Biodiversity Data Journal 13: e138625
doi: 10.3897/BDJ.13.e138625

Taxonomy & Inventories

New distribution records of wild bees (Hymenoptera, Apoidea) in South Tyrol (Italy): expanding the wild bee database

Sebastiano Zanini[‡,§], Matteo Dainese[|], Timo Kopf[¶], Lisa Obwegs[§,‡], Matteo Anderle[§], Georg Leitinger[‡], Ulrike Tappeiner[‡,§]

‡ Universität Innsbruck, Innsbruck, Austria
§ Eurac Research, Bolzano/Bozen, Italy
| University of Verona, Verona, Italy
¶ Freelance Biologist, Innsbruck, Austria

Corresponding author: Lisa Obwegs (lisa.obwegs@eurac.edu)

Academic editor: Grégoire Noël

Received: 04 Oct 2024 | Accepted: 04 Feb 2025 | Published: 25 Feb 2025

Citation: Zanini S, Dainese M, Kopf T, Obwegs L, Anderle M, Leitinger G, Tappeiner U (2025) New distribution records of wild bees (Hymenoptera, Apoidea) in South Tyrol (Italy): expanding the wild bee database. Biodiversity Data Journal 13: e138625. https://doi.org/10.3897/BDJ.13.e138625

Abstract

Background

Throughout South Tyrol, in northern Italy, there is a data deficiency relating to wild bee species pool. Here, we present significant findings from the collection of 3,313 wild bees gathered over two separate studies conducted in consecutive years. Our research focused on the impact of landscape heterogeneity, temperature and land-use change on wild bee communities and their pollination services in an agricultural and mountainous landscape. This article provides a detailed account of the 150 identified wild bee species collected using coloured pan traps. We report habitat type, occurrence data, threat status, sociality, nesting strategy and diet breadth. In Italian regions where information on wild bee distribution is lacking or outdated, sharing data is crucial for developing conservation policies.

New information

The compiled species list strengthens regional and national wild bee database by providing new distribution data for extinction-threatened species, such as *Dufourea dentiventris* (Nylander, 1848), *Dufourea inermis* (Nylander, 1848), *Lasioglossum brevicorne* (Schenck, 1870), *Lasioglossum laevigatum* (Kirby, 1802), *Lasioglossum monstrificum* (Morawitz, 1891), *Nomada mutica* Morawitz, 1872 and *Nomada villosa* Thomson, 1870. Additionally, we present recent findings of species that are valuable for understanding range expansions, recording species previously unreported in South Tyrol and updating historical data for the region.

Keywords

nature conservation, agroecosystem, biodiversity, Red List, mountain region

Introduction

Over the last 30 years, pollinator abundance and diversity have declined globally due to multiple factors, primarily anthropogenic pressures (Hallmann et al. 2017, Powney et al. 2019, Granata et al. 2023, Ulyshen and Horn 2023). Land-use change, intensive agricultural management alongside associated pesticide use, invasive alien species and climate change are the main threats to pollinators (Potts et al. 2016). The conservation of pollinators is of utmost importance as they play an essential role in the life cycle of many organisms, including humans. An estimated two-thirds of global food crops require pollination to set fruits and seeds (Klein et al. 2006). Animals pollinate 87.5% of crop and wild plant species (Ollerton et al. 2011) and from an economic perspective, the ecosystem service provided by pollinators amounts globally to approximately $351 billion (USD)/ year for food production (Lautenbach et al. 2012). In Europe, considering horticulture alone, more than 4000 vegetable varieties depend on wild and managed bee pollinations (Kluser et al. 2010). Thus, the commitment to curb pollinator decline is pivotal to three of the Sustainable Development Goals (SDG) from the Food and Agriculture Organization of the United Nations (FAO 2018): ensure biodiversity (SDG 15), food security (SDG 2) and, ultimately, human well-being (SDG 1).

The European Commission supports pollinator projects through funding programmes. However, a significant data gap exists on wild bee species, especially in central-southern Europe (Quaranta et al. 2004). Italy, for example, is a hotspot for more than 1,000 species (Comba 2019, Reverté et al. 2023), but the first complete national catalogue of bee species was produced only in 1995 by Pagliano G. (Quaranta et al. 2018). Since then, research has made progress, but with unequal effort and continuity in every region (Quaranta et al. 2002). Sharing new distribution records is important to build a numerical reference that will contribute to assessing the demographic trends of wild bee

populations objectively. Ultimately, the aim is to evaluate the status of wild bee species for conservation, but this is only possible once data are available (Quaranta et al. 2018).

Mountain regions are valuable study areas because the complex topography offers many niches for species adapted to various microclimates and habitats. The interplay of abiotic pressures along the elevational gradient allows species to co-exist with different ecological requirements, making valleys and mountainside ecosystems critical for biodiversity conservation (Körner 2002). With climate change, these highly dynamic areas face potential species migration from warmer to colder regions, including higher elevations (Körner 2003). Additionally, species may shift along the latitudinal gradient, adapting to different climatic conditions or finding new niches (Wasof et al. 2013).

In 2021 and 2022, we conducted two separate studies in the agricultural landscapes of South Tyrol, a mountainous region in northern Italy. These studies involved surveys in various habitats, including apple orchards (14), vineyards (5), pastures (4), meadows (6), orchard meadows (2) and annual crop fields (2). After identifying the wild bees caught with pan traps, we evaluated their IUCN Red List status for Europe (Nieto et al. 2014) and Italy (Quaranta et al. 2018). Since South Tyrol lacks a Red List of wild bee species, we compared our findings with the most recent and complete synopsis of wild bees in South Tyrol (Hellrigl 2006). This data paper aims to provide open access to wild bee abundance data and a list of species in a region of substantial ecological importance. These data expand the database on wild bees for South Tyrol.

Materials and methods

The Autonomous Province of Bolzano/Bozen - South Tyrol is dominated by mountains and is rich in forests, grasslands, watercourses and lakes. Valley floors are intensively cultivated and mainly occupied by settlements, managed apple monocultures and vineyards. With increasing elevation, cropland is progressively substituted by meadows, pastures and forests. Despite the intensively cultivated valleys, natural and semi-natural habitats (SNH) cover 82.3% of the region's surface (Anderle et al. 2022). Data collection occurred within two valleys: Eisacktal/Valle Isarco (from Bozen/Bolzano to Klausen/ Chiusa)
and Etschtal/Val D´Adige (from Prad am Stilfser Joch/Prato allo Stelvio to Salurn/Salorno) (Fig. 1). Exact locations are provided in Suppl. material 1 and are also part of the monitoring programme for other taxa, including vascular plants, grasshoppers, butterflies, birds, bats and others, conducted by the "Biodiversity Monitoring South Tyrol" (Hilpold et al. 2023).

For bees collected during the first year, a specimen (of both sexes, if present) per species per site was prepared to be stored in an insect box. In the second year, we prepared one specimen (of both sexes, if present) per species per site. All the other bees are labelled, temporarily stored in 70% ethanol and checked regularly in case ethanol refilling was necessary. The specimens will be temporarily kept by the Institute for Alpine Environment at Eurac Research for further research and then gifted to the South Tyrol Museum of

Nature in Bolzano/Bozen. Abundance data for each species in each study year are provided in Suppl. material 3; for detailed sampling methodology and habitat descriptions, see Suppl. material 4. The first checklist provides the list of wild bee species, while Suppl. material 2 includes details on their sociality, nesting strategies, dietary preferences and threat status.

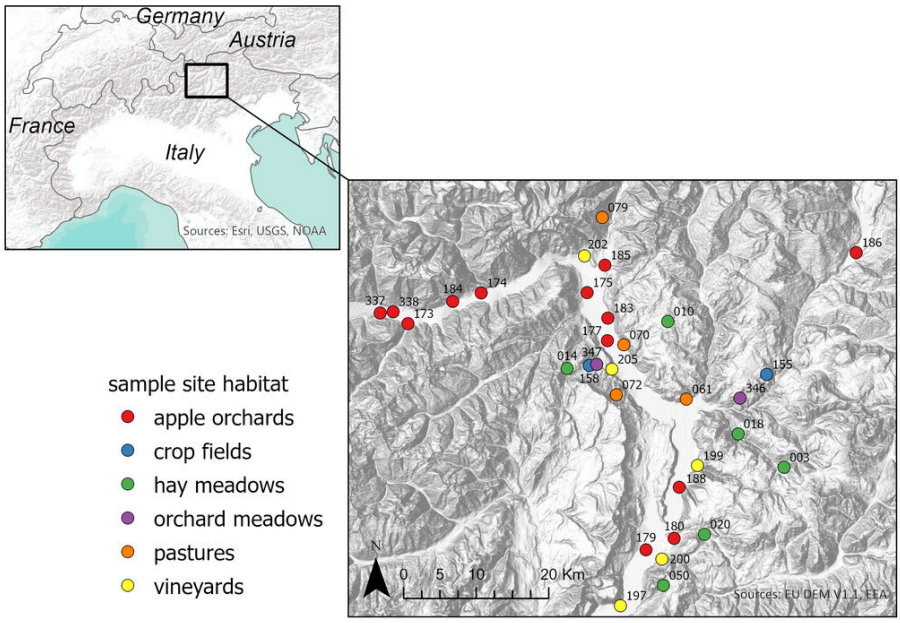

Figure 1. doi

Section of the Autonomous Province of Bolzano/Bozen, Italy, with the study area and sites categorised by habitat class. Site code specifications and coordinates can be found in Suppl. material 1.

Taxonomic framework

Wild bee specimens were identified at species level using identification keys provided by Amiet (1996), Amiet et al. (1999), Amiet et al. (2001), Amiet et al. (2004), Amiet et al. (2007), Amiet et al. (2010), Bogusch and Straka (2012), Ebmer (1969), Ebmer (1971), Ebmer (1984), Mauss (1994) and Scheuchl (1995), Scheuchl (2006). Females of *Halictus simplex* Blüthgen, 1923 were difficult to differentiate from *H. longobardicus* Blüthgen, 1944 and *H. eurygnathus* Blüthgen, 1931 (Ebmer 1975). We addressed this group of species as the "*Halictus simplex* group". Similarly, distinguishing *Hylaeus confusus* Nylander, 1852 from *H. incongruus* Foster 1871 and *H. gibbus* Saunders, 1850 proved challenging (Le Divelec 2022). Therefore, we refer to this group as *Hylaeus* cf. *confusus*. Morphological differentiation between *Andrena barbareae* Panzer, 1805 and the closely-related *Andrena cineraria* (Linnaeus, 1758) was also problematic, so we treat it as *Andrena* cf. *barbareae*. Lastly, it is worth mentioning that *Andrena spinigera* (Kirby, 1802)

is considered a distinct species from *A. trimmerana* (Kirby, 1802) by German and Swiss apidologists, though recent barcoding efforts found no genetic differences between the two (Villalta et al. 2021).

Data resources

The data underpinning the analysis reported in this paper are deposited at GBIF, the Global Biodiversity Information Facility, https://doi.org/10.15468/h4r92a

Wild bee species list

Andrena alfkenella Perkins, 1914

Notes: 2022, Burggrafenamt

Andrena barbareae (cf.) Panzer, 1805

Notes: 2021 and 2022, Überetsch-Unterland

Andrena bicolor Fabricius, 1775

Notes: 2022, Salten-Schlern, Burggrafenamt, Überetsch-Unterland

Andrena carantonica Pérez, 1902

Notes: 2021, Vinschgau, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Andrena combinata (Christ, 1791)

Notes: 2022, Burggrafenamt

Andrena curvungula Thomson, 1870

Notes: 2022, Burggrafenamt, Überetsch-Unterland, Salten-Schlern

Andrena dorsata (Kirby, 1802)

Notes: 2021, Überetsch-Unterland, Vinschgau, Burggrafenamt, Salten-Schlern; 2022, Burggrafenamt, Salten-Schlern

Andrena falsifica Perkins, 1915

Notes: 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Andrena flavipes Panzer, 1799

Notes: 2021, Überetsch-Unterland; 2022, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Andrena fulva (Müller, 1766)

Notes: 2021, Vinschgau, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Andrena fulvago (Christ, 1791)

Notes: 2022, Bozen, Salten-Schlern, Überetsch-Unterland, Burggrafenamt

Andrena gelriae Van der Vecht, 1927

Notes: 2022, Burggrafenamt

Andrena haemorrhoa (Fabricius, 1781)

Notes: 2021, Überetsch-Unterland, Burggrafenamt, Vinschgau, Salten-Schlern; 2022, Überetsch-Unterland

Andrena hattorfiana (Fabricius, 1775)

Notes: 2022, Burggrafenamt, Überetsch-Unterland, Salten-Schlern

Andrena humilis Imhoff, 1832

Notes: 2022, Salten-Schlern, Überetsch-Unterland, Burggrafenamt

Andrena labiata Fabricius, 1781

Notes: 2022, Burggrafenamt

Andrena minutula (Perkins, 1914)

Notes: 2021, Vinschgau, Burggrafenamt, Salten-Schlern, Überetsch-Unterland; 2022, Überetsch-Unterland

Andrena minutuloides (Kirby, 1802)

Notes: 2022, Überetsch-Unterland

Andrena nigroaenea (Kirby, 1802)

Notes: 2021, Überetsch-Unterland, Vinschgau, Burggrafenamt, Salten-Schlern; 2022, Salten-Schlern, Bozen, Burggrafenamt, Überetsch-Unterland

Andrena nitida (Müller, 1776)

Notes: 2021, Salten-Schlern

Andrena ovatula (Kirby, 1802) [species group]

Notes: 2021, Überetsch-Unterland, Vinschgau; 2022, Überetsch-Unterland

Andrena pandellei Pérez, 1895

Notes: 2022, Burggrafenamt

Andrena saxonica Stöckhert, 1935

Notes: 2021 and 2022, Überetsch-Unterland

Andrena schencki Morawitz, 1866

Notes: 2022, Überetsch-Unterland

Andrena simontornyella Noskiewicz, 1939

Notes: 2021, Überetsch-Unterland

Andrena spinigera Kirby, 1802

Notes: 2021 and 2022, Überetsch-Unterland

Andrena subopaca Nylander, 1848

Notes: 2021, Burggrafenamt

Andrena symphyti Schmiedeknecht, 1883

Notes: 2022, Überetsch-Unterland

Andrena taraxaci Giraud, 1861

Notes: 2021, Burggrafenamt, Überetsch-Unterland; 2022, Überetsch-Unterland

Andrena thoracica (Fabricius, 1775)

Notes: 2022, Burggrafenamt

Andrena vaga Panzer, 1799

Notes: 2021, Salten-Schlern

Andrena ventralis Imhoff, 1832

Notes: 2021, Salten-Schlern

Andrena wilkella (Kirby, 1802)

Notes: 2022, Überetsch-Unterland

Anthidium manicatum (Linné, 1758)

Notes: 2022, Burggrafenamt

Anthidium nanum Mocsary, 1881

Notes: 2022, Burggrafenamt

Anthidium oblongatum (Illiger, 1806)

Notes: 2022, Überetsch-Unterland

Anthidium punctatum Latreille, 1809

Notes: 2022, Salten-Schlern

Anthophora plumipes (Pallas, 1772)

Notes: 2021, Burggrafenamt

Bombus barbutellus (Kirby, 1802)

Notes: 2022, Burggrafenamt, Salten-Schlern

Bombus bohemicus Seidl, 1838

Notes: 2021, Salten-Schlern; 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Bombus campestris (Panzer, 1801)

Notes: 2022, Burggrafenamt

Bombus cryptarum (Fabricius, 1775)

Notes: 2022, Salten-Schlern

Bombus hortorum (Linné, 1761)

Notes: 2022, Burggrafenamt

Bombus jonellus (Kirby, 1802)

Notes: 2022, Überetsch-Unterland

Bombus lapidarius (Linnaeus, 1758)

Notes: 2021, Vinschgau; 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Bombus lucorum (Linnaeus, 1761)

Notes: 2021, Vinschgau, Salten-Schlern, Burggrafenamt; 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Bombus pascuorum (Scopoli, 1763)

Notes: 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Bombus pratorum (Linnaeus, 1761)

Notes: 2021, Salten-Schlern; 2022, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Bombus soroeensis (Fabricius, 1776)

Notes: 2022, Überetsch-Unterland, Burggrafenamt

Bombus sylvestris (Lepeletier, 1832)

Notes: 2021, Salten-Schlern; 2022, Salten-Schlern, Burggrafenamt

Bombus terrestris (Linnaeus, 1758)

Notes: 2021, Vinschgau; 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Ceratina chalybea Chevrier, 1872

Notes: 2022, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Ceratina cucurbitina (Rossi, 1792)

Notes: 2021, Burggrafenamt; 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Ceratina cyanea (Kirby, 1802)

Notes: 2021, Salten-Schlern; 2022, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Chelostoma distinctum (Stöckhert, 1929)

Notes: 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Chelostoma florisomne (Linnaeus, 1758)

Notes: 2021, Burggrafenamt; 2022, Überetsch-Unterland, Burggrafenamt

Chelostoma foveolatum (Morawitz, 1868)

Notes: 2022, Burggrafenamt

Chelostoma rapunculi (Lepeletier, 1841)

Notes: 2022, Salten-Schlern, Burggrafenamt

Dufourea dentiventris (Nylander, 1848)

Notes: 2022, Salten-Schlern, Burggrafenamt

Dufourea inermis (Nylander, 1848)

Notes: 2022, Burggrafenamt

Eucera longicornis (Linné, 1758)

Notes: 2022, Überetsch-Unterland, Salten-Schlern

Eucera nigrescens Pérez, 1879

Notes: 2021, Vinschgau, Überetsch-Unterland; 2022, Überetsch-Unterland, Burggrafenamt

Halictus langobardicus Blüthgen, 1944

Notes: 2022, Überetsch-Unterland

Halictus maculatus Smith, 1848

Notes: 2021, Vinschgau; 2022, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Halictus rubicundus (Christ, 1791)

Notes: 2022, Burggrafenamt

Halictus sexcinctus (Fabricius, 1775)

Notes: 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Halictus simplex (cf.) Blüthgen, 1923

Notes: 2021, Vinschgau; 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Halictus subauratus (Rossi, 1792)

Notes: 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Halictus tumulorum (Linné, 1758)

Notes: 2022, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Heriades truncorum (Linnaeus, 1758)

Notes: 2022, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Hylaeus angustatus (Schenck, 1861)

Notes: 2022, Bozen, Salten-Schlern, Burggrafenamt

Hylaeus brevicornis Nylander, 1852

Notes: 2021, Überetsch-Unterland; 2022, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Hylaeus communis Nylander, 1852

Notes: 2022, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Hylaeus confusus (cf.) Nylander, 1852

Notes: 2021, Vinschgau, Überetsch-Unterland, Burggrafenamt; 2022, Bozen, Überetsch-Unterland, Salten-Schlern, Burggrafenamt

Hylaeus difformis (Eversmann, 1852)

Notes: 2022, Salten-Schlern

Hylaeus dilatatus (Kirby, 1802)

Notes: 2022, Salten-Schlern, Burggrafenamt

Hylaeus gredleri Förster, 1871

Notes: 2022, Burggrafenamt

Hylaeus hyalinatus Smith, 1842

Notes: 2022, Salten-Schlern, Burggrafenamt

Hylaeus kahri Förster, 1871

Notes: 2022, Salten-Schlern, Burggrafenamt

Hylaeus leptocephalus (Morawitz, 1870)

Notes: 2022, Überetsch-Unterland

Hylaeus nigritus (Fabricius, 1798)

Notes: 2022, Salten-Schlern

Hylaeus sinuatus (Schenck, 1853)

Notes: 2022, Salten-Schlern, Burggrafenamt

Hylaeus styriacus Förster, 1871

Notes: 2022, Salten-Schlern

Hylaeus variegatus (Fabricius, 1798)

Notes: 2022, Salten-Schlern, Bozen

Lasioglossum aeratum (Kirby, 1802)

Notes: 2022, Salten-Schlern, Burggrafenamt

Lasioglossum albipes (Fabricius, 1781)

Notes: 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum bluethgeni Ebmer, 1971

Notes: 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum brevicorne (Schenck, 1870)

Notes: 2022, Burggrafenamt, Salten-Schlern

Lasioglossum calceatum (Scopoli, 1763)

Notes: 2021, Vinschgau, Burggrafenamt, Salten-Schlern, Überetsch-Unterland; 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum fulvicorne (Kirby, 1802)

Notes: 2021, Vinschgau, Salten-Schlern, Überetsch-Unterland; 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum glabriusculum (Morawitz, 1872)

Notes: 2021, Überetsch-Unterland; 2022, Salten-Schlern, Überetsch-Unterland

Lasioglossum laevigatum (Kirby, 1802)

Notes: 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum laterale (Brullé, 1832)

Notes: 2021 and 2022, Überetsch-Unterland

Lasioglossum laticeps (Schenck, 1870)

Notes: 2021, Vinschgau, Burggrafenamt, Salten-Schlern, Überetsch-Unterland; 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum lativentre (Schenck, 1853)

Notes: 2021, Salten-Schlern; 2022, Burggrafenamt, Salten-Schlern

Lasioglossum leucopus (Kirby, 1802)

Notes: 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum leucozonium (Schrank, 1781)

Notes: 2022, Bozen, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum lissonotum (Noskiewicz, 1926)

Notes: 2022, Burggrafenamt

Lasioglossum minutissimum (Kirby, 1802)

Notes: 2021 and 2022, Burggrafenamt, Überetsch-Unterland

Lasioglossum monstrificum (Morawitz, 1891)

Nomenclature:

Syn. *L. sabulosum* (Warncke, 1986)

Notes: 2021, Salten-Schlern

Lasioglossum morio (Fabricius, 1793)

Notes: 2021, Vinschgau, Burggrafenamt, Salten-Schlern, Überetsch-Unterland; 2022, Bozen, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum nitidulum (Fabricius, 1804)

Notes: 2022, Bozen, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum pauxillum (Schenck, 1853)

Notes: 2021, Burggrafenamt, Überetsch-Unterland; 2022, Bozen, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum politum (Schenck, 1853)

Notes: 2021, Überetsch-Unterland; 2022, Salten-Schlern

Lasioglossum punctatissimum (Schenck, 1853)

Notes: 2021, Burggrafenamt, Überetsch-Unterland; 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum rufitarse (Zetterstedt, 1838)

Notes: 2022, Burggrafenamt

Lasioglossum transitorium (Schenck, 1868)

Notes: 2021, Vinschgau, Überetsch-Unterlan; 2022, Bozen, Salten-Schlern

Lasioglossum villosulum (Kirby, 1802)

Notes: 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Lasioglossum zonulum (Smith, 1848)

Notes: 2021, Burggrafenamt, Vinschgau, Überetsch-Unterland; 2022, Burggrafenamt, Salten-Schlern, Überetsch-Unterland

Megachile centuncularis (Linné, 1758)

Notes: 2022, Burggrafenamt, Überetsch-Unterland

Megachile melanopyga Costa, 1863

Notes: 2022, Überetsch-Unterland

Megachile parietina (Geoffroy, 1785)

Notes: 2022, Salten-Schlern

Megachile pilidens Alfken, 1924

Notes: 2022, Burggrafenamt, Bozen

Megachile rotundata (Fabricius, 1787)

Notes: 2022, Burggrafenamt

Megachile versicolor Smith, 1844

Notes: 2021, Überetsch-Unterland; 2022, Burggrafenamt

Megachile willughbiella (Kirby,1802)

Notes: 2021, Vinschgau

Melecta albifrons (Forster, 1771)

Notes: 2022, Überetsch-Unterland

Melecta luctuosa (Scopoli, 1770)

Notes: 2022, Bozen

Melitta haemorrhoidalis (Fabricius, 1775)

Notes: 2022, Burggrafenamt, Salten-Schlern

Melitta leporina (Panzer, 1799)

Notes: 2022, Burggrafenamt, Salten-Schlern

Nomada emarginata Morawitz, 1877

Notes: 2022, Burggrafenamt

Nomada flava Panzer, 1798

Notes: 2021, Burggrafenamt

Nomada flavoguttata (Kirby, 1802)

Notes: 2022, Überetsch-Unterland

Nomada flavopicta (Kirby, 1802)

Notes: 2022, Burggrafenamt, Salten-Schlern

Nomada integra Brullé, 1832

Notes: 2022, Salten-Schlern

Nomada mutica Morawitz, 1872

Notes: 2021, Vinschgau

Nomada sexfasciata Panzer, 1799

Notes: 2022, Salten-Schlern, Überetsch-Unterland

Nomada signata Jurine 1807

Notes: 2021, Burggrafenam

Nomada villosa Thomson, 1870

Notes: 2022, Salten-Schlern

Nomada zonata Panzer 1798

Notes: 2021, Burggrafenam

Osmia bicornis (Linnaeus, 1758)

Notes: 2021, Überetsch-Unterland, Burggrafenamt, Vinschgau; 2022, Bozen, Überetsch-Unterland, Burggrafenamt, Salten-Schlern

Osmia brevicornis (Fabricius, 1798)

Notes: 2022, Burggrafenamt

Osmia caerulescens (Linné, 1758)

Notes: 2022, Überetsch-Unterland, Burggrafenamt

Osmia cornuta (Latreille, 1805)

Notes: 2021, Burggrafenamt

Osmia gallarum Spinola, 1808

Notes: 2022, Überetsch-Unterland, Burggrafenamt

Osmiav leucomelana (Kirby, 1802)

Notes: 2022, Überetsch-Unterland, Burggrafenamt

Osmia mitis Nylander, 1852

Notes: 2022, Überetsch-Unterland, Burggrafenamt

Osmia mustelina Gerstaecker, 1869

Notes: 2022, Salten-Schlern

Osmia rufohirta Latreille, 1811

Notes: 2022, Bozen, Burggrafenamt

Osmia tridentata Dufour & Perris, 1840

Notes: 2022, Überetsch-Unterland

Osmia tuberculata Nylander, 1848

Notes: 2022, Salten-Schlern

Panurgus banksianus (Kirby, 1802)

Notes: 2022, Überetsch-Unterland, Burggrafenamt, Salten-Schlern

Panurgus calcaratus (Scopoli, 1763)

Notes: 2022, Überetsch-Unterland, Salten-Schlern

Sphecodes ephippius (Linnaeus, 1767)

Notes: 2021, Vinschgau, Burggrafenamt; 2022, Burggrafenamt

Sphecodes ferruginatus Hagens, 1882

Notes: 2022, Burggrafenamt

Sphecodes monilicornis (Kirby, 1802)

Notes: 2022, Überetsch-Unterland

Sphecodes niger Hagens, 1874

Notes: 2022, Burggrafenamt

Stelis ornatula (Klug, 1807)

Notes: 2022, Burggrafenamt

Xylocopa valga Gerstaecker, 1872

Notes: 2022, Überetsch-Unterland

Xylocopa violacea (Linné, 1758)

Notes: 2022, Burggrafenamt

Near threatened species according to the European Red List of Bees

Andrena hattorfiana (Fabricius, 1775)

Materials

a. country: Italy; stateProvince: South Tyrol; verbatimLocality: Tisens; verbatimElevation: 1430 m; decimalLatitude: 46.547390; decimalLongitude: 11.115870; samplingProtocol: pan trap; eventDate: 14/6/2022; habitat: hay meadow; individualCount: 1; sex: male; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 0846AC6F-A292-5A4B-9BFE-5A1CE0EDFAE3

b. country: Italy; stateProvince: South Tyrol; verbatimLocality: Gfrill; verbatimElevation: 1267 m; decimalLatitude: 46.275860; decimalLongitude: 11.282120; samplingProtocol: pan trap; eventDate: 12/6/2022; habitat: hay meadow; individualCount: 1; sex: female; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: FC544941-6974-5DC8-96CF-56D4C9318AA8

c. country: Italy; stateProvince: South Tyrol; verbatimLocality: Sinich; verbatimElevation: 276 m; decimalLatitude: 46.640990; decimalLongitude: 11.153260; samplingProtocol: pan trap; eventDate: 10/7/2022; habitat: apple orchard; individualCount: 1; sex: female; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: A2A27312-BDD6-5634-A685-A00E0972807A

d. country: Italy; stateProvince: South Tyrol; verbatimLocality: Unterinn; verbatimElevation: 901 m; decimalLatitude: 46.506610; decimalLongitude: 11.424850; samplingProtocol: pan trap; eventDate: 13/7/2022; habitat: orchard meadow; individualCount: 3; sex: 3 females; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 7C27E016-61CA-536E-971A-CA8CD37B35EE

e. country: Italy; stateProvince: South Tyrol; verbatimLocality: Siffian; verbatimElevation: 1055 m; decimalLatitude: 46.535360; decimalLongitude: 11.473600; samplingProtocol: pan trap; eventDate: 13/7/2022; habitat: crop field; individualCount: 4; sex: 4 females; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 64F8427E-1AF7-5751-9F20-BA640E69F54B

f. country: Italy; stateProvince: South Tyrol; verbatimLocality: Salurn; verbatimElevation: 209 m; decimalLatitude: 46.251770; decimalLongitude: 11.204790; samplingProtocol: pan trap; eventDate: 8/7/2022; habitat: vineyard; individualCount: 1; sex: male;

occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 174051B0-D2E5-58BB-9742-02046497EF24

g. country: Italy; stateProvince: South Tyrol; verbatimLocality: Prissian; verbatimElevation: 770 m; decimalLatitude: 46.551600; decimalLongitude: 11.168630; samplingProtocol: pan trap; eventDate: 14/6/2022; habitat: orchard meadow; individualCount: 1; sex: female; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: EDA31884-143E-5475-A72B-5F9DAD9AB365

Notes: solitary behaviour, nests below-ground, oligolectic (Caprifoliaceae).

Dufourea dentiventris (Nylander, 1848)

Materials

a. country: Italy; stateProvince: South Tyrol; verbatimLocality: Deutschnofen; verbatimElevation: 1333 m; decimalLatitude: 46.419560; decimalLongitude: 11.501210; samplingProtocol: pan trap; eventDate: 12/6/2022; habitat: hay meadow; individualCount: 1; sex: male; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 6F1E8C93-A927-57FB-80E6-6F8DF94E163E

b. country: Italy; stateProvince: South Tyrol; verbatimLocality: Deutschnofen; verbatimElevation: 1333 m; decimalLatitude: 46.419560; decimalLongitude: 11.501210; samplingProtocol: pan trap; eventDate: 12/6/2022; habitat: hay meadow; individualCount: 1; sex: female; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: A6795E44-78C2-5E59-A42A-93D26C4CC07A

c. country: Italy; stateProvince: South Tyrol; verbatimLocality: Tisens; verbatimElevation: 1430 m; decimalLatitude: 46.547390; decimalLongitude: 11.115870; samplingProtocol: pan trap; eventDate: 17/7/2022; habitat: hay meadow; individualCount: 1; sex: female; occurrenceRemarks: yellow pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 80DF03D8-7A94-54A5-AECD-400CD1CE6C1B

Notes: solitary behaviour, nests below-ground, oligolectic (*Campanula* sp.).

Dufourea inermis (Nylander, 1848)

Materials

a. country: Italy; stateProvince: South Tyrol; verbatimLocality: Gargazon; verbatimElevation: 323 m; decimalLatitude: 46.575370; decimalLongitude: 11.217770; samplingProtocol: pan trap; eventDate: 10/7/2022; habitat: pasture; individualCount: 1; sex: female; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 81DFB6D9-BCF6-53FA-BC38-32376CB2A162

b. country: Italy; stateProvince: South Tyrol; verbatimLocality: Prissian; verbatimElevation: 770 m; decimalLatitude: 46.551600; decimalLongitude: 11.168630; samplingProtocol: pan trap; eventDate: 15/5/2022; habitat: orchard meadow; individualCount: 1; sex: male; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: CF41AD34-A50B-5BFA-928C-6865178199AB

Notes: solitary behaviour, nests below-ground, oligolectic (*Campanula* sp.).

Lasioglossum brevicorne (Schenck, 1870)

Materials

a. country: Italy; stateProvince: South Tyrol; verbatimLocality: Siffian; verbatimElevation: 1055 m; decimalLatitude: 46.535360; decimalLongitude: 11.473600; samplingProtocol: pan trap; eventDate: 18/5/2022; habitat: crop field; individualCount: 1; sex: female; occurrenceRemarks: white pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: A8E8BFA2-C655-5B67-A5DE-86748A6B7A98

b. country: Italy; stateProvince: South Tyrol; verbatimLocality: Siffian; verbatimElevation: 1055 m; decimalLatitude: 46.535360; decimalLongitude: 11.473600; samplingProtocol: pan trap; eventDate: 13/7/2022; habitat: crop field; individualCount: 1; sex: female; occurrenceRemarks: yellow pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 49C71A37-38F7-5131-A658-A5B35FA253F7

c. country: Italy; stateProvince: South Tyrol; verbatimLocality: Ried; verbatimElevation: 1087 m; decimalLatitude: 46.733800; decimalLongitude: 11.182640; samplingProtocol: pan trap; eventDate: 22/5/2022; habitat: pasture; individualCount: 3; sex: 3 females; occurrenceRemarks: white pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 1C860E6F-13ED-5902-9BD0-8B802D622BAC

Notes: sociality unkown (probably solitary), nests below-ground, polylectic.

Lasioglossum laevigatum (Kirby, 1802)

Materials

a. country: Italy; stateProvince: South Tyrol; verbatimLocality: Tisens; verbatimElevation: 1430 m; decimalLatitude: 46.547390; decimalLongitude: 11.115870; samplingProtocol: pan trap; eventDate: 14/6/2022; habitat: hay meadow; individualCount: 1; sex: female; occurrenceRemarks: white pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 506F84C5-A743-5D07-BD30-FE7145948ADD

b. country: Italy; stateProvince: South Tyrol; verbatimLocality: Tisens; verbatimElevation: 1430 m; decimalLatitude: 46.547390; decimalLongitude: 11.115870; samplingProtocol: pan trap; eventDate: 14/6/2022; habitat: hay meadow; individualCount: 1; sex: female; occurrenceRemarks: yellow pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 97872A31-3F28-5A8F-A3A5-8E17AA2CB489

c. country: Italy; stateProvince: South Tyrol; verbatimLocality: Kaltenbrunn; verbatimElevation: 928 m; decimalLatitude: 46.338600; decimalLongitude: 11.357090; samplingProtocol: pan trap; eventDate: 13/7/2022; habitat: hay meadow; individualCount: 1; sex: female; occurrenceRemarks: blue pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 81B63674-F5FE-5214-BAE1-083A88D8BC5D

d. country: Italy; stateProvince: South Tyrol; verbatimLocality: Siffian; verbatimElevation: 1055 m; decimalLatitude: 46.535360; decimalLongitude: 11.473600; samplingProtocol: pan trap; eventDate: 18/5/2022; habitat: crop field; individualCount: 1; sex: female; occurrenceRemarks: white pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: EA006B4C-3974-551F-AE14-60938417B51D

e. country: Italy; stateProvince: South Tyrol; verbatimLocality: Tisens; verbatimElevation: 903 m; decimalLatitude: 46.550230; decimalLongitude: 11.155200; samplingProtocol: pan trap; eventDate: 20/5/2022; habitat: crop field; individualCount: 1; sex: female; occurrenceRemarks: yellow pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 50C1C572-A98F-5610-89BF-FDA0A382679C

f. country: Italy; stateProvince: South Tyrol; verbatimLocality: Tisens; verbatimElevation: 903 m; decimalLatitude: 46.550230; decimalLongitude: 11.155200; samplingProtocol: pan trap; eventDate: 14/6/2022; habitat: crop field; individualCount: 1; sex: female; occurrenceRemarks: yellow pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 8C344DC6-7BE8-52C9-AEFB-9443988EC332

Notes: solitary behaviour, nests below-ground, polylectic.

Lasioglossum monstrificum (Morawitz, 1891)

Material

a. country: Italy; stateProvince: South Tyrol; verbatimLocality: Albeins; verbatimElevation: 546 m; decimalLatitude: 46.684385; decimalLongitude: 11.638950; samplingProtocol: pan trap; eventDate: 19/5/2021; habitat: apple orchard; individualCount: 3; sex: 3 females; occurrenceRemarks: white pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: FACD76BC-0926-5505-95D6-2E17E080A57E

Notes: primitively eusocial behaviour, nesting unknown, polylectic.

Nomada mutica Morawitz, 1872

Material

a. country: Italy; stateProvince: South Tyrol; verbatimLocality: Schlanders; verbatimElevation: 694 m; decimalLatitude: 46.618851; decimalLongitude: 10.781159; samplingProtocol: pan trap; eventDate: 19/5/2021; habitat: apple orchard; individualCount: 1; sex: male; occurrenceRemarks: white pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 1BABFE2E-5D65-536F-9107-06C137A0AE78

Notes: parasitic, *Andrena ferox* is the main host bee.

Nomada villosa Thomson, 1870

Material

a. country: Italy; stateProvince: South Tyrol; verbatimLocality: Unterinn; verbatimElevation: 901 m; decimalLatitude: 46.506610; decimalLongitude: 11.424850; samplingProtocol: pan trap; eventDate: 18/5/2022; habitat: orchard meadow; individualCount: 1; sex: female; occurrenceRemarks: yellow pan trap; recordedBy: S. Zanini; identifiedBy: T. Kopf; occurrenceID: 8B0E29C6-0735-5EDE-BBE1-0AA46A7F4F63

Notes: parasitic, *Andrena lathyri* is the main host bee.

Analysis

Overall, we collected 3,313 wild bee specimens across various habitats in South Tyrol, including apple orchards, vineyards, meadows, pastures and arable land (habitat description in Suppl. material 4). We reported 150 wild bee species from 21 genera, sex

differentiation and their abundance in the surveyed locations (Suppl. material 3). Additionally, our species list in Suppl. material 2 provides insights into sociality, nesting strategies, and dietary preferences sourced from relevant literature (Scheuchl and Willner 2016, Westrich 2019, Geppert et al. 2023). In the first study, we sampled 792 wild bees representing 55 species, while in the second study, we sampled 2,521 individuals encompassing 135 species. Amongst the sampled species, only 21 out of the 150 were parasitic. The most abundantly caught species in the first study were *Andrena minutula* (Perkins, 1914), *A. dorsata* (Kirby, 1902) and *A. nigroaenea* (Kirby, 1902). We identified 17 *Andrena* species within those caught, representing 31% of the assessed specimens. In terms of abundance, *Andrena* specimens accounted for 70% of the total catches. In the second study, the most abundant species caught were *Lasioglossum morio* (Fabricius, 1793), *Panurgus banksianus* (Kirby, 1802) and *Lasioglossum zonulum* (Smith, 1848). *Lasioglossum* specimens accounted for almost 50% of the total catch, with 24 species representing 18% of the total species richness. Blue pan traps yielded 748 wild bee specimens, white traps 546 and the yellow ones 1,227. On average, per site, we found 13 species in blue pan traps, 11 in white traps and 14 in yellow ones. According to the European Red List of Wild Bees (ERL), our compilation entails eight near-threatened (NT) species (second checklist) and 28 species labelled as data deficient (DD).

Discussion

Only nine of the 150 species identified are mentioned in the Italian Red List. They are labelled as data deficient (DD) or of least concern (LC): *Andrena hattorfiana*; *Andrena ovatula* (Kirby, 1802); *Andrena symphyti* Schmiedeknecht, 1883; *Dufourea dentiventris*; *Dufourea inermis*; *Lasioglossum brevicorne*; *Lasioglossum laevigatum*; *Nomada mutica* and *Nomada villosa*. However, according to the European Red List (ERL), these species are all considered near-threatened (NT), except for *A. sympthyti*, categorised as DD. For example, a recent European Commission report links *A. hattorfiana* decline in northern Europe to habitat loss from intensive agriculture (Michez et al. 2023). These nine species exhibit diverse behavioural, diet and habitat preference traits (second checklist), which highlights the importance of maintaining diverse and heterogeneous landscapes to support their ecological requirements and ensure the provision of critical pollination services across different ecosystems (Lázaro and Alomar 2019, Katumo et al. 2022, Zanini et al. 2024). Additionally, we found specimens of the *Andrena ovatula* [species group], which would also be considered NT by the ERL if the identification could be confirmed. However, this species is visually similar to *A. afzeliella* (Kirby, 1802) and *A. ovata* Schenk, 1853, which are common in Italy and are difficult to differentiate (Praz et al. 2022). Addressing taxonomic issues, including the classification of bees, is not the aim of this work; thus, we did not include it in the second checklist. Wild bee presence and diversity depend on seasonality, floral resources and nesting site availability, though sampling methods have inherent limitations (O'Connor et al. 2019, Hutchinson et al. 2021). While our two studies were not designed for comprehensive site monitoring, the absence of *Colletes* spp. and *Dasypoda* spp. in our pan-trap samples suggests that certain species may have been under-represented.

Taxonomy often varies significantly between regions and countries, as understanding and species classification depend heavily on local expertise, available references and regional biodiversity data. Therefore, this can result in gaps or inconsistencies in the identification and classification of species. Upon consultation of the most complete regional list of wild bees from Hellrigl (2006), we found seven species in our data-set that, in 2006, were considered "not present but anticipated to migrate to South Tyrol from neighbouring regions" (DD or LC in the ERL). Additionally, we found two species believed to be "already present but without substantiated data to confirm it" (DD or LC in the ERL). We also found 11 species absent from Hellrigl's assessment, labelled LC, NT or DD in the ERL. Here, we briefly list these species and discuss potential issues with misclassifications and historical identifications.

- Presence of *Hylaeus leptocephalus* (Morawitz, 1870), *Andrena ventralis* Imhoff, 1832 and *Andrena alfkenella* Perkins, 1914 in South Tyrol was considered highly probable. Indeed, before us, the first two species were found in 2003 and the third one in 2006/2007 (Kopf 2008).
- As previously discussed, several specimens that proved challenging to diagnose were provisionally assigned to *Andrena* cf. *barbareae* (DNA barcoding failed to confirm the correctness of the identification). *A. barbareae* is present in Switzerland (Amiet et al. 2010) and Comba (2019) mentions its presence in Trentino Alto-Adige. However, reliable data regarding the distribution over South Tyrol remain deficient.
- *Andrena carantonica* Pérez, 1902 is not included in the synopsis of Hellrigl, but it appears under the synonym *Andrena jacobi* Perkins, 1921. Recently, one female of this species was found by Timo Kopf during a survey in 2014 (unpublished data, "Die Blütenbesucher in den Gärten von Schloss Trauttmansdorff"; a report requested by the Castle Trauttmansdorff's gardens and the Laimburg Pfatten Agricultural and Forestry Research Center). For the species *Andrena gelriae* Van der Vecht, 1927, we could not find a prior record of this species in South Tyrol. Despite this, it is reportedly present in Italy, Austria, and Switzerland (Amiet et al. 2010, Gusenleitner et al. 2012, Comba 2019).
- *Andrena minutuloides* (Kirby, 1802) and *Nomada signata* Jurine 1807 were respectively considered "to be expected" and "not present" in Hellrigl's synopsis. However, both were found some years later by Timo Kopf (2008).
- *Andrena pandellei* Pérez, 1895 was expected to appear in South Tyrol according to Hellrigl (2006). Before us, it was collected by Timo Kopf in the gardens of the Castle Trauttmansdorff (Meran/Merano, unpublished reference mentioned above). Similarly, *A. symphyti* Schmiedeknecht, 1883 was found by T. Kopf in 2011 near Salurn/Salorno (unpublished data, report curated for the Office of Public Water Resources of the Autonomous Province of Bolzano/Bozen).
- According to *Hellrigl (2006)* also *Andrena saxonica* Stöckhert, 1935 and *A. simontornyella* Noskiewicz, 1939 were species expected to be present in South Tyrol since they were already present in Italy, Austria and Switzerland (Amiet et al. 2010, Gusenleitner et al. 2012, Comba 2019). Still, we found no references in literature regarding their presence in the region.

- According to Comba (2019), *Andrena taraxaci* Giraud, 1861 is present in Trentino Alto Adige and Wood et al. (2023) mention that this species is difficult to differentiate from *A. pastellensis* Schwenninger, 2007. Neither of these species' has been reported in South Tyrol, which suggests that they may have been overlooked or were not present.
- *Halictus langobardicus* Blüthgen, 1944 was absent from Hellrigl's list; however, one female individual was found in 2011 (although it represented a provisional identification since male material for comparison was missing) (Kopf et al. 2012). Similarly, *Hylaeus dilatatus* (Kirby, 1802) was confused and reported by Hellrigl as *Hylaeus annularis* (Kirby, 1802). The distinction between the two species was successively clarified by Notton and Dathe (2008). Comba (2019) reports the presence of *H. dilatatus* in Trentino Alto Adige.
- *Hylaeus styriacus* Förster, 1871 and *Lasioglossum rufitarse* (Zetterstedt, 1838) were recently captured in South Tyrol in 2009 (Wilhalm and Schatz 2010).
- According to Comba M., *Lasioglossum transitorium* (Schenck, 1868) is present in Trentino Alto Adige; however, we could not find any more detailed information on findings in South Tyrol. Additionally, *Nomada emarginata* Morawitz, 1877, was similarly found in literature to be present in Italy and Austria (Gusenleitner et al. 2012, Comba 2019), but reportedly not in South Tyrol.
- *Lasioglossum monstrificum* is an NT species according to the ERL; a synonym is *Lasioglossum sabulosum* (Warncke, 1986) and neither of these names appears in the synopsis from Hellrigl. It should be noted that Timo Kopf found two females in 2011 near Salurn/Salorno (unpublished data, report curated for the Office of Public Water Resources of the Autonomous Province of Bolzano/Bozen). The distribution of this species remains unclear due, in part, to past confusion with *Lasioglossum sexstrigatum* (Schenk, 1870) (Cornalba et al. 2024). In any case, *L. sexstrigatum* is also rated as "not present, but expected", which suggests that they may have been overlooked in the past, misidentified or were not present in South Tyrol.

Acknowledgements

We acknowledge the Autonomous Province of Bolzano/Bozen and Eurac Research for providing data from the Biodiversity Monitoring South Tyrol. Special thanks go to Elia Guariento, Chiara Paniccia and Andreas Hilpold for sharing study site information and species richness data. Many thanks to Thomas Marsoner, who prepared Fig. 1, the data used in Suppl. material 1 and for his support. Our gratitude goes to the landowners for field access. We thank Laura Barraclough for proofreading the manuscript. The authors thank Eurac Research Open Access Fund for covering the Open Access publication costs.

S.Z. was supported by the scholarship awarded by the University of Innsbruck, Vice-Rectorate for Research (Doktoratsstipendiums aus der Nachwuchsförderung). This work is part of S.Z.'s PhD at the University of Innsbruck.

Author contributions

Sebastiano Zanini conceived the study, collected data in the field, curated and analysed the data, finalised the tables and authored the manuscript drafts. Matteo Dainese contributed to the study design, supervised the data analysis and reviewed the drafts of the article. Timo Kopf identified wild bees at the species level. Matteo Anderle prepared Supplementary material 1 and reviewed drafts. Lisa Obwegs curated the data, conceived Supplementary material 2 and reviewed drafts. Georg Leitinger reviewed the drafts. Ulrike Tappeiner contributed to the study design and reviewed the drafts. All authors critically contributed to the drafts and gave their final approval for publication.

References

- Amiet F (1996) Apidae 1. Teil: allgemeiner Teil, Gattungsschlüssel, die Gattungen *Apis*, *Bombus* und *Psithyrus*. Société entomologique suisse, 188 pp. [In German and French].
- Amiet F, Müller A, Neumeyer R (1999) Apidae 2: *Colletes*, *Dufourea*, *Hylaeus*, *Nomia*, *Nomioides*, *Rhophitoides*, *Rophites*, *Sphecodes*, *Systropha*. 4. Fauna Helvetica, 219 pp. [In German and French].
- Amiet F, Herrmann M, Müller A, Neumeyer R (2001) Apidae 3: *Halictus*, *Lasioglossum*. 6. Fauna Helvetica, 208 pp. [In German and French].
- Amiet F, Herrmann M, Müller A, Neumeyer R (2004) Apidae 4: *Anthidium*, *Chelostoma*, *Coelioxys*, *Dioxys*, *Heriades*, *Lithurgus*, *Megachile*, *Osmia*, *Stelis*. 9. Fauna Helvetica, 273 pp. [In German and French].
- Amiet F, Herrmann M, Müller A, Neumeyer R (2007) Apidae 5: *Ammobates*, *Ammobatoides*, *Anthophora*, *Biastes*, *Ceratina*, *Dasypoda*, *Epeoloides*, *Epeolus*, *Eucera*, *Macropis*, *Melecta*, *Melitta*, *Nomada*, *Pasites*, *Tetralonia*, *Thyreus*, *Xylocopa*. 20. Fauna Helvetica, 356 pp. [In German and French].
- Amiet F, Herrmann M, Müller A, Neumeyer R (2010) Apidae 6: *Andrena*, *Melitturga*, *Panurginus*, *Panurgus*. 26. Fauna Helvetica, 316 pp. [In German and French].
- Anderle M, Paniccia C, Brambilla M, Hilpold A, Volani S, Tasser E, Seeber J, Tappeiner U (2022) The contribution of landscape features, climate and topography in shaping taxonomical and functional diversity of avian communities in a heterogeneous Alpine region. Oecologia 199 (3): 499-512. https://doi.org/10.1007/s00442-022-05134-7
- Bogusch P, Straka J (2012) Review and identification of the cuckoo bees of Central Europe (Hymenoptera: Halictidae: *Sphecodes*). Zootaxa 3311: 1-41. https://doi.org/10.11646/zootaxa.3311.1.1
- Comba M (2019) Catalogue of Italian bee species, Mario Comba. [last accessed 30/08/2024]. URL: https://digilander.libero.it/mario.comba/Introduction.htm#
- Cornalba M, Quaranta M, Selis M, Flaminio S, Gamba S, Mei M, Bonifacino M, Cappellari A, Catania R, Niolu P, Tempesti S, Biella P (2024) Exploring the hidden riches: Recent remarkable faunistic records and range extensions in the bee fauna of Italy (Hymenoptera, Apoidea, Anthophila). Biodiversity Data Journal 12 https://doi.org/10.3897/BDJ.12.e116014
- Ebmer A (1969) Die Bienen des Genus Halictus Latr. S. L. im Grossraum von Linz (Hymenoptera, Apidae) Teil I: Systematik, Biogeographie, Ökologie und Biologie mit

Berücksichtigung aller bisher aus Mitteleuropa bekannten Arten. Naturkundliches Jahrbuch der Stadt Linz133-183. [In German].

- Ebmer A (1971) Die Bienen des Genus Halictus Latr. S. L. im Grossraum von Linz (Hymenoptera, Apidae) Teil III: *Lasioglossum* (Evylaeus Rob.). Naturkundliches Jahrbuch der Stadt Linz63-156. [In German]. URL: https://digitalcommons.usu.edu/bee_lab_du/50
- Ebmer AW (1975) Neue westpaläarktische Halictidae (Halictinae, Apoidea), Teil III. Linzer Biologische Beiträge 7 (1): 41-118. [In German].
- Ebmer AW (1984) Die westpaläarktischen Arten der Gattung *Dufourea* Lepeletier 1841 mit illustrierten Bestimmungstabellen (Insecta: Hymenoptera: Apoidea: Halictidae: Dufoureinae). Senckenbergiana Biologica 64 (4): 15-42. [In German].
- FAO (2018) Transforming food and agriculture to achieve the SDGs: 20 interconnected actions to guide decision-makers. Food and Agriculture Organization of the United Nations, Rome, Italy, 71 pp. URL: http://www.fao.org/3/I9900EN/i9900en.pdf
- Geppert C, Cappellari A, Corcos D, Caruso V, Cerretti P, Mei M, Marini L (2023) Temperature and not landscape composition shapes wild bee communities in an urban environment. Insect Conservation and Diversity 16 (1): 65-76. https://doi.org/10.1111/icad.12602
- Granata E, Pedrini P, Marchesi L, Fedrigotti C, Biella P, Ronchi S, Brambilla M (2023) Environmental and management factors drive biological communities and ecosystem services in agroecosystems along an urban-natural gradient. Agriculture, Ecosystems & Environment 357 https://doi.org/10.1016/j.agee.2023.108693
- Gusenleitner F, Schwarz M, Mazzucco K (2012) Apidae (Insecta: Hymenoptera). Biosystematics and ecology series 29: 9-129.
- Hallmann C, Sorg M, Jongejans E, Siepel H, Hofland N, Schwan H, Stenmans W, Müller A, Sumser H, Hörren T, Goulson D, Kroon Hd (2017) More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLOS One 12 (10). https://doi.org/10.1371/journal.pone.0185809
- Hellrigl K (2006) Synopsis der Wildbienen Südtirols: (Hymenoptera: Apidae). Forest observer 2 (3): 421-472. [In German].
- Hilpold A, Anderle M, Guariento E, Marsoner T, Mina M, Paniccia C, Plunger J, Rigo F, Rüdisser J, Scotti A, Seeber J, Steinwandter M, Stifter S, Strobl J, Suárez-Muñoz M, Vanek M, Bottarin R, Tappeiner U (2023) Handbook Biodiversity Monitoring South Tyrol. Eurac Research, Bozen/Bolzano, Italy. https://doi.org/10.57749/2qm9-fq40
- Hutchinson L, Oliver T, Breeze T, O'Connor R, Potts S, Roberts SM, Garratt MD (2021) Inventorying and monitoring crop pollinating bees: Evaluating the effectiveness of common sampling methods. Insect Conservation and Diversity https://doi.org/10.1111/icad.12557
- Katumo DM, Liang H, Ochola AC, Lv M, Wang Q, Yang C (2022) Pollinator diversity benefits natural and agricultural ecosystems, environmental health, and human welfare. Plant Diversity 44 (5): 429-435. https://doi.org/10.1016/j.pld.2022.01.005
- Klein A, Vaissière BE, Cane JH, Steffan-Dewenter I, Cunningham SA, Kremen C, Tscharntke T (2006) Importance of pollinators in changing landscapes for world crops. Proceedings of the Royal Society B: Biological Sciences 274 (1608): 303-313. https://doi.org/10.1098/rspb.2006.3721
- Kluser S, Neumann P, Chauzat M, Pettis J, Peduzzi P, Witt R, Fernandez N, Theuri M (2010) Global honey bee colony disorders and other threats to insect pollinators. UNEP Emerging Issues1-16.

- Kopf T (2008) Die Bienenfauna (Hymenoptera: Apidae) des Schlerngebietes (Südtirol, Italien) mit Angaben zu den Artengemeinschaften ausgewählter Lebensräume. Gredleriana 8: 429-466.
- Kopf T, Schatz H, Ruedi H, Wilhalm T (2012) Bienen und Wespen (Hymenoptera: Symphyta und Apocrita partim – Trigonalidae, Apidae, Sphecidae, Crabronidae, Tiphiidae, Mutillidae,Vespidae). In Schatz H., Haller R. & Wilhalm T.: Tag der Artenvielfalt 2011 im Münstertal in den Gemeinden Taufers (I) und Müstair (CH). Gredleriana 12: 347-354.
- Körner C (2002) Mountain Biodiversity, its Causes and Function: an Overview. In: Körner C, Spehn EM (Eds) Mountain Biodiversity: a global assessment. 1. Routledge, London, 350 pp. https://doi.org/10.4324/9780429342585
- Körner C (2003) Alpine Plant Life. 2. Springer Berlin, Heidelberg, 134 pp. https://doi.org/10.1007/978-3-642-18970-8
- Lautenbach S, Seppelt R, Liebscher J, Dormann C (2012) Spatial and temporal trends of global pollination benefit. PLOS One 7 (4). https://doi.org/10.1371/journal.pone.0035954
- Lázaro A, Alomar D (2019) Landscape heterogeneity increases the spatial stability of pollination services to almond trees through the stability of pollinator visits. Agriculture, Ecosystems & Environment 279: 149-155. https://doi.org/10.1016/j.agee.2019.02.009
- Le Divelec R (2022) A taxonomic account on the Hylaeus gibbus species-group (Hymenoptera: Apoidea: Colletidae). Annales de la Société entomologique de France (N.S.) 58 (3): 229-249. https://doi.org/10.1080/00379271.2022.2085627
- Mauss V (1994) Bestimmungsschlüssel für die Hummeln der Bundesrepublik Deutschland. Deutscher Jugendbundf fuer Naturbeobachtung, Hamburg. [In German].
- Michez D, Radchenko V, Macadam C, Wilkins V, Raser J, Hochkirch A (2023) Teasel-plant specialised bees in Europe – Conservation Action Plan 2023-2030. EU Commission: Publications Office of the European Union https://doi.org/10.2779/191765
- Nieto A, Roberts S, Kemp J, Rasmont P, Kuhlmann M, García Criado M, Biesmeijer J, Bogusch P, Dathe H, Rúa P, De Meulemeester T, Dehon M, Alexandre D, Ortiz-Sanchez F, Lhomme P, Pauly A, Potts S, Praz C, Quaranta M, Michez D (2014) European Red List of Bees. IUCN: International Union for Conservation of Nature
- Notton DG, Dathe HH (2008) William Kirby's types of Hylaeus Fabricius (Hymenoptera, Colletidae) in the collection of the Natural History Museum, London. Journal of Natural History 42 (27-28): 1861-1865.
- O'Connor R, Kunin W, Garratt MD, Potts S, Roy H, Andrews C, Jones C, Peyton J, Savage J, Harvey M, Morris RA, Roberts SM, Wright I, Vanbergen A, Carvell C (2019) Monitoring insect pollinators and flower visitation: The effectiveness and feasibility of different survey methods. Methods in Ecology and Evolution 10 (12): 2129-2140. https://doi.org/10.1111/2041-210x.13292
- Ollerton J, Winfree R, Tarrant S (2011) How many flowering plants are pollinated by animals? Oikos 120 (3): 321-326. https://doi.org/10.1111/j.1600-0706.2010.18644.x
- Potts SG, Imperatriz-Fonseca V, Ngo HT, Biesmeijer JC, Breeze TD, Dicks LV, Garibaldi LA, Hill R, Settele J, Vanbergen AJ (2016) The assessment report on pollinators, pollination and food production: summary for policymakers. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, IPBES https://doi.org/10.5281/ZENODO.3402857
- Powney G, Carvell C, Edwards M, Morris RA, Roy H, Woodcock B, Isaac NB (2019) Widespread losses of pollinating insects in Britain. Nature Communications 10 (1). https://doi.org/10.1038/s41467-019-08974-9

- Praz C, Genoud D, Vaucher K, Bénon D, Monks J, Wood T (2022) Unexpected levels of cryptic diversity in European bees of the genus Andrena subgenus Taeniandrena (Hymenoptera, Andrenidae): implications for conservation. Journal of Hymenoptera Research 91: 375-428. https://doi.org/10.3897/jhr.91.82761
- Quaranta M, Medrzycki P, Porrini C, Romagnoli F, Celli G, Maini S, Longo S, Mazzeo G, Ricciarelli Darbore G, Palmieri N (2002) Il censimento dei pronubi selvatici In Italia, con particolare riferimento agli Imenotteri Apoidei. In: Istituto Nazionale di Apicoltura. (Ed.) Atti del convegno finale" Il ruolo della ricerca in apicoltura". Bologna, (pp. 333-344) pp. [In Italian].
- Quaranta M, Ambroselli S, Barro P, Bella S, Carini A, Celli G, Comba L C, Comoli R, Felicioli A, Floris I, Intoppa F, Longo S, Maini S, Manino A, Mazzeo G, Medrzycki P, Nardi E, Niccolini L, Palmieri N, Patetta A, Piatti C, Piazza MG, Pinzauti M, Porporato M, Porrini C, Ricciardelli Dalbore G, Romagnoli F, Ruiu L, Satta A, Zandigiacomo P (2004) Wild bees in agroecosystems and semi-natural landscapes. 1997-2000 collection period in Italy. Bulletin of Insectology 57: 11-61. URL: https://iris.unito.it/handle/2318/22778?mode=complete
- Quaranta M, Cornalba M, Biella P, Comba M, Battistoni A, Rondinini C, Teofili C (2018) Lista Rossa IUCN delle api italiane minacciate. [Red list IUCN of the Italian threatened bees]. Comitato Italiano IUCN e Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Roma, 66 pp. [In Italian]. URL: https://www.iucn.it/pdf/Comitato_IUCN_Lista_Rossa_delle_Api_italiane_minacciate.pdf
- Reverté S, Miličić M, Ačanski J, Andrić A, Aracil A, Aubert M, Balzan MV, Bartomeus I, Bogusch P, Bosch J, Budrys E, Cantú-Salazar L, et al. (2023) National records of 3000 European bee and hoverfly species: a contribution to pollinator conservation. Insect Conservation and Diversity 16 (6): 758-775. https://doi.org/10.1111/icad.12680
- Scheuchl E (1995) Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Österreichs. Bd 1, Schlüssel der Gattungen und der Arten der Familie Anthophoridae. Published by the author, 158 pp. [In German].
- Scheuchl E (2006) Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Osterreichs, Bd 2, Megachilidae - Melittidae. Published by the author, 192 pp. [In German].
- Scheuchl E, Willner W (2016) Taschenlexikon der Wildbienen Mitteleuropas: Alle Arten im Porträt. Quelle & Meyer Verlag [In German].
- Ulyshen M, Horn S (2023) Declines of bees and butterflies over 15 years in a forested landscape. Current Biology 33 (7). https://doi.org/10.1016/j.cub.2023.02.030
- Villalta I, Ledet R, Baude M, Genoud D, Bouget C, Cornillon M, Moreau S, Courtial B, Lopez-Vaamonde C (2021) A DNA barcode-based survey of wild urban bees in the Loire Valley, France. Scientific Reports 11 (1). https://doi.org/10.1038/s41598-021-83631-0
- Wasof S, Lenoir J, Gallet-Moron E, Jamoneau A, Brunet J, Cousins SO, De Frenne P, Diekmann M, Hermy M, Kolb A, Liira J, Verheyen K, Wulf M, Decocq G (2013) Ecological niche shifts of understorey plants along a latitudinal gradient of temperate forests in north-western Europe. Global Ecology and Biogeography 22 (10): 1130-1140. https://doi.org/10.1111/geb.12073
- Westrich P (2019) Die Wildbienen Deutschlands-2., aktualisierte Auflage. Verlag Eugen Ulmer, Stuttgart, 824 pp. [In German].
- Wilhalm T, Schatz H (2010) GEO-Tag der Artenvielfalt 2009 im Tauferer Tal nördlich von Bruneck (Pustertal, Gemeide Bruneck, Südtirol, Italien). Gredleriana 10: 327-390.

- Wood TJ, Praz C, Selis M, Flaminio S, Mei M, Cornalba M, Rosa P, Le Divelec R, Michez D (2023) Revisions to the Andrena fauna of Italy, with the description of a new species (Hymenoptera: Andrenidae). Fragmenta entomologica 55 (2).
- Zanini S, Dainese M, Kopf T, Leitinger G, Tappeiner U (2024) Maintaining habitat diversity at small scales benefits wild bees and pollination services in mountain apple orchards. Ecological Solutions and Evidence 5 (2). https://doi.org/10.1002/2688-8319.12320

Supplementary materials

Suppl. material 1: Site information doi

Authors: Sebastiano Zanini, Matteo Dainese, Timo Kopf, Lisa Obwegs, Matteo Anderle, Georg Leitinger, Ulrike Tappeiner
Data type: ecological
Brief description: Table containing site coordinates, elevation, slope, aspect, seasonal mean temperatures and precipitations.
Download file (26.67 kb)

Suppl. material 2: Identified species doi

Authors: Sebastiano Zanini, Matteo Dainese, Timo Kopf, Lisa Obwegs, Matteo Anderle, Georg Leitinger, Ulrike Tappeiner
Data type: Species list
Brief description: This table lists the species of wild bees caught in the two sampling years and provides information on sociality, nesting strategy, diet and threat status.
Download file (36.23 kb)

Suppl. material 3: Pan trap data: wild bees doi

Authors: Sebastiano Zanini, Matteo Dainese, Timo Kopf, Lisa Obwegs, Matteo Anderle, Georg Leitinger, Ulrike Tappeiner
Data type: abundance
Brief description: This table includes pan trap catches with abundance data on the collected wild bees. We have detailed the sampling date, number of sessions (replicates), pan trap identification number (or group), pan trap colour, specimen sex and the habitat type where the traps were placed.
Download file (492.73 kb)

Suppl. material 4: Sampling methods and habitats description doi

Authors: Sebastiano Zanini, Matteo Dainese, Timo Kopf, Lisa Obwegs, Matteo Anderle, Georg Leitinger, Ulrike Tappeiner
Data type: Information on sampling methods and habitats description
Download file (15.67 MB)