Lasioglossum inexpectatum sp. nov., a new species from Sardinia and Corsica (Hymenoptera: Apoidea: Halictidae)

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ARTICLE

Lasioglossum inexpectatum sp. nov., a new species from Sardinia and Corsica (Hymenoptera: Apoidea: Halictidae)

Simone Flaminio[1,*] • **Alain Pauly**[2,*] • **Giovanni Cilia**[3,†] • **Alexandre Cornuel-Willermoz**[4] • **Laura Bortolotti**[5] • **Marino Quaranta**[6]

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Abstract
Wild bee communities of Sardinia and Corsica, two Mediterranean islands, have been relatively understudied. In this article, *Lasioglossum inexpectatum* sp. nov., which is known exclusively in Sardinia and Corsica, is described, emphasizing the importance of ongoing research and conservation efforts to protect the unique wild bee biodiversity in the Mediterranean basin.

Keywords | Bees • endemic • Mediterranean basin • islands • integrative taxonomy

***Lasioglossum inexpectatum* sp. nov., une nouvelle espèce de Sardaigne et de Corse (Hymenoptera : Apoidea : Halictidae)**

Résumé
Les populations d'Abeilles sauvages de Sardaigne et de Corse, deux îles méditerranéennes, ont été relativement peu étudiées. Cet article décrit une nouvelle espèce, *Lasioglossum inexpectatum* sp. nov., connue exclusivement de Sardaigne et de Corse, montrant l'importance de poursuivre les efforts de recherche et de conservation pour protéger la biodiversité originale d'abeilles sauvages dans le Bassin méditerranéen.

Mots-clefs | Abeilles • endémique • Bassin méditerranéen • îles • taxonomie intégrative

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INTRODUCTION

Sardinia, despite being the second largest island in the Mediterranean Sea, has been little investigated in the past century concerning the fauna of Hymenoptera Apoidea. After the first investigations conducted by Alfken (1938), Guiglia (1948), and Grandi (1958), it was only towards the end of the last century that Prota (1993), Nobile (1995), Nobile *et al.* (2000, 2005, 2015, 2016, 2021), Müller (2012, 2018) and Catania *et al.* (2021) brought the number of

[1] [SF] Laboratory of Zoology, Research Institute for Biosciences, University of Mons, Place du parc 20, B – 7000 Mons, Belgium • flaminiosimone88@gmail.com
+ Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia (CREA), Centro di Ricerca Agricoltura e Ambiente, Agraria-via di Corticella 133, I – 40128 Bologna, Italy
https://orcid.org/0000-0002-5823-1202 • ZooBank https://zoobank.org/B2F75DC9-3348-44E7-8EAE-E35AE563B698
[2] [AP] Royal Belgian Institute of Natural Sciences, O.D. Taxonomy and Phylogeny, Rue Vautier 29, B – 1000 Brussels, Belgium • alain.pauly54@gmail.com
https://orcid.org/0000-0002-9030-9786 • ZooBank https://zoobank.org/23D6117F-2542-41AB-9280-C1C170D6A710
[3] [GC] Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia (CREA), Centro di Ricerca Agricoltura e Ambiente, Agraria-via di Corticella 133, I – 40128 Bologna, Italy
• giovanni.cilia@crea.gov.it
https://orcid.org/0000-0002-5234-1240• ZooBank https://zoobank.org/7643C44E-732A-4A9A-A38C-313D4D3FD029
[4] [ACW] Office de l'Environnement de la Corse, Observatoire Conservatoire des Invertébrés de Corse, 14 avenue Jean-Nicoli, F – 20250 Corte, France • alexandre.cornuel-willermoz@oec.fr
https://orcid.org/0009-0008-6158-3496 • ZooBank https://zoobank.org/B39056A1-9F54-46DE-B02E-8C524D323AEC
[5] [LB] Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia (CREA), Centro di Ricerca Agricoltura e Ambiente, Agraria-via di Corticella 133, I – 40128 Bologna, Italy
• laura.bortolotti@crea.gov.it
https://orcid.org/0000-0001-7372-1579 • ZooBank https://zoobank.org/61764853-FEF4-4925-A14A-13FCB10F74DE
[6] [MQ] Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia (CREA), Centro di Ricerca Agricoltura e Ambiente, Agraria-via di Corticella 133, I – 40128 Bologna, Italy
• marino.quaranta@crea.gov.it
http://orcid.org/0000-0003-0082-4555• ZooBank https://zoobank.org/76C5542D-427C-40CA-AE76-78B453834560

* These authors share the first authorship
† Corresponding author

species to 332 (REVERTÉ *et al.*, 2023). Of these, 74 species belong to the family Halictidae, including 36 of the genus *Lasioglossum* CURTIS, 1833. Only the subspecies *Lasioglossum nitidiusculum pseudocombinatum* BLÜTHGEN, 1921, distributed in the mountains of the island, is endemic to Sardinia.

Corsica, the fourth largest island in the Mediterranean and separated from Sardinia by 11 km of the Bonifacio Strait, has also been little studied from the perspective of wild bees. Despite the sampling efforts carried out by FERTON (1901a; 1901b) and the expeditions of the University of Mons (RASMONT, 1982; RASMONT & ADAMSKI, 1995; LECOCQ, 2006), the work of MENEGUS (2018), the mission "Our Planet Reviewed – Corsica 2019-2021" (TOUROULT *et al.*, 2023) and the important inventory work led by the OCIC since 2017, knowledge of the bee fauna of Corsica remains incomplete, standing now at 309 species (REVERTÉ *et al.*, 2023). Of these, 72 species belong to the family Halictidae of which 43 are *Lasioglossum*, with *Lasioglossum corsicanum* BLÜTHGEN, 1931 and *L. aureimontanum* EBMER, 1970 being the only endemic species, both occurring in the mountains.

Herein, a new species, *Lasioglossum inexpectatum* sp. nov., only known from Sardinia and Corsica and probably endemic, is described using an integrative approach.

MATERIAL AND METHODS

Morphological terminology follows MICHENER (2007). Specimens were measured from the vertical plane of the front of the head to the tip of the metasoma. The pictures of the lateral and dorsal habitus were taken using an Olympus E-M1 Mark I with an Olympus Zuiko 60 mm macro lens. Close-ups were taken with a Keyence microscope VHX-970F.

Molecular Analysis and DNA Barcode

Total DNA was extracted from the right hind leg (VILLALTA *et al.*, 2021). The hind legs were fully immersed in 1 mL of specific digestion buffer (CILIA *et al.*, 2022) in order to obtain a high quantity of mitochondrial DNA (FLAMINIO *et al.*, 2023a, 2023b) and incubated for 18 hours at 56 °C. As reported by CILIA *et al.* (2022), total DNA purification was performed using a phenol-chloroform extraction (Ultrapure™ Phenol:Chloroform:Isoamyl Alcohol, ThermoFisher Scientific, Waltham, MA, USA) and the obtained DNAs were quantified using the spectrophotometer Infinite 200 PRO NanoQuant™ (TECAN Life Technologies, Männedorf, Switzerland) and stored at −20 °C until the analysis. Double-distilled Rnase-Dnase-free water was used as a negative control for all of these processes.

Amplification of mithocondrialDNA (mtDNA) was performed using primer pairs able to amplify a 710-bp fragments within the highly conserved region coding for the Cytochrome C oxidase subunit I (COI) gene: LCO1490 (5' GGTCAACAAATCATAAAGATATTGG 3') and HC02198 (5' TAAACTTCAGGGTGACCAAAAAATCA 3') (FOLMER *et al.*, 1994). The PCR and amplicon visualization were performed. The obtained amplicons were purified using ExoSAP-IT Ex-press (ThermoFisher Scientific) and were then sequenced through the standard SANGER methodology. The obtained sequences were analysed using BioEdit (HALL, 1999) to create the consensus one aligning forward and reverse sequences and BLAST (using the megablast algorithm) (ALTSCHUL *et al.*, 1990).

To analyze the relationship with the other close species, we downloaded public sequences for *Lasioglossum nitidiusculum* (Accession number FBAPD651-11) and *L. parvulum* (Accession number FBHAP727-09) and produced a sequence for *L. transitorium* (Accession number OR800271). Then we aligned all the DNA sequences using ClustalW with the default parameters in MEGA ver. 11 (TAMURA *et al.* 2021). Based on the global similarity of the nucleotide sequences, we reconstructed a Neighbor-Joining (NJ) tree (SAITOU & NEI, 1987) with bootstrap replicates (n = 1000) (FELSENSTEIN, 1985). *Nomiapis diversipes* sequence (Accession number POLB023-23) was used as an outgroup.

Box A. Abbreviations

- **SFC.** Simone FLAMINIO Collection, Bologna, Italy
- **OÖLM.** Oberösterreichisches Landesmuseum, Linz, Austria
- **CRASI.** Collezione Riferimento Api Selvatiche d'Italia, CREA, Bologna, Italy
- **CUSS.** Collezione Università di Sassari, University of Sassari, Sassari, Italy
- **OCIC.** Observatoire Conservatoire des Invertébrés de Corse Collection, OCIC, Corte, France

RESULTS

Lasioglossum (Hemihalictus) inexpectatum sp. nov. FLAMINIO & PAULY, 2024

ZooBank https://zoobank.org/E9F8E138-0284-4261-A2BA-669B05266660

Holotype

1 ♀, Italy, Sardinia, Sassari, Lago Baratz (40°41'22"N – 8°13'14"E), 30.IV.2022, on *Raphanus sativus*, *leg.* M. LEZZERI (OÖLM).

Paratypes

Idem holotype, 4 ♀♀ on *Raphanus sativus*, 2 ♀♀ on *Oxalis pes-caprae*, 1 ♀ on *Chrysanthemum coronarium*, 2 ♀♀ on *Malva sylvestris*, 1 ♀ on *Allium triquetrum*, *leg.* M. LEZZERI (SFC, CRASI, CUSS). 3 ♂♂, France, Corsica, Talasani, Figaretto, (47°24'48"N – 9°32'16"E), 08.VII.2020, *leg.* A. CORNUEL-WILLERMOZ (2 ♂♂ OCIC, 1 ♂ SFC). 1 ♂ France, Corsica, Vescovato, Terragliolo (42°31'27" N – 9°31'39"E), 30.VI.2020, *leg.* A. CORNUEL-WILLERMOZ, OÖLM.

Figure 1. *Lasioglossum inexpectatum* sp. nov., female. **A.** Dorsal habitus. **B.** Lateral habitus. **C.** Head (frontal view). **D.** Scutum. **e.** Propodeum. **F.** Spur of the hind tibia, **g**. First tergum. Scale bar is 1 mm.

Description

Female

Body length 6 mm (figure 1a–b).

Head. Head (figure 1c) shorter than wide (length/width = 0.85), clypeus coarsely and densely punctate (interspaces 0.5–0.7 punctures diameter), the punctures slightly elongated and the underlying surface shiny. Supraclypear area more densely punctate in the proximal half (interspaces 0.5 punctures diameter) than on the distal half (interspaces at least 1 puncture diameter), underlying surface shiny. Frons densely and finely punctate. Vertex short and finely striated.

Mesosoma. Scutum and scutellum densely punctated, interspaces shagreened and equal to 1–2 points diameter (figure 1d). Propodeum not carinated, the horizontal part almost as long as the scutellum (propodeum/scutellum length = 0.94) and wrinkled in the proximal two-thirds, marginal part without wrinkles and slightly reboarded (figure 1e). Mesopleurae punctate, underlying

Figure 2. *Lasioglossum inexpectatum* sp. nov., male. **a.** Dorsal habitus. **b**. Lateral habitus. **c.** Head (frontal view). Scale bar is 1 mm.

Figure 3. *Lasioglossum inexpectatum* sp. nov., male. **a.** Abdomen. **b.** Sterna. **c.** First and second tergum. **d.** Scutum. **e.** Propodeum. **f.** Genitalia (frontal view). **g.** Genitalia (ventral view).

surface shiny. Legs black, hind tibial spur serrated (figure 1f).

Metasoma. The marginal part of the terga slightly translucid and brownish. The first tergum shiny, and almost impunctate on the disc, the center of the marginal part being slightly depressed and more densely but very delicately punctate (interspaces 1–1.5 punctures diameter), punctures becoming sparser in the center (figure 1g). Following terga shiny and more densely punctate, on the disc interspaces equal to less than one point diameter; the marginal part less densely punctate, and interspaces equal to several puncture diameter.

Male

Body length 5.5 mm (figure 2a–b).

Head. Head (figure 2c) as long as wide (length/width = 1), clypeus densely and coarsely punctate (interspaces less than 0.5 punctures diameter), yellow in the apical third. Labrum also yellow, and mandibles yellowish only in the middle. Frons densely and delicately punctate, vertex short and shiny. Antennae moderately long, flagellomeres as long as wide (length/width = 1), underside ochraceous; scape and pedicel black.

Mesosoma. Scutum and scutellum (figure 3d) densely punctate (interspaces equal to 0.5-1 puncture diameter), underlying surface shiny. Propodeum not carinated, the horizontal part clearly shorter than the scutellum (length/width = 0.58), wrinkled all over, and shiny (figure 3e). Mesopleurae punctate, underlying surface shiny. Basitarsus and following tarsomeres of all legs yellowish, and basal and apical parts of the tibia also yellowish.

Metasoma. Marginal part of the terga slightly translucid and brownish (figure 3c). The first tergum

Figure 4. Locus typicus of *Lasioglossum inexpectatum* sp. nov.: Lago Baratz, Sardinia, Italy (55 m a.s.l.).

shiny, sparsely punctate on the disc, and more densely punctate in the apical margin (figure 3a). Following terga more densely and uniformly punctate (interspaces less than 1 puncture diameter), apical margin almost impunctate and horizontally shagreened. Sterna with erect whitish hairs (figure 3b). Gonostyli small and pointed (figure 3f), membranous lobe of gonocoxite short, broad and rounded (figure 3g).

Diagnosis

Lasioglossum inexpectatum sp. nov. can be assigned to the subgenus *Hemihalictus* COCKERELL, 1897 by the propodeum not carinated with the horizontal part not sloping directly into the vertical part and by the black integument. The closest taxa, considering the distribution areal, are *L. nitidiusculum* KIRBY, 1802, *L. parvulum* SCHENCK, 1853, and *L. transitorium* SCHENCK, 1868. *Lasioglossum nitidiusculum* and *L. parvulum* can be separated, in the female sex, by the shiny cuticle of the scutum, which is instead shagreened and less densely punctate in *L. inexpectatum* sp. nov., and by the shorter and differently sculptured basal part of the propodeum. Furthermore, the first tergum of *L. nitidiusculum* is more densely punctate than in *L. inexpectatum* sp. nov. Male specimens can be easily separated by the tufts of hairs on the sterna of *L. nitidiusculum*, absent in *L. inexpectatum* sp. nov., and by the clearly different gonostyli and membranous lobe. *L. transitorium* can be separated, in the female sex, mainly for the longer head, the shiny cuticle of the scutum, and the spur of the hind tibia with semi-columnar processes. The male sex can be separated by the longer head, the labrum black, and the differences in the shape of the gonostyli and the membranous lobe.

Distribution and ecology

Lasioglossum inexpectatum is known only from Sardinia (Italy) and Corsica (France). The type locality, Lago Baratz (Sassari, 56 m a.s.l., figure 4), is the only natural Sardinia basin. The collection site (Lago Baratz) is characterized by a typical Mediterranean shrub habitat, featuring sclerophyllous species. In the more open grassy areas, species such as *Pistacia lentiscus* L., *Phillyrea angustifolia* L., *Arbutus unedo* L., and *Erica arborea* L. are found, while in the understory consisting of *Juniperus phoenicea* L. and *Quercus ilex* L., shrubs like *Ruscus aculeatus* L., *Clematis flammula* L., and *Asparagus acutifolius* L. are widespread.

Additionally, in the outermost zone of Lago Baratz, a pine reforestation (*Pinus pinea* L., *Pinus halepensis* MILLER) was planted in the 1950s, along with *Eucalyptus* and *Robinia* (BORGARELLO *et al.*, 2000). The habitat vegetation was confirmed by floristic surveys in the field at the time of captures. All female specimens were collected in April by aerial net while visiting flowers of *Raphanus raphanistrum* L. subsp. *sativus* (L.) SCHMALH. (Brassicaceae), *Oxalis pes-caprae* L. (Oxalidacae), *Malva sylvestris* L. (Malvaceae), *Allium triquetrum* L. (Amaryllidaceae) and *Glebionis coronaria* (L.) SPACH (= *Chrysanthemum coronarium* L.) (Asteraceae). Males were also collected by aerial net in Terragliolo, a Mediterranean scrub close to Golo River in June, and in Talassani, a coastal dunal system in July. Interestingly, unlike other species and subspecies endemic to the two islands, *L. inexpectatum* seems to be present only at low altitudes (Figure 5). The map in Figure 7 shows the collecting locations.

Molecular analysis

High-quality DNA sequences were obtained from one female specimens (Accession number OR807151) and one of the male specimens (Accession number OR807152). Sequences obtained were used as queries in the BOLD-IS tool and then blasted on *GenBank*, returning a partial match with *L. nitidiusculum* (identity percentage 94.92 %, E-value 0^{-180}) and *L. parvulum* (88.98 %, E-value 4^{-180}) sequences deposited

on *GenBank*. In Figure 6, the neighbor-joining tree, showing the relationships between male and female specimens of *L. inexpectatum* and other related species of *Lasioglossum (Hemihalictus)*, is reported. The bootstrap is indicated on the branches.

Derivatio nominis

From the Latin adjective *inexpectatum* (unexpected), because of the stupor of the discovery of this new species in Europe.

Figure 5. Collecting site of the male of *L. inexpectatum* sp. nov., Vescovato (Corsica, France, 46 m a.s.l.).

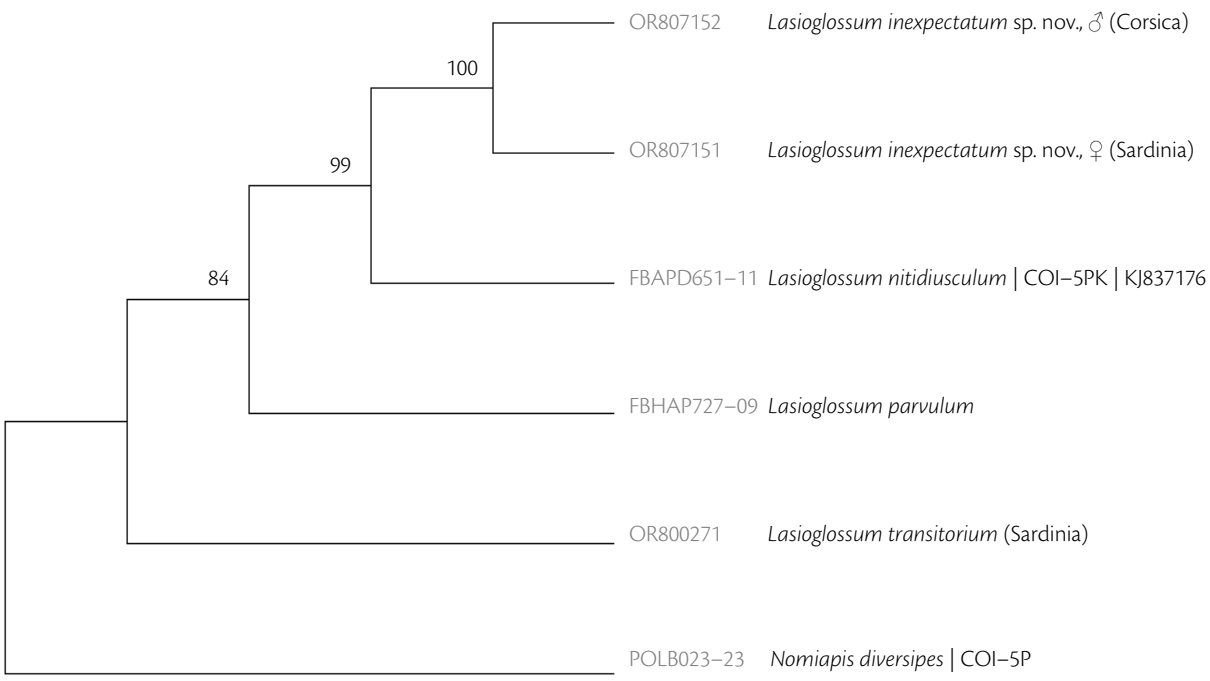

Figure 6. Neighbor-Joining tree, showing the relationships between *L. inexpectatum* sp. nov. and other related species of *Lasioglossum* (*Hemihalictus*). The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1000 replicates) are shown above the branches. The evolutionary distances were computed using the Maximum Composite Likelihood method. This analysis involved 6 nucleotide sequences.

Figure 20. Map showing the finding localities of *Lasioglossum inexpectatum*. Map *QGIS* version 3.1.

DISCUSSION AND CONCLUSION

The discovery of *Lasioglossum inexpectatum* adds to the evidence that there is still a taxonomic gap in Europe regarding Hymenoptera Apoidea (GHISBAIN *et al.*, 2023a; GHISBAIN *et al.*, 2023b; PRAZ & BÉNON, 2023; PRAZ *et al.*, 2022; WOOD, 2022, 2023; WOOD & LE DIVELEC, 2022; WOOD *et al.*, 2022) and that further research expeditions and projects aimed at deepening the fauna especially of southern Europe are necessary.

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