Notes on the biology, distribution and taxonomy of *Chondrostega* Lederer, 1857 in the Iberian Peninsula with a description of the southern Spanish *Chondrostega escobesae* sp. nov. (Lepidoptera: Lasiocampidae, Chondrosteginae)

● Josef J. de Freina, Yeray Monasterio León, Carlos Alberto Antonietty & Roger Vila

Abstract. Spanish populations of *Chondrostega* Lederer, 1857 are examined based on external and internal morphology as well as molecular data from the mitochondrial cytochrome oxidase subunit I gene (COI). According to relevant diagnostic features and genetic differentiation, two species with allopatric distribution are recognized within the Iberian Peninsula. Andalusian populations, here described as *Chondrostega escobesae* sp. nov., are compared to the closely related *Chondrostega vandalicia* (Millière, 1865), which is limited to the northern half of the Iberian Peninsula. They can be recognized by largely constant morphological features such as a different pattern on the underside of the wings of the male, adult male genital structure, different structure of the canthus and the colour of hairs in the final instars. Phylogenetic analyses based on COI identify the two species as sister clades with a minimum genetic divergence of 3.8%. Adults, including the apterous females, immature stages, larval host plants and natural habitat are described and illustrated. A neotype is designated for *C. vandalicia*.

Resumen. Consideraciones sobre la biología, distribución y taxonomía de *Chondrostega* Lederer, 1857 en la península ibérica, con la descripción de *Chondrostega escobesae* sp. nov. del sur de España (Lepidoptera: Lasiocampidae, Chondrosteginae)
Se realiza una revisión taxonómica de las poblaciones españolas de *Chondrostega* Lederer, 1857, a partir del estudio de caracteres morfológicos internos y externos, así como del gen mitocondrial citocromo oxidasa subunidad I (COI). Atendiendo a características diagnósticas relevantes, el género se divide en dos especies alopátridas en la península ibérica. Las poblaciones presentes en Andalucía se describen aquí como *Chondrostega escobesae* sp. nov. y son comparadas con *Chondrostega vandalicia* (Millière, 1865), limitada a la mitad norte de Iberia. Estas especies pueden ser diferenciadas a partir de varias características como la existencia de un patrón diferente en el reverso de las alas de los machos, la estructura genital masculina, diferente estructura del canthus y la coloración de la pilosidad de los últimos estadios larvarios. El análisis filogenético basado en el COI muestra las dos especies como clados hermanos con una divergencia genética del 3.8%. Se describen e ilustran los adultos de ambos sexos, estadios inmaduros, plantas nutricias de las orugas y varios hábitats. Se designa además un neotipo para *C. vandalicia*.

Zusammenfassung. Von spanischen Populationen der Gattung *Chondrostega* Lederer, 1857 werden äußere und innere morphologische Merkmale wie auch molekulare Datensätze der mitochondrial cytochrome oxidase subunit I gene (COI) untersucht und ausgewertet. Die Diagnose belegt die Existenz zweier allopatrisch wie auch genetisch getrennter Arten auf der Iberischen Halbinsel. Populationen Andalusiens werden als *Chondrostega escobesae* sp. nov. beschrieben und mit ihrer Schwesterart *Chondrostega vandalicia* (Millière, 1865) verglichen, deren Verbreitung sich auf die Nordhälfte der Iberischen Halbinsel beschränkt. Beide Arten sind anhand konstanter morphologischer Unterschiede wie der verschieden ausgeprägten Hinterflügelzeichnung, der männlichen Genitalstruktur, der Form des Canthus und der deutlich voneinander abweichenden Färbung erwachsener Raupen unterscheidbar. Die Auswertung der DNA-Barcoding ergibt einen DNA-Sequenzunterschied des mtDNA Cytochromoxydase-I-Gens (COI) zwischen nord- und südspanischen Tieren von mindestens 3,8%. Der Beitrag liefert Beschreibungen und Abbildungen der Imagines einschließlich des apteren Weibchens, der letzten Präimaginalstadien, Wirtspflanzen und Lebensräume. Für *C. vandalicia* wird ein Neotypus designiert.

Key words. Lepidoptera, Lasiocampoidea, Lasiocampidae, *Chondrosteginae*, Chondrostega, Iberian Peninsula, new species, neotype, taxonomy, Palaearctic region, DNA barcoding, mitochondrial DNA.

Introduction

Chondrostega Lederer, 1857 is a complex of species and forms, rather difficult to classify, that is distributed from the southern Europe and North Africa to central and western Asia, whereas *Chondrostegoides* Aurivillius, 1905 is limited to southern Africa. Theaptery of *Chondrostega* females has presumably resulted in many dispersed populations. This is especially true for the *Chondrostega vandalicia* (Millière, 1865) species group, one of the cases with controversial taxonomy in this genus

(Rougeot & Viette 1978, de Freina & Witt 1987, Leraut 2006), which displays scattered populations from the Iberian Peninsula and over the entire Maghreb to the Levant. Absence of diagnostic characters both in genitalia and larval stages has led to descriptions of a considerable number of taxa of uncertain validity, listed below:

C. constantina Aurivillius, 1894; *C. powelli* Oberthür, 1912; *C. tingitana* Powell, 1916; *C. maghrebica* de Joannis, 1929 (described from populations of Morocco and Algeria); *C. zanoni* Turati, 1922; *C. misuratana* (Krüger, 1939 (described from Libya); *C. subfasciata* Klug, 1830; *C. palaestrana* Staudinger, 1891; *C. fasciana* Staudinger, 1891; *C. longespinata* Aurivillius, 1894; *C. aurivillii* Püngeler, 1902; *C. goetschmanni* Sterz, 1915; *C. osthelderi* Püngeler, 1925; *C. intacta* Gaede, 1933; *C. pauli* Gaede, 1933; *C. schwingenschussi* Zerny, 1933; *C. elema* Wiltshire, 1941; *C. brunneicornis* Wiltshire, 1944 (all described from Levantine populations).

To test the validity of these taxa, further research is essential and molecular data may shed light on the extent of diversification among populations. It should be expressly mentioned here that due to lack of scientific verification we can not accept the arbitrary taxonomic changes within the *Chondrostega* group made by Leraut (2006). This means that we still consider *C. vandalicia* as non-conspecific with any of the North African taxa.

The Iberian populations of *Chondrostega* have all been previously treated as belonging to *C. vandalicia* (Millière, 1865). However, we show that the genital structure, canthus morphology and DNA sequence data of the southern Spanish populations display considerable differences compared to those in northern Spain. Furthermore, morphological differences in male adults, as well as a significant difference in larval colour, suggest that two geographically separate species exist, despite the virtually identical appearance of the adults. Based on these morphological differences and mitochondrial DNA results, we propose that *C. vandalicia* exists in the northern half of the Iberian Peninsula, while the Andalusian populations represent a separate species, here described as *Chondrostega escobesae* sp. nov.

Methods and materials

Morphologie and repositories

Cleaned, stained genitalia were stored and examined in 30 % ethanol, and slide-mounted in Euparal before being photographed.

Repository abbreviations are as follows: BC – Barcode; CFM – Collection de Freina, München; CML – Collection Monasterio León, Logroño; GPdF – Genitalia dissection de Freina; IBEB – Institut de Biologia Evolutiva (CSIC-UPF), Barcelona; ID – Identifying number; MWM – Collection of Lepidopterological Museum Witt, Munich; ZMHU – Museum für Naturkunde, Berlin (formerly Zoologisches Museum der Humoldt-Universität, Germany); ZSM – Bavarian State Collection of Zoology, Munich.

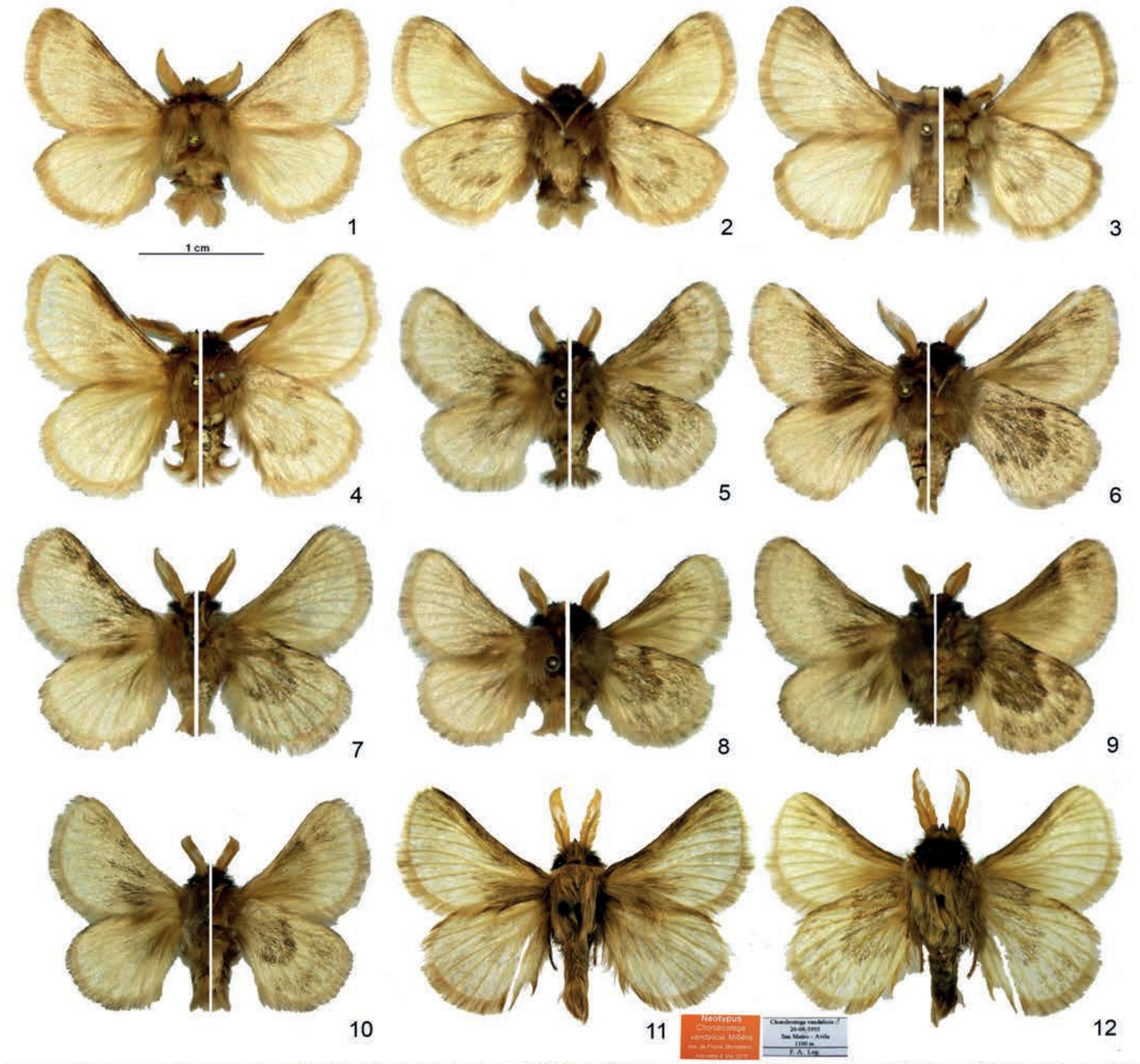
Description and comparative diagnosis is supplemented by biogeographical and biological data concerning *C. vandalicia* and the new species *C. escobesae*. This information has been obtained as a result of intensive observations of immature stages and life history both in natural conditions and captive breeding by Y. M. L., C. A. A. and further supporting lepidopterologists (see acknowledgements). The study of the life-cycle was carried out in several locations in Iberia over a period of several years to the present day.

DNA Analysis

We analyzed the cytochrome c oxidase I (COI) mitochondrial marker for ten *Chondrostega* specimens representing five populations in the Iberian Peninsula. DNA was extracted from one leg removed from dried specimens as well as from larvae preserved in absolute ethanol. Total genomic DNA was extracted using Chelex 100 resin, 100–200 mesh, sodium form (Biorad), under the following protocol: the tissue was introduced into 100 µL of Chelex 10 % and 5 µL of Proteinase K (20 mg/mL) were added. The samples were incubated overnight at 55°C and were subsequently incubated at 100°C for 15 minutes. Samples were then centrifuged for 10 seconds at 3.000 rpm. A 655-bp fragment at the 5' end of the mitochondrial gene (COI) was amplified by polymerase chain reaction (PCR) using the primers UniLepF1 (5'-TAA TAC GAC TCA CTA TAG GGA TTC AAC CAA TCA TAA AGA TAT TGG AAC-3') and UniLepR1 (5'-ATT AAC CCT CAC TAA AGT AAA CTT CTG GAT GTC CAA AAA ATC A-3'), with universal T7 and T3 tails here highlighted in bold.PCR was carried in 25-µL volumes containing: 14.4 µL autoclaved Milli-Q water, 5 µL 5x buffer, 2 µL 25 mM MgCl2, 0.5 µL 10 mM dNTPs, 0.5 µL of each primer (10 µM), 0.1 µL Taq DNA Polymerase (Promega, 5U/µL) and 2 µL of extracted DNA. The typical thermal cycling profile was: first denaturation at 92°C for 60 s, followed by five cycles of 92°C for 15 s, 49°C for 45 s and 62°C for 150 s, and then by 35 cycles of 92°C for 15 s, 52°C for 45 s and 62°C for 150 s and a final extension at 62°C for 420 s. PCR products were purified and sequenced by Macrogen Inc. using the T7 and T3 universal primers. Sequences were edited and aligned using GENEIOUS PRO 6.0.5 created by Biomatters (http://www.geneious.com/). A Neighbour-Joining (NJ) phylogenetic tree was obtained using MEGA 6 (Tamura et al. 2013), based on p-distance and pairwise deletion. Node supports were assessed through 100 bootstrap pseudo-replicates. Sequences for two lasiocampid species were obtained from GenBank and used as outgroup. Genetic distances between species are reported as minimum uncorrected pairwise distances, while intraspecific variation is reported as maximum uncorrected pairwise distances.

DNA extracts are stored at the IBEB. All studied specimens and samples, identifica-

Figs 1–4. Adult habitus of male *C. escobesae* sp. nov. – **1, 2.** Holotype, upperside (1), underside (2): Andalucía, Malaga (Ronda), Sierra de las Nieves, Puerto de los Pilones, 1750 m, 5.IX.2014, C. Antonietty leg. (DNA extraction code RVcoll. 14V507). **3, 4.** Paratypes upperside (left), underside (right), same data as Fig. 1 (Fig. 3: GPdF2014/25, Fig. 4: DNA extraction code RVcoll. 14V506). – **Figs 5–10.** Adult habitus of male *C. vandalicia* (Millière, 1865), upperside (left), underside (right): Spain, Castilla y León, Soria, Borobia [SW area of the Sierra del Moncayo], 1169 m, 19.VII.2014, Y. Monasterio & R. Escobés leg. (CFM) (Fig. 5: DNA extraction code RVcoll. 14V502). – **Figs 11, 12.** *Chondrostega vandalicia* (Millière, 1865), neotype male with labels, upperside (11), underside (12): Spain, Castilla y León, Ávila, Cerro de San Mateo, 1100 m, UTM 30T UL50, 26.VIII.1995, F. Aguilar leg. (CFM, MWM/ZSM). – **Figs 13–15.** *Chondrostega vandalicia* (Millière, 1865), male. – **13, 14.** Castilla y León, Cembranos, 806 m, 5.VIII.2006, Y. Monasterio cult. (CFM). **15.** Castilla y León, Soria, Borobia, 1169 m, 19.VII.2014, Y. Monasterio & R. Escobés leg. (CFM). – **Figs 16–19.** Adult habitus of female *C. escobesae* sp. nov. – **16–18.** Andalucía, Jaén, Pico Jabalcuz, Los Villares, 30.IX.2006. **19.** PT, same patria, 16.VII.2007, Y. Monasterio León leg. et cult. (CDF).


1 cm
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Neotypus
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tion numbers (ID) listed below, are in the collections of the authors:

Chondrostega vandalicia: ID IBEB 14V502 and ID IBEB 14V503: Spain, Castilla y León, Soria, Borobia, 1169 m, UTM 30T WM91, 19.VII.2014, Y. Monasterio & R. Escobés leg. (CFM). – ID IBEB 14V665, ID IBEB 14V666 and ID IBEB 14V667: Caterpillars each: Spain, Castilla y León, Soria, Almazán, 965 m, UTM 30T WL39, 6. II.2014, O. Moreno leg. (CML). – ID IBEB 14V504: Spain, Castilla y León, Cembranos, 806 m, UTM 30T TN80, caterpillar 8.IV.2006, F. J. Gonzáles leg., e. l. 5.VIII. 2006, Y. Monasterio cult. (CFM). Sample proved to be invalid for DNA study. – ID IBEB 14V670 and ID IBEB 14V671: Caterpillars each: Spain, Castilla y León, León, Antimio de Arriba, 858 m, UTM 30T TN81, 22.IV.2014, D. Lapuente leg., 5.VIII.2006, Y. Monasterio cult. (CML). – ID IBEB 14V505: Spain, Castilla y León, Ávila, Cerro de San Mateo, 1100 m, UTM 30T UL50, 26.VIII.1995, F. Aguilar leg. (CFM). Sample proved to be invalid for DNA study.

Chondrostega escobesae: ID IBEB 14V507: Holotype, Spain, Andalucía, Málaga (Ronda), Sierra de las Nieves, Puerto de los Pilones, 1750 m, UTM 30S UF16, 5. IX.2014, C. Antonietty leg. (CFM, MWM/ZSM). – ID IBEB 14V506: Paratype, Spain, Andalucía, Málaga (Ronda), Sierra de las Nieves, Puerto de los Pilones, 1750 m, UTM 30S UF16, 5.IX.2014, C. Antonietty leg. (CFM, MWM/ZSM). – ID IBEB 14V668 and ID IBEB 14V669: Caterpillars each: Spain, Andalucía, Jaén (Los Villares), Sierra de Jabalcuz, Pico Jabalcuz, 1560 m, UTM 30S VG27, 13.III.2014, C. Antonietty leg. (CML).

Genetic results

Molecular methods represent new tools which are intensely improving the study and view of taxonomy. Mitochondrial DNA in particular proved to be a valuable character for highlighting cryptic diversity, which nevertheless needs to be corroborated by independent data like nuclear markers, morphology or ecology. From the COI phylogenetic tree (Tab. 1) we obtained two clades, one corresponding to the northern (Soria and León) and the other to the southern (Málaga and Jaén) populations. A deep minimum genetic divergence of 3.8 % between the two clades is documented, which corresponds approximately to two to three million years of isolation based on typical insect mitochondrial substitution rates (Queck et al. 2014). This result supports our hypothesis regarding the existence of two *Chondrostega* species in the Iberian Peninsula with allopatric distributions.

Each clade displays some instraspecific genetic variability. In fact, the two *C. vandalicia* specimens sequenced from the Moncayo region (Borobia population) differ lightly (one base substitution) from the rest. This suggests that this population has become isolated from the rest restrelatively recently, which could also explain why the larvae in this population also differ slightly from typical *C. vandalicia* (see Figs 45–52). The slight differentiation of this population is unexpected, as the Moncayo range is very close to Almazán, but Almazán shares COI haplotypes with the more distant Antimio de Arriba (León) and the larvae are also similar.

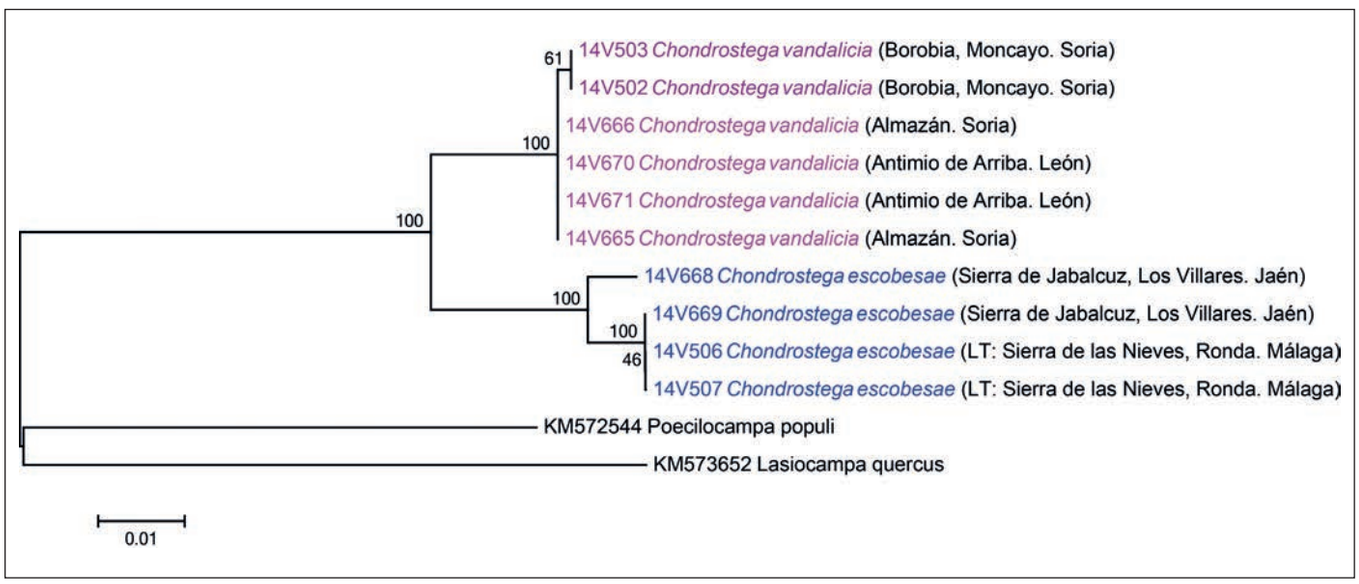
Three *C. escobesae* samples sequenced display the same COI haplotype, but the fourth is notably diverged from them (eigth base substitutions, 1.2 %), even if it is from a population where the more common haplotype was also found (Sierra de Jabalcuz, Los Villares, Jaén). Thus, it is likely that substantial intraspecific variability will become evident when more populations are studied, and a clearer picture for the biogeographical history of the genus *Chondrostega*in the Iberian Peninsula may be obtained.

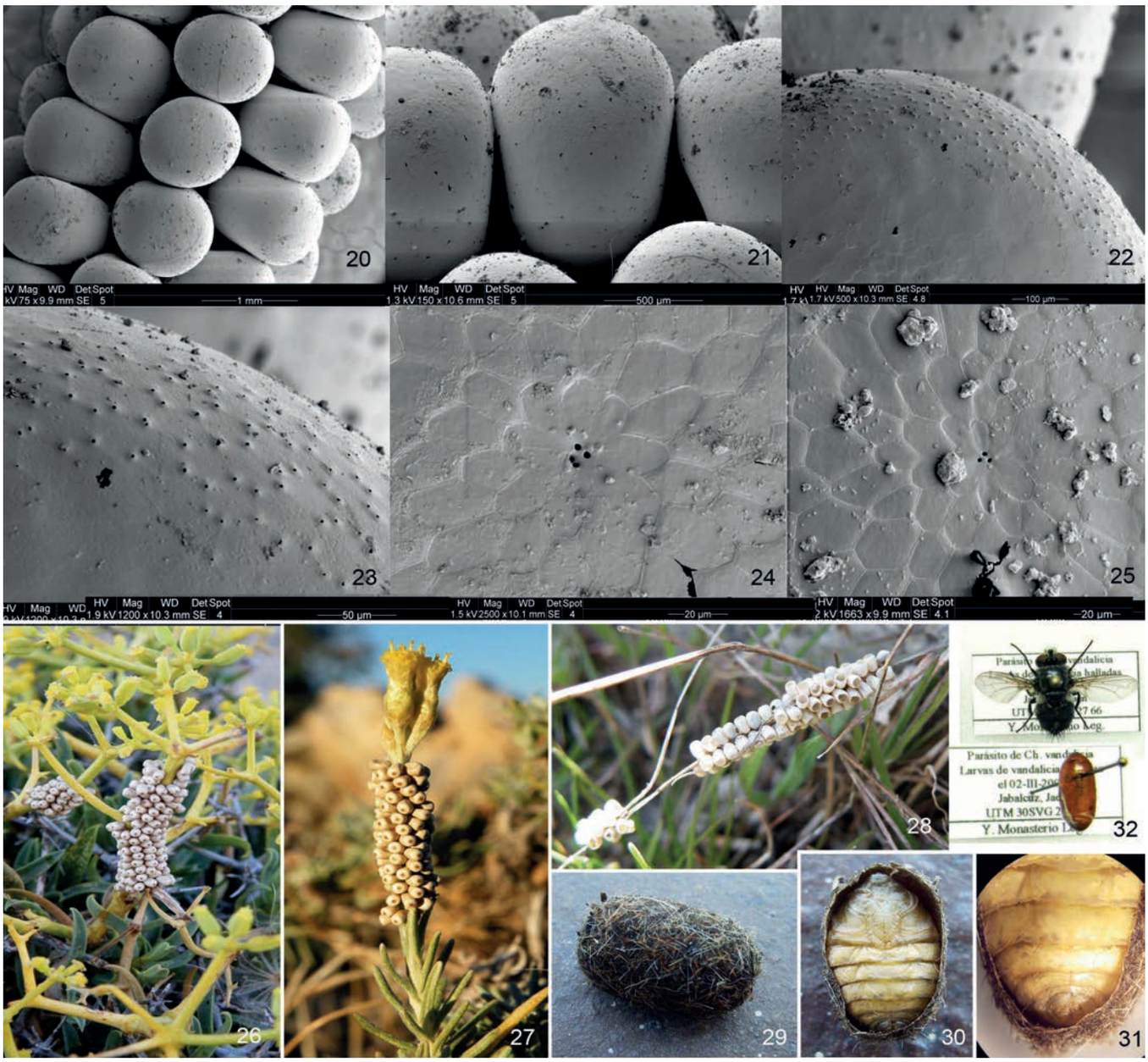
Neotype of *Chonstrostega vandalicia* (Millière, 1865)

Annotations on the type locality of *C. vandalicia* and the designation of a neotype.

The original description from Millière provides no clear information about type locality of this species. In Millière only „Andalousie" is mentioned. In particular it is stated that the caterpillars were "rapportés d´Andalousie" and that the new species was named as *Bombyx vandalicia* "pour rappeler sa patrie". The term *vandalicia* (the geographical term „Vandalitien", or „Vandalucía" in Spanish, is used in some older maps for Andalusia (Hübner 1693).

Tab. 1. Neighbour Joining tree of Iberian *Chonstrostega* Lederer, 1857 (Kimura 2 parameter, built with MEGA 5; cf. Tamura et al. 2007. Only barcodes.





Figs 20–25. *Chondrostega escobesae* sp. nov. Morphology of eggs (scanning electron micrographs). **20.** Clutch. **21.** Overall view. **22, 23.** View of the chorion http://www.google.de/url?source=transpromo&rs=rssf&q=//translate.google.com/community?source=all in different scales. **24, 25.** Micropylar region. – **Figs 26–28.** Eggclutches, Andalusia, Málaga (Ronda), Sierra de las Nieves, Puerto de los Pilones, 1750 m, 5.IX.2014 (Figs 26, 27) and 26.III.2014 (Fig. 28), leg. Antonietty (CFM). **Figs 29–31.** Female cocoon. **29.** Closed. **30.** Cocoon (opened) with female pupa (ventral view). **31.** As Fig. 30, pupa, distal part with cremaster, enlarged. – **Fig. 32.** *Pales processioneae* (Ratzeburg, 1840), tachinid parasitic fly of *C. escobesae* sp. nov.

However, it seems that Millière made a mistake and the type material was actually not from Andalusia. Indeed, Vázquez Figueroa (1895) cites a letter he sent to Staudinger where he explains that in April 1862 he found four caterpillars in La Granja de San Ildefonso (Segovia). Specified as similar to those of *Saturnia pavonia*, Staudinger thought they were caterpillars of *Saturnia isabellae* (= *Actias isabelae*). Two of those caterpillars were sent to Millière, from which the species *Bombyx vandalicia* was described. The first male adults were collected by Vázquez Figueroa in 1886 in the same locality and were sent to Staudinger, who determined them as *B[ombyx]. vandalicia* (Vázquez Figueroa 1893). On the basis of these specimens a subsequent description was actually made by Staudinger (1892: 258).

No specimen from San Ildefonso exists in the collection O. Staudinger (in ZMHU), but one male and three females, labelled „Castilia/Vazqu." and „Valladolid/1893, Vazquez" respectively. Only in the Püngeler collection (in ZMHU) was a caterpillar from San Ildefonso 1899, prepared by Staudinger found. Because of the lack of type material and to make a comparison with *C. escobesae* sp. nov. possible, a male neotype of *C. vandalicia* is designated on the basis of article 75 of the Code (ICZN 1999):

Neotype. ♂, "Spain, Castilla y Leon, Ávila, Cerro de San Mateo, 1100 m, UTM 30T UL50, 26.VIII.1995, F. Aguilar leg." (Figs 11, 12).

The neotype is deposited in the CFM (MWM in Zoological State Collection Mu-

nich). The recognition of the neotype, selected from a locality near the type locality is guaranteed by the colour illustration of the upper- and underside, as well as the labels of this (Figs 11, 12).

Chondrostega escobesae sp. nov.

Holotype. ♂, Andalucía, Málaga (Ronda), Sierra de las Nieves, Puerto de los Pilones, 1750 m, UTM 30S UF16, 5.IX.2014, C. Antonietty leg. (CFM; MWM/ZSM, BC DNA-N° IBEB 14V507; Figs 1, 2).

Paratypes. 2 ♂, same locality and data as Holotype (GPdF2014/27, BC DNA-N° IBEB 14V506; IBEB; Figs 3, 4); 8 ♂, same locality as Holotype, but 18.VIII, 2015, leg. Y. Monasterio (CML); 1 ♂, Andalucía, Jaén, Pico Jabalcuz, Los Villares, 1560 m, UTM 30S VG27, ex larva 26.VII.2014, C. Antonietty leg. et cult. (GPdF2014/28; IBEB; 1 ♀ (Fig. 19) Andalucía, Jaén, Pico Jabalcuz, Los Villares, UTM 30S VG27, ex larva 16.VII.2007, Y. Monasterio León leg. et cult. (CFM).

Further evaluable material. 2 egg clutches (Figs 26, 27) from Andalucía, Málaga (Ronda), Sierra de las Nieves, Puerto de los Pilones, 1750 m, UTM 30S UF16, 26.VII.2014, C. Antonietty leg. (CFM, MWM/ZSM) plus some frozen larvae preserved in absolute ethanol: Andalucía, Jaén, Pico Jabalcuz, Los Villares, 1560 m, UTM 30S VG27, 13.III.2014, C. Antonietty leg. (CML) and Málaga (Ronda), Sierra de las Nieves, Puerto de los Pilones, 1750 m, UTM 30S UF16, 26.III.2014, C. Antonietty leg. (CML).

Another egg clutch from Andalucía, Málaga, Sierra de Almijara, Collado de los Carneros, Alhama de Granada/Canillas de Albaida, 1500 m, 19.VIII.2015, Y. Monasterio León leg. (CML).

Etymology. The patronym acknowledges the merits of Ruth Escobés Jiménez, Logroño, for her entomological commitment in the documentation and conservation of Spanish Lepidoptera, as well as her help in the study of this new species over many years.

Description. *Male. Head.* Vestiture dark ochraceous; antenna bipectinate, not ciliate, longest rami 0,35 length of antenna; eye round, with stout bristles; vertex, frons and labial palp furry, with long hairs; haustellum reduced and poorly sclerotized, presumably non-functional; labial palp short, decurved, extending up to vestiture of frons; scleotized canthus triple-pointed with an extra long middle lobe (Figs 1–4, 16–19).

Thorax. Vestiture extremely furry, entirely brownish ochre; tegulae extending beyond dorsum. Forewing length 12.9–13.6 mm (mean 13.2 mm; n = 3), length/width ratio averaging 2.1; ground colour silky ochreous with a brown suffusion in the subbasal area and along the costa; upper side same as underside. Hindwing identical in colour to the forewing, but with a darker brownish curved median band on the underside.

Abdomen. Same ground colour as the thorax, ending in a bifid tuft.

Male genitalia. In *C. vandalicia* and *C. escobesae* sp. nov. highly simplified, with a fused uncus-tegumen-complex; uncus short, compressed, thickened; phallus with bulbous basal portion; vesica not pronounced, not spiculate.

In *Chondrostega vandalicia.* Uncus strongly sclerotized, distally only slightly concave, chisel-shaped, not longer than the width of the base, laterally straight, broadly smoothly joined to the wide tegument. Tegumen broadened proximally, somewhat longer than wide, gnathos sclerotized, pointed triangular to elliptical. Valvae symmetrical, ligulate, with blunt tip. Vinculum broadly rounded; sacculus lanceolate. Phallus strongly curved, coecum slightly enhanced, two fifth length of the aedeagus, tapered distally (Figs 41, 42, see GPdF2014/25, GP2014/26).

In *Chondrostega escobesae* sp. nov. (in differential diagnosis to *C. vandalicia*) (Figs 43, 44, see GPdF 2014/27, GPdF 2014/28). Uncus with a centred cuneiform notch distally, 1.5 times longer than the width of the base, bilaterally distinctly concave, with intergradation to the twice as broad tegumen. Tegumen on both sides curving and strongly concave, gnathos semicircular. Vinculum relatively flat; sacculus slimmer, more digitate. Phallus strongly curved, broader than in *C. vandalicia*; coecum extremely enhanced, one third length of the aedeagus, tapered distally. Regarding the structure of the abdominal tergites/sternites (Figs 41–44), no significant and consistent difference is apparent.

Female. Hypopterous and incapable of flight. Length ca. 20 mm; antennae 0.75 times as long as that of the male, finely biserrate; thinly ciliate; vertex, frons and labial palps as in the male; proboscis atrophied; vestiture appressed, reddish brown. Thorax vestiture similar to that of the head; legs reduced, as long as those of male. Abdomen reddish-brown with fine, short velvety hairs; tergites well sclerotized, ovipositor missing.

Diagnosis. Considering the divergence in the mtDNA cytochrome oxidase subunit I gene (COI) between north and south Iberian populations, in combination with morphological differences, the species status for *C. escobesae* seems adequate. We also conclude that the differences in the male genitalia, relatively minor but nevertheless apparent, offer evidence to support the division into various species. A difference with regard to the shape of the uncus-tegumen-complex, mainly its extremely concave flanks, the concave notch on the apical end of the uncus, the sacculus and the phallus.

Importantly, the canthus (frontal process of the forehead), a character traditionally important for the taxonomy of the group, is different in these species: visibly longer and more obviously triple toothed in *C. vandalicia* than in *C. escobesae* sp. nov. (Figs 33–40). Despite the external similarity in colour and pattern, colour differences between typical *C. escobesae* sp. nov. and *C. vandalicia* appear to occur. *Chondrostega escobesae* sp. nov. is largely distinguishable by the somewhat paler wing colouration and the more diffuse, less accentuated brownish subbasal wing patterning. It should be noted, that older *Chondrostega* specimens tend to bleach out, which lightens the ground colour.

Finally, apart from intrapopulational divergences in both species, we have found a conspicuous colour difference between all the mature caterpillars of both species that have been examined. Except for an unusual white larval morph in *C. vandalicia* larvae, described and illustrated here for the first time, the larvae in this species are tangerine in colour. In contrast, final-instar larvae of *C. escobesae* sp. nov. are pale yellow.

Variability. There are only a few specimens known and therefore the statements about variability are limited. Structurally, *C. escobesae* sp. nov. seems quite homogeneous and there is only very little variation

Figs 33–36. *Chondrostega vandalicia* (Millière, 1865). Head (frons) with canthus, same data as neotype (Fig. 11). **33.** Ventral view. **34.** Canthus, dorsal. **35.** Canthus, lateral. **36.** Canthus, lateral, enlarged. – **Figs 37–40.** *Chondrostega escobesae* sp. nov. Paratype, same data as Fig. 1. **37.** Canthus, ventral. **38.** Canthus, dorsal. **39.** Canthus, lateral. **40.** Canthus, lateral, enlarged. – **Figs 41–44.** Male genitalia (ventral view), phallus removed (lateral view) and abdominal sternites/tergites. **41, 42.** *Chondrostega vandalicia*. **41.** GPdF2014/25: Spain, Castilla y León, Soria, Borobia, 1169 m, 19.VII.2014, Y. Monasterio & R. Escobés leg. **42.** GP2014/26: Spain, Castilla y León, Cembranos, 806 m, e. l. 5.VIII.2006, Y. Monasterio cult. (CFM). **43, 44.** *C. escobesae*. sp. nov. **43.** GPdF2014/27, Paratype, same data as Fig. 3. **44.** GPdF2014/28: Andalucía, Jaén, Pico Jabalcuz, Los Villares, 1560 m, ex larva 26.VII.2014, C. Antonietty leg. et cult.

in both colour and size. One specimen tends to be paler with faint markings, according to the infrasubspecific variety "ab." *pujoli* Fernández, 1948 in *C. vandalicia*. Well-marked individuals with a brownish shade are previously only known for *C. vandalicia*.

Larva. Larvae are solitary from the first instar; *C. vandalica* larvae are found from November to April, while those of *C. escobesae* sp. nov. should probably should be found up to May, as we found half-grown L3 larvae in late March (on 26th). Also on Jabaluz L3 to L5 caterpillars were col-

lected early to mid-March. Although *C. vandalicia* caterpillars can be found both on the ground and perched on stems, *C. escobesae* sp. nov. larvae were always found feeding on low plants on the ground at the base of sunlit grass tufts, never on the stems, feeding on low plants. They were more abundant in sunlit areas protected from the wind by the angle of the terrain rocks or shrubs.

As previously mentioned, there are noticeable differences in the colouring of *C. escobesae* sp. nov. and *C. vandalicia* larvae. Both, when alarmed, curl themselves up to form a ring, so that the warning colouration of the hairs in this defence position becomes conspicuous.

Hairs and red verrucae of *C. escobesae* sp. nov. larvae of the two last instars are more pronounced than in previous instars (when they are translucent pale yellow). The colour of the soft hairs is mostly silvery white or yellowish in the last instar, with subdorsal and lateral setae mixed in, somewhat yellow subventrally and ventrally. In contrast, caterpillars of *C. vandalicia* are blackish, with the soft hairs dorsally and laterally, typically a rich yellowish orange in the last instar, somewhat tangerine subventrally and ventrally. The tubercles are red and bear a tuft of short black bristles (see also Gómez de Aizpúrua 1988, 2002). The last instar of the *C. vandalicia* larva is occasionally dichromatic.

In addition to the typical form already described, a creamy white morph has been found twice and is illustrated here for the first time (Figs 53, 54). This white variant seems to appear occasinally within the Cáceres-Toledo populations (A. Blázquez and C. Gómez de Aizpúrua, pers. comm.). We know about two sightings, one from Cáceres and another from an imprecise location in the province of Toledo, which could refer to the northern limit between the two provinces, such that both occurences may well belong to the same population. This colour form could be a genetic feature of *C. vandalicia* populations in this region.

The larval foodplants of *C. vandalicia* are mainly grass species such as *Nardus stricta*, *Festuca* spp., *Anthoxanthum aristatum* and other species belonging to the Poaceae (Fernández 1948), but also some from other families such as *Hypochaeris radicata*, *Artemisia campestris*, *Cichorium endivium* (Asteraceae), *Cytisus multiflorus*, *Astragalus* spp. (Fabacea) (Corley et al. 2009), *Raphanus* spp., *Capsella* spp. (Brassicaceae), *Plantago* spp. (Plantaginaceae) or *Thapsia garganica* (Apiaceae). It is worth noting that most of these foodplants were reported in captivity.

Chondrostega escobesae is polyphagous on various low plants. Most of the larvae in the Jabalcuz population were found feeding sheltered into *Festuca scariosa* (Poaceae). Other low plants the larvae were observed feeding on are *Verbascum giganteum* (Scrophulariaceae), *Asphodelus. ramosus* (Asphodelaceae), *Erodium* spp. (Geraniaceae) and *Centaurea granatensis* (Asteraceae). In captivity, larvae showed an intense phototropism and became highly active under direct sunlight. With respect to food plants, they accepted a variety of species not present in their original habitat such as *Echium plantagineum* (Boraginaceae), *Plantago lanceolata*, *Plantago lagopus* (Plantaginaceae), *Punica granatum* (Lythraceae), *Populus spp.* (Salicaceae), *Lactuca virosa* (Asteraceae) and several species of Poaceae.

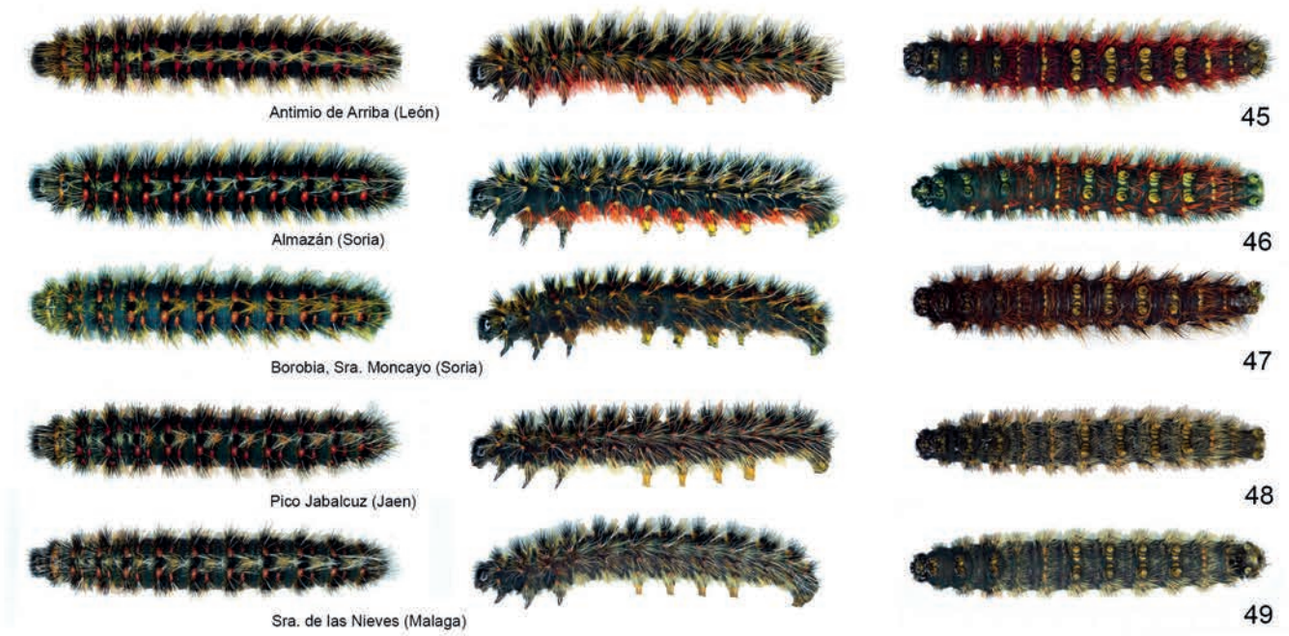
Pupa. The chrysalis of *C. escobesae* is brown and is enclosed in a brown ovoid cocoon, which consists of a single layer, the larval setae remain attached. Pupation takes place on the surface of the ground, usually within dead leaves and detritus, or half buried into the ground.

Ecology. We provide here the characteristics of the type locality Puerto de los Pilones (Málaga), the habitat in the Sierra de Jabalcuz (Jaén), which should also be considered representative for this species, and as a result of investigation in 2015 another habitat in Andalucía, between Granada and Málaga provinces: Collado de los Carneros, Alhama de Granada/Canillas de Albaida, UTM 30S VF18, egg cluster 19.VIII.2015, Y. Monasterio León leg. (CFM).

The Puerto de los Pilones (1750 m) is a mountain pass located near the town of Ronda, Málaga, in Sierra de las Nieves Natural Park (Figs 66–68) The park and its surroundings are situated in a mountain range of the same name, which is formed mainly of metamorphosed limestone and marl. The locality lies at the limit between upper supra-Mediterranean and oro-Mediterranean bioclimatic belts in a high-precipitation zone (Nieto et al. 1991; Cabezudo et al. 1998). The vegetation belongs to the *Abieto pinsapo-Juniperetum sabinae* Pérez Latorre & Cabezudo association (Pérez et al. 1998, Cabezudo & Pérez 1999), although larvae are more common in pasture areas surrounded by low thorny shrubs as *Astragalus nevadensis* (Fabaceae), *Bupleurum fruticescens* subsp. *spinosum* (Umbelliferae) and *Erinacea anthyllis* (Fabaceae), which are not predominant plants of this association.

Jabalcuz peak (1614 m) is a mountain located four kilometre southwest of the city of Jaén, in the Sierra de Jabalcuz (Figs 63–65). The area is composed of Jurassic and Cretacic calcareous materials, although the peak is of Jurassic origin only (Ortuño 2003). As with the habitat at the Puerto de los Pilones this site is also located in the supra-Mediterranean bioclimatic belt (see Consejería de Medio Ambiente 2004). At the summit, the vegetation belongs to the *Erinaceetosum-Anthyllidis* sub-association within the *Santolino-Salvietum oxyodonti* association on the north face and the *Campanulo-Festucetum scariosae* association on the south face (Fernández López et. al. 1984). Stunted *Quercus ilex* ssp. *ballota* occur sporadically, as a consequence of climatic adaption. The fact that the south-facing slpoes at the summit are used for grazing sheep has resulted in an increase of nitrophilous plant species such as *Asphodelus ramosus*. On this mountain *Chondrostega escobesae* is apparently restricted to the grassy, her-

Figs 45–49. Comparative presentation of the adult larva, dorsal, lateral and ventral view. **45.** *Chondrostega vandalicia* (typical form). Population Castilla y León, León, Antimio de Arriba, 858 m (see Figs 57–60). **46.** Dto. (typical form). Population Castilla y León, Soria, Almazán, 965 m. **47.** Dto. (slightly divergent). Population Castilla y León, Soria, Borobia, SW area of the Sierra del Moncayo,1169 m (see Figs 61, 62). **48.** *Chondrostega escobesae* sp. nov. Population Jaén, Pico Jabalcuz, Los Villares, 1560 m. **49.** Dto. Population Malaga, Sierra de las Nieves, Puerto de los Pilones, 1750 m. – **Figs 50–52.** *Chondrostega vandalicia.* Adult larva, typical form. **50:** Castilla y León, Cembranos, 806 m, 8.IV.2006. **51.** Malanquilla (Zaragoza), 23.II.2011 (foto A. Murria Beltràn. **52.** Madrid, unknown date (foto C. G. de Aizpúrua). – **Figs 53, 54.** *Chondrostega vandalicia.* Adult larva on food-plant *Hypochaeris*, white form, Toledo (foto C. G. de Aizpúrua). – **Figs 55, 56.** *Chondrostega escobesae* sp. nov. Adult larva. **55.** Málaga, Sierra de las Nieves, Puerto de los Pilones (Ronda), 26.III.2014 (see Figs 66–68). **56.** Jaén, Pico Jabalcuz, Los Villares 8.II.2006 (see Figs 63–65).


Antimio de Arriba (León)
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Almazán (Soria)
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Borobia, Sra. Moncayo (Soria)
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Pico Jabalcuz (Jaen)
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Sra. de las Nieves (Malaga)
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baceous habitat of the southern face, where there is snowfall almost every year and it is not steep.

The Collado de los Carneros (1508 m) is placed in the Sierra de Almijara, on the boundary between Granada and Málaga and inside the Sierras de Tejeda, Almijara y Alhama Natural Park.. It is a calcareous area where the habitat is located between the meso-Mediterranean and supra-Mediterranean bioclimatic belts. The vegetation belongs to the *Cistoclusii-Ulicetum rivasgodayanii* Nieto Caldera y Cabezudo association (Nieto Caldera, Cabezudo y Trigo 1989), where the main plant is *Ulex parviflorus* subsp. *rivasgodayanus*. The eggs cluster was found at the edge of a pasture area where the most common plants where *Eryngium grosii (*Apiaceae*), Phlomis crinita* subsp. *malacitana (*Lamiaceae*), Onobrychis* sp. *(*Fabaceae*), Lavandula lanata* (Lamiaceae) or *Thymus baeticus* (Lamiaceae). The eggs were laid on dried flower stem of this last species.

It seems that the populations are strongly associated with bioclimatic belts at the upper the supra-Mediterranean level and above. The location of these belts, as with any bioclimatic zone, varies with latitude and altitude, with an inverse relationship between these two parameters (Rivas-Martínez 2011). Thus, although the supra-Mediterranean bioclimatic belt is mainly associated with mountain peaks in southern areas, it is also found distributed along steppes, plateaux or badlands around 1000 metres above sea level in central and northern areas of the Iberian Peninsula. Both *C. vandalica* and *C. escobesae* sp. nov. mainly colonize this type of herbaceous badland and steppe habitat. However, the cold-temperate alpine biotopes in which the Iberian endemic *C. escobesae* sp. nov. can be found, do not correspond with those that *C. vandalicia* usually occupies. The latter is not a montane species in the strict sense. It is present predominantly in a zone between 700 and 1100 metres. We know of just one higher locality, at 1500 metres above sea level at the Puerto de Malgagón (San Lorenzo del Escorial, Segovia).

This means that, although both *C. vandalica* and *C. escobesae* sp. nov. probably require relatively similar temperature and rainfall conditions, they may show divergent features of niche exploitation pattern on closer examination. Records for *C. escobesae* sp. nov. from the Sierra de las Nieves are the most southerly thus far reported for the entire genus in the Iberian Peninsula, as well as the highest locations in this region, at 1750 metres above sea level.

Nevertheless, the lower altitudinal range of *C. escobesae* sp. nov. in some parts of Andalusia is similar to that of *C. vandalicia* in the centre and north of the Iberian Peninsula. This is the case of several populations in the province of Granada, which are located at around 800 m.above sea level (Pérez López 1993). The prevailing bioclimatic belt in this zone is the dry Meso-Mediterranean lower belt (Rivas-Martínez 2011), which makes these populations good candidates for further studies to explore possible ecological differences.

Ethology & biology. The life history and the habitat requirements of the *C. vandalicia* group have been only imperfectly ascertained based solely on *C. vandalicia* populations from the northern half of Spain. The phenology of *C. escobesae* is not substantially different from *C. vandalicia*. *Chondrostega escobesae* is a univoltine species, taking approximately 9–10 months to develop from egg to pupa. Based on current data, adult males are on the wing from early August to mid-September. They are weak fliers, flying low over herbage and hiding in short vegetation. In the studies carried out at the type locality at the Puerto de los Pilones, male adults were captured at light between 21.00 and 23.00. The males were not directly attracted to light bulbs or UV tubes, but remained in the trap surroundings. It is not known whether they are also active at dusk and at dawn.

The female moths arrange their eggs closely coiled around plant stems, mainly on the upper parts of the tallest plants, predominantly non-host plants. Most of them were found on the flower stems of *Bupleurum fruticescens* ssp. *spinosum* (Apiaceae) or *Helichrysum serotinum* (Asteraceae). The eggs (Figs 20–25) are fairly elongated ovals, poles flattened, with little surface sculpturing; micropyle blackish brown, ochreous, not becoming darker prior to hatching. Hatching takes place from late October to late November about 30–45 days after oviposition.

Distribution. It must be strongly emphasized that the distributions of both species are still insuficiently known. However, *C. escobesae* appears to have evolved in geographical isolation in the southern half of the Iberian Peninsula and evidently it does not interbreed with *C. vandalicia*.

The first well-documented populations of *C. escobesae* were reported from the Sierra de Parapanda and Sierra de Elvira (Granada) (Pérez López 1993, Fuentes García et al. 1999). Later its presence in the province of Jaén was published (Monasterio León 2007). Finally, Martinez García (2012) and López-Tirado et al. (2012) reported the presence of the species in Málaga. There is also an imprecise record from the Sierra Norte in the province of Sevilla (Gomez Bustillo & Fernández-Rubio 1976) that, in the case of it being confirmed, would represent the oldest published record for *C. escobesae*.

Although at present we do not have adult males from Granada, we tentatively assume that those Andalusian populations belong to this new species, and that it may also occur in other places throughout southern Spain.

By contrast, *C. vandalicia* is known from the northern and central Spanish provinces. Millière initially indicated the Ebro River as the northern limit and the south of the province of Madrid as the southern limit for the species. There are references published in magazines and pictures on the Internet confirming its presence in the provinces of Ávila, Zamora, León, Burgos, Salamanca, Segovia, Valladolid, Madrid, Cáceres, Castellón, Zaragoza, Cuenca, Teruel and Guadalajara (Márquez Figueroa 1893, 1895; Fernández 1948; Gómez Bustillo & Fernández-Rubio 1976; García-Barros 1981; Gómez de Aizpurua 1988; 2002; Magro 1990; Perez de Gregorio et al. 2001; Novoa et al. 2002; Jambrina et al. 2008; Blázquez 2008, 2014; Murria-Beltrán 2012; Ma-

Figs 57–62. Habitats of *Chondrostega vandalicia* (Millière, 1865). **57–60.** León, Antimio de Arriba, 858 m, 22.IV.2014 (foto D. Lapuente), (Fig. 60 inset shows the larva enlarged). **61, 62.** Soria, Borobia, SW area of the Sierra del Moncayo, 1169 m, 1.II.2014. – **Figs 63–68.** Habitats of *C. escobesae* sp. nov. **63–65.** Jaén, Pico Jabalcuz, Los Villares, 1560 m, 16.III.2005 (Fig. 54) and 13.III.2014 (Figs 55, 56). **66–68.** Málaga (Ronda), Sierra de las Nieves, Puerto de los Pilones, 1750 m (type locality), 26.III.2014 (Figs 57, 58) and 5.IX.2014 (Fig. 59).


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gro & Jambrina 2013). We also provide data from Soria, confirming its presence in all provinces of the autonomous region of Castilla y León. In addition, *C. vandalicia* has been reported from northern and central Portugal (Parque Biológico de Vinhais, Trás-os-Montes near Morais, Serra da Gardunha) (Mendes 1903; Corley et al. 2009).

Parasitoids. *Chondrostega* spp. larvae are often parasitized by tachinid flies and *Uclesia fumipennis* is known as a host of *C. vandalicia* (Fernández 1948). *Chonstrostega escobesae* larvae are parasitized by *Pales processioneae* (Ratzeburg, 1840) (Fig. 32). *Pales* spp. lay microtype eggs that are swallowed by the caterpillar during feeding. The parasite–host relationship between *Pales processioneae* and the genus *Chondrostega* Led. has never previously been reported.

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● Josef J. de Freina,
Eduard Schmid-Str. 10,
D-81541 München, Germany;
E-Mail: defreina.j@online.de

● Yeray Monasterio León,
Asociación ZERYNTHIA
(www.asociation-zerynthia.org),
Madre de Dios, n°14-7°D,
E-26004, Logroño, Spain;
E-Mail: zerynthia.org@gmail.com

● Carlos Antonietty,
Asociación ZERYNTHIA
(www.asociacion-zerynthia.org),
Universidad de Sevilla; Departament of Zoology, Faculty of Biology,
Avda. Reina Mercedes 6,
E-41012, Sevilla, Spain;
E-Mail: antonietty@us.es

● Roger Vila,
Institut de Biologia Evolutiva (CSIC-UPF),
Pg. Marítim de la Barceloneta 37,
E-8003, Barcelona, Spain;
E-Mail: roger.vila@csic.es

Erratum

In the paper "The identity of *Euphitrea* Baly, 1875 and redescription of *Euphitrea carinata* (Bryant, 1954) nov. comb. (Coleoptera: Chrysomelidae, Galerucinae)" in *Entomologische Zeitschrift* **125** (3): 175–179 (Beenen 2015) the name listed with Fig. 5 should be *Euphitrea carinata* (Bryant, 1954). The name that was incorrectly given with this figure, *Euphitrea manfredi* sp. nov., is to be regarded a "nomen nudum" with no taxonomic validity.