Agrees with male in most characters except the following: mesonotum broadly concave posteriorly; lateral glandular folds on tergites 3 and 4 not developed; tergites 6–9 smooth, not rugoso-striate at the sides; ultimate tergite with lateral longitudinal ridge less developed. Penultimate sternite trigonal, narrowed posteriorly, with posterior margin truncated. Forceps (fig. 3D) with simple and straight contiguous branches, weakly regularly concave from base to tip.

Distribution. Canary Islands: El Hierro.

Etymology. The specific epithet is the Latinised adjective derived from the name Hierro with added suffix -ensis, denoting the place of origin.

Canarilabis maxima (Brullé, 1838)

Figs. 1A (clade 2, lineage "C"), 4K–O, 5C

Type locality. Spain: Canary Islands; the island not specified (Brullé, 1838; Burr, 1908)

Material examined. Spain: Canary Isl., Tenerife, La Orotava env., 28 °19′35.9″N, 16 °31′59.9″W, 1620 m a.s.l., 9.xii.2016; under stones, P. Kočárek and I. Horká leg. (5 males, 6 females) (UNOV); Spain: Tenerife ins. c., Aquamansa 4 km SW, 24.03.2015, Pinetum under rocks, 1550 m, 28 °20′05″N, 16 °31′18″W, 7 ex., M. Mantič leg. (MMCO); Spain: Tenerife ins. occ., Baracan Mt. 1,5 km SE of Los Bailaderos,

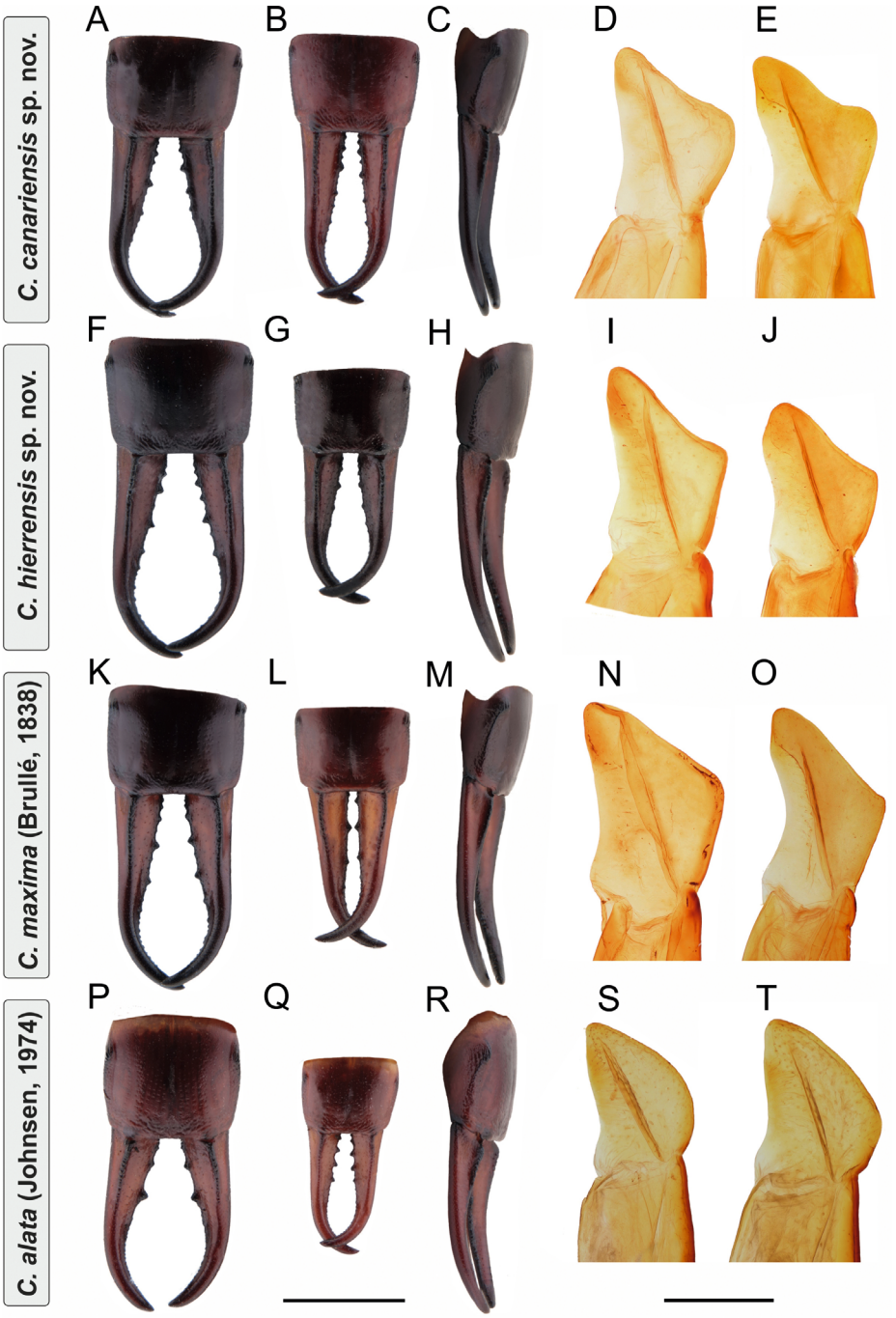


FIGURE 4 Variability of male forceps (dorsal and lateral views) and right parameras in *Canarilabis canariensis* sp. nov. (A–E), *C. hierrensis* sp. nov. (F–J), *C. maxima* (Brullé, 1838) (K–O), and *C. alata* (Johnsen, 1974) (P–T). Scale bars: A–C, F–H, K–M, P–R = 2.0 mm; and D, E, I, J, N, O, S, T = 0.5 mm.

18.xi.2015, Laureto-Ericetum, under rocks, 28 °20′06″N, 16 °51′46″W, M. Mantič leg. (MMCO).

Published records. Bolivar (1893: 47–48); Krauss (1892: 163); Burr (1908: 30); Willemse (1936: 56); Chopard (1954: 13); Brindle (1968: 143–144); Kruseman & Jeekel (1972: 25); Johnsen (1974: 33); Allcard & Valletta (1978: 91); Allcard & Valletta (1982: 116); Beron (2015: 213). Records published from La Gomera should be considered as *Canarilabis alata* (Johnsen, 1974): May (1912: 186) as *Anisolabis maxima*; Brindle (1968: 143–144) as *Gelotolabis maxima*. Records published from Gran Canaria should be considered as *Canarilabis canariensis* Kočárek, Bonczek & Kočárková, sp. nov.: Bolivar (1893: 47–48); Chopard (1954: 13); Brindle (1968: 143–144); Kruseman & Jeekel (1972: 25); Bivar de Sousa & Sakai (1997: 291). Records published from El Hierro should be considered as *Canarilabis hierrensis* Kočárek, Bonczek & Kočárková, sp. nov.: Chopard (1954: 13); Brindle (1968: 143–144).

Diagnosis. Similar to the rest of the species of *Canarilabis* in terms of external morphology, males can be identified by the unique combination of the following characters: tegmina absent; lateral glandular folds developed on both tergites 3 and 4 but sometimes slightly visible; tergites 7–9 rugoso-striate at sides; penultimate sternite with posterior margin narrow, truncate, truncate part as wide as 1/4–1/5 of the maximal width of sternite; manubrium approximately 1.8–2.0 times longer than penultimate sternite; and outer margin of paramere with angular projection. Females are indistinguishable.

Comment. Brullé (1838) described *Forficula maxima* from the Canary Islands (Îles Canaries) without specification of the type locality. The type material (male and female) are stored in Museum National d'Histoire Naturelle, Paris (Burr, 1908), for labels see MNHN (2024). The type male tergites 7–9 are rugoso-striate laterally (see MNHN, 2024) and this character distinguishes *C. maxima* from both *C. canariensis* sp. nov. and *C. hierrensis* sp. nov. with tergites 6–9 rugoso-striate laterally (fig. 6). The type material therefore belongs to the *C. maxima sensu stricto* and was evidently collected in Tenerife.

Canarilabis alata (Johnsen, 1974)

Figs. 1A (clade 1), 4P–T, 5D

Type locality. Spain: Canary Isl., La Gomera, La Palmita (Johnsen 1974)

Material examined. Spain: Canary Isl., La Gomera, Benchijigua: Los Neruegos, 28 °06′15.9″N, 17 °13′54.7″W, 14.vi.2016, under logs of *Erica*, P. Kočárek and I. Horká leg. (2 males, 3 females) (UNOV); Spain: Canary Isl., La Gomera, La Laguna Grande, 24.xi.2010, V. Šilha leg. (5 males, 1 female) (UNOV); Spain: Canary Isl., La Gomera, Chipude, 24.xi.2010, V. Šilha leg. (7 males, 6 females) (UNOV); Spain: La Gomera ins., Tagamicha Mt., 1.5 km NW of Jerdune, 28 °05′58″N, 17 °10′44″W, 950 m, 16.i.2020, under stones, M. Mantič leg. (4 males) (MMCO); Spain: La Gomera ins., Alto de Garajonay N of Iguajero, 28 °06′35″N, 17 °14′54″W, 1400 m, 13.i.2020, under stones, M. Mantič leg. (2 males, 2 females) (MMCO); Spain: La Gomera ins., Ermita de las Nieves, 700 m N of Vegaipala, 28 °06′04″N, 17 °12′08″W, 1100 m, 16.i.2020, under stones, M. Mantič leg. (1 male, 1 female) (MMCO).

Published records. Johnsen (1974: 29–30) as *Anisolabis alata*; Bivar de Sousa & Sakai (1997: 291).

Diagnosis. Similar to the other species of *Canarilabis* in terms of external morphology, males can be identified by the unique combination of the following characters: rudimentary tegmina present as lateral flaps; lateral glandular folds developed on both tergites 3 and 4 but only slightly visible; tergites 6–9 or 7–9 rugoso-striate at sides; penultimate sternite with posterior margin truncate, slightly concave, truncate part as wide as 1/3 of the maximal width of sternite, manubrium approximately 1.6–1.8 times longer than penultimate sternite; outer margin of paramere broadly rounded, without angular projection.

Identification of* Canarilabis *spp.

All four here described species of the genus *Canarilabis* are very similar (figs. 4, 5) and identification is therefore not easy. Identification characters are found only on males and identification of females collected without simultaneous finding of males is therefore impossible. The only exception is *C. alata*, which can be easily distinguished from all congeners by the presence of tegmina rudiments in the form of lateral flaps, and females can be identified in this way. Males of *C. maxima* can be distinguished from males of *C. hierrensis* sp. nov. and *C. canariensis* sp. nov. by looking at the lateral sides of the abdominal tergites, on which rugoso-striate structures can be observed. These are present in *C. maxima* on 7–9 abdominal tergites (fig. 6A), and in *C. hierrensis* sp. nov. and *C. canariensis* sp. nov. on 6–9 tergites (fig. 6B). However, in the less developed and smaller males, these structures are not so distinct and it is, therefore, good to compare more specimens. The most difficult identification is between the species *C. hierrensis* sp. nov. and *C. canariensis* sp. nov., which are identical in terms of external cuticular structures, and the characters were only found in the length of the manubrium of the subgenital plate (see the identification key). To confirm the correctness of the identification, we consider it important to examine the male copulatory organs. Differences usable for identification were found in the shape of the parameres (fig. 4). Given the observed variability, the extent of which is not yet known, we recommend using and comparing multiple copulatory organs of individuals from the same population.

***Identification key to* Canarilabis (*males only*)**

1 (2) Mesonotum with rudiments of tegmina laterally; La Gomera ..... *C. alata* (Johnsen, 1974)

2 (1) Mesonotum without tegmina 3

3 (4) Tergites 7–9 rugoso-striate laterally (fig. 6A), Tenerife. ..... *C. maxima* (Brullé, 1838)

4 (4) Tergites 6–9 rugoso-striate laterally (fig. 6B) 5

5 (6) Outer margin of paramere with broadly rounded projection (fig. 4D, E), subgenital plate with shorter manubrium (1.5 times longer than sg. plate) (fig. 2E); Gran Canaria ..... *C. canariensis* sp. nov.

6 (5) Outer margin of paramere with angular projection (fig. 4I, J), subgenital plate with longer manubrium (2 times longer than sg. plate) (fig. 3E); El Hierro ..... *C. hierrensis* sp. nov.

Distribution

The genus *Canarilabis* is distributed on five Canary Islands: Gran Canaria, Tenerife, La Gomera, La Palma, and El Hierro (fig. 7). On the basis of the results of the phylogenetic analyses and morphological comparisons

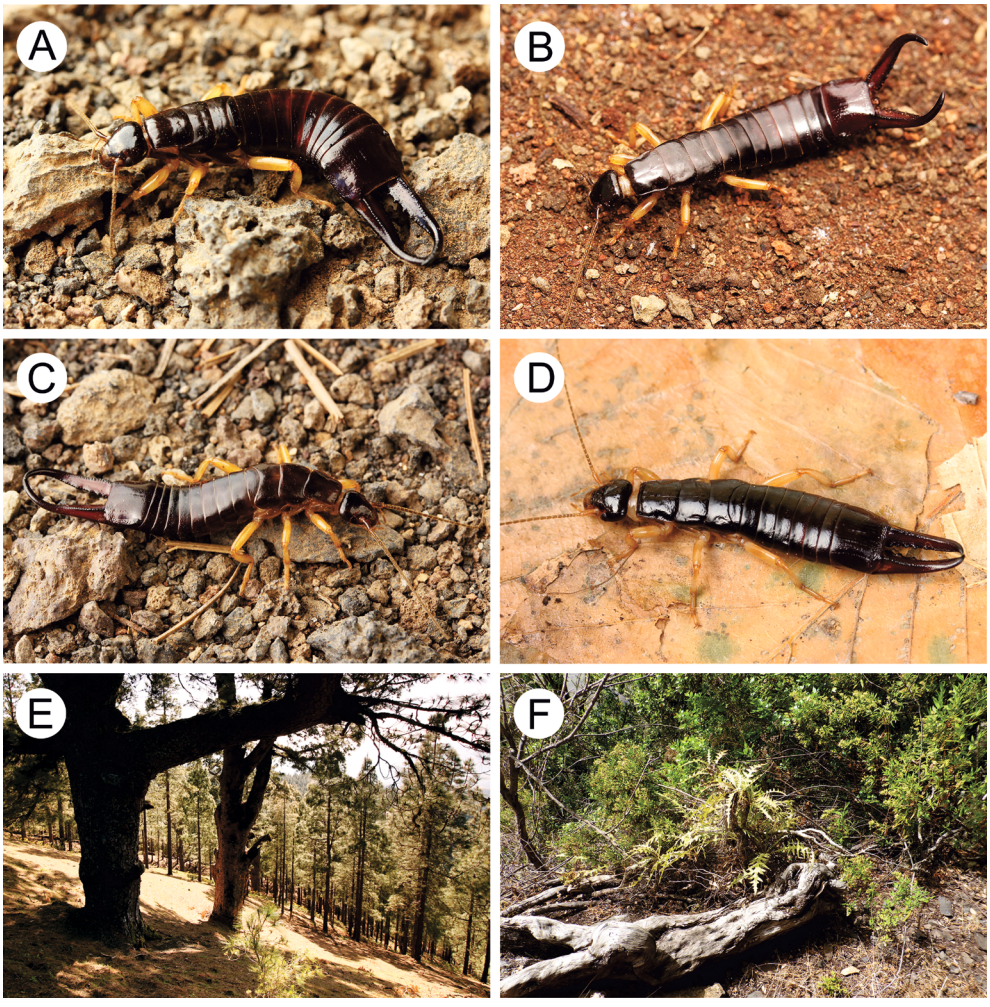


FIGURE 5 Living *Canarilabis* species and their habitats. (A) *C. canariensis* Kočárek, Bonczek & Kočárková sp. nov., male, Gran Canaria, Cruz de Tejeda env.; (B) *C. hierrensis* Kočárek, Bonczek & Kočárková sp. nov., male, El Hierro: Frontera env.; (C) *C. maxima*, male, Tenerife: La Orotava env; (D) *C. alata* (Johnsen, 1974), female, La Gomera, Benchijigua: Los Neruegos; (E) Habitat of *C. canariensis* sp. nov., Gran Canaria: Cruz de Tejeda env., type locality; and (F) Habitat of *C. hierrensis* sp. nov., El Hierro: Frontera env., type locality. Photos by P. Kočárek.

of the studied material, we determined the distributions of *C. alata* (Johnsen, 1974) on La Gomera, *C. maxima* (Brullé, 1838) on Tenerife, *C. canariensis* sp. nov. on Gran Canaria, and *C. hierrensis* sp. nov. on El Hierro. The occurrence of *Canarilabis* sp. was published from La Palma by Brindle (1968), but only nymphs were collected there (Johnsen, 1974). Thus, the species status of the La Palma population will remain unclear until the finding of adults or at least fresh DNA-grade nymphs suitable for molecular identification.

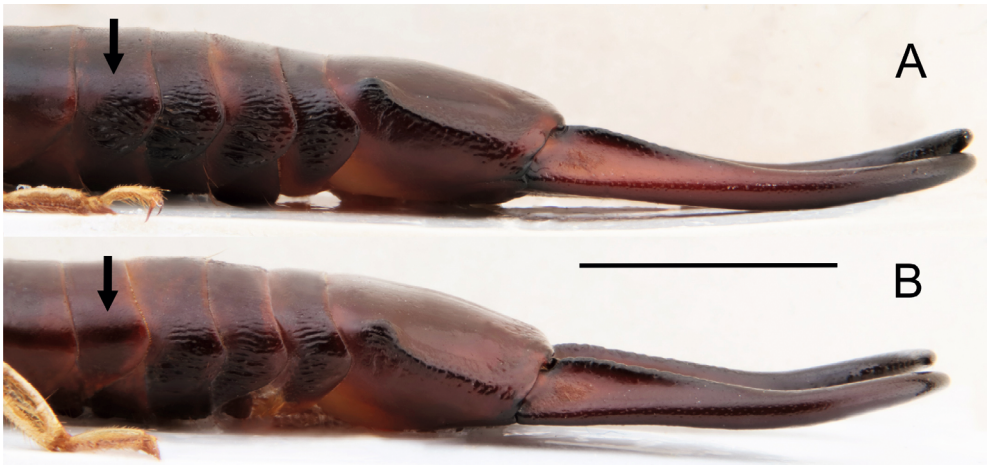


FIGURE 6 Lateral view of abdomen of (A) *C. maxima*, male, Tenerife: La Orotava env., and (B) *C. canariensis* sp. nov., Gran Canaria: Cruz de Tejeda env. Arrows point to rugoso-striate or smooth lateral sides of 6th tergite. Scale bar: = 5 mm.

Canarilabis canariensis sp. nov. has been reported from 22 localities (one locality cannot be exactly geolocalised) on Gran Canaria by Bolivar (1893), Chopard (1954), Brindle (1968), Kruseman & Jeekel (1972), Bivar de Sousa & Sakai (1997), and the GBIF database (GBIF.org, 2024). We present records from four other localities (fig. 7). Eleven records were located exactly by GPS coordinates, which allowed the exact altitude of the find to be evaluated. The lowest confirmed altitude is 37 m, and the highest is 1728 m; the average altitude of Gran Canaria records is 972 m. Most records were reported from the central mountainous area of the island, several records from lower altitudes in the northwestern part of the island, and one isolated record was located in the southern part of the island in Puerto Rico (https://www.inaturalist.org/observations/1969226).

Canarilabis hierrensis sp. nov. has been reported from 19 localities (five localities cannot be exactly geolocalised) on El Hierro by Chopard (1954), Brindle (1968), Johnsen (1974), Feliu et al. (2012), and the GBIF database (GBIF.org, 2024). We present records from two other localities (fig. 7). Most of the records from El Hierro were located inland in the central part of the island, but there were also a few isolated findings from the western, southern, and eastern parts. Eleven records were located exactly by GPS coordinates, which allowed the exact altitude of the find to be evaluated. The lowest recorded altitude is 77 m, and the highest is 1315 m; the average altitude is 800.5 m.

Canarilabis maxima has been recorded from 34 localities (four localities cannot be exactly geolocalised) on Tenerife by Bolivar (1893), Krauss (1892), Burr (1908), Willemse (1936), Chopard (1954), Brindle (1968), Kruseman & Jeekel (1972), Johnsen (1974), Allcard & Valletta (1978, 1982), Beron (2015), and the GBIF database (GBIF.org, 2024). We present records from another five localities (fig. 7). The distribution on the island is not continuous and is concentrated in three mountain areas:

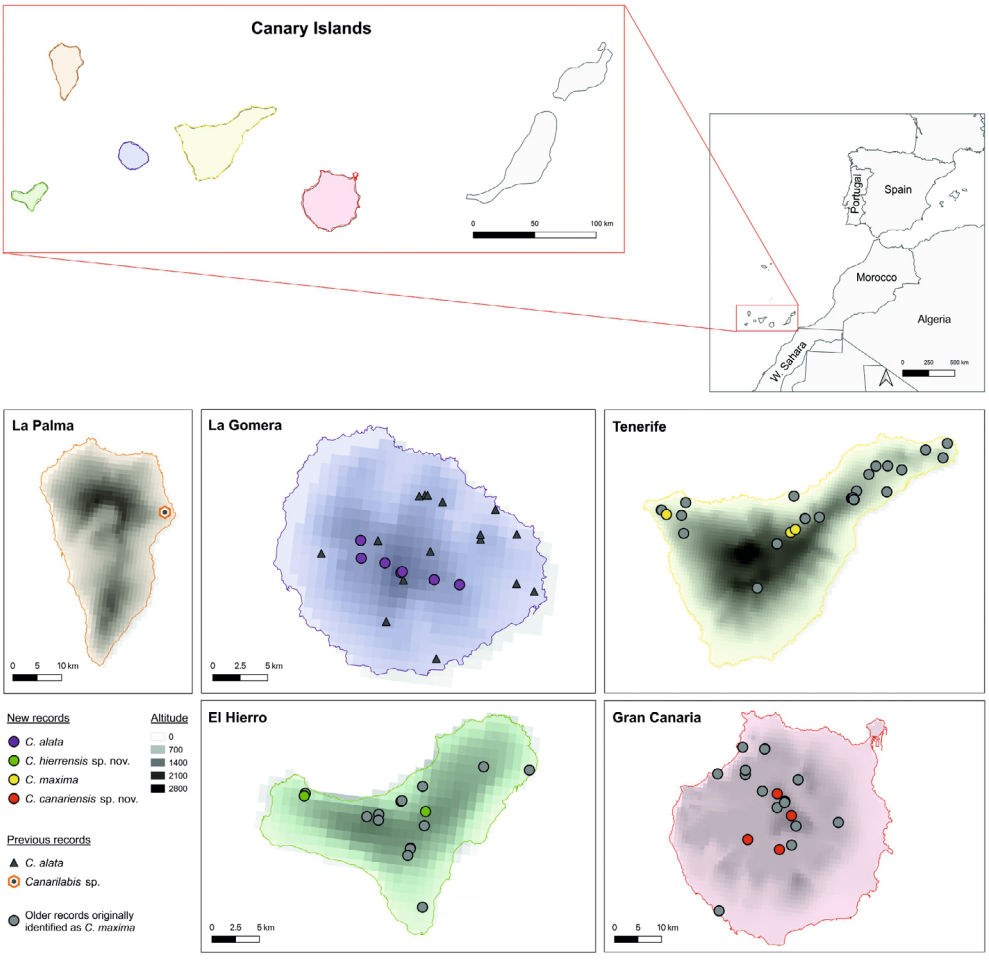


FIGURE 7 Geographic distribution of *Canarilabis* species on the Canary Islands. Old published and not revised records from Gran Canaria, Tenerife, El Hierro and La Gomera are marked with gray symbols.

the Teno Mountains in the western part of the island, the eastern part of the Teide Mountains in the central part of the island and the Anaga Mountains in the eastern part of the island. Only one isolated record from Bremeja Mountain comes from the area south of the Teide Mountains (Brindle, 1968). Twenty records were exactly located by GPS coordinates and allowed the exact altitude of the find to be evaluated. The highest confirmed altitude is 1,700 m, and the lowest is 50 m; the average altitude of the records is 1,095 m.

Canarilabis alata has been reported from 19 localities (two localities cannot be exactly geolocalised) on La Gomera by May (1912), Brindle (1968), Johnsen (1974), Bivar de Sousa & Sakai (1997), and GBIF (GBIF.org, 2024). We present records from another seven localities (fig. 7). *Canarilabis alata* has been recorded across all of La Gomera except the northwestern part

of the island (fig. 7). Most records were reported from mountainous central parts (NP Garajonay and surroundings); several records have been published from eastern and southern parts, which are closer to the coast and have lower altitudes. Seventeen records were located exactly by GPS coordinates, which allowed the exact altitude of the find to be evaluated. The lowest reported altitude is 220 m (locality near the Casas de Taguluche, close to the sea), and the highest altitude is 1,484 m from the locality above Benchijigua village. The average altitude is 847.5 m.

The distribution of *Canarilabis* on La Palma remains unclear. In 1957, Lundblad found nymphs in Puntallana (Brindle, 1968) and identified them as *Anisolabis maxima*. Brindle (1968) revised the material and confirmed Lundblad's identification, but no other species of *Canarilabis* were known at this time. Therefore, Bivar de Sousa & Sakai (1997) considered the record questionable because the nymphs are not sufficient for species identification. There are no other records from La Palma; therefore, there is no possibility to confirm which of the species inhabit this island.

Discussion

The earwigs of the genus *Canarilabis* were sequenced and subjected to molecular phylogenetic analysis for the first time. *Canarilabis* was found to form a monophyletic sister clade to Eurasian *Euborellia*, with which it probably shares a common ancestor. The origin of the genus *Canarilabis* can thus be sought in continental Africa, where the evolutionary center of Anisolabidinae, with the greatest recent species diversity (approximately 40% of the subfamily world diversity), is likely located (Popham, 2000). A comparison of populations from individual islands revealed that different endemic species inhabit each of them. Although all the newly distinguished species are morphologically very uniform, the genetic differences are significant and demonstrate that these evolutionary lineages evolved in long geographic isolation. Within the genus, two main clades were distinguished (fig. 1A), in which *Canarilabis alata* (clade 1) is a sister species to the other three species (clade 2; lineages "A–C"). *Canarilabis maxima* (lineage "C") is a sister species to the subclade formed by *C. canariensis* sp. nov. (lineage "A") and *C. hierrensis* sp. nov. (lineage "B"), which are the most genetically similar. The haplotype network (fig. 1B) suggested a likely evolutionary history and speciation, with *C. maxima* and *C. alata* arising from a common ancestor from which the common ancestor of *C. canariensis* sp. nov. and *C. hierrensis* sp. nov. was also derived.

On the basis of the available data and analyses, the entire evolutionary history cannot yet be elucidated, but it is clear that the species occupying the two geographically most distant islands, El Hierro (*C. hierrensis* sp. nov.) and Gran Canaria (*C. canariensis* sp. nov.), are the most genetically similar and have a common origin. A similar pattern is known from the Canarian *Laparocerus* Schönherr, 1834, which contains 128 species from the Canary Islands with a complicated history and probable multiple colonization waves. One of the four described lineages includes *L. bimbache* Machado, 2011, from El Hierro and close relatives

L. microphthalmus Lindberg, 1950, with *L. osorio* Machado, 2012, and *L. obsitus* Wollaston, 1864, from Gran Canaria (Faria et al., 2016). Considering the ages of these islands (Gran Canaria – 14.5 MYA, El Hierro – 1.1 MYA) (Zaczek et al., 2015; Ramalho et al., 2015), it can be assumed that older Gran Canaria was the probable source from which the ancestor of the current *C. hierrensis* sp. nov. spread to El Hierro. The phylogeography of Canarian lizards *Gallotia* Boulenger, 1916 (Cox et al., 2010), skinks (Brown & Pestano, 1998), blue tits (Kvist et al., 2005), and the Tenebrionidae beetle *Pimelia* Fabricius, 1775 (Juan et al., 1995) have also been studied. These studies described different patterns of dispersal than we found. Gran Canaria seems to be an island where ancestral lineages were derived. Tenerife and La Gomera were colonised from Gran Canaria, whereas El Hierro was the last colonised island by populations from Tenerife or more likely from La Gomera. The confirmed presence of two haplotypes on El Hierro is particularly exciting, as it may testify to ongoing sympatric speciation. Owing to low genetic divergence, morphological identity, and COI-based ASAP analysis (fig. 1A), we currently consider both haplotypes to be one species. However, COI-based ABGD delimitation analysis recognized them as two different species. The limited material studied currently does not allow for solving this problem, but the population genetics of *C. hierrensis* sp. nov. will soon be studied in detail.

All representatives of *Canarilabis* inhabit similar habitats, i.e., moist pine and laurel forests, which are located inland and at higher altitudes of the mentioned islands. These forests are fragmented at present, but historically, they probably covered larger continuous areas within individual islands (Fernández et al., 2011). The exception is Tenerife, where these forests are located in three historically mutually isolated areas (Teno, Teide, and Anaga Mountains), which have probably never been connected by these habitats (Carracedo et al., 2006). Unfortunately, we did not have available DNA-grade *Canarilabis* material from the Teno and Anaga Mountains, which would have allowed the evaluation of genetic differences between these populations. It would be interesting to compare these long-term isolated populations in the future.

No *Canarilabis* species was observed on the eastern, geologically oldest islands, Fuerteventura and Lanzarote. These islands did not develop mountain forests (Ciferri, 1962); therefore, they are currently not suitable for *Canarilabis*. However, it cannot be ruled out that these islands could have played a role in the evolution and speciation of *Canarilabis* during the Miocene (25–5 MYA), when these islands were more elevated (Rodríguez-Sánchez et al., 2009; Fernández et al., 2011). During this period, these islands possessed a wide range of habitats, including laurel forest. At the end of the Miocene and the start of the Pliocene, these habitats were lost after changes in climate and erosion (Rodríguez-Sánchez et al., 2009; Fernández et al., 2011). Currently, *Canarilabis* habitats are found mainly in the central parts of individual islands (fig. 7), and records from the coast of nearby areas are exceptional and usually do not reach 100 m a.s.l. because of the absence of optimal forest cover. Therefore, the potential of crossing

the sea with debris during waves or tsunamis is low, and gene flow is unlikely.

Compared with representatives of the sister genus *Euborellia*, all the species of *Canarilabis* are stout and large earwigs. *Euborellia* is a genus distributed worldwide that includes 44 species, and its size ranges from 6 to 26 mm (Steinmann, 1989). Since *Euborellia* and *Canarilabis* probably share a common ancestor, or possibly the genus *Canarilabis* is derived from *Euborellia*, a noticeable increase in size may be a manifestation of the island gigantism phenomenon in which the isolated island species are larger than their continental relatives (Foster, 1964). Another possible case of island gigantism from the Canary Islands has already been found within the genus *Gallotia,* whose representatives are the largest lizards of Lacertidae. Some of the species are strictly endemic to certain islands, such as in the case of *Canarilabis* (Cox et al., 2010; Čerňanský et al., 2016). Many cases of this phenomenon are known from vertebrates, but there are few possible cases within insects (Meiri et al., 2011). A similar case is the extinct *Labidura herculeana* Fabricius, 1798, an endemic species on Saint Helena Island (Chown & Gaston, 2010). This is the largest known extant/extinct earwig species, which was probably wiped out a few decades ago because of habitat loss and predation from introduced rodents, mantis, and centipedes (Pryce & White, 2014).

Our study, which distinguished four endemic species of *Canarilabis* that inhabit four different Canary Islands, must be considered a pilot study. To resolve the taxonomy and understand the evolutionary history of this genus, it is necessary to collect a larger dataset and genetically sample populations originating from different parts of individual islands. It will also be important to verify the occurrence of the genus *Canarilabis* on the island of La Palma and, if confirmed, to resolve its species status.

Conclusion

Molecular phylogenetic analyses confirmed the monophyly of the genus *Canarilabis* endemic to the Canary Islands. The taxonomic revision of *Canarilabis* carried out on the basis of the molecular phylogenetic evaluation revealed unexpected cryptic diversity among the populations inhabiting the different islands. We confirmed the species status of *C. alata* (Johnsen, 1974), endemic to La Gomera, but within *C. maxima* (Brullé, 1838) three different species were distinguished, two of which are described in this study: *C. canariensis* Kočárek, Bonczek & Kočárková, sp. nov., inhabiting Gran Canaria; *C. hierrensis* Kočárek, Bonczek & Kočárková, sp. nov., inhabiting El Hierro; and *C. maxima sensu novo* associated with Tenerife.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Data availability

All obtained sequences are stored in GenBank. Supplementary data for this study (GenBank accession numbers, table of studied samples) are available in the online version of this article.

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Supplementary material

Supplementary material is available online at:
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