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Großer Eichenbock (*Cerambyx cerdo*), Castelfeder (Foto Audrey Marsy)

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Inhaltsverzeichnis / Indice

Dallinger R. & Kirchmair M.: *Gastrosporium simplex.* Ein pannonischer Steppenpilz aus dem Nordtiroler Karwendel-Gebirge 5

Schaub F., Zeni T. & Schönswetter P.: Morphological and elevational differentiation between diploid and tetraploid cytotypes of the *Lotus corniculatus* aggregate (Fabaceae) along three elevational transects in the Vinschgau/Val Venosta valley 13

Iberl K., Kirschner P., Koç A., Hasáková T., Wellstein C. & Štenc J.: Camera-based monitoring of floral visitors on vertical rock faces: A pilot study in the Eastern Alpine endemic *Physoplexis comosa* (Campanulaceae) 25

Wilhalm T. & Spögler E. (eds.): Notulae Florae austrotiroliensis (3) 33

Repetto E., Soldovieri N., Rocca F., Hilpold A. & Guariento E.: New species for the orthopteran fauna of South Tyrol (Prov. Bolzano, Italy): *Poecilimon ornatus* (Schmidt, 1850) and new observation of *Bicolorana bicolor* (Philippi, 1830) (Insecta, Orthoptera) 59

Repetto E., Battiston R., Tormen N., Guariento E. & Hilpold A.: Proceedings of the First Italian Congress of Orthopterology 67

Hilpold A., Rabitsch W., Friess T., Marsy A. & Guariento E.: New species for the true bug fauna of South Tyrol (Prov. Bolzano, Italy): *Aelia klugii*, *Alydus rupestris*, *Corythucha arcuata*, *Deraeocoris flavilinea*, *Holcogaster fibulata* and *Nagusta goedelii* (Insecta, Heteroptera) 93

Marsy A. A. N., Guariento E., Ligazzolo G., Dallmöller S. S., Repetto E., von Mörl G. & Hilpold A.: Monitoring of three protected saproxylic beetles (*Cerambyx cerdo, Osmoderma eremita, Rosalia alpina*) in South Tyrol: Population status and habitat management 101

Requena E., Ceresa F., Franzoi A., Maistri R., Scanferla J. & Anderle M.: New breeding evidence of Zitting Cisticola *Cisticola juncidis* in South Tyrol after 1970/1980s 121

Richtlinien für Autorinnen und Autoren 129

Linee guida per gli autori 133

Guidelines for authors 137

Veröffentlichungen des Naturmuseums Südtirol 141

Reinhard Dallinger[1] und Martin Kirchmair[2]

Gastrosporium simplex: Ein pannonischer Steppenpilz aus dem Nordtiroler Karwendel-Gebirge

Abstract

Gastrosporium simplex ('steppe truffle') is a rare, hypogeous to epigeous, endangered gastroid fungus belonging to the Gastrosporiaceae (Phallales, Agaricomycetes, Basidiomycota) family. Previously found in the Pannonian region of Austria, it has now been discovered in the Fragenstein nature reserve near Zirl on the south-western edge of the Karwendel mountains, marking its first recorded occurrence in North Tyrol. The fungus's occurrence is limited to a small area of dry, south-facing limestone grassland, which is part of a xerothermic habitat in succession from former sheep and goat grazing land. The most important characteristics of the fungus (fruit body, rhizomorphs, basidia and spores), as determined by macro- and microscopic examination, correspond to species descriptions of *G. simplex* from other regions in Eurasia, as well as from the American continent. Molecular rDNA data confirm its affiliation with this species, and a phylogenetic tree calculation including related species shows that *G. simplex*, together with *G. gossypinum*, forms a monophyletic family within the order Phallales (Agaricomycetes). Although *G. simplex* is found worldwide, it is globally considered a near threatened species which is endangered with extinction in some European countries (https://www.iucnredlist.org/species/63579691/63579694#population). This is due to the fact that the fungus usually forms only small populations within fragmented, xerothermic dry grassland habitats, which are declining and particularly susceptible to human impact.

Keywords: Step truffle; morphology; rDNA phylogeny; xerothermic dry habitats; endangered species.

1. Einleitung

Gastrosporium simplex Mattir. („Steppentrüffel") ist ein seltener, vom Aussterben bedrohter, zu den Phallales (Agaricomycetes) gehörender gastroider Pilz mit einer bislang in Österreich vorwiegend pannonischen Verbreitung, der jetzt überraschenderweise im Naturschutzgebiet Fragenstein am südwestlichen Rand des Karwendelgebirges entdeckt und damit für Nordtirol erstmals nachgewiesen wurde. Die Entdeckung dieses seltenen Pilzes im Naturschutzgebiet Fragenstein, das zum Europa-Naturpark Karwendel gehört, unterstreicht die hohe ökologische Wertigkeit dieses inner-alpinen, xerothermen Trocken-Standortes als Hotspot der Artenvielfalt und als Habitat für seltene, wärmeliebende Pilz-, Pflanzen- und Tierarten (Landmann 2013). Es wäre daher wünschenswert, dass die Marktgemeinde Zirl und das Land Tirol jene Schutzmaßnahmen zur Erhaltung der offenen Trockenrasen-Flächen umsetzen würden, die sie sich selber auferlegt haben (Tiroler Landesregierung 1988; Marktgemeinde Zirl 2018), und die in einer umfangreichen Bestandsaufnahme durch Dobner (2008) schon vor Jahren empfohlen wurden.

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2. Untersuchungsgebiet und Standortbeschreibung

Das ca. 8 ha große Naturschutzgebiet Fragenstein liegt im Norden der Marktgemeinde Zirl und grenzt im Süden an die nach Seefeld führende Bundesstraße B171. Die geschützten Flächen des Naturschutzgebietes erstrecken sich rund um die gleichnamige Burgruine entlang der südlichen, zum Inntal hin bis an den Rand des Ortsgebietes abfallenden Hänge. Das Naturschutzgebiet ist Teil des sich über 727 km^2 erstreckenden Alpenparks Karwendel (gleichzeitig Natura 2000-Gebiet) (Sitecode AT3309000). Das Areal ist seit 1989 als Naturschutzgebiet ausgewiesen (Tiroler Landesregierung 1988) und gehört seit 2018 zur UN-Liste geschützter Gebiete (UN List of Protected Areas) (Landmann 2015). Es beherbergt kleinräumige Trocken-Standorte mit ungedüngten Rasengesellschaften und einer wärmeliebenden Flora und Fauna. Es handelt sich dabei um die Überreste einer alten Kulturlandschaft, die seit dem Mittelalter unter menschlichem Einfluss durch Entwaldung und Beweidung entstanden ist. Das Tiroler Oberland beherbergt mehrere solcher inneralpiner Trockenrasen und Magerwiesen. Sie gehören zu den am stärksten bedrohten Lebensräumen Mitteleuropas und genießen daher einen hohen Schutz-Status und internationale Bedeutung (Holzner 1986) (Abb. 1).

Der neu entdeckte Standort von *Gastrosporium simplex* erstreckt sich über mehrere Quadratmeter und liegt an einem Weg nahe dem westlichen Rand des Naturschutzgebietes Fragenstein. Er kann von einem Parkplatz an der B177 aus nach etwa 100 m in Richtung der oberen Burgruine Fragenstein erreicht werden (Abb. 1, roter Punkt). Es handelt sich dabei um einen südseitig exponierten, steil zu einem Fußweg abfallenden Kalkmagerrasen, der nach Norden, Osten und Westen hin an einen montanen, trockenen Mischwald-Bestand grenzt (Abb. 2A).

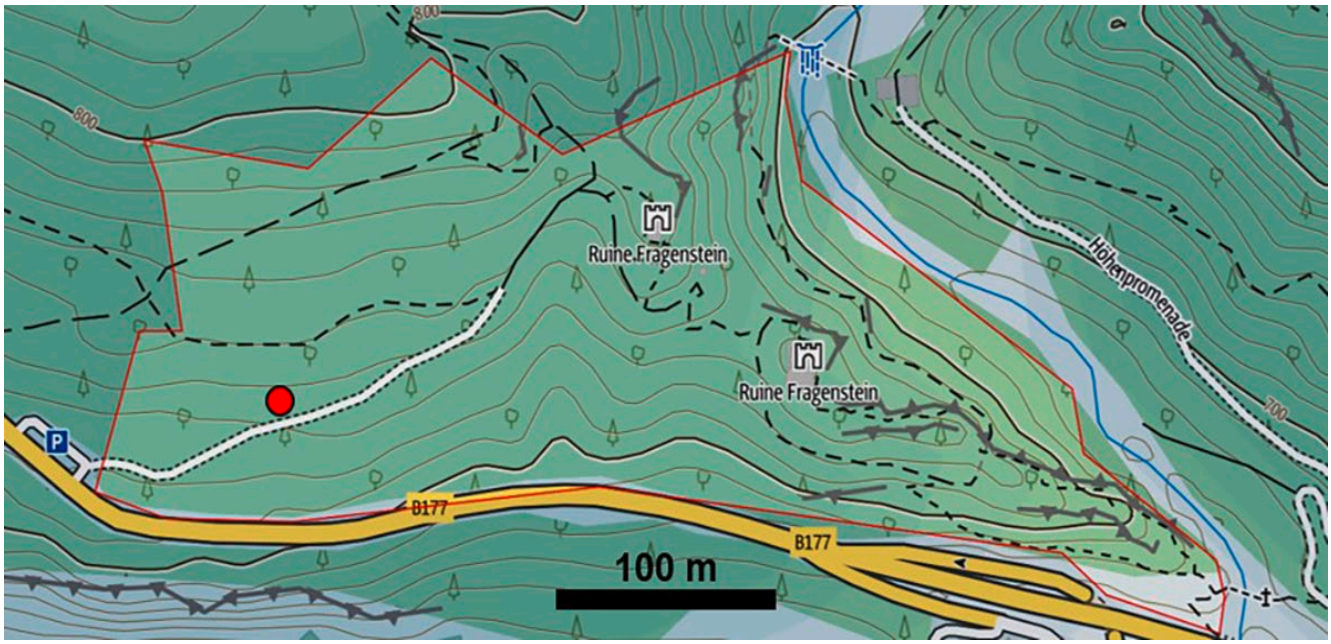


Abb. 1: Karte des Naturschutzgebietes Fragenstein (rot umrandet) mit dem neu entdeckten Standort von *Gastrosporium simplex* (roter Punkt) am Weg vom Parkplatz (P) an der Seefelder Straße (B177) zur Ruine Fragenstein.
Figure 1: Map of the Fragenstein nature reserve (outlined in red) showing the newly discovered location of *Gastrosporium simplex* (red dot) on the path from the car park (P) on Seefelder Straße (B177) to the Fragenstein ruins.

3. Material und Methoden

3.1 Begehung und Probensammlung

Der Standort von *Gastrosporium simplex* wurde über mehrere Jahre (2020–2024) und zu allen Jahreszeiten besucht und dokumentiert. Pilzproben wurden von R. D. insgesamt drei Mal entnommen (8. Mai 2020, 2. Mai 2021, 2. Mai 2022) und an das Institut für Mikrobiologie verbracht. Zusätzlich wurden Grasproben von den Horsten der Grasarten, mit denen der Pilz durch seine Hyphengeflechte vergesellschaftet war, entnommen und bestimmt.

3.2 Systematische Bestimmung

Makroskopische Merkmale: Eine erste Bestandsaufnahme des Pilzes erfolgte am Standort im Gelände. Für die Dokumentation des Standortes und die makroskopische Beschreibung des Pilzes wurde eine Kleinbildkamera (Panasonic Lumix TZ71) verwendet. Ein Bildarchiv zum Standort und der Morphologie des Pilzes liegt bei R. D. und am Institut für Mikrobiologie der Universität Innsbruck auf, wo von M. K. auch genauere makroskopische Merkmals-Erhebungen durchgeführt wurden.

Mikroskopie: Für die Aufnahme licht-mikroskopischer Details wurden Präparate von Pilzproben in 3 % KOH fixiert und mit Hilfe eines Nikon Optiphot-Mikroskops (20×, 40×, 100×Öl, DIC) untersucht und fotografiert.

Erhebung molekularer Daten und Stammbaumberechnung: Für die molekulare Artbestimmung erfolgte die Sequenzierung der ITS1-5.8S-ITS2-rDNA (Microsynth AG, Balgach, Schweiz) (Primerpaar: ITS1/ITS4; siehe White et al. 1990). Die Berechnung eines phylogenetischen Stammbaumes (Maximum Likelyhood, Kimura 2-parameter model + G) erfolgte mithilfe des Software-Pakets MEGA 11 (Tamura et al. 2021). Für die Analyse wurde Pilz-Material der Arten *Gastrosporium simplex* und *Phallogaster saccatus* aus der Referenzsammlung des Instituts für Mikrobiologie der Universität Innsbruck verwendet (*Gastrosporium simplex* Mattir.: Fragenstein, Zirl, Tirol, leg. R. Dallinger (2. Mai 2021), det.: M. Kirchmair (3. Mai 2022); Mykologische Sammlung Innsbruck IB20200005; GenBank: PX232414; ITS1-5.8S.ITS rDNA; sowie *Phallogaster saccatus* Morgan: Bruck, Tirol, leg. M. Kirchmair (11. Juni 2025), det.: M. Kirchmair; Mykologische Sammlung Innsbruck IB20220580; GenBank: PX232413; ITS1-5.8S.ITS rDNA). Zusätzliche analoge Sequenzen von *Gastrosporium simplex* und verwandter Arten zur Berechnung der Phylogenie wurden aus GenBank bezogen.

4. Ergebnisse

4.1 *Gastrosporium simplex*: Artbestimmung

Makroskopische Merkmale: Der Pilz bildet dünn-ledrig weiße bis hell ockerfarben fleckige, 1–4 cm große, unregelmäßig kugelig-knollige, epigäische bis semihypogäische Gastrokarpe ohne Stiel, jedoch mit einem an der Basis ansetzendem, 1–3 cm langem, weißem, dünnem, schnurartigem Rhizomorph („Basalstrang“) (Abb. 2 B–D); Peridie doppelt; Exoperidie trocken, aus dicht mit

Kristallen inkrustierten Hyphen bestehend (Abbildung 2E), Endoperidie gelatinös; Gleba schwammartig bis zellig-löchrig, hellbraun ocker- bis sandfarben, im reifen Pilz mit aufgeplatzter Peridie von pulveriger Konsistenz (Abb. 2C, 2D); lange, weiße, teils kräftige Rhizomorphe, die die Wurzeln und Halme der Wirtsgräser umhüllen.

Mikroskopischer Befund: Basidien vier- bis achtsporig, mit Basalschnalle (Abb. 2F); reife Sporen breit elliptisch bis rund, 3,5–6,0 x 3,5–5,0 µm im Durchmesser, deutlich warzig (Abb. 2F, 2G); Hyphen des Paracapillitium regelmäßig septiert, stellenweise mit Schnallen (Abb. 2G), Hyphen der Exoperidie und der Rinde der Rhizomorphe septiert und mit Schnallen, deutlich mit Kristallen inkrustiert (Abb. 2E).

Molekulare Phylogenie: *Gastrosporium simplex* bildet zusammen mit *G. gossypinum* eine monophyletische Familie innerhalb der Ordnung Phallales (Abb. 3).



Abb. 2: Standort und Merkmale von *Gatrosporium simplex* aus dem Naturschutzgebiet Fragenstein. **A**, Standort von *G. simplex* in einer Steilwiese oberhalb des Weges zur Burgruine Fragenstein. **B**, Fruchtkörper von *G. simplex in situ*. Balken = 1 cm. **C**, Fruchtkörper, zum Teil durchgeschnitten, deutlich sichtbar die Basalstränge. Balken = 1 cm. **D**, aufgeschnittene und aufgeplatzte Fruchtkörper mit deutlich sichtbarer zweischichtiger Peridie (Exoperidie durch Kristalle an den Hyphen kreideartig, Endoperidie gelatinös). Balken = 1 cm. **E**, Hyphen der Exoperidie mit Kristallinkrustationen. Balken = 10 µm. **F**, Basidien mit Basidiosporen, vereinzelt mit reifen Sporen. Balken = 10 µm. **G**, Septierte Hyphen des Paracapillitium, darunter reife Sporen mit warziger Oberfläche. Balken = 10 µm.

Figure 2: Location and characteristics of *Gatrosporium simplex* from the Fragenstein nature reserve. **A**, Location of *G. simplex* in a steep meadow above the path to the Fragenstein castle ruins. **B**, Fruit bodies of *G. simplex in situ*. Bar = 1 cm. **C**, Fruit bodies, partially cut through, basal strands clearly visible. Bar = 1 cm. **D**, Cut and burst fruit bodies with clearly visible two-layered peridium (exoperidium chalky due to crystals on the hyphae, endoperidium gelatinous). Bar = 1 cm. **E**, Hyphae of the exoperidium with crystal encrustations. Bar = 10 µm. **F**, Basidia with basidiospores, occasionally with mature spores. Bar = 10 µm. **G**, Septate hyphae of the paracapillitium, underneath mature spores with a warty surface. Bar = 10 µm.

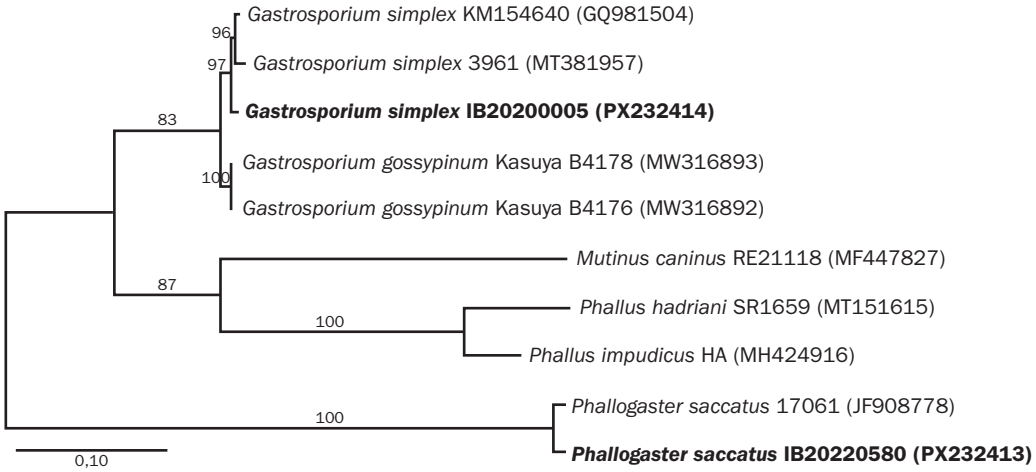


Abb. 3: Maximum-Likelyhood-Stammbaum (Kimura 2-Parameter Modell + G) der Gastrosporiaceae und Phallaceae mit *Phallogaster saccatus* (Phallogastraceae) als Outgroup. Bootstrap-Werte über den Zweigen (500 Replikate). Stammnummern und GenBank Accession Numbers (in Klammer) an den Zweig-Enden. Sequenzen aus Pilzproben, die im Rahmen dieser Arbeit generiert wurden, sind fett gedruckt.
Figure 3: Maximum likelihood phylogenetic tree (Kimura 2-parameter model + G) of Gastrosporiaceae and Phallaceae with *Phallogaster saccatus* (Phallogastraceae) as outgroup. Bootstrap values are shown above the branches (500 replicates). Stem numbers and GenBank accession numbers (in brackets) are given at the branch ends. Sequences from fungal samples generated as part of this work are printed in bold.

4.2 Habitat und Ökologie am Standort Fragenstein

Am bislang einzigen Fundort innerhalb des Naturschutzgebietes Fragenstein (Abb. 1 und 2A) kann *Gastrosporium simplex* auf vereinzelt freien Bodenflecken entdeckt werden, oder wenn die Grasbüschel der dort gedeihenden Gräser beiseite gebogen werden, sodass der darunter liegende Boden freigelegt wird. Der auf dolomitischem Untergrund aufsetzende Boden zeigt am Standort eine sandig-grusige Struktur, die mit organischer Substanz aus zerfallenden Wurzelresten und Grashalmen vermengt ist und einen Kalkmagerrasen bildet.

Die Fruchtkörper von *Gastrosporium simplex* entwickeln sich im Sommer und Winter zunächst unterirdisch und brechen im Frühjahr ausgereift durch die oberste Bodenschicht hervor. Der Pilz lebt weitgehend versteckt saprophytisch an Wurzeln und Horsten von Gräsern und umhüllt mit seinem weißen Myzel Graswurzeln oder abgestorbene Grashalme. Am Fundort in Fragenstein konnte eine Assoziation des Pilzes (durch überwuchernde Myzelbildung) mit *Carex humilis* (Cyperaceae, Sauergrasgewächse) und mit *Festuca rupicola* (Poaceae, Süßgräser) beobachtet werden. Assoziationen mit anderen Grasarten können jedoch nicht ausgeschlossen werden, wie Bestandaufnahmen von Habitaten dieser Pilzart in Polen nahelegen (Tomaszewska et al. 2012).

5. Diskussion

5.1 *Gastrosporium simplex*: Systematische Zuordnung

Die Erstbeschreibung von *Gastrosporium simplex* geht auf den italienischen Mykologen Oreste Mattirolo zurück, der in einer seiner Publikationen systematisch unterschiedliche hypogäische Pilze aus Aufsammlungen seiner Kollegen an diversen Fundorten in Italien beschrieb (Mattirolo 1903). Die Art wurde inzwischen auch aus anderen europäischen Ländern (Stasińska 2005, 2008; Senn-Irlet 2012), aus Nord- und Südamerika (Miller & Askew 1981; Dominguez de Toledo & Castellano 1997), sowie aus Asien (Dörfelt 2005; Gorbunova 2017) beschrieben.

In der Literatur werden die weißen, 2–3 cm großen, knollig-rundlichen, bovist-artigen Fruchtkörper mit ihrem in der Regel zähen, weißen Basalstrang als distinktiv für *Gastrosporium simplex* angeführt (Senn-Irlet 2012; Tomaszewska et al. 2012). Bei mikroskopischer Betrachtung gelten zudem die warzige Oberflächenstruktur der Sporen,

kristalline Ablagerungen an den Hyphen der Exoperidie, sowie die septierten, mit Schnallen versehenen Hyphen des Paracapillitium als typische Merkmale für *G. simplex* (Miller & Askew 1992).

Auch die in der vorliegenden Untersuchung erhobenen molekularen Daten bestätigen die Identität von *Gastrosporium simplex* (Abb. 3).

Seit der Publikation von Mattirolo (1903) sind innerhalb der Gattung *Gastrosporium* noch zwei weitere Arten dazugekommen, sodass man inzwischen innerhalb der Familie der Gastrosporiaceae drei Arten unterscheidet: *G. simplex* (Mattirolo 1903), *G. asiaticum* aus der Altai-Region (Dörfelt & Bumžaa 1986) und *G. gossypinum* aus Japan (Kasuya et al. 2020). Somit lässt sich die systematische Zuordnung von *G. simplex* nach neuesten molekularen Daten wie folgt zusammenfassen: Der Pilz gehört zur Familie der Gastrosporiaceae, die ihrerseits zur Ordnung der Phallales innerhalb der Klasse der Agaricomycetes gehört (Melanda et al. 2021).

5.2 Vorkommen, Verbreitung und Gefährdung

Das Vorkommen von *Gastrosporium simplex* am Südrand des Karwendelgebirges ist nicht nur der Erst-Nachweis für diese Pilzart in Tirol, sondern zugleich eine überraschende Entdeckung, liegen doch die bisher spärlichen bekannten Vorkommen Österreichs fast ausnahmslos auf Trockenrasen des pannonischen Raums von Niederösterreich bis in die südliche Steiermark (Österreichische Mykologische Gesellschaft 2021–laufend). Tatsächlich wird *G. simplex* im deutschen Sprachraum gemeinhin auch als „Steppentrüffel" bezeichnet (Rauschert 1956; Senn-Irlet 2012) und wurde als seltene Pilzart der pannonischen Steppen Ungarns identifiziert (Rimóczi et al. 2011). Auch die Tatsache, dass diese Pilzart erstmals aus xerothermen Biotopen Italiens beschrieben wurde (Mattirolo 1903), spricht für die Annahme, dass es sich bei *G. simplex* um einen wärmeliebenden Steppenpilz handelt, der zumeist an warmen, sonnigen Standorten mit Temperaturen von oftmals über 39 °C gedeiht (Stasińska 2005), wenngleich Pilzfunde aus einer nordexponierten Hanglage in Polen dieser Regel zu widersprechen scheinen (Tomaszewska et al. 2012). Auf den ersten Blick unerwartet scheint jedenfalls sein Vorkommen im Naturschutzgebiet Fragenstein am Rand des Nordtiroler Karwendelgebirges zu sein. Bei näherer Betrachtung allerdings ergibt sich zwischen den kleinräumigen Biotopen rund um die Ruine Fragenstein und jenen der pannonischen Steppenrasen eine auffallende Gemeinsamkeit: In beiden Fällen handelt es sich um trockene, leicht saure bis alkalische Magerrasen-Standorte, an denen stellenweise trockenresistente Arten aus den Familien der Sauergrasgewächse (Cyperaceae, z. B. *Carex* sp.) und der Süßgräser (Poaceae, z. B. *Brachypodium* sp., *Bromus* sp., *Festuca* sp., *Koeleria* sp., *Sesleria* sp., *Stipa* sp.) dominieren (Tomaszewska et al. 2012). Vielfach „parasitiert" *G. simplex* mit seinem langen Myzel an den Wurzeln oder an abgestorbenen Halmen dieser Arten (Tomaszewska et al. 2012). Dies trifft auch auf den neu entdeckten Bestand der Kalkmagerrasen-Habitate im Naturschutzgebiet Fragenstein zu, dessen Myzel in engem Kontakt mit Wurzeln von *Festuca* sp. und *Carex* sp. vorgefunden wurde. Relativierend dazu muss jedoch festgehalten werden, dass eine an Gräsern parasitierende Lebensweise bei Pilzen aus nordgriechischen Vorkommen nicht bestätigt werden konnte (Iosifidou & Agerer 2002).

Obwohl *Gastrosporium simplex* trocken- und wärmeliebend ist, ist der Pilz gleichzeitig auch kälte-resistent und entwickelt sich auch den Winter über unter der Schneedecke (Senn-Irlet 2012). Auch dieser Befund ist mit den klimatischen Bedingungen sowohl der pannonischen Steppen als auch der inneralpinen Trockenrasen vereinbar, in denen *G. simplex* gedeiht. Kaum verwunderlich ist daher, dass Fundorte dieser Pilzart im gesamten kontinentalen Raum Eurasiens bekannt geworden sind, von Frankreich (Pilát 1934) über Schweden (Kers 1980), Deutschland (Rauschert 1956; Winterhoff 1974), Polen (Stasińska 2005, 2008; Tomaszewska et al. 2012, 2015) bis hin in die Republik Altai (Gorbunova 2017), die Mongolei (Dörfelt & Bumžaa 1986; Dörfelt 2005) und Sibirien (Iosifidou & Agerer 2002). Auffallend große Ähnlichkeiten mit dem Vorkommen im Naturschutzgebiet Fragenstein finden sich übrigens an einigen Wuchsplätzen im Süden der Schweiz (z. B. im Wallis und im Unterengadin), in denen der Pilz ebenfalls auf

inneralpinen Trockenrasen nachgewiesen wurde (Senn-Irlet 2012). Darüber hinaus kennt man auch Vorkommen von *G. simplex* in Nord- und Südamerika (Miller & Askew 1982; Dominguez de Toledo & Castellano 1997), sodass man fast von einer kosmopolitischen Pilzart sprechen kann.

Maßgeblich ist jedoch die Tatsache, dass trotz der weltweiten Verbreitung von *Gastrosporium simplex* die Anzahl der jeweils auftretenden lokalen Populationen und die der vorgefundenen Individuen oftmals klein ist (Senn-Irlet 2012; Gorbunova 2017). Einer der Gründe dafür dürften die kleinräumigen Mikrohabitat-Anforderungen dieser Pilzart sein (Tomaszewska et al. 2015), die z. B. in Mitteleuropa hauptsächlich auf xerotherme Gasnarben mit Pflanzengesellschaften des Typus Festuco-Stipetum beschränkt ist (Stasińska 2005; Stolle 2016). Derartige Biotope gelten aus mehreren Gründen als extrem bedroht. Zum einen kann übermäßige Beweidung zum Verschwinden von Horst-Gräsern führen, auf deren Assoziation *G. simplex* angewiesen ist (Gorbunova 2017). Weiters sind die oftmals kleinflächigen Trockenrasen-Vorkommen menschlichen Eingriffen jeglicher Art ausgesetzt, die somit ebenfalls zu lokalen Extinktionen von *G. simplex* führen (Senn-Irlet 2012; Stolle 2016). Eutrophierung kontinentaler Trockenrasen-Standorte durch Überdüngung (Pless 1994) kann als Ursache für das Verschwinden von *G. simplex* ebenfalls nicht ausgeschlossen werden. Schließlich sind die meisten xerothermen Trockenstandorte im Zuge der natürlichen Sukzession durch Verbuschung und Verwaldung bedroht (Dobner 2008), was ebenfalls zu einem lokalen Aussterben von *G. simplex* führt (Senn-Irlet 2012). Dies gilt auch für den bislang einzig bekannten Standort von *G. simplex* im Naturschutzgebiet Fragenstein, wo die noch existierenden Trockenrasen-Gesellschaften auf eine Zeit zurückgehen, als die nach Zirl abfallenden Hänge des Areals um die Ruine Fragenstein bis in die 1960-er Jahre hinein durch Ziegen und Schafe beweidet wurden, wodurch die Trockenrasenflächen weitgehend frei von Büschen erhalten blieben (Dobner 2008). Die heutigen Trockenrasen sind Relikte aus dieser Zeit und durch natürliche Verbuschung und Verwaldung bedroht.

All diese Faktoren haben dazu geführt, dass *Gastrosporium simplex* eine hoch gefährdete Pilzart ist, die aktuell in sieben Ländern als gefährdet oder vom Aussterben bedroht eingestuft wird (Heilmann-Clausen 2007; Senn-Irlet 2012; Berube et al. 2019). Für den Bestand in Zirl besteht somit die Gefahr in unmittelbarer Zukunft zu verschwinden, sollte er nicht aktiv durch Eindämmung der Sukzession gesichert werden.

Zusammenfassung

Gastrosporium simplex Mattir. („Steppentrüffel“) ist ein seltener, hypogäisch bis epigäisch lebender, potentiell gefährdeter, zur Klasse der Agaricomycetes gehörender gastroider Pilz mit einer bislang in Österreich vorwiegend pannonischen Verbreitung, der jetzt überraschenderweise im Naturschutzgebiet Fragenstein bei Zirl am südwestlichen Rand des Karwendelgebirges entdeckt und damit für Nordtirol erstmals nachgewiesen wurde. Der Fundort des Pilzes beschränkt sich auf eine kleine Fläche eines nach Süden geneigten, trockenen Kalkmagerrasens, der zu einem xerothermen Lebensraum in der Sukzession ehemaliger Schaf- und Ziegenweideflächen gehört. Die nach makro- und mikroskopischer Befund-Erhebung wichtigsten Merkmale des Pilzes (Fruchtkörper, Rhizomorphe, Basidien und Sporen) stimmen mit Art-Beschreibungen von *G. simplex* aus anderen Fundregionen Eurasiens, aber auch des amerikanischen Kontinents, überein. Molekulare rDNA-Daten bestätigen die Zugehörigkeit zu dieser Art, und eine Stammbaumberechnung unter Einschluss verwandter Arten zeigt, dass *G. simplex* zusammen mit *G. gossypinum* eine monophyletische Familie innerhalb der Ordnung Phallales (Agaricomycetes) bildet. Obwohl der Pilz weltweit verbreitet ist, gilt *G. simplex* als bedrohte Pilzart. Dies ist darauf zurückzuführen, dass der Pilz innerhalb fragmentierter, xerothermer Trocken-Habitate zumeist nur kleine Populationen bildet, die für anthropogene Stress-Einwirkungen besonders anfällig sind.

Literatur

Berube J., Jeppson M., Knutsson T., Rebriev, Y., 2019: *Gastrosporium simplex*. The IUCN Red List of Threatened Species 2019: e. T63579691A63579694.

Dobner M., 2008: Die Zirler Trockenrasen. Projektbericht zur Vorbereitung von Pflege und Monitoring. Im Auftrag des Amtes der Tiroler Landesregierung, 146 pp.

Dörfelt H. & Bumžaa D., 1986: Die Gasteromyceten (Bauchpilze) der Mongolischen Volksrepublik. Nova Hedwigia, 43: 87–111.

Dörfelt H., 2005: Die Gasteromyceten der Mongolei und ihre Bedeutung für die Systematik, Chorologie und Ökologie. Erforsch. biol. Ress. Mongolei (Halle/Saale) 2005 (9): 465–474.

Dominguez de Toledo L. & Castellano M. A., 1997: First report of *Gastrosporium simplex* (Gasteromycetes) from South America. Mycotaxon, Vol. LXIV: 443–448.

Gorbunova I. A., 2017: New data on agaricoid fungi of the Katunsky state nature reserve and rare fungi of the republic of Altai (Russia). Nature Conservation Research, 2 (Suppl. 2): 43–55.

Heilman-Clausen J., 2007: Compilation of European Red List and Candidates for an European Red List. European Council for the Conservation of Fungi. Siehe www.eccf.info.

Holzner W. (ed.), 1986: Österreichischer Trockenrasenkatalog. Grüne Reihe des Bundesministeriums für Gesundheit und Umweltschutz, Wien, Band 6, 380 pp.

Iosifidou P. & Agerer R., 2002: Die Rhizomorphen von *Gastrosporium simplex* und einige Gedanken zur systematischen Stellung der Gastrosporiaceae (Hymenomycetes, Basidiomycota). Feddes Repertorium, 113 (1–2): 11–23.

Kasuya T., Hanawa S. & Hosaka K., 2020: A new species of *Gastrosporium* (Phallales) from coastal sand dunes of Ibaraki Prefecture, central Japan. Truffology, 3 (1): 9–16.

Kers L. E., 1980: Fynd av *Gastrosporium simplex* och *Cordyceps canadiensis* i Sverige. Svensk Bot. Tidskr., 74: 29–30.

Landmann A., 2013: Wildnisareal Tiroler Karwendelgebirge: Naturräumliche und naturkundliche Bedeutung und Besonderheiten. WWF Österreich, 154 pp.

Landmann A., 2015: Priority conservation area Tyrolean Karwendel mountains: The significance and diversity of its landscape and ecosystems. WWF Österreich, 65 pp.

Marktgemeinde Zirl, 2018: Umweltbericht zur strategischen Umweltprüfung, Dezember 2013, aktualisiert 2018 – Entwurf (PLAN ALP ZT GmbH), 69 pp.

Mattirolo O., 1903: I funghi ipogei italiani raccolta da O. Beccari, L. Caldesi, A. Carestia, V. Cesati, P. A. Saccardo – Mem. Reale Accad. Sci. Torino, Ser. 2, 53: 329–366.

Melanda G. C. S., Silva-Filho A. G. S., Lenz A. R., Menolli N., Lima A. A., Ferreira R. J., Assis N. M., Cabral T. S., Martin M. P., Baseia I. G., 2021: An overview of 24 years of molecular phylogenetic studies in Phallales (Basidiomycota) with notes on systematics, geographic distribution, lifestyle, and edibility. Front. Microbiol. 12:689374. doi: 10.3389/fmicb.2021.689374.

Miller K. Jr. & Askew W. B., 1982: The genus *Gastrosporium* in North America. Can. J. Bot., 60: 364–368.

Österreichische Mykologische Gesellschaft, 2021-laufend: Mykologische Datenbank. Bearbeitet von Krisai-Greilhuber I., Friebes G. (Fortsetzung von Dämon W., Hausknecht A., Krisai-Greilhuber I.: Datenbank der Pilze Österreichs). – Mykologische Datenbank (pilzdaten-austria.eu).

Pilát A., 1934: Sur le genre *Gastrosporium* Mattirolo (Gastéromycetes). Bull. Soc. Mycol. France, 50: 37–49.

Pless H., 1994: Pflanzensoziologische Untersuchungen der kontinentalen Kalkmagerrasen bei Frankfurt / Oder – Veränderung der Vegetation nach 40 Jahren. Verh. Bot. Ver. Berlin Brandenburg, 127: 117–138.

Rauschert S., 1956: Die Steppentrüffel *Gastrosporium simplex* Matt. in Mitteldeutschland. Z. Pilzkunde, 22: 80–82.

Rimóczi I., Jeppson M. & Benedek L., 2011: Characteristic and rare species of Gasteromycetes in Eupannonicum. In: Fungi non Delineati, Ed. Candusso. Vol. 56–57, 230 pp.

Senn-Irlet B., 2012: Merkblatt Pilze: Gemeine Steppentrüffel. *Gastrosporium simplex* Mattirolo. [published online October 2012]. Available from Internet https://swissfungi.wsl.ch/de/artenfoerderung/merkblaetter/ Birmensdorf, Eidg. Forschungsanstalt WSL. 2 pp.

Stasińska M., 2005: Macromycetes of xerothermic swards of the Western Pomerania (NW Poland). Acta Mycologica, 40 (1): 133–140.

Stasińska M., 2008: The state of knowledge of Macromycetes in xerothermic grasslands in Poland. Ann. Universitatis Mariae Curie – Skłodowska Lublin – Polonia, Vol. LXIII/1/5, Section C: 71–78.

Stolle J., 2016: Der ehemalige Schwerzer Berg nordöstlich von Halle (Saale) – ein Nachruf aus floristischer Sicht. Mitt. florist. Kart. Sachsen-Anhalt (Halle 2016), 21: 53–62.

Tamura K., Stecher G. & Kumar S., 2021: MEGA11: Molecular Evolutionary Genetics Analysis Version 11. Mol. Biol. Evol. 2021 Jun 25; 38(7): 3022–3027. doi: 10.1093/molbev/msab120. PMID: 33892491; PMCID: PMC8233496.

Tiroler Landesregierung, 1988: Verordnung der Landesregierung vom 20. Dezember 1988 über die Erklärung des Gebietes um die Ruine Fragenstein in der Marktgemeinde Zirl zum Naturschutzgebiet (Naturschutzgebiet Fragenstein). 2 pp.

Tomaszewska A., Łuszczyński J., Łuszczyńska B. & Jaworska J., 2012: The contribution and importance of rare macrofungi in selected plots of endangered xerothermic grasslands in the Nida basin. Acta Agrobotanica, 65 (2): 147–154.

Tomaszewska A, Łuszczyński J, Lechowicz Ł & Chrapek M., 2015: Selected rare and protected macrofungi (Agaricomycetes) as bioindicators of communities of xerothermic vegetation in the Nida Basin. Acta Mycol., 50 (1), 12 pp.:1058. http://dx.doi.org/10.5586/am.1058.

White T. J., Bruns T., Lee S. & Taylor J. W., 1990: Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. Pp. 315–322 In: PCR Protocols: A Guide to Methods and Applications, eds. Innis M. A., Gelfand D. H., Sninsky J. J., White T. J., Academic Press, Inc., New York.

Winterhoff W., 1974: Mannstreu-Seitling (*Pleurotus eryngii*) und Steppentrüffel (*Gastrosporium simplex*) – zwei seltene Trockenrasenpilze in der Pfalz. Mitt. Pollichia Pfälz. Vereins Naturk., 1 (21): 68–71.

Friedrich Schaub, Teresa Zeni & Peter Schönswetter

Morphological and elevational differentiation between diploid and tetraploid cytotypes of the *Lotus corniculatus* aggregate (Fabaceae) along three elevational transects in the Vinschgau / Val Venosta valley

Abstract

Polyploidy represents a major evolutionary mechanism in plants and is frequently associated with ecological and morphological differentiation. The common legume *Lotus corniculatus* also known as birdsfoot trefoil, Gewöhnlicher Hornklee or Ginestrino comune comprises diploid and tetraploid cytotypes, which in other species are known to often occupy different ecological niches. This study investigates cytotype distribution and morphological variation in the Vinschgau / Val Venosta valley (South Tyrol, Italy). We sampled 150 individuals across three independent elevational transects, collecting leaf material in silica gel for ploidy analysis alongside corresponding herbarium specimens for morphometric assessment. Ploidy levels were determined using flow cytometry, and eleven quantitative morphological traits were measured on the pressed material. Contrary to the classic hypothesis that polyploids dominate harsher, high-alpine environments – but in accordance with recent findings –, diploid individuals were found to be restricted to high elevations, whereas tetraploid individuals dominated lower sites. Vegetative organs tended to be larger in tetraploids, while generative traits showed limited differentiation. Regression analyses revealed decreasing sizes of some vegetative organs with increasing elevation as opposed to similar or even larger sizes of generative parts. These results indicate that both genetic effects associated with polyploidy and environmental factors shape morphological variation in this system.

Keywords: polyploidy, morphological differentiation, elevational variation, *Lotus corniculatus*

1. Introduction

Polyploidy, defined as the presence of more than two complete sets of chromosomes in somatic cells, is a widespread phenomenon in flowering plants and a major driver of plant evolution (Otto & Whitton 2000; Soltis & Soltis 2000). It primarily arises through the formation and fusion of unreduced gametes resulting from meiotic non-disjunction, or via interspecific hybridization followed by chromosome doubling (Ramsey & Schemske 1998; Levin 2002). Polyploidization can influence gene dosage, developmental pathways, cell size and organ size, often producing marked phenotypic shifts in the phenotype (Levin 2002; Beaulieu et al. 2008). Because duplicated genomes can buffer deleterious mutations and increase phenotypic flexibility, polyploid lineages may also show altered ecological performance under stress (Fox et al. 2020; Van De Peer et al. 2021).

Heteroploid taxa, which comprise different ploidy levels either within a species or within a group of closely related species are especially informative for studying effects of polyploidization. This is especially true for study taxa distributed in mountain ranges such as the European Alps because temperature, radiation, wind exposure and the length of the growing season change rapidly over short distances, generating strong

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selection pressure on plant stature and phenology (Körner 2003). In such heterogeneous environments, polyploid lineages may show ecological differentiation from their diploid relatives (Parisod et al. 2010). At the same time, the direction and magnitude of these effects are context-dependent; some alpine systems show pronounced ecological sorting, whereas others retain broad overlap between cytotypes (Hörandl 2022).

The *Lotus corniculatus* aggregate (Fabaceae) is a heteroploid (di- and tetraploid) complex in the European Alps; its taxonomic treatment remains highly inconsistent across recent standard literature. For instance, Aeschimann et al. (2004) in their pan-Alpine Flora alpina separate (sub)alpine *L. alpinus* (Ser.) Schleich. ex Ramond from lowland to subalpine *L. corniculatus* L. without indicating differences in ploidy. In contrast, Fischer et al. (2008) in the excursion flora for Austria, South Tyrol and Liechtenstein separate "mostly tetraploid" lowland to subalpine *L. corniculatus* var. *corniculatus* s. lat. from (sub)alpine *L. corniculatus* var. *alpicola* (no ploidy level given), and explicitly state that *L. alpinus* is a Western Alpine, diploid taxon not occurring in the area covered by the flora. Pignatti et al. (2017) in their "Flora d'Italia" treat *L. alpinus* as a distinct species characteristic of alpine pastures, while distinguishing multiple subspecies within *L. corniculatus* (e.g., subsp. *corniculatus* and subsp. *delortii*). Finally, Schratt-Ehrendorfer et al. (2022) in the most recent check list for Austria include subsp. *alpicola* in *L. corniculatus* s. str., whereas Hegi (1989) recognised several subspecies within *L. corniculatus* (e.g., subsp. *eu-corniculatus*, subsp. *tenuifolius*, subsp. *major*) and noted that these cannot be sharply distinguished based on morphological characters alone. Taken together, these obvious controversies underline the group's complexity; however, to the best of our knowledge, no DNA-based study has hitherto targeted its likely reticulate evolution.

Gauthier et al. (1998) applied morphometry and allozymes to plants sampled across contact zones of both ploidy cytotypes in the French Alps; they found that diploid *L. corniculatus* predominated at higher elevations, whereas tetraploids occurred in lower areas. Further, they found that morphological differentiation was strongest in vegetative traits, while generative characters remained largely overlapping. Their allozyme data showed largely shared allele pools, higher heterozygosity in tetraploids and only a few ploidy-specific alleles, suggesting limited gene flow and supporting an autopolyploid origin of the tetraploid lineage. However, the resolution of allozyme markers is limited, and their ability to disentangle relationships among closely related taxa has been questioned, so that these inferences should be interpreted with caution.

Additional studies have documented considerable morphological variation within the *L. corniculatus* complex across different habitats (Drobná 2010), while early work highlighted a complex evolutionary origin involving polyploidization and hybridization processes (Ross & Jones 1985). Together, these studies indicate that the species complex is a suitable model for examining how genome duplication, environment and morphology interact in alpine plants. The present study therefore asks whether the elevational distribution pattern of ploidy cytotypes in the Eastern Alps follows the elevational segregation observed in the Western Alps, and whether morphological traits allow for the discrimination of di- and tetraploids. We emphasise that our fairly local study can certainly not resolve the group's intricate taxonomy, which would require a range-wide sampling and a DNA-based approach. It may, however, facilitate the taxonomic decision whether di- and tetraploids can indeed be discriminated in the field and are probably "worth" to be taxonomically recognised.

2. Study area

The study was conducted in the Vinschgau / Val Venosta valley (South Tyrol, Italy), an inner-alpine dry valley characterized by pronounced climatic gradients. Sampling was carried out on three mountains: Arundakopf (1246–2720 m a.s.l.), Tschenglser Köpfl (962–2520 m a.s.l.) and Vermoispitz (635–2731 m a.s.l.). The sampling thus spans an elevation range from 635 to 2731 m a.s.l. and includes vegetation types ranging from dry valley grasslands to alpine meadows.

3. Materials and Methods

Field sampling was conducted from 4 to 6 July 2025 (Fig. 1). From each individual, leaf material collected for cytological analysis was dried and stored in silica gel and a herbarium specimen was preserved for morphometric measurements. Geographic coordinates and elevation were recorded in the field using a mobile GPS device (measurement accuracy mean ± SD: 3.6 ± 1.6 m). Sampling site selection was informed by prior occurrence records (Zeni et al. 2026).

Ploidy levels were determined using DAPI flow cytometry following the protocol of Otto (1990). Relative genome size (RGS) was measured using *Bellis perennis* (2C = 3.38 pg; Schönswetter et al. 2007) as an internal standard, allowing assignment of individuals to diploid or tetraploid cytotypes. For each sample, silica-dried leaf tissue was co-chopped with fresh leaf tissue of *Bellis perennis*. Nuclei were released in Otto I buffer, filtered through a 30 µm nylon mesh and stained with Otto II buffer containing DAPI. Samples were measured on a CyFlow Space flow cytometer (Sysmex), with a minimum of 3,000 nuclei recorded per sample.

Morphological variation was assessed by measuring eleven quantitative traits on herbarium specimens using a digital caliper. These included the vegetative traits leaflet length and width (measured on the central leaflet of the uppermost fully developed leaf below the inflorescence), petiole length and width (measured on the same leaf), peduncle length and width (measured on the peduncle of the corresponding inflorescence), and bract length, as well as the generative traits calyx length, standard length and standard width. The number of flowers per inflorescence was recorded as an additional reproductive character. Elevation was treated as an ecological descriptor for each individual.

Statistical analyses were performed in R version 4.5.2 (R Core Team 2025). For each morphological trait, linear models were used to assess differences between cytotypes while accounting for the effects of elevation and transect. Transect was included as a categorical explanatory variable to account for variation among sampling transects. Models including a cytotype × elevation interaction were initially considered to test whether morphological responses to elevation differed between cytotypes. As the interaction did not improve model fit, it was excluded from the analyses. To account for multiple testing across traits, p-values for cytotype and elevation effects were adjusted separately using the Benjamini-Hochberg procedure. For comparison of cytotype effects among traits, each trait was standardized (mean = 0, SD = 1) and the models

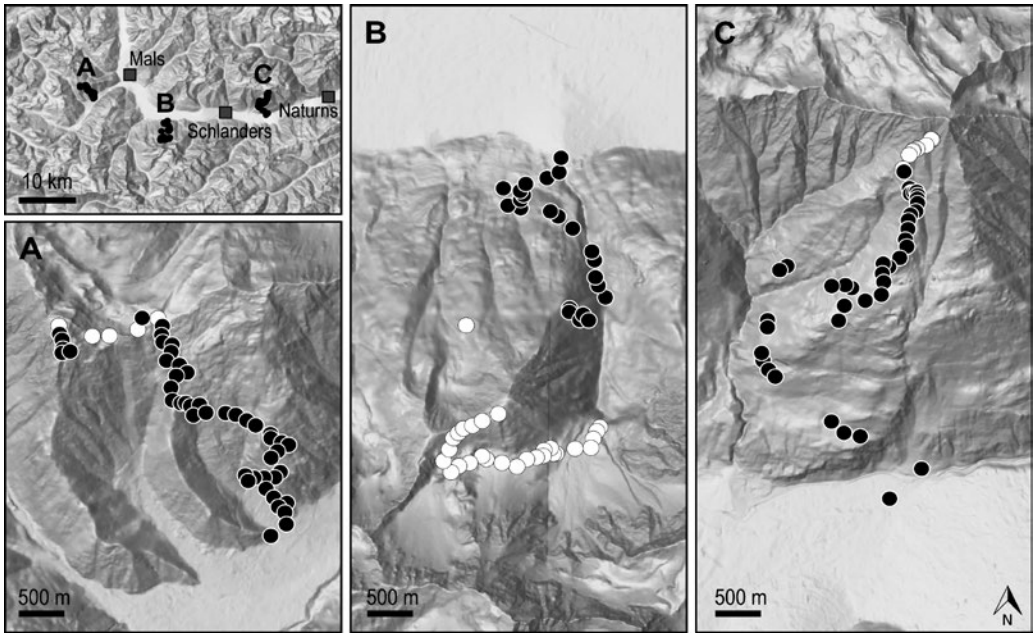


Fig. 1: Geographic locations of diploid (2*x*, white) and tetraploid (4*x*, black) individuals of the *Lotus corniculatus* aggregate in the Vinschgau / Val Venosta valley in South Tyrol (Italy). A: Arundakopf, B: Tschenglser Köpfl, C: Vermoispitz.

refitted. Means and standard deviations were calculated for each trait and elevation for each cytotype. Differences in elevation between cytotypes were assessed using a Welch's t-test (unequal variances), with Cohen's d calculated as a measure of effect size.

Multivariate morphological differentiation was examined using principal component analysis (PCA). Individuals with missing values were excluded, and the eleven morphological traits were standardized prior to analysis. Linear discriminant analysis (LDA) was then performed using the lda() function in the R package MASS7.3.61 (Venables & Ripley 2002) to assess separation of cytotypes based on morphological traits. The dataset was randomly divided into training (80%) and test (20%) subsets, and traits were standardized prior to analysis using means and standard deviations of the training dataset. Backward feature elimination was performed by subsequently removing the trait with the the smallest absolute LD1 coefficient until two traits were left. Classification accuracy was evaluated for each model using the test dataset. The final two-trait model was refitted using the complete dataset and Wilks' lambda was assessed using MANOVA to test for multivariate differences between cytotypes. Relative contributions of the selected traits to LD1 were calculated from their absolute LD1 coefficients.

4. Results

The sampled individuals fell into two RGS classes corresponding to diploids (RGS mean ± SD: 1.10 ± 0.02) and tetraploids (2.28 ± 0.05). In total, 150 individuals were sampled, of which 41 were diploid and 109 were tetraploid (Fig. 1; Supplementary Table 1). The distribution of these cytotypes varied across the three elevation transects: at Vermoispitz, 8 out of 48 sampled individuals were diploid; at Tschenglser Köpfl, diploids represented more than half of the sample (28 out of 51 individuals); and at Arundakopf, only 5 out of 51 individuals were diploid. Across the study area, cytotypes displayed clear elevational segregation: diploids were concentrated at higher elevations, whereas tetraploids were more frequent at lower and mid-elevation sites (Fig. 1). Accordingly, mean elevation differed strongly between cytotypes (diploids: 2346 ± 239 m a.s.l.; tetraploids: 1734 ± 487 m a.s.l.; Welch's t-test, $p < 0.001$; Cohen's $d = 1.41$).

After accounting for differences in elevation and transect, cytotypes differed significantly in five of the 11 measured morphological traits. Following BH correction, significant cytotype effects were found only for some of the vegetative traits (petiole length, leaflet length, peduncle width and petiole width). Measured values of vegetative characters were consistently larger in tetraploids than in diploids, whereas generative characters showed no significant difference between cytotypes, except for the number of flowers per inflorescence (Tab. 1, Fig. 2). The strongest morphological differences between cytotypes were observed for petiole width and peduncle width (both $p < 0.001$), which showed the largest effect sizes. Number of flowers per inflorescence, petiole length and leaflet length also differed significantly between cytotypes, with moderate to strong effect sizes (all $p < 0.05$). Smaller, non-significant differences were found for leaflet width ($p = 0.199$), bract length ($p = 0.584$) and peduncle length ($p = 0.242$). Generative traits showed little or no differentiation: standard length ($p = 0.262$), standard width ($p = 0.313$) and calyx length ($p = 0.227$) did not differ significantly between diploid and tetraploid individuals (Tab. 1). Bract length, leaflet length, and peduncle length significantly decreased with elevation, reflecting a general reduction in vegetative biomass in high-alpine environments (Fig. 3). The observed increase in standard length with elevation was only marginally significant. No significant elevation-related changes were detected for the remaining seven morphological traits.

In the PCA, the first two components explained 56.3% of the total morphological variation (Fig. 4). PC1 was mainly associated with vegetative traits, PC2 with generative traits, generally showing high overlap between cytotypes. Backward feature elimination retained petiole width and peduncle width as the two most discriminant traits. The final LDA significantly discriminated between cytotypes (Wilks' $\lambda = 0.484$, $F(2,120) = 63.858$, $p < 0.001$), with a classification accuracy of 96% on the test dataset (Fig. 5). In contrast, LDAs based on more traits had a lower classification accuracy of 92%.

Table 1: Morphological differentiation between diploid (2*x*) and tetraploid (4*x*) individuals of the *Lotus corniculatus* aggregate sampled in the Vinschgau/Val Venosta valley (South Tyrol). Shown are means and standard deviation for each cytotype together with regression coefficients of cytotype and elevation from linear models. Coefficients (β) and Benjamini-Hochberg-adjusted p-values are given for ploidy and elevation effects. Standardized cytotype β represents the cytotype regression coefficient from models fitted with the response trait standardized to mean = 0 and SD = 1, and therefore expresses the adjusted cytotype difference in units of trait standard deviations. Models included ploidy, elevation, and transect as fixed effects. Significant p-values are in bold.

Trait	Mean ± SD (2*x*)	Mean ± SD (4*x*)	Cytotype β	Standardized cytotype β	p-value Cytotype (BH)	Elevation β	p-value Elevation (BH)
Bract length (mm)	5.37 ± 1.39	6.16 ± 1.97	0.268	0.145	0.584	–0.001	**0.036**
Calyx length (mm)	3.93 ± 0.49	4.06 ± 0.59	0.226	0.398	0.227	0	0.755
Flowers per inflorescence (n)	2.18 ± 0.69	2.93 ± 0.97	0.720	0.749	**0.012**	0	0.450
Leaflet length (mm)	6.15 ± 1.71	8.81 ± 2.98	1.811	0.618	**0.016**	–0.002	**< 0.001**
Leaflet width (mm)	3.25 ± 1.01	3.98 ± 1.67	0.669	0.434	0.199	0	0.548
Peduncle length (mm)	29.31 ± 11.30	42.36 ± 22.10	6.523	0.318	0.242	–0.016	**< 0.001**
Peduncle width (mm)	0.50 ± 0.07	0.67 ± 0.13	0.130	0.950	**< 0.001**	0	0.070
Petiole length (mm)	2.97 ± 0.93	4.01 ± 1.48	1.037	0.728	**0.012**	0	0.450
Petiole width (mm)	0.31 ± 0.09	0.51 ± 0.12	0.212	1.488	**< 0.001**	0	0.450
Standard length (mm)	11.61 ± 1.39	11.84 ± 1.49	0.491	0.336	0.262	0.001	0.066
Standard width (mm)	7.45 ± 1.67	7.91 ± 1.43	0.464	0.306	0.313	0	0.454

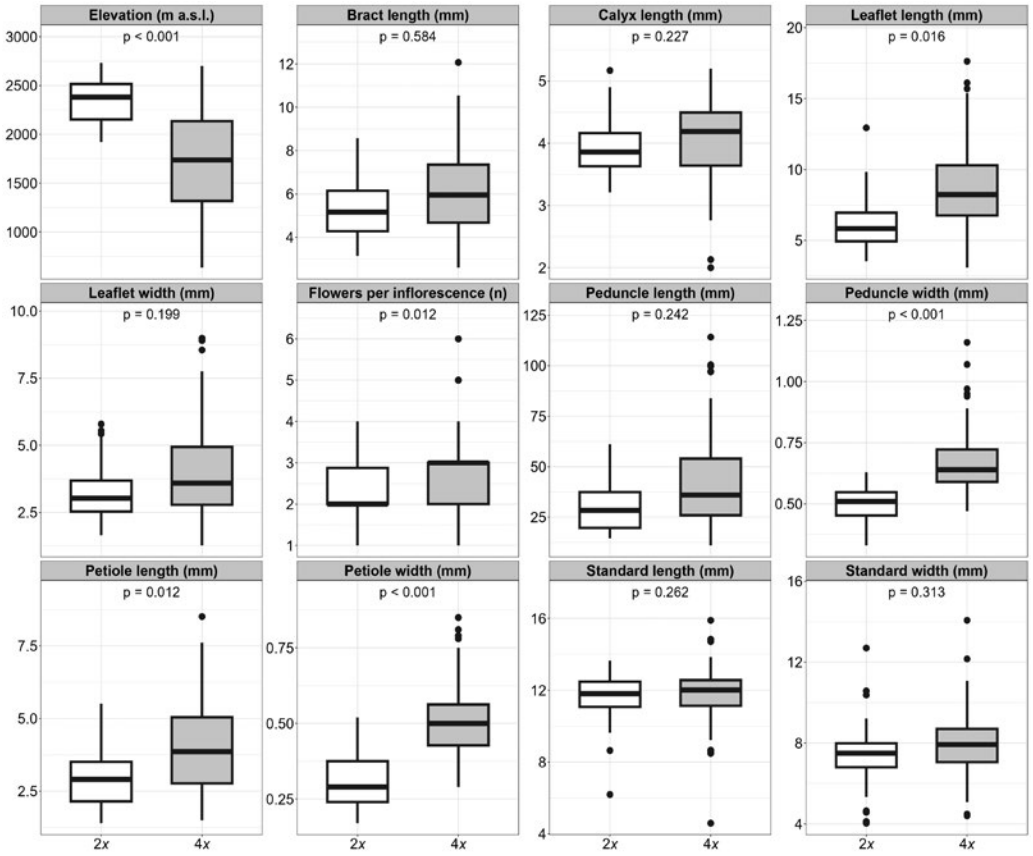


Fig. 2: Elevational distribution and morphological traits of diploid (2*x*) and tetraploid (4*x*) individuals of the *Lotus corniculatus* aggregate sampled in the Vinschgau / Val Venosta valley (South Tyrol). Boxplots show the median (horizontal line) and the interquartile range (IQR, 25th to 75th percentiles; box bounds). Whiskers extend to the most extreme data points located within 1.5* IQR from the box edges. Individual dots represent statistical outliers exceeding this range. The elevation panel shows the uncorrected p-value from a Welch's t-test comparing cytotypes. For the traits, cytotype effects were tested using linear models (trait ~ elevation + ploidy + transect), with p-values for the ploidy effect adjusted for multiple testing using the Benjamini-Hochberg (BH) procedure. BH-adjusted p-values are indicated in the respective panels.

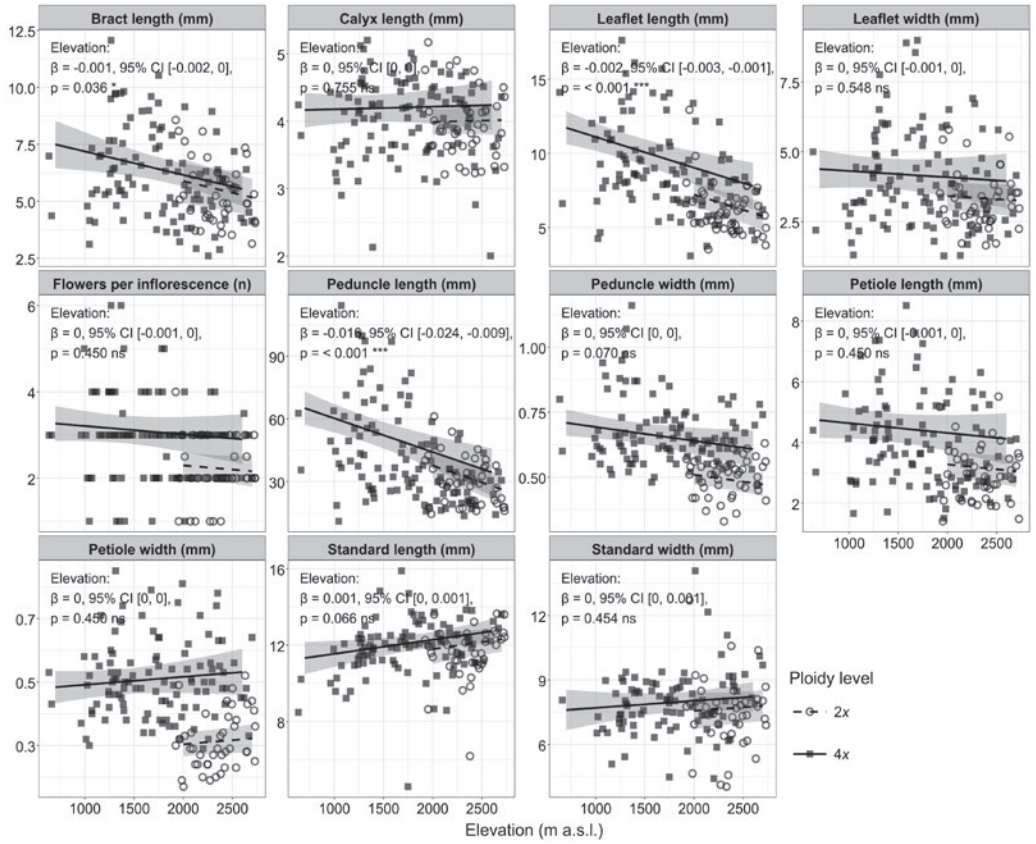


Fig. 3: Relationships between elevation and morphological traits in diploid (2*x*) and tetraploid (4*x*) individuals of the *Lotus corniculatus* aggregate in the Vinschgau / Val Venosta valley (South Tyrol). Points represent individual observations, lines show model-predicted relationships between elevation and each trait for the two cytotypes, shaded areas indicating 95% confidence intervals. For each trait, the estimated elevation effect (β), 95% confidence interval (CI), and Benjamini-Hochberg-adjusted p-value are indicated in the respective panel, with significance denoted by asterisks. Models included elevation, ploidy, and transect as fixed effects. Significance levels: ns, $p > 0.05$; * $p \leq 0.05$; *** $p \leq 0.001$.

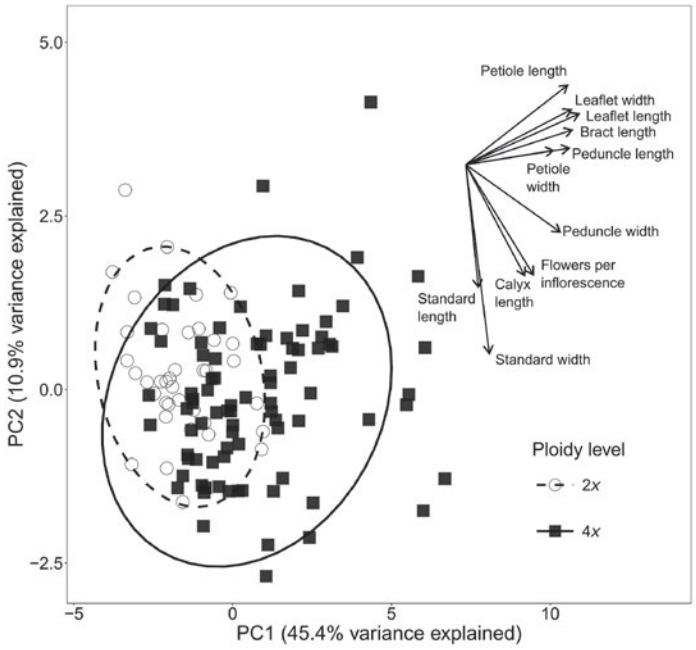


Fig. 4: Principal component analysis (PCA) of morphological traits in diploid (2*x*) and tetraploid (4*x*) individuals of the *Lotus corniculatus* aggregate sampled in the Vinschgau/Val Venosta valley (South Tyrol). Variables were standardized prior to PCA. Arrows represent trait loadings on the principal components. Ellipses indicate the 95% concentration of individuals within each cytotype.

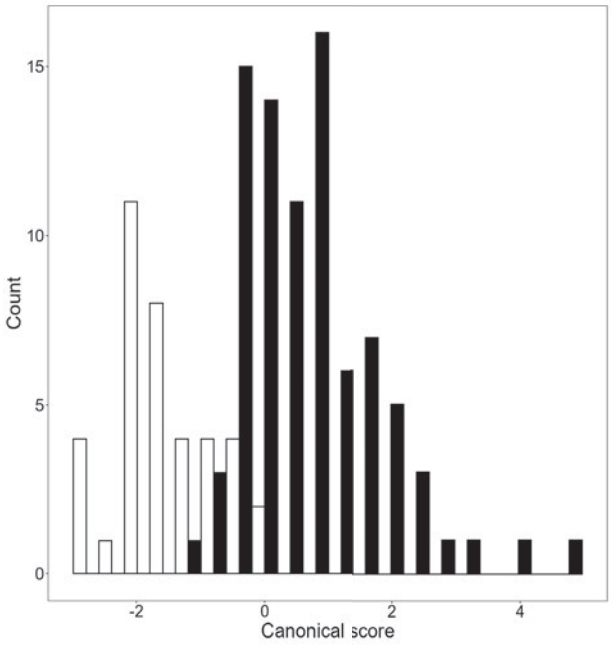


Fig. 5: Linear discriminant analysis (LDA) showing the morphological differentiation between diploid (2*x*, white) and tetraploid (4*x*, black) individuals of the *Lotus corniculatus* aggregate sampled in the Vinschgau/Val Venosta valley (South Tyrol) based on two morphological characters, petiole width and peduncle width. The contribution of the two characters to the linear discriminant function was 57% and 43%, respectively.

5. Discussion

The present study demonstrates that diploid and tetraploid cytotypes of the *Lotus corniculatus* aggregate are differentiated both elevationally (Fig. 1) and morphologically (Fig. 2) in the three study areas of the Vinschgau / Val Venosta valley. The pronounced elevational separation between cytotypes is consistent with ecological sorting along the elevation gradient and parallels the pattern reported by Gauthier et al. (1998) from the French Alps. Taken together, the two studies indicate that elevational segregation of cytotypes is not a local idiosyncrasy but a recurrent feature of Alpine *Lotus* populations. Such a pattern is compatible with restricted inter-cytotype hybridisation and with theoretical expectations of minority cytotype exclusion (Levin 1975) and may thereby contribute to the maintenance of ploidy structure over time.

Whereas the PCA based on the 11 scored morphological characters illustrated a broad overlap between the two cytotypes (Fig. 4), an LDA with backward character elimination showed that 96% of individuals can be correctly classified based on only two morphological characters, petiole width and peduncle width (Fig. 5); adding additional characters led to a slight drop in classification accuracy. In the univariate analyses, the strongest morphological differences were observed in vegetative traits, particularly petiole width and peduncle width (Fig. 2, Tab. 1). That the measured values were consistently larger in the tetraploids compared to the diploids is in line with the so-called gigas effect commonly associated with genome duplication, in which larger genome size is translated into larger cells and, ultimately, larger organs (Levin 2002; Beaulieu et al. 2008). Tetraploids are larger for many traits, even after accounting for elevation and transect (Tab. 1) indicating that the tetraploid phenotype is not explained solely by lower-elevation habitat quality. Indeed, although both cytotypes generally decreased in size towards higher elevations, elevation effects were only significant for three traits (leaflet length, bract length, and peduncle length; Fig. 3, Table 1). Altogether, the data suggest that ploidy contributes a substantial intrinsic component to organ size, while elevation imposes an additional environmental constraint that reduces size in both cytotypes.

Similar patterns of trait variation along elevational transects have been documented in other alpine plant complexes. For instance, in *Biscutella laevigata* (Brassicaceae), genome duplication similarly induces a fixed baseline increase in vegetative organ size (gigas effect), while both diploid and tetraploid cytotypes exhibit a parallel reduction in overall plant stature towards high elevations in response to alpine climatic constraints (Parisod & Besnard 2007). Likewise, studies on alpine polyploids such as *Ranunculus kuepferi* show that tetraploids maintain larger cell and tissue dimensions even at high elevations, where extreme temperatures and short growing seasons enforce general dwarfing across all cytotypes (Schinkel et al. 2016). This congruence across taxonomically distant alpine taxa suggests that the interplay between ploidy-driven cell enlargement and environment-driven size reduction represents a widespread evolutionary mechanism along mountain gradients.

In contrast to vegetative traits, generative traits showed little differentiation between the two cytotypes (Figs. 2–4, Tab. 1). Flowers are often subject to strong functional constraints because their size and shape must remain compatible with pollinator behaviour and reproductive success (Ollerton & Lack 1998). More generally, stabilizing selection can maintain the shape of flowers even where vegetative traits are free to diverge, as generative traits are often subject to stronger genetic and functional constraints than vegetative traits (Ashman & Majetic 2006). In the present study, the limited variation of standard length, standard width and calyx length suggests that floral architecture may be buffered against both elevation and ploidy effects, whereas vegetative traits remain more responsive to ploidy level and environmental filtering.

Polyploidy can generate ecological novelty and broaden the range of viable phenotypes because duplicated genomes provide raw material for selection and can buffer the effects of environmental stress (Otto & Whitton 2000; Soltis & Soltis 2000; Fox et al. 2020; Van De Peer et al. 2021). At the same time, polyploid complexes do not always show simple niche expansion. Alpine examples indicate that some polyploid cytotypes

expand into novel habitats, whereas others remain closely tied to the ecological optimum of their diploid ancestors (Parisod et al. 2010; Hörandl 2022). Against this backdrop, the *Lotus corniculatus* aggregate appears to exhibit partial ecological differentiation rather than complete niche displacement: tetraploids are shifted towards lower elevations, whereas diploids seem to be restricted to higher elevations (Fig. 1).

The observational design of the present study imposes an important limitation. Because plants were measured under natural field conditions, genetic differences, maternal effects and environmentally induced plasticity cannot be disentangled. Common garden experiments, reciprocal transplant experiments and genomic analyses would be needed to determine how much of the vegetative divergence is genetically fixed. Such approaches would also help to evaluate whether the diploid and tetraploid cytotypes should be treated as separate evolutionary lineages – and thus as separate taxa – or as ecologically differentiated cytotypes within a broadly defined species. Finally, it remains to be established whether the alpine diploids in the Western and the Eastern Alps have a common ancestry and should thus be treated as one entity, following Aeschimann et al. (2004).

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References

Aeschimann D., Lauber K., Moser D. M. & Theurillat J. P., 2004: Flora alpina. Ein Atlas der Gefäßpflanzen der Alpen. Haupt, Bern.

Ashman T.-L. & Majetic C. J., 2006: Genetic constraints on floral evolution: a review and evaluation of patterns. Heredity, 96: 343–352. https://doi.org/10.1038/sj.hdy.6800815

Beaulieu J. M., Leitch I. J., Patel S., Pendharkar A. & Knight C. A., 2008: Genome size is a strong predictor of cell size and stomatal density in angiosperms. New Phytologist, 179: 975–986. https://doi.org/10.1111/j.1469-8137.2008.02528.x

Drobná J., 2010: Morphological variation in natural populations of *Lotus corniculatus* in association to geographical parameters of collecting sites. Biologia, 65: 213–218. https://doi.org/10.2478/s11756-010-0011-0

Fischer M. A., Adler W. & Oswald K., 2008: Exkursionsflora für Österreich, Liechtenstein und Südtirol. 3. Aufl. Biologiezentrum der Oberösterreichischen Landesmuseen, Linz.

Fox D. T., Soltis D. E., Ross P. S., Ashman T.-L. & Van De Peer Y., 2020: Polyploidy: a biological force from cells to ecosystems. Trends in Cell Biology, 30: 688–694. https://doi.org/10.1016/j.tcb.2020.06.006

Gauthier P., Lumaret R. & Bédécarrats A., 1998: Genetic variation and gene flow in Alpine diploid and tetraploid populations of *Lotus* (*L. alpinus* (D.C.) Schleicher / *L. corniculatus* L.). I. Insights from morphological and allozyme markers. Heredity, 80: 683–693. https://doi.org/10.1046/j.1365-2540.1998.00334.x

Hegi G., 1989: Illustrierte Flora von Mitteleuropa. Band IV, Teil 3: Angiospermae, Dicotyledones 2 (Leguminosae – Tropaeolaceae). 3. Aufl. Paul Parey, Berlin/Hamburg: 1364–1370.

Hörandl E., 2022: Novel approaches for species concepts and delimitation in polyploids and hybrids. Plants, 11: 204. https://doi.org/10.3390/plants11020204

Körner C., 2021: Alpine plant life. Functional plant ecology of high mountain ecosystems. 3rd ed. Springer, Cham.

Levin D. A., 1975: Minority cytotype exclusion in local plant populations. Taxon, 24: 35–43. https://doi.org/10.2307/1218997

Levin D. A., 2002: The role of chromosomal change in plant evolution. Oxford University Press, Oxford.

Ollerton J. & Lack A., 1998: Relationships between flowering phenology, plant size and reproductive success in *Lotus corniculatus* (Fabaceae). Plant Ecology, 139: 35–47. https://doi.org/10.1023/A:1009798320049

Otto F., 1990: DAPI staining for flow cytometry. In: Darzynkiewicz Z. & Crissman H. A. (Eds.), Methods in Cell Biology, Vol. 33. Academic Press / Humana Press, San Diego & Totowa, NJ: pp. 105–110. https://doi.org/10.1016/S0091-679X(08)60516-6.

Otto S. P. & Whitton J., 2000: Polyploid incidence and evolution. Annual Review of Genetics, 34: 401–437. https://doi.org/10.1146/annurev.genet.34.1.401

Parisod C., & Besnard G., 2007: Glacial refugia and postglacial colonization routes of the polyploid complex *Biscutella laevigata* L. (Brassicaceae) in the Alps. Molecular Ecology, 16: 4994–5006. https://doi.org/10.1111/j.1365-294X.2007.03541.

Parisod C., Holderegger R. & Brochmann C., 2010: Evolutionary consequences of autopolyploidy. New Phytologist, 186: 5–17. https://doi.org/10.1111/j.1469-8137.2009.03142.x

Pignatti S., Guarino R. & La Rosa M., 2017: Flora d'Italia. 2ª ed. Edagricole-New Business Media, Milano.

Ramsey J. & Schemske D. W., 1998: Pathways, mechanisms, and rates of polyploid formation in flowering plants. Annual Review of Ecology and Systematics, 29: 467–501. https://doi.org/10.1146/annurev.ecolsys.29.1.467

R Core Team (2025): R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Ross M. D. & Jones W. T., 1985: The origin of *Lotus corniculatus*. Theoretical and Applied Genetics, 71: 284–288. https://doi.org/10.1007/BF00252068

Schinkel C. C., Kirchheimer B., Dellinger A. S., Klatt S., Winkler M., Dullinger S. & Hörandl E., 2016: Physiological reaction norms of diploid and autotetraploid *Ranunculus kuepferi* (Ranunculaceae) along an altitudinal gradient in the Alps. Annals of Botany, 118: 1159–1172. https://doi.org/10.1093/aob/mcw182

Schönswetter P., Suda J., Popp M., Weiss-Schneeweiss H. & Brochmann C., 2007: Circumpolar phylogeography of *Juncus biglumis* (Juncaceae) inferred from AFLP fingerprints, cpDNA sequences, nuclear DNA content and chromosome numbers. Molecular Phylogenetics and Evolution, 42: 92–103.

Schratt-Ehrendorfer L., Niklfeld H., Schröck C., Stöhr O., Gilli C., Sonnleitner M., Adler W., Barta T., Beiser A., Berg C., Bohner A., Franz W., Gottschlich G., Griebl N., Haug G., Heber G., Hehenberger R., Hofbauer M., Hohla M., Hörandl E., Kaiser R., Karrer G., Keusch C., Király G., Kleesadl G., Kniely G., Köckinger H., Kropf M., Kudrnovsky H., Lefnaer S., Mrkvicka A., Nadler K., Novak N., Nowotny G., Pachschwöll C., Pagitz K., Pall K., Pflugbeil G., Pilsl P., Raabe U., Sauberer N., Schau H., Schönswetter P., Starlinger F., Strauch M., Thalinger M., Trávníček B., Trummer-Fink E., Weiss S., Wieser B., Willner W., Wittmann H., Wolkerstorfer C., Zernig K. & Zuna-Kratky T., 2022: Rote Liste der Farn- und Blütenpflanzen Österreichs. Stapfia, 114: 1–357

Soltis D. E. & Soltis P. S., 2000: The role of genetic and genomic attributes in the success of polyploids. Proceedings of the National Academy of Sciences USA, 97: 7051–7057. https://doi.org/10.1073/pnas.97.13.7051

Van De Peer Y., Ashman T.-L., Soltis P. S. & Soltis D. E., 2021: Polyploidy: an evolutionary and ecological force in stressful times. The Plant Cell, 33: 11–26. https://doi.org/10.1093/plcell/koaa015

Venables W. N. & Ripley B. D., 2002: Modern Applied Statistics with S. Fourth Edition. Springer, New York. ISBN 0-387-95457-0

Zeni T., Margreiter V., Unzeta M., Urfus T., Carnicero P., Frajman F., Wessely J., Koutecký P., Kolář F., Dullinger S. & Schönswetter P.: 2026: Polyploid frequency decreases with elevation but increases with distance to glacial refugia in the Eastern European Alps. Nature Communications (2026). https://doi.org/10.1038/s41467-026-77752-1.

Supplementary Table 1: Sampling information (transect, geographic coordinates and elevation above sea level in m [m a.s.l.]), and genome size relative to *Bellis perennis* (3.38 pg; Schönswetter et al. 2007) for 150 individuals of the *Lotus corniculatus* aggregate collected in the Vinschgau / Val Venosta valley in South Tyrol (Italy).

Individual	Transect	Geographic coordinates	Elevation (m a.s.l.)	RGS	Ploidy
V1	Vermoispitz	46°39'25.103"N 10°52'5.774"E	2731	0.32	2
V2	Vermoispitz	46°39'25.179"N 10°52'5.216"E	2728	0.32	2
V3	Vermoispitz	46°39'23.027"N 10°52'2.638"E	2699	0.33	2
V4	Vermoispitz	46°39'21.713"N 10°51'57.893"E	2653	0.63	4
V5	Vermoispitz	46°39'21.226"N 10°51'55.910"E	2645	0.32	2
V6	Vermoispitz	46°39'20.830"N 10°51'55.585"E	2645	0.32	2
V7	Vermoispitz	46°39'19.513"N 10°51'53.874"E	2629	0.33	2
V8	Vermoispitz	46°39'14.455"N 10°51'50.636"E	2537	0.33	2
V9	Vermoispitz	46°39'13.303"N 10°51'51.071"E	2517	0.64	4
V10	Vermoispitz	46°39'7.140"N 10°51'53.751"E	2436	0.66	4
V11	Vermoispitz	46°39'5.850"N 10°51'54.512"E	2430	0.32	2
V12	Vermoispitz	46°39'5.108"N 10°51'54.236"E	2425	0.66	4
V13	Vermoispitz	46°39'5.558"N 10°51'56.163"E	2408	0.65	4
V14	Vermoispitz	46°39'5.792"N 10°51'57.513"E	2396	0.65	4
V15	Vermoispitz	46°39'4.529"N 10°51'57.980"E	2370	0.66	4
V16	Vermoispitz	46°39'3.261"N 10°51'57.773"E	2357	0.67	4
V17	Vermoispitz	46°39'1.551"N 10°51'57.883"E	2338	0.67	4
V18	Vermoispitz	46°38'58.539"N 10°51'56.947"E	2295	0.67	4

Individual	Transect	Geographic coordinates	Elevation (m a.s.l.)	RGS	Ploidy
V19	Vermoispitz	46°38’57.258”N 10°51’54.180”E	2278	0.66	4
V20	Vermoispitz	46°38’55.214”N 10°51’52.994”E	2254	0.67	4
V21	Vermoispitz	46°38’52.000”N 10°51’52.784”E	2212	0.65	4
V22	Vermoispitz	46°38’48.040”N 10°51’51.394”E	2172	0.67	4
V23	Vermoispitz	46°38’45.473”N 10°51’52.127”E	2132	0.66	4
V24	Vermoispitz	46°38’41.316”N 10°51’48.438”E	2085	0.66	4
V25	Vermoispitz	46°38’38.015”N 10°51’42.657”E	2041	0.67	4
V26	Vermoispitz	46°38’39.245”N 10°51’39.813”E	2013	0.69	4
V27	Vermoispitz	46°38’35.556”N 10°51’39.304”E	1992	0.67	4
V28	Vermoispitz	46°38’32.392”N 10°51’39.995”E	1964	0.66	4
V29	Vermoispitz	46°38’27.693”N 10°51’38.712”E	1933	0.66	4
V30	Vermoispitz	46°38’25.559”N 10°51’30.395”E	1901	0.68	4
V31	Vermoispitz	46°38’30.312”N 10°51’23.478”E	1865	0.66	4
V32	Vermoispitz	46°38’31.419”N 10°51’20.242”E	1819	0.67	4
V33	Vermoispitz	46°38’23.784”N 10°51’19.606”E	1789	0.68	4
V34	Vermoispitz	46°38’18.248”N 10°51’16.579”E	1746	0.68	4
V35	Vermoispitz	46°38’31.151”N 10°51’13.203”E	1729	0.68	4
V37	Vermoispitz	46°38’38.756”N 10°50’50.347”E	1615	0.69	4
V38	Vermoispitz	46°38’37.253”N 10°50’46.563”E	1581	0.69	4
V41	Vermoispitz	46°38’18.750”N 10°50’40.038”E	1404	0.68	4
V42	Vermoispitz	46°38’16.063”N 10°50’39.947”E	1390	0.69	4
V43	Vermoispitz	46°38’3.721”N 10°50’37.406”E	1296	0.68	4
V44	Vermoispitz	46°38’6.572”N 10°50’36.769”E	1312	0.70	4
V45	Vermoispitz	46°38’0.276”N 10°50’40.250”E	1266	0.68	4
V46	Vermoispitz	46°37’57.684”N 10°50’43.636”E	1241	0.69	4
V47	Vermoispitz	46°37’40.828”N 10°51’12.261”E	1072	0.68	4
V48	Vermoispitz	46°37’36.577”N 10°51’18.615”E	1045	0.68	4
V49	Vermoispitz	46°37’35.200”N 10°51’27.024”E	1024	0.69	4
V50	Vermoispitz	46°37’22.935”N 10°51’58.345”E	662	0.69	4
V51	Vermoispitz	46°37’11.968”N 10°51’41.719”E	635	0.69	4
A1	Arundakopf	46°40’15.945”N 10°26’11.252”E	2720	0.32	2
A2	Arundakopf	46°40’12.871”N 10°26’11.627”E	2699	0.66	4
A3	Arundakopf	46°40’10.685”N 10°26’12.894”E	2668	0.65	4
A4	Arundakopf	46°40’7.394”N 10°26’13.286”E	2641	0.65	4
A5	Arundakopf	46°40’5.840”N 10°26’12.813”E	2617	0.66	4
A6	Arundakopf	46°40’6.392”N 10°26’16.996”E	2588	0.66	4
A7	Arundakopf	46°40’11.962”N 10°26’28.462”E	2540	0.33	2
A8	Arundakopf	46°40’12.060”N 10°26’37.253”E	2501	0.32	2
A9	Arundakopf	46°40’14.400”N 10°26’51.903”E	2404	0.32	2
A10	Arundakopf	46°40’18.631”N 10°26’54.155”E	2398	0.66	4
A11	Arundakopf	46°40’18.417”N 10°27’2.304”E	2379	0.33	2
A12	Arundakopf	46°40’15.598”N 10°27’4.519”E	2350	0.66	4
A13	Arundakopf	46°40’12.214”N 10°27’4.073”E	2320	0.67	4
A14	Arundakopf	46°40’9.640”N 10°27’4.710”E	2292	0.66	4
A15	Arundakopf	46°40’8.625”N 10°27’9.542”E	2258	0.66	4
A16	Arundakopf	46°40’5.980”N 10°27’8.952”E	2231	0.66	4
A17	Arundakopf	46°40’2.728”N 10°27’6.537”E	2202	0.66	4

Individual	Transect	Geographic coordinates	Elevation (m a.s.l.)	RGS	Ploidy
A18	Arundakopf	46°40’1.084”N 10°27’13.253”E	2172	0.68	4
A19	Arundakopf	46°39’58.280”N 10°27’17.105”E	2141	0.66	4
A20	Arundakopf	46°39’57.115”N 10°27’11.503”E	2110	0.66	4
A21	Arundakopf	46°39’52.670”N 10°27’8.737”E	2082	0.66	4
A22	Arundakopf	46°39’47.976”N 10°27’9.448”E	2051	0.66	4
A23	Arundakopf	46°39’46.902”N 10°27’13.861”E	2016	0.67	4
A24	Arundakopf	46°39’46.966”N 10°27’16.362”E	1983	0.66	4
A25	Arundakopf	46°39’45.839”N 10°27’18.780”E	1946	0.68	4
A26	Arundakopf	46°39’46.268”N 10°27’23.482”E	1917	0.66	4
A27	Arundakopf	46°39’42.349”N 10°27’20.232”E	1885	0.67	4
A28	Arundakopf	46°39’43.313”N 10°27’26.710”E	1858	0.68	4
A29	Arundakopf	46°39’43.133”N 10°27’36.774”E	1829	0.69	4
A30	Arundakopf	46°39’42.480”N 10°27’42.031”E	1807	0.67	4
A31	Arundakopf	46°39’40.395”N 10°27’47.619”E	1782	0.67	4
A32	Arundakopf	46°39’38.506”N 10°27’52.184”E	1761	0.67	4
A39	Arundakopf	46°39’35.257”N 10°27’59.744”E	1720	0.68	4
A40	Arundakopf	46°39’33.744”N 10°27’59.980”E	1695	0.68	4
A41	Arundakopf	46°39’32.171”N 10°28’5.579”E	1674	0.67	4
A42	Arundakopf	46°39’31.199”N 10°28’9.107”E	1638	0.67	4
A43	Arundakopf	46°39’28.865”N 10°28’3.296”E	1597	0.68	4
A44	Arundakopf	46°39’26.453”N 10°28’0.080”E	1571	0.68	4
A45	Arundakopf	46°39’21.134”N 10°28’4.774”E	1515	0.67	4
A46	Arundakopf	46°39’19.122”N 10°28’1.879”E	1486	0.67	4
A47	Arundakopf	46°39’19.041”N 10°27’56.376”E	1463	0.68	4
A48	Arundakopf	46°39’19.043”N 10°27’51.235”E	1444	0.67	4
A49	Arundakopf	46°39’20.003”N 10°27’46.725”E	1421	0.68	4
A50	Arundakopf	46°39’17.899”N 10°27’48.157”E	1397	0.68	4
A51	Arundakopf	46°39’14.950”N 10°27’57.360”E	1372	0.67	4
A52	Arundakopf	46°39’11.667”N 10°28’1.259”E	1349	0.67	4
A53	Arundakopf	46°39’9.672”N 10°28’8.031”E	1320	0.68	4
A54	Arundakopf	46°39’8.203”N 10°28’3.756”E	1301	0.67	4
A55	Arundakopf	46°39’6.147”N 10°28’7.003”E	1280	0.67	4
A56	Arundakopf	46°39’1.742”N 10°28’7.695”E	1246	0.67	4
A57	Arundakopf	46°38’57.487”N 10°27’59.641”E	1264	0.67	4
T1	Tschenglser Köpfl	46°35’3.196”N 10°38’28.317”E	1923	0.33	2
T2	Tschenglser Köpfl	46°35’1.695”N 10°38’26.707”E	1963	0.33	2
T3	Tschenglser Köpfl	46°34’58.891”N 10°38’24.870”E	1985	0.33	2
T4	Tschenglser Köpfl	46°34’55.566”N 10°38’23.629”E	2002	0.33	2
T5	Tschenglser Köpfl	46°34’55.297”N 10°38’15.424”E	2015	0.33	2
T6	Tschenglser Köpfl	46°34’53.537”N 10°38’5.744”E	2073	0.32	2
T7	Tschenglser Köpfl	46°34’53.445”N 10°38’4.257”E	2082	0.32	2
T8	Tschenglser Köpfl	46°34’55.555”N 10°38’2.850”E	2100	0.33	2
T9	Tschenglser Köpfl	46°34’54.776”N 10°37’59.449”E	2122	0.33	2
T10	Tschenglser Köpfl	46°34’52.711”N 10°37’59.048”E	2146	0.32	2
T11	Tschenglser Köpfl	46°34’52.138”N 10°37’55.546”E	2173	0.33	2
T12	Tschenglser Köpfl	46°34’51.472”N 10°37’50.589”E	2197	0.32	2
T13	Tschenglser Köpfl	46°34’48.802”N 10°37’45.501”E	2227	0.32	2

Individual	Transect	Geographic coordinates	Elevation (m a.s.l.)	RGS	Ploidy
T14	Tschenglser Köpfl	46°34’50.233”N 10°37’37.822”E	2245	0.33	2
T15	Tschenglser Köpfl	46°34’51.661”N 10°37’29.803”E	2249	0.32	2
T16	Tschenglser Köpfl	46°34’52.764”N 10°37’27.620”E	2272	0.32	2
T17	Tschenglser Köpfl	46°34’50.317”N 10°37’21.240”E	2305	0.32	2
T18	Tschenglser Köpfl	46°34’49.198”N 10°37’15.704”E	2331	0.32	2
T19	Tschenglser Köpfl	46°34’46.910”N 10°37’11.587”E	2348	0.32	2
T20	Tschenglser Köpfl	46°34’51.082”N 10°37’7.741”E	2382	0.32	2
T21	Tschenglser Köpfl	46°34’55.368”N 10°37’10.753”E	2391	0.33	2
T22	Tschenglser Köpfl	46°34’59.560”N 10°37’12.966”E	2421	0.33	2
T23	Tschenglser Köpfl	46°35’1.469”N 10°37’15.558”E	2444	0.34	2
T24	Tschenglser Köpfl	46°35’3.085”N 10°37’18.159”E	2459	0.33	2
T25	Tschenglser Köpfl	46°35’4.137”N 10°37’22.855”E	2473	0.33	2
T26	Tschenglser Köpfl	46°35’5.868”N 10°37’27.906”E	2494	0.33	2
T27	Tschenglser Köpfl	46°35’8.437”N 10°37’36.154”E	2520	0.33	2
T28	Tschenglser Köpfl	46°35’41.414”N 10°37’20.031”E	1954	0.32	2
T29	Tschenglser Köpfl	46°35’47.385”N 10°38’13.266”E	1757	0.69	4
T30	Tschenglser Köpfl	46°35’46.084”N 10°38’13.059”E	1749	0.68	4
T31	Tschenglser Köpfl	46°35’43.059”N 10°38’18.561”E	1721	0.68	4
T32	Tschenglser Köpfl	46°35’45.084”N 10°38’20.173”E	1683	0.69	4
T33	Tschenglser Köpfl	46°35’42.911”N 10°38’23.003”E	1649	0.70	4
T34	Tschenglser Köpfl	46°35’51.363”N 10°38’31.747”E	1396	0.67	4
T35	Tschenglser Köpfl	46°35’55.760”N 10°38’28.097”E	1383	0.67	4
T36	Tschenglser Köpfl	46°35’58.872”N 10°38’26.665”E	1367	0.68	4
T37	Tschenglser Köpfl	46°36’5.180”N 10°38’26.298”E	1335	0.68	4
T38	Tschenglser Köpfl	46°36’8.448”N 10°38’24.956”E	1306	0.68	4
T39	Tschenglser Köpfl	46°36’17.061”N 10°38’15.233”E	1282	0.69	4
T40	Tschenglser Köpfl	46°36’21.544”N 10°38’7.824”E	1258	0.68	4
T41	Tschenglser Köpfl	46°36’23.477”N 10°38’3.817”E	1241	0.70	4
T42	Tschenglser Köpfl	46°36’24.707”N 10°37’48.558”E	1205	0.69	4
T43	Tschenglser Köpfl	46°36’25.784”N 10°37’41.996”E	1164	0.69	4
T44	Tschenglser Köpfl	46°36’27.823”N 10°37’48.569”E	1146	0.71	4
T45	Tschenglser Köpfl	46°36’29.614”N 10°37’50.023”E	1120	0.70	4
T46	Tschenglser Köpfl	46°36’31.136”N 10°37’48.444”E	1101	0.68	4
T47	Tschenglser Köpfl	46°36’32.157”N 10°37’39.727”E	1071	0.70	4
T48	Tschenglser Köpfl	46°36’33.732”N 10°37’51.291”E	1047	0.68	4
T49	Tschenglser Köpfl	46°36’35.865”N 10°38’2.224”E	1013	0.68	4
T50	Tschenglser Köpfl	46°36’37.932”N 10°38’8.476”E	993	0.67	4
T51	Tschenglser Köpfl	46°36’43.306”N 10°38’9.544”E	962	0.68	4

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Camera-based monitoring of floral visitors on vertical rock faces: A pilot study in the Eastern Alpine endemic *Physoplexis comosa* (Campanulaceae)

Abstract

Understanding floral visitor dynamics along elevational gradients is essential for assessing potential implications for pollen limitation and genetic processes in fragmented populations of cliff-dwelling alpine endemics. *Physoplexis comosa* (Campanulaceae) is a chasmophytic paleoendemic restricted to vertical rock faces on dolomitic and limestone bedrock from 200 to 2,800 m a.s.l. The species exhibits a conspicuous inflorescence possessing pale lilac to violet flowers with fused corolla apices, basal openings for nectar access, and secondary pollen presentation, yet its functional floral visitor assemblage has remained poorly characterized across the species' elevational range.

In this pilot study, we tested a two-tier camera-monitoring setup that paired action cameras for diurnal monitoring with Raspberry Pi-based systems equipped with IR illumination for combined diurnal and nocturnal recording. We conducted monitoring across five elevational sites (1,480–2,400 m a.s.l.) in the Eastern Alps. Recorded video material was downsampled and annotated using the Addax platform alongside manual cross-validation to record physical contact events.

Preliminary results confirm the technical feasibility of continuous monitoring in steep terrain and suggest possible elevational variation in diurnal visitors, alongside nocturnal activity by Geometridae moths. Camera-based observations provided higher functional resolution and revealed a different visitor spectrum than previous eDNA metabarcoding trials.

This proof-of-concept establishes a methodological foundation for forthcoming multi-day monitoring campaigns and complements ongoing studies of the mating system and population genetic analyses.

Keywords: *Physoplexis comosa*, Alpine endemic, chasmophyte pollination, floral visitors, camera monitoring, eDNA metabarcoding, mating system

Introduction

Understanding how pollination dynamics vary along elevational gradients is essential for assessing potential pollinator limitation and its genetic consequences for isolated plant populations (Dai et al. 2017; Tong et al. 2021). For narrow-range endemics such as the tertiary paleoendemic cliff-dweller *Physoplexis comosa* (L.) Schur (Campanulaceae), reproductive success may be closely linked to the availability of efficient pollinators across varying abiotic conditions along a broad elevational range (200–2,800 m a.s.l.).

Although the species exhibits a captivating floral morphology – characterized by radially symmetrical flowers with permanently fused corolla lobes, basal corolla openings available at anthesis for nectar access, and secondary pollen presentation along the style – its mating system remains unknown. Knowing whether it is capable of autonomous self-pollination or relies on insect-mediated cross-pollination to set seeds

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is essential for understanding population persistence and providing context for its population genetic properties, particularly inbreeding indices.

To clarify the mating system, targeted floral isolation experiments were conducted during the 2026 flowering season, with seed set analyses planned after capsule harvest in October 2026. Establishing reliable baseline information on active floral visitor assemblages and visitation rates is therefore critical for interpreting potential pollinator limitation across the species' elevational range (Ashman et al. 2004; Kudo & Ida 2013; Inouye 2020; Körner 2021).

In this Short Communication, we present a technical proof-of-concept for camera monitoring on vertical rock face habitats. Our long-term aim is to qualitatively and quantitatively document diurnal and nocturnal floral visitor assemblages along an elevational gradient in the Eastern Alps, providing the methodological foundation for subsequent ecological and genetic assessments.

While the robustness of floral visitor communities to climate warming represents an important ecological question, this Short Communication focuses solely on establishing the technical feasibility of camera-based monitoring in extreme terrain and evaluating its performance relative to previous eDNA metabarcoding.

Materials & Methods

Study Species and Study Sites

Physoplexis comosa (L.) Schur (Campanulaceae) is a tertiary paleoendemic cliff-dwelling species restricted to dolomitic and limestone rock faces and crevices across the Southern Limestone Alps, ranging from the Bergamasque Alps in the west to the Julian Alps in the east. To establish a methodological baseline for future investigations of floral visitor assemblages along an elevational gradient, monitoring was conducted as a pilot study to prepare a comprehensive project encompassing a broader elevational range from 200 m to 2,400 m a.s.l. Field recording spanned five representative sites from 1,480 m a.s.l. on the slopes of Monte Grappa to 2,400 m a.s.l. beneath Monte Lagazuoi (Table 1). Recording sessions were executed under stable weather conditions, characterized by clear to partly cloudy skies, light air to gentle breezes (2.2–18.7 km/h), and ambient daytime temperatures ranging between 9 °C and 21 °C. The climatic data were excerpted from the Open-Meteo API (Zippenfenig 2024). As a preliminary assessment of autonomous self-pollination, selected inflorescences at two locations (Mt Altissimo and Monte Baldo) were bagged prior to anthesis and subsequently assessed for seed production.

Camera Setup

(i) 24-Hour and Night-Vision Monitoring: Recording was conducted using three custom Raspberry Pi Zero 2 W camera systems equipped with an ODSEVEN Camera HD IR-CUT (OV5647, 5 MP) day/night module paired with 850 nm infrared LED illuminators. The cameras were mounted on tripods at a distance of 30–70 cm from target inflorescences (settings: 1080p resolution at 30 fps) (Figure 1). This setup enabled uninterrupted nocturnal and diurnal monitoring without altering insect behaviour or inducing phototropic responses (at Passo di Falzarego, 2,100 m a.s.l.).

(ii) Supplementary Diurnal Monitoring: Additionally, three Lamax 9.0 action cameras were deployed during peak diurnal insect activity (Table 1) to increase overall recording coverage per site and to evaluate recording quality, footage length, and battery performance across different camera systems under alpine conditions.

Continuous video recording was implemented instead of motion-triggered workflows to minimize the risk of missing floral visitation events during the short flowering period of *Physoplexis comosa*.



Figure 1: Field monitoring setup and confirmed floral visitor. **(a)** Custom Raspberry Pi-based camera setup for combined diurnal and nocturnal monitoring, deployed at Passo Falzarego (2,100 m a.s.l.). Three camera units are directed at inflorescences on a steep dolomitic rock face adjacent to blooming *Physoplexis comosa*. **(b)** Diurnal visitor contact event: *Aglais urticae* visiting an inflorescence of *P. comosa* at the same study site.

Table 1: Overview of study sites, sampling dates, environmental baseline conditions, plant phenology, and applied monitoring methodologies for *Physoplexis comosa* during the 2026 field campaign.

Location	**Mte. Grappa**	**Mte. Altissimo**	**Mte. Tremalzo**	**Passo di Falzarego**	**Lagazuoi Piccolo**
Date	026/06/2026	07/07/2026	08/07/2026	23–24/07/2026	25/07/2026
Time	8:50–10:00	10:15–11:45	10:00–11:30	17:00–15:00	09:00–11:00
Duration of stay	70 min	90 min	90 min	22 hours / overnight	120 min
Elevation	1400 m a.s.l.	1930 m a.s.l.	1880 m a.s.l.	2100 m a.s.l.	2400 m a.s.l.
Abundance / *Phys. com.*	low	high	medium-low	low	high
Temperature	20.9–21.4 °C	14.8–17.7 °C	18.3–19.2 °C	12.5–14.2 °C	
Solar radiance	high	high	medium	high	high
Cloud cover	low	low	low	low	low
Windiness	light air/ light breeze	light air	low breeze	gentle breeze	light air
Bagging	NO	YES	NO	NO	NO
Camera recording	NO	YES	YES	YES	YES
Phenology	OPTIMUM	OPTIMUM	OPTIMUM	OPTIMUM / LATE	OPTIMUM

Data Processing and Visitor Annotation

Here, visitor annotation comprised the detection, identification, and labelling of floral visitation events within the recorded image sequences rather than computer-vision model training. A valid visitation event was defined as physical contact between an insect and any floral element of the inflorescence, whereas non-contact fly-bys were excluded. To optimize data processing from high-resolution raw footage, video files were downsampled into single image sequences using FFmpeg at sampling intervals of 1 to 3 seconds per frame (1–0.33 fps), tailored to the respective recording setup.

Annotation was conducted using a dual, complementary workflow combining automated pre-screening and manual verification (Stark et al. 2023): **(i) Automated Pre-screening**: To reduce visual inspection effort across extensive datasets (> 10,000 frames), image sequences were pre-screened via the AddaxAI platform, version 0.7.8 (van Lunteren 2023) using MegaDetector v5a at a conservative 15% confidence threshold to flag candidate frames with potential target objects. **(ii) Manual Validation:** All candidate frames flagged by MegaDetector v5a, as well as unflagged image sequences and short-duration clips, were subjected to manual visual inspection by the authors to confirm physical contact with floral elements and annotate visitors to the finest achievable taxonomic level (primarily family level, and rarely to genus or species level).

To complement the camera-based recording, direct *in situ* field observations were conducted during daylight hours while monitoring the sites. Consequently, visitation data are presented separately in Table 1, distinguishing between camera-recorded visits and direct field observations.

Given the pilot nature and qualitative scope of this study, data processing was limited to descriptive evaluation. Floral-visitor taxa were compiled per site and elevational step to document basic visitor presence, assemblage composition, and diurnal versus nocturnal activity patterns. Formal statistical modelling is reserved for forthcoming multi-day screening campaigns, where standardized observation windows will allow quantitative analyses.

Results

Continuous camera-monitoring and direct field observations revealed a diverse spectrum of floral visitors across all study sites, represented by Diptera, Hymenoptera, and Lepidoptera (Table 2).

Across the five study locations (1,480–2,400 m a.s.l.), automated camera monitoring was successfully conducted at four sites, while the lowest elevation site (slopes of Monte Grappa, 1,480 m a.s.l.) was assessed solely via direct in situ observations (Table 1). Lower to subalpine sites (1,480–1,930 m a.s.l.) were characterized by active diurnal foraging of

Table 2: Comparison of floral visitor taxa recorded on *Physoplexis comosa* via continuous camera monitoring and direct field observations across study sites during the 2026 campaign.

Location/Site	Elevation (m a.s.l.)	Date	Camera-recorded floral visitors	Directly observed floral visitors
Monte Grappa 45.8622439N, 11.8087256E	1,480	26/06/2026	No cameras used	Apidae (*Bombus* sp.), Nymphalidae (*Erebia sp., Vanessa cardui*)
Monte Tremalzo 45.8414450N, 10.7008447E	1,880	08/07/2026	Apidae (*Xylocopa* sp.), Syrphidae	Syrphidae
Mte. Altissimo 45.8059053N, 10.8886053E	1,930	07/07/2026	Apidae (*Bombus* sp.)	Apidae (*Bombus* sp.)
Passo di Falzarego 46.5237656N, 12.0228939E	2,100	24/07/2026	Syrphidae, Muscidae, Geometridae, Nymphalidae (*Aglais urticae, Erebia* sp.)	Syrphidae, Muscidae
Mte. Lagazuoi Piccolo 46.5273619N, 12.0159686E	2,400	25/07/2026	Muscidae	Muscidae

Hymenoptera/Apidae (*Bombus* sp., *Xylocopa* sp.) and Lepidoptera/Nymphalidae (*Erebia* sp., *Vanessa cardui*). At high-elevation sites (2,100–2,400 m a.s.l.), Diptera (Syrphidae, Muscidae) dominated diurnal visits alongside Lepidoptera (*Erebia* sp. and *Aglais urticae*) (Figure 1b). Automated nocturnal recording at Passo di Falzarego (2,100 m a.s.l.) captured night-active Geometridae moths actively visiting the inflorescences.

The camera recordings successfully captured flower visits at four key sites (e.g., *Bombus* sp. at Monte Altissimo di Nago; Syrphidae and Muscidae at Monte Tremalzo, Passo di Falzarego, and Monte Lagazuoi) while additionally capturing larger transient visitors such as *Xylocopa* sp. and various Lepidoptera (Table 2). Direct in situ observations carried out in 2026 recorded visiting insects across all five sampled locations, validating camera recordings. These records included major functional floral visitors such as *Bombus* sp. and *Vanessa cardui* at Monte Grappa, as well as various Syrphidae and Muscidae across higher-located sites (Monte Tremalzo, Passo di Falzarego, Monte Lagazuoi).

These records complement preliminary direct field observations from 2023 (K. Iberl, pers. obs.), which documented sporadic visits by Formicidae at Monte Verzegnis (Carnic Prealps), Miridae near Predil (Julian Alps), and Geometridae at Monte Altissimo di Nago (Garda Prealps). The bagging experiments yielded apparently well-filled seeds in four enclosed inflorescences. Fruit set was generally low, with 4/18, 5/12, 4/11 and 1/7 capsules producing seeds, corresponding to an overall fruit set of ~29%. The viability of the resulting seeds remains to be tested.

Discussion & Outlook

Consistent with previous studies across different environments (Darras et al. 2024; van Klink et al. 2024), camera-based monitoring provides clear and reliable functional resolution of floral visitors in the exposed terrain of vertical rock cliffs. Our observations suggest possible elevational shifts in diurnal floral visitor assemblages, alongside a notable nocturnal component represented by Geometridae moths at the subalpine-alpine boundary elevations (Passo di Falzarego, slopes of Lagazuoi Piccolo, 2,100 m a.s.l.). This activity highlights a previously underestimated nocturnal interaction pathway in the reproductive biology of this paleoendemic cliff-dweller. While plant–pollinator studies have historically focused on diurnal taxa such as Apidae and Syrphidae (e.g., Walton et al. 2020), nocturnal Lepidoptera may provide functional complementarity and resilience in harsh, high-elevation environments (Knop et al. 2017; Macgregor & Scott-Brown 2020).

At the same time, specific environmental constraints should be kept in mind when using camera setups to monitor floral visitors on exposed rock faces. While motion-triggered systems reduce storage space and extend battery life during long-term deployments, they pose specific trade-offs in alpine environments. Continuous video recording was implemented instead of motion-triggered workflows to minimize the risk of missing floral visitation events (false negatives) during the short flowering period of *Physoplexis comosa*, e.g., when small or rapidly moving insects fail to activate the trigger. Continuous camera monitoring (Droissart et al. 2021) effectively captures visitation events in steep habitats, whereas visitor detection and identification were conducted during post-processing using automated pre-screening and manual verification, and no real-time AI-based insect recognition was employed on site. We preferred to do so for two main reasons: First, continuous real-time computer vision processing would increase power consumption, strongly shortening battery life. Second, running intensive AI algorithms inside weatherproof hardware enclosures creates a risk of processor overheating.

For automated pre-screening, referring to the detection and flagging of candidate floral visitation frames, we utilized the AddaxAI platform (v. 0.7.8) with the implemented MegaDetector v5a model to filter out empty frames across extensive image sequences (>10,000 frames) and reduce manual visual effort. In our pilot deployment, this pipeline performed reliably in isolating insect visitation events, though detection sensitivity was influenced by confidence thresholds. Specifically, applying a 15% detection

threshold in AddaxAI led to a small number of missed visits, which were subsequently identified during manual cross-validation. While general-purpose wildlife detectors like MegaDetector v5a can introduce limitations when capturing small arthropods under constrained light conditions, our combination of automated pre-screening with subsequent manual validation ensured that all visitation events were captured. For our upcoming research campaigns, we plan to evaluate and implement higher-tier, arthropod-specific vision models including recent YOLO-based architectures (e.g., Bjerge et al. 2023) to enhance automated detection recall and precision for small floral visitors under challenging field conditions.

Beyond potential technical challenges under adverse weather, biotic flight thresholds of diurnal alpine Diptera and Hymenoptera can lead to "false-zero" visitation records when ambient temperatures drop below 10–12°C or during dense cloud cover (compare McCall & Primack 1992; Körner 2021). However, morning records of Muscidae at the highest site (slopes of Lagazuoi Piccolo, 9–12.7 °C) suggest that direct solar radiation on east-facing cliff faces can locally overcome low ambient air temperatures by warming the rock microenvironment and ectothermic visitors. Continuous camera monitoring in cliff environments is therefore methodologically most informative when interpreted alongside baseline abiotic conditions and microclimatic exposure (Table 1).

The necessity for a visual monitoring approach is further underscored by initial methodological comparisons using environmental DNA from floral surfaces (eDNA): while eDNA metabarcoding offers promising, non-invasive monitoring options, previous testing in our study system revealed that floral surface DNA was dominated by resident micro-arthropods (e.g., Thysanoptera, Acari), whereas transient flying visitors (Hymenoptera, Diptera) went largely undetected. Consequently, continuous camera monitoring was required to reliably record the active pollinator assemblage of *Physoplexis comosa*. However, while this pilot campaign confirms the technical feasibility of both diurnal and nocturnal camera monitoring on vertical rock faces, capturing the full spatio-temporal variation in visitor assemblages across the species' broad elevational gradient requires extended observation windows. A comprehensive quantitative field study along the entire elevational gradient is therefore planned for the upcoming season. Furthermore, preliminary bagging trials yielded apparently well-filled seeds in a subset of enclosed inflorescences, indicating a limited capacity for autonomous self-pollination. However, the low fruit set recorded under pollinator exclusion suggests that autonomous seed production represents the exception rather than the norm, and that animal-mediated pollination is likely essential for substantial reproductive output in *P. comosa*. Future studies should assess the degree of self-compatibility, offspring viability and potential inbreeding effects using germination assays and population genetic approaches.

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Bibliography

Ashman T.-L., Knight. T. M., Steets J. A., Amarasekare P., Burd M., Campbell D. R. et al., 2004: Pollen limitation of plant reproduction: ecological and evolutionary causes and consequences. Ecology, 85: 2408–2421.

Bjerge K., Frigaard C. E. & Karstoft H., 2023: Object Detection of Small Insects in Time-Lapse Camera Recordings. Sensors (Basel, Switzerland), 23. DOI: 10.3390/s23167242.

Dai W.-K., Kadiori E. L., Wang Q.-F. & Yang C.-F., 2017: Pollen limitation, plasticity in floral traits, and mixed mating system in an alpine plant *Pedicularis siphonantha* (Orobanchaceae) from different altitudes. Journal of Systematics and Evolution, 55: 192–199.

Darras K. F. A., Balle M., Xu W., Yan Y., Zakka V. G., Toledo-Hernández M. et al., 2024: Eyes on nature: Embedded vision cameras for terrestrial biodiversity monitoring. Methods in Ecology and Evolution, 15: 2262–2275. DOI: 10.1111/2041-210X.14436.

Droissart V., Azandi L., Onguene E. R., Savignac M., Smith T. B. & Deblauwe V., 2021: PICT: A low-cost, modular, open-source camera trap system to study plant-insect interactions. Methods in Ecology and Evolution, 12: 1389–1396. DOI: 10.1111/2041-210X.13618.

Inouye D. W., 2020: Effects of climate change on alpine plants and their pollinators. Annals of the New York Academy of Sciences, 1469: 26–37. DOI: 10.1111/nyas.14104.

Knop E., Zoller L., Ryser R., Gerpe C,. Hörler M. & Fontaine C., 2017: Artificial light at night as a new threat to pollination. Nature, 548: 206–209. DOI: 10.1038/nature23288.

Körner C., 2021: Alpine Plant Life. Functional Plant Ecology of High Mountain Ecosystems: Cham: Springer Nature Switzerland AG.

Kudo G. & Ida T. Y., 2013: Early onset of spring increases the phenological mismatch between plants and pollinators. Ecology, 94: 2311–2320. DOI: 10.1890/12-2003.1.

Macgregor C. J. & Scott-Brown A. S., 2020: Nocturnal pollination: an overlooked ecosystem service vulnerable to environmental change. Emerging Topics in Life Sciences, 4: 19–32. DOI: 10.1042/ETLS20190134.

McCall C. & Primack R. B., 1992: Influence of flower characteristics, weather, time of day, and season on insect visitation rates in three plant communities. American Journal of Botany, 79: 434–442.

Stark T., Ştefan V., Wurm M., Spanier R., Taubenböck H. & Knight T. M., 2023: YOLO object detection models can locate and classify broad groups of flower-visiting arthropods in images. Scientific Reports, 13, Article 16364.

Tong Z.-Y., Wu L.-Y. & Huang S.-Q., 2021: Reproductive strategies of animal-pollinated plants on high mountains: A review of studies from the "Third Pole". Journal of Sytematics and Evolution, 59: 1159–1169. DOI: 10.1111/jse.12680.

van Klink R., Koch Sheard J., Høye T. T., Roslin T., Do Nascimento L. A. & Bauer S., 2024: Towards a toolkit for global insect biodiversity monitoring. Philosophical Transactions: Biological Sciences, 379, Article 20230101.

van Lunteren P., 2023: AddaxAI: A no-code platform to train and deploy custom YOLOv5 object detection models. JOSS, 8: 5581. DOI: 10.21105/joss.05581.

Walton R. E., Sayer C. D., Bennion H. & Axmacher J. C., 2020: Nocturnal pollinators strongly contribute to pollen transport of wild flowers in an agricultural landscape. Biology Letters, 16: 20190877. DOI: 10.1098/rsbl.2019.0877.

Zippenfenig P., 2024: Open-Meteo.com Weather API: Zenodo.

Thomas Wilhalm & Elias Spögler (eds.)

Notulae Florae austrotiroliensis (3)

Abstract

Notulae Florae austrotiroliensis (3) include the following first records for South Tyrol (Province of Bolzano, Italy): Among the native taxa are *Botrychium simplex*, *Campanula glomerata* subsp. *cervicarioides*, *Luzula divulgatiformis*, and *Thalictrum simplex* subsp. *galioides*, among the neophytes classified as casual are *Arum italicum*, *Aucuba japonica*, *Campanula medium*, *Ceratocapnos claviculata*, *Cotoneaster bullatus*, *Helleborus orientalis*, *Hesperocyparis arizonica*, *Hylotelephium ewersii*, *Monarda didyma*, *Muhlenbergia mexicana*, *Nandina domestica*, *Oenothera sesitensis*, *Oe. speciosa*, *Phedimus hybridus*, *Pittosporum tobira*, *Ranunculus parviflorus*, *Soleirolia soleirolii*, and *Yucca gloriosa*. The newly discovered species *Cotoneaster divaricatus, Eryngium giganteum, Muscari armeniacum, Phyllostachys aurea* and *Rabelera holostea* are considered locally established.

The neophytic species *Adonis annua*, *Falcaria vulgaris* and *Hylotelephium telephium* are recorded again after decades of missing records in South Tyrol. The same applies to the native *Orobanche salviae* and *Cyperus longus* and to *Rosa gallica*, whose status remains unclear.

Remarkable new distribution data are given for the native taxa *Amelanchier ovalis* subsp. *embergeri*, *Festuca stenantha*, *Fourraea alpina*, *Ophioglossum vulgatum*, *Potamogeton praelongus*, *Sparganium hyperboreum*, and *Trifolium spadiceum*.

Keywords: catalogue of vascular plants, first and new records, South Tyrol, Italy

Einführung

Die „Notulae Florae austrotiroliensis“ wurden erstmals im Jahre 2025 eingeführt, um die bisherige Serie „Ergänzungen und Korrekturen zum Katalog der Gefäßpflanzen Südtirols“ als Publikationsplattform für Neu- und Wiederfunde von Gefäßpflanzen in der Provinz Bozen (Italien) offener, d. h. optional für verschiedene Herausgeber in den Sprachen Deutsch, Italienisch und Englisch, zu gestalten (siehe Wilhalm & Spögler 2025 für weitere Details).

Taxonomie & Nomenklatur der angeführten Taxa richten sich, wenn nicht eigens vermerkt, nach Fischer et al. (in Druck), Galasso et al. (2024) bzw. WFO (2026). Allgemeine Angaben zu Ökologie und Verbreitung der Taxa sind den jeweils aktuellen Ausgaben des Hegi (1906–) sowie POWO (2026) und Fischer et al. (l.c.) entnommen, gegebenenfalls zusätzlich angeführter Literatur.

Die den angeführten Funden zugrunde liegenden Belege befinden sich im Herbarium BOZ des Naturmuseums Südtirol. Besteht nur ein Fotonachweis, so ist dies durch * gekennzeichnet, besteht nur die bloße Angabe, so durch #.

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Neufunde

Arum italicum Mill. (Araceae)

Fund: Überetsch, Kaltern, 1,3 km S Klughammer Richtung Gmund, Rand des Leuchtenburger Waldes, 218 m [9633/2], Gehölzrand (*Celtis australis*, *Robinia pseudoacacia*, *Ruscus aculeatus*), geschlägerte Böschung, 7 Pflanzen in Blüte, 1.5.2026, Erika Sölva (BOZ 50284, vegetative Pflanzen bereits am 1.2.2026 entdeckt; eine nachträgliche Recherche ergab, dass dieser Bestand unabhängig davon bereits am 13.07..2025 von Luca Boscain entdeckt und auf iNaturalist veröffentlicht wurde).
Bemerkungen: Neu für Südtirol. Die stenomediterrane Art wird in allen Regionen Italiens als einheimisch eingestuft (Bartolucci et al. 2024). Im Trentino sind Vorkommen südlich von Trient bekannt; nach Prosser et al. (2019) gibt es aber nur im Gardasee-Gebiet stabile Populationen, während es sich bei den meisten Vorkommen um unbeständige handelt. Die Autoren stellen daher in Frage, ob die Art im Trentino überhaupt als autochthon einzustufen ist.

Die Herkunft des kleinen Bestands am Kalterer See ist unklar. Möglicherweise stammen die Pflanzen aus entsorgten Gartenabfällen, aus denen die Samen gekeimt sind, oder sie gelangten über von Vögeln verschleppte Samen hierher.
Status: nicht einheimisch; unbeständig

Aucuba japonica Thunb. (Garryaceae) (Abb. 1)

Fund: Sarntal, Sarner Schlucht 1,8 km SSW Halbweg, 0,24 km NNE Moarhäusl, orographisch rechts an der Talfer, 485 m [9434/1], Bachböschung mit Ablagerung von Gartenmaterial, ein ca. 2 m hoher, reich verzweigter, blühender Strauch, panaschierte Kulturvarietät „Variegata“, 19.4.2026, E. Spögler (BOZ 50381, entdeckt bereits am 14.2.2026).
Bemerkungen: Neu für Trentino-Südtirol. Die Japan-Aukube („Fleckenlorbeer“) stammt aus Südostasien (Süd-China, Süd-Japan, Taiwan) und wird hauptsächlich als Kübel- und Zimmerpflanze kultiviert. Angaben von Verwilderungen gibt es aus der



Abb. 1: *Aucuba japonica*, Sarntal (Foto: E. Spögler)

Schweiz (vor allem Tessin und Genfer See, InfoFlora 2026) und aus Deutschland, wo Gartenabfälle als primäre Quelle für die (vegetative) Verwilderung angegeben werden und wo in wintermilden Gebieten bereits eine generative Ausbreitung zu beobachten ist (Hetzel & Gausmann 2010 und darin zitierte Literatur). In Italien ist die Art aus den nördlichen Regionen Lombardei, Venetien und Ligurien sowie aus Sardinien gemeldet – vorerst nur als unbeständig (Galasso et al. 2024).

Die Aukube gehört neben *Laurus nobilis*, *Prunus laurocerasus*, *Trachycarpus fortunei*, *Ligustrum lucidum* und anderen zu jenen immergrünen exotischen Arten, die im Zusammenhang mit dem Phänomen der Laurophyllisierung stehen. Damit ist die Unterwanderung laubwerfender Wälder von immergrünen Laubgehölzen und letztlich die Umwandlung in immergrüne Wälder im Zuge der globalen Erwärmung gemeint (vgl. Klötzli et al. 1996).

Status: nicht einheimisch; unbeständig

Botrychium simplex E. Hitchc. (Ophioglossaceae) (Abb. 2)

Fund: Eisacktal, Kastelruth, Seiser Alm, Schutzgebiet Großes Moos/Gran Paluch, 1855 m [9435/4], Niedermoor, kleinflächiger Bestand mit 23 gezählten oberirdischen Sprossen, zusammen mit *Paludella squarrosa*, 15.7.2026, Jonas Noah Geurden* (Fotobeleg, teste Karsten Horn). Bestätigung des Bestandes am 4.8.2026 durch E. Spögler und Simon Stifter mit rund 30 nachgewiesenen oberirdischen Sprossen.
Bemerkungen: Neu für Südtirol. Nach *Botrychium simplex* wurde in Südtirol seit Jahren gesucht, ist doch die Art schon länger aus allen angrenzenden Regionen bekannt (vgl. Übersicht in Horn & Korneck 2003). Zu biologischen und naturschutzfachlichen Aspekten dieser schwerpunktmäßig zirkumborealen Art und insbesondere zur Bedeutung des vorliegenden Fundes für Südtirol siehe Spögler & Geurden (in Vorb.).

Status: einheimisch; etabliert



Abb. 2: *Botrychium simplex*, Seiser Alm (Foto: J. N. Geurden)

Campanula glomerata subsp. *cervicarioides* (Schut.) Arcang. (Campanulaceae)

Funde: Überetsch, Kaltern, N Klughammer, an der Straße zum Kreither Sattel, 297 m [9633/2], Straßenböschung, Rand submediterraner Eichenwald, 11.7.2022, Erika Sölva (BOZ 47966, det. T. Wilhalm); Südtiroler Unterland, Altrei, 1,1 km N Dorf, am Wanderweg (Nr. 5) 0,77 km SE Krabesalm, 1370 m [9734/1], Magerwiese, kleiner Bestand, 22.6.2025, Erika Sölva (BOZ 49970, det. T. Wilhalm).
Bemerkungen: Neu für Südtirol. Laut Fischer et al. (2026) hebt sich diese von den Autoren in den Rang einer Unterart gehobene Sippe von anderen Formen der *Campanula glomerata* durch folgende Merkmale ab: Blütenstand mit seitlichen Blütenköpfen, daher unterbrochen; mittlere Stängelblätter lanzettlich, Blätter steifhaarig (weder kahl noch flaumhaarig, vgl. andere Formen von *C. glomerata*). Die Pflanzen aus Kaltern entsprechen dieser Beschreibung sehr gut, zudem sind die Stängel durchgehend von kurzen steifen Haaren bedeckt. Jene aus Altrei weichen etwas ab: Die unteren Stängelblätter sind ähnlich wie bei *C. cervicaria* keilförmig in den Blattstiel verschmälert (von dieser aber durch die nahezu kahlen Stängel, die spitzen Kelchzähne und den kürzeren, die Krone nicht überragenden Griffel unterschieden).

Die meisten Autoren erkennen dieser Sippe keinen taxonomischen Rang zu (höchstens Varietätsrang), da die genannten Merkmale auf Populations- oder gar auf Ebene von Individuen variieren. Auch geografisch und ökologisch lassen sich kaum trennende Eigenschaften erkennen (vgl. Pignatti 2017–19; Bartolucci et al. 2024).

Status: einheimisch; etabliert

Campanula medium L. (Campanulaceae)

Fund: Ahrntal, Weißenbach, am Mitterbach am Eingang des Mitterbachtales, Nordrand von Weißenbach im Bereich der letzten Häuser, 1380 m [9037/1], Bachböschung, Einzelpflanze, 13.7.2025, Mario Larcher*.
Bemerkungen: Neu für Südtirol. Submediterrane Art, als Zierpflanze kultiviert. Die verwilderte Pflanze aus Weißenbach stammt wahrscheinlich aus einem 200 m entfernt liegenden Garten; allerdings finden sich dort nur weißblühende Pflanzen in Kultur, während die Pflanze am Mitterbach blaublühend war. Angaben von Verwilderungen liegen auch aus dem benachbarten Trentino (Prosser et al. 2019) vor.

Stauts: nicht einheimisch; unbeständig



Abb. 3: *Ceratocapnos claviculata*, Kolfuschg (Foto: T. Wilhalm)

Ceratocapnos claviculata (L.) DC. (Fumariaceae) (Abb. 3)

Fund: Westliche Dolomiten, Gadertal, Westrand von Kolfuschg, beim Restaurant Mathiaskeller, 1674 m [9437/1], als Beikraut in einem Blumentrog mit gepflanzter Konifere, mehrere Pflanzen in Blüte, 21.7.2026, Georg Aichner & T. Wilhalm (BOZ 50342).
Bemerkungen: Neu für Trentino-Südtirol und Italien. Der Weiße Rankenlerchensporn ist ein ozeanisches Florenelement und westeuropäisch verbreitet (vgl. Arealkarte unter https://www.floraweb.de/php/artenhome.php?name-use-id=21221). Laut Fischer et al. (in Druck) tritt die Art in Österreich unbeständig verschleppt auf und ist möglicherweise in Ausbreitung begriffen. Hinweise auf Vorkommen in Ländern wie der Schweiz oder Italien fehlen allerdings bislang (vgl. InfoFlora 2026 und Galasso et al. 2024). Die Herkunft der Pflanzen aus Kolfuschg bleibt unklar, eine Einschleppung durch Gartenerde erscheint plausibel.

Status: nicht einheimisch; unbeständig

Cotoneaster bullatus Bois (Rosaceae)

Fund: Eisacktal, Vahrn, südlich des Dorfes, Osthang, W der Eisenbahnlinie 0,1 km NW Hof Gatscher, 623 m [9235/4], Wald-/Wegrand, Kastanienwald, mehrere Individuen, 16.4.2026, Alois Fundneider & Camilla Wellstein (BOZ 50404).
Bemerkungen: Neu für Trentino-Südtirol. Aus China stammender Zierstrauch. In Italien bislang nur aus der Lombardei gemeldet und zwar als eingebürgert (Galasso et al. 2024). Anders in Österreich, Deutschland und der Schweiz, wo die Art in vielen Gebieten verwildert auftritt, in Südbayern sogar bestandsbildend in Wäldern (Dickorè & Kasperek 2010; siehe auch FloraWeb 2026, InfoFlora 2026, Fischer et al. in Druck).

Status: nicht einheimisch; unbeständig (?)

Cotoneaster divaricatus Rehder & E. H. Wilson (Rosaceae) (Abb. 4)

Funde: Wipptal, Gossensaß, S- bis SSE-Abfall der Franz-Josefs-Höhe 0,6 km (S)SE Pfarrkirche, 1116 m [9034/4], verbuschter, felsiger Trockenhang, Gehölzbestand, kleiner Bestand, mehrere Sträucher, 18.4.2026, E. Spögler (BOZ 50382); Eisacktal, Neustift, rund 0,5 km N Kloster, 0,1 km W unterhalb Hof Jummer, 700 m [9235/4], Föhrenwald, kleiner Bestand von einigen Sträuchern, 20.4.2026, Alois Fundneider & Camilla Wellstein (BOZ 50390).
Bemerkungen: Neu für Trentino-Südtirol. Der ursprünglich aus China stammende, als Zierstrauch vielfach kultivierte *Cotoneaster divaricatus* ist wahrscheinlich in Mitteleuropa die häufigste verwilderte und etablierte allochthone Art der Gattung. Sie tritt in vielen Gebieten auf und bildet lokal große, wohl durch Vögel verbreitete und sich selbst erhaltende invasive Bestände (Dickorè & Kasperek 2010 und darin zitierte Literatur). In Italien war die Art erstmals – und bislang einzig – unbeständig aus der Lombardei gemeldet (Galasso et al. 2021, 2024), während Angaben aus dem Piemont auf Verwechslungen mit *C. symondsii* beruhen (siehe Anmerkung in Acta Plantarum 2026, als „*C. simonsii*“). In den an Südtirol angrenzenden Gebieten liegen Nachweise aus Nordtirol und Graubünden vor (Pagitz et al. 2023; Fischer et al. in Druck), nicht aber aus dem Trentino.

Die Bestimmung der vorliegenden Belege erfolgte mit den Schlüsseln in Dickoré & Kasperek (l.c.) und Stace (2010) unter Zuhilfenahme von Fischer et al. (l.c.) und Meyer (2026).

Status: nicht einheimisch; lokal beständig



Abb. 4: *Cotoneaster divaricatus*, Neustift (Foto: A. Fundneider)

Eryngium giganteum M. Bieb. (Apiaceae)

Fund: Eisacktal, Tiers, St. Zyprian, ca. 0,3 km ESE Forstgarten, 1207 m [9535/1], Böschung zwischen Forstweg und Fichtenwald, mit Hochstauden und (temporärer?) Ablagerung von Gartenabfällen, 2 blühende und ein gutes Dutzend vegetative Individuen, zusammen mit *Hemerocallis* sp. und *Mentha* sp., offensichtlich durch Gartenabfälle eingebracht, 11.8.2026, E. Spögler (BOZ 50376, von Georg Aichner bereits am 17.7.2026 entdeckt*).
Bemerkungen: Neu für Trentino-Südtirol und Italien. Die Art wird als Zier- und Bienennährpflanze kultiviert und stammt ursprünglich aus Kaukasien und der Nord-Türkei. Verwilderungen sind vor allem aus Mitteleuropa bekannt, aus Italien liegen noch keine Angaben vor (vgl. Galasso et al. 2024). Als mögliche Quelle des neu entdeckten Bestandes kommt der Garten des ca. 1,3 km W der Fundstelle gelegenen Zipperle-Hofes infrage, wo die Art kultiviert wird.

Status: nicht einheimisch; lokal beständig

Helleborus orientalis Lam. (inkl. Zuchtsorten und Hybriden) (Ranunculaceae)

Fund: Eisacktal, Steinegg, Oberdorf, orographisch rechts im Graben des Viglatscher Baches ca. 50 m WSW unterhalb Hof Wieser, 874 m [9534/2], schattiger Bachgraben, Mischwald, 1 blühendes Individuum, offensichtlich aus Ablagerung von Gartenabfällen hervorgegangen, 15.3.2026, E. Spögler (BOZ 50384).
Bemerkungen: Erste belegte Angabe für Trentino-Südtirol. Der Erstnachweis (Fotobeleg) wurde einige Tage zuvor, am 10.3.2026, von Tisk Liekens im Frühlingstal bei Montiggl erbracht und auf iNaturalist veröffentlicht (siehe https://www.inaturalist.org/observations/349827043). Die Art wird als Zierpflanze kultiviert und stammt ursprünglich aus der Türkei und dem Kaukasus. Nachweise adventiver Vorkommen konzentrieren sich auf Mittel- und Nordeuropa (z.B. Stace 2010; InfoFlora 2026; Fischer et al. in Druck), in Italien ist sie bislang nur aus der Region Friaul-Julisch-Venetien dokumentiert (Galasso et al. 2024).

Status: nicht einheimisch; unbeständig

Hesperocyparis arizonica (Greene) Bartel (Cupressaceae)

Fund: Untervinschgau, Naturns, Kompatsch, Eingang des Schnalstales, westlich über dem ersten Straßentunnel, 555 m [9331/4], aufgeschüttete Böschung im Kontaktbereich mit der inneralpinen Trockenvegetation, ein ausgewachsener Baum, völlig isoliert, 1.6.2026, T. Wilhalm (BOZ 50285).
Bemerkungen: Neu für Trentino-Südtirol. Das Auftreten der Arizona-Zypresse am Eingang des Schnalstals in halbnatürlicher Umgebung erscheint völlig unklar. Der Straßentunnel wurde 2003 eröffnet, d. h. der Baum kann erst danach an Ort und Stelle aufgetreten sein. Rein von der Größe des Baumes her betrachtet, dürfte das aber bald geschehen sein. Nach Auskunft der Forstbehörde (lokale Forststation und Amt für Forstplanung der Autonomen Provinz Bozen-Südtirol) war die Art bislang bei keinerlei forstlicher Maßnahme in Südtirol in Verwendung; der Baum muss daher wohl auf eine unbekannte, private Einzel-Anpflanzungsaktion zurückgehen oder – eher unwahrscheinlich – aus einem eingetragenen Samen hervorgegangen sein. Es sind jedenfalls weitum keine Anpflanzungen bekannt, die als Samenquelle in Frage kämen.

Status: nicht einheimisch; unbeständig

Synonym: *Cupressus arizonica*



Abb. 5: *Hylotelephium ewersii*, Raas (Foto: A. Fundneider)

Hylotelephium ewersii (Ledeb.) H. Ohba (Crassulaceae) (Abb. 5)

Fund: Eisacktal, Raas, 0,48 km S Pfarrkirche, Bushaltestelle (Richtung Norden) beim Hotel Hochrain, 805 m [9235/4], Trockenmauer, Straßenrand, eine einzige ausladende Pflanze (30 × 20 cm) mit einem einzigen Blühtrieb, weitum keine Anpflanzungen, 9.8.2026, Alois Fundneider & Camilla Wellstein (BOZ 50391).
Bemerkungen: Neu für Trentino-Südtirol und Italien. Die zentralasiatische Steppen-Waldfetthenne oder Himalaja-Fetthenne wird als Zierpflanze kultiviert, Angaben von einem adventiven Auftreten sind selten und beschränken sich bislang auf Deutschland (FloraWeb 2026), Tschechien (Hejný & Salvík 2003) und Skandinavien (Lid 2005) (vgl. auch POWO 2026). Die völlig isolierte Pflanze bei Raas gibt Rätsel auf, denn es kommt weder eine Ansalbung noch eine Einsaat in Frage, noch sind Anpflanzungen in der näheren und weiteren Umgebung ausfindig zu machen.

Status: nicht einheimisch; unbeständig

Luzula divulgatiformis Bačič & Jogan (Juncaceae)

Funde: Südtiroler Unterland, Leifers, Breitenberg, entlang der Straße zu den Bauernhöfen, 0,25 km E Hof Tschuegg, 734 m [9534/3], 29.5.2023, Jonas Noah Geurden & Valentin Heimer (Sammlung J. N. Geurden); Sarntaler Alpen N Bozen, Jenesien, 0,7 km NNW Kirche St. Georgen, längs des Katzensteigs, 789 m [9434/3], 29.5.2023, Jonas Noah Geurden & Valentin Heimer (Sammlung J. N. Geurden) (bei beiden Angaben handelt es sich um Detaildaten zum Pflanzenmaterial, das im Rahmen der Arbeit von Heimer et al. 2025 gesammelt und zytologisch und genetisch untersucht wurde; siehe Bemerkungen unten); Etschtal, Sarntaler Alpen, Gargazon, Westhang 80 m W unterhalb Kröllturm, 371 m [9433/1], submediterraner Laubmischwald (*Quercus pubescens*, *Fraxinus ornus*) mit Trockenrasenfragmenten, Porphyr, 9.5.2025, T. Wilhalm (BOZ 49919); Eisacktal, Feldthurns, Osthänge 1 km NNE Schrambach, am ‚Törggelesteig‘,

676 m [9335/2], Lichtung im thermophilen Mischwald (*Fraxinus ornus*, *Pinus sylvestris*), Magerrasen, 19.5.2026, T. Wilhalm & Arbeitskreis Flora von Südtirol (BOZ 50281).
Bemerkungen: Neu für Südtirol. Das Vorkommen der diploiden Art aus dem *Luzula campestris*-Aggregat (*Luzula* sect. *Luzula*) ist für Südtirol zwar bereits bei Heimer et al. (2025) pauschal durch zwei Aufsammlungen belegt (siehe oben), Detailangaben zu den beiden Fundorten fehlten aber bislang. Diese werden hier nachgeliefert und durch zwei weitere Nachweise ergänzt.

Die Vertreter der sect. *Luzula* weisen eine komplexe Evolutionsgeschichte auf, in der Polyploidie (v.a. Agmatoploidie, d.i. die Veränderung der Chromosomenzahl durch Fragmentierung von Chromosomen) und Hybridisierung die Haupttreiber der Artbildung sind und wo Genfluss und unvollständige Trennung von Abstammungslinien zu schwacher genetischer Differenzierung zumindest bei einigen Linien führt (Heimer et al. 2025). Dies schlägt sich auch in der taxonomischen Bewertung und der morphologischen Abgrenzung der Taxa nieder und erst die systematische Bearbeitung in jüngerer Zeit hat wesentliche – wenn auch lange noch nicht erschöpfende – Erkenntnisse zu deren Morphologie, Ökologie und Areal gebracht (siehe Heimer et al. l.c. und darin zitierte Literatur).

Luzula divulgatiformis wird erstmals 2007 als eigene Art beschrieben (Bačič et al. 2007a, 2007b). Ihr Lebensraum sind thermophile Eichenwälder tiefer Lagen (Bačič et al. 2007b), nach Fischer et al. (in Druck) lichte Traubeneichen-Kastanien-Wälder, Waldränder und -schläge in niederen Lagen. Das grenzt sie schon rein ökologisch recht gut von den meisten anderen Vertretern der Sektion *Luzula* ab. In Südtirol sind das nach bisherigem Kenntnisstand *L. campestris*, *L. multiflora*, *L. sudetica*, *L. exspectata* und *L. alpina* (vgl. www.florafauna.it).

Morphologisch unterscheidet sich *Luzula divulgatiformis* von *L. campestris*, mit der sie in Südtirol am ehesten denselben Lebensraum teilt, durch den horstförmigen Wuchs (fehlende Ausläufer!) und durch die dicht papillösen Blattränder. Von der habituell sehr ähnlichen *L. multiflora* lässt sie sich hingegen durch längere Griffel und Narben sowie kürzere Stomata abgrenzen. Die diesbezüglichen Maße bei den beiden Südtiroler Belegen BOZ 49919 und BOZ 50281 fallen exakt in den bei Bačič et al. (2007b) angegebenen Bereich.

Status: einheimisch; etabliert



Abb. 6: *Monarda didyma*, Vahrn (Foto: A. Fundneider)

Monarda didyma L. (Lamiaceae) (Abb. 6)

Fund: Eisacktal, Vahrn, 1,2 km NE Pfarrkirche, 0,1 km SE unterhalb Hof Voitsberger, 812 m [9235/4], Ruderalfläche an der Straße, Rand Robinien-Holunderbestand, eine ausladende Pflanze mit vielen Blühtrieben, wahrscheinlich aus dem Garten des Hofes verwildert, 20.7.2026, Alois Fundneider & Camilla Wellstein*.
Bemerkungen: Neu für Trentino-Südtirol und Italien. Die nordamerikanische Goldmelisse wird als Zier-, Gewürz- und Bienenpflanze kultiviert. Meldungen von Verwilderungen in Zentraleuropa liegen nur aus Österreich und zwar aus sechs Bundesländern inklusive Tirol (Fischer et al. in Druck) sowie aus Deutschland (siehe https://www.flora-germanica.de) vor.

Status: nicht einheimisch; unbeständig

Muhlenbergia mexicana (L.) Trin (Poaceae)

Fund: Obervinschgau, St. Valentin auf der Haide, SE-Teil des Dorfes 0,8 km SSE Pfarrkirche, 1470 m [9229/1], Beikraut in Blumenbeet, wenige Pflanzen, 29.8.2013, T. Wilhalm (BOZ 24842).
Bemerkungen: Neu für Südtirol. Der Herbarbeleg wurde bereits 2013 gesammelt, dann aber vorerst unbestimmt abgelegt, vergessen und erst im Zuge einer aktuellen Revision wieder bearbeitet. Die aus Nordamerika stammende Art tritt in einigen Ländern Europas adventiv auf. Einige Autoren (z.B. Walters & al. 1984; Hetzel 2006) gingen ursprünglich von Verwilderungen aus gärtnerischer Kultur aus. Das Gras hat aber wohl keinen gärtnerischen Wert und dürfte daher eher als Beikraut nach Europa eingeschleppt und dann ausgehend von Gärtnereien weiterverbreitet worden sein (siehe Verloove 2026 und darin zitierte Literatur).

In Italien gibt es bislang nur eine Angabe eines unbeständigen Auftretens aus dem Trentino (Prosser et al. 2019; Galasso et al. 2024). Angaben aus weiteren italienischen Regionen (Piemont, Lombardei, Emilia-Romagna) beziehen sich hingegen auf *M. frondosa*, die sich von *M. mexicana* u.a. durch glatte anstatt dicht und kurz behaarte Stängelinternodien unterscheidet (vgl. Verloove l.c.). Möglicherweise handelt es sich bei den Angaben von *M. frondosa* tatsächlich auch um *M. mexicana* (vgl. die Anmerkung „*M. „frondosa*, auct. ital.?“ bei *M. mexicana* in Fischer et al. in Druck).

Status: nicht einheimisch; unbeständig

Muscari armeniacum H. J. Veitch (Hyacinthaceae)

Funde: Bozen, Oswaldleiten, bei schmalem Betonsteg zu Haus Nr. 13, 300 m [9434/3], Wegrand, 19.3.2014, Andreas Hilpold (BOZ 27329, als cf. *armeniacum*, confirm. T. Wilhalm 2026); Etschtal, Terlan, am Beginn des Margarethenweges 0,8 km NE Pfarrkirche, 335 m [9433/4], Waldrand, Wegböschung, 5 Exemplare, 27.3.2026, T. Wilhalm (BOZ 50232).
Bemerkungen: Neu für Südtirol. *Muscari armeniacum* stammt ursprünglich aus Südosteuropa und Kleinasien und wird als Zierpflanze kultiviert. In vielen europäischen Ländern tritt sie verwildert auf, so auch in Italien, wo sie aus mehreren Regionen gemeldet ist (Galasso et al. 2024). Aus dem Trentino liegen ein gutes Dutzend Nachweise vor (Prosser et al. 2019). In Südtirol besteht schon seit längerem der Verdacht, dass es sich bei einzelnen Funden um *M. armeniacum* handeln könnte. Die sichere Unterscheidung zu anderen im Gebiet vorkommenden *Muscari*-Arten wurde erst langsam klar, besonders nach Einbeziehung umfangreicher Bestimmungsliteratur. Demnach lässt sich *M. armeniacum* durch die Farbe der fertilen Blüten im unteren Teil des Blütenstandes (hellblau *vs.* schwarzblau) und die Blätter (1–6 mm breit, viel länger als der Blühtrieb, „unordentlich“ *vs.* 2–2,5 mm breit, kürzer oder bis 1,8 × so lang wie der Blühtrieb) von *M. neglectum* unterscheiden. *M. botryoides* unterscheidet sich hingegen durch die steiflichen, mehr oder weniger aufrechten Blätter, die kürzer oder so lang wie der Blühtrieb und an der Spitze deutlich am breitesten und kapuzenförmig ausgebildet sind (*vs.* lang zugespitzt und ohne Kapuzenspitze). Eine gute und illustrative Bestimmungshilfe der genannten sowie weiterer *Muscari*-Arten bietet Meyer (2026). Neben den oben gelisteten Belegen liegen noch weitere mögliche Belege von *M. armeniacum* in BOZ vor, die aber teils unvollständig gesammelt wurden, teils im getrockneten Zustand keine sichere Zuordnung mehr erlauben (vor allem Blütenmerkmale sind eindeutig im frischen Zustand besser zu beurteilen).

Status: nicht einheimisch; unklar, ob unbeständig oder lokal beständig

Nandina domestica Thunb. (Berberidaceae)

Fund: Etschtal, Vilpian, Westhang 0,73 km N Pfarrkirche, bergseitig der Siedlung nördlich der Talstation der Seilbahn nach Schlaneid (Mölten), 278 m [9433/1], dunkler Laubmischwald über Porphyrschutt, ein 0,5 m hoher vegetativer Strauch zusammen mit *Ruscus aculeatus* und *Oplismenus hirtellus* subsp. *undulatifolius*, 18.9.2026, T. Wilhalm (BOZ 50399).
Bemerkungen: Neu für Trentino-Südtirol. Der aus Süd- und Ostasien stammende Himmelsbambus wird als Zierpflanze kultiviert. In Europa sind bislang nur wenige (unbeständig) verwilderte Vorkommen bekannt, so in Italien (in 7 Regionen; Galasso et al. 2024) und der Schweiz (im Tessin, im Raum Zürich und Genf; InfoFlora 2026).
Status: nicht einheimisch; unbeständig

Oenothera sesitensis A. Soldano (Onagraceae) (Abb. 7)

Fund: Eisacktal, Tiers, 1 km E St. Zyprian (Kirche), an der Forststraße orographisch rechts des Schwaiger Baches, 1136 m [9535/1], halbruderale Fläche mit Ablagerungen von Erdmaterial, 3 Pflanzen, 13.7.2026, Georg Aichner (BOZ 50397; confirm. Georg Pflugbeil).
Bemerkungen: Neu für Trentino-Südtirol. *Oenothera sesitensis* wurde von Soldano aus Norditalien beschrieben (vgl. Soldano 1993 und darin zitierte Literatur). Sie ist bislang aus den Regionen Aosta, Piemont, Lombardei und Emilia-Romagna dokumentiert und gilt dort als etabliert bis invasiv (Galasso et al. 2024). Außerhalb Italiens ist die Art noch nicht sicher nachgewiesen worden (vgl. Hassler 2019). Sie gehört in den Formenkreis von *Oe. fallax* und *Oe. depressa*, aus dem in Südtirol bereits *Oe. adriatica* bekannt ist (siehe www.florafauna.it und Wilhalm et al. 2020)) und der sich durch Sippen mit mittelgroßen Blüten, rot gestreiften Blütenknospen und rot punktierten (rote Haarbasis), aber nicht rot überlaufenen Stängeln auszeichnet. Die Südtiroler Pflanzen weisen alle typischen Merkmale von *Oe. sesitensis* auf, bis auf die Fruchtlänge, die mit maximal 35 mm an der unteren Grenze der Art liegt (siehe Soldano l.c. und Hassler l.c.).
Status: nicht einheimisch; unbeständig (?)



Abb. 7: *Oenothera sesitensis*, Tiers (Foto: G. Aichner)

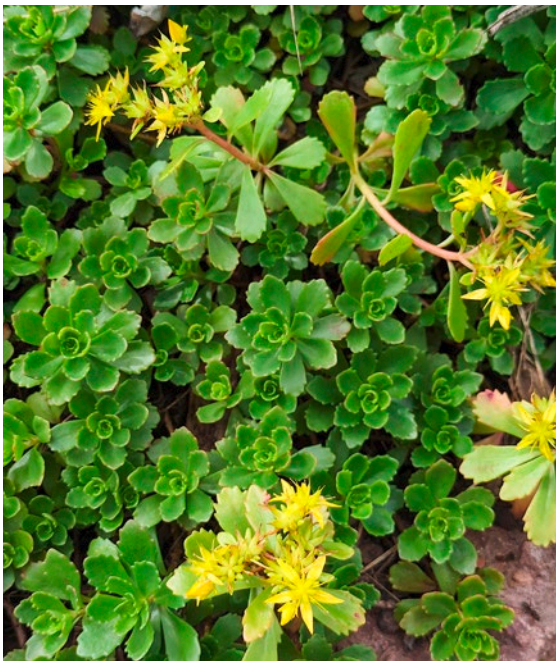


Abb. 8: *Oenothera speciosa*, Seiser Alm (Foto: G. Frener)

Oenothera speciosa Nutt. (Onagraceae) (Abb. 8)

Fund: Eisacktal, Kastelruth, Seiser Alm, 0,4 km W Ritsch-Schwaige, 1915 m [9435/4], Waldrand, Weide, ein 2 m² großer Bestand blühender Pflanzen, 25.9.2026, Georg Frener*.
Bemerkungen: Neu für Trentino-Südtirol. Aus Nordamerika stammende Zierpflanze, die aktuell aus vier Regionen Norditaliens, mehrheitlich als unbeständig, angeführt wird (Galasso et al. 2024). Nachweise von Verwilderung in Österreich, Deutschland und der Schweiz fehlen bislang. Über das Auftreten des kleinen Bestands auf der Seiser Alm kann nur spekuliert werden. Eine Anpflanzung kann aufgrund der Abgeschiedenheit des Wuchsortes ausgeschlossen werden. Denkbar ist hingegen, dass es vor Ort einen Misthaufen gab, über den Gartenabfälle aus dem Tal eingebracht wurden, aus denen sich die Pflanzen aus Samen entwickelten.
Status: nicht einheimisch; unbeständig

Abb. 9: *Phedimus hybridus*, Terlan (Foto: T. Wilhalm)



Phedimus hybridus (L.) ʻt Hart (Crassulaceae) (Abb. 9)

Fund: Etschtal, Terlan, 0,42 km NNE Pfarrkirche, Kirchgasse, 276 m [9433/4], Rand Weinberg, unter Gebüsch, kleiner Bestand, 23.5.2025, T. Wilhalm & Walter Stockner (BOZ 50369).
Bemerkungen: Neu für Trentino-Südtirol und Italien. Aus Sibirien stammende Zierpflanze, die nach Fischer et al. (in Druck) kaum verwildert. Die Bestimmung erfolgte anhand Meyer (2026) und Fischer et al. (l.c.). Die vorliegenden Pflanzen besitzen stark bewurzelte Kriechtriebe, 2–3 cm lange, nur vorne stumpf gezähnte Blätter, 7–8 mm lange, goldgelbe Kronblätter und gelbe Antheren, was sie von ähnlichen *Phedimus*-Arten, allen voran *P. kamtschaticus*, unterscheidet. Nachweise in angrenzenden Ländern liegen aus Österreich (Fischer et al. l.c.), darunter auch aus Tirol (Pagitz et al. 2023) sowie der Schweiz (InfoFlora 2026, als *Sedum hybridum*) vor, während Angaben aus dem restlichen Italien fehlen (vgl. Galasso et al. 2024).
Status: nicht einheimisch; unbeständig



Abb. 10: *Phyllostachys aurea*, Eppan, Pillhof: links lebender Spross mit den arttypischen verkürzten Internodien und den teils asymmetrisch angeordneten Knoten an der Halmbasis; rechts Herbarbeleg mit alten Halmbasen, an denen auch die typischen Halmverdickungen im Bereich der unteren Halmnodien erkennbar sind (Fotos: T. Wilhalm).

Phyllostachys aurea Rivière & C. Rivière (Poaceae) (Abb. 10)

Funde: Burggrafenamt, Schenna, talseitig am Rasteinweg 0,3 km N(NE) Vernaun, 808 m [9333/1], Mischwaldbestand zwischen Obstwiesen, kleiner Bestand, 12.3.2017, T. Wilhalm# (Bestand wiederbestätigt am 18.9.2026*); Überetsch, Eppan, Frangart, 0,1 km S oberhalb Kreisverkehr talseitig des Alten Pillhofs, 295 m [9533/2], Waldböschung, dichter Bestand von 500–600 m², 11.9.2026, T. Wilhalm (BOZ 50388); ebenda, 0,28 km SW oberhalb Kreisverkehr bzw. 0,1 km E Hof Neuhaus, 295 m [9533/2], Hopfenbuchenwald, frische Schlagfläche, lehmiger Boden mit Ruderalvegetation, lockerer Bestand aus Neuaustrieben, ca. 100 m², 11.9.2026, T. Wilhalm* (die letzten beiden Bestände entdeckt von Förster Roman Matzoll aus Kaltern und mitgeteilt von Julia Tonner).
Bemerkungen: Neu für Südtirol. Die älteste Südtiroler Angabe von Ladurner in Handel-Mazzetti (1953, als *Bambusa aurea*): „Passeiertal beim Bade Fellenbach [Bad Fallenbach am Nordrand von St. Leonhard, Anmerkung der Autoren] ein 7 m hoher Strauch ganz verwildert“ stufen Wilhalm et al. (2006) nicht als echte Verwilderung ein, sondern als Kulturrelikt. *Phyllostachys aurea* wird in Südtirol häufig kultiviert, auch außerhalb des Siedlungsgebiets. Umso schwieriger ist es festzustellen, welche Bestände auf Anpflanzungen zurückgehen und welche auf Verschleppungen bzw. spontane Verwilderungen. Auch könnten sich einige Angaben von „*Phyllostachys aurea*“ aus der floristischen Kartierung, zumal ältere und ohne (ausreichendes) Beleg- und/oder Fotomaterial, auf

andere *Phyllostachys*-Arten beziehen. An dieser Stelle werden daher nur Vorkommen gelistet, bei denen die Artbestimmung gesichert und bei denen eine echte Verwilderung – nach bisheriger Einschätzung am wahrscheinlichsten durch Rhizomstücke in widerrechtlich entsorgten Gartenabfällen, die austreiben und spontan neue Bestände bilden – sehr wahrscheinlich ist.

In Italien sind insgesamt 12 neophytische *Phyllostachys*-Arten angeführt (Galasso et al. 2024). Dabei tritt *P. aurea* am häufigsten, d. h. in 10 Regionen auf (unbeständig; etabliert nur im Piemont und Kampanien), gefolgt von *P. reticulata* (7 Regionen; unbeständig). In Südtirol ist mit Sicherheit eine weitere Art verwildert, deren definitive Bestimmung aber noch aussteht (Wilhalm, in Vorb.).

Status: nicht einheimisch; lokal beständig

Pittosporum tobira (Thunb.) W. T. Aiton (Pittosporaceae)

Fund: Bozen, 0,22 km NW ‚G'scheibter Turm', talseitig der Auffahrt nach St. Georgen, gegen die Fagenschlucht, 385 m [9434/3], submediterraner Buschwald, Porphyr, eine ausgewachsene Pflanze, möglicherweise über entsorgte Gartenabfälle eingebracht, 11.1.2026, T. Wilhalm (BOZ 50067).
Bemerkungen: Neu für Südtirol. Der Chinesische Klebsame stammt ursprünglich aus (Süd-)Ostasien und wird weltweit als Zierpflanze in Parks und Gärten, vor allem als Heckenpflanze, kultiviert. In Italien tritt die Art in den meisten Regionen verwildert auf, in zentralen und südlichen ist sie teils auch schon etabliert (Galasso et al. 2024). Im Trentino sind spontane Verwilderungen vor allem aus dem Gardasee-Gebiet dokumentiert (Prosser et al. 2019).

Status: nicht einheimisch; unbeständig

Ranunculus parviflorus L. (Ranunculaceae)

Fund: Bozen, 70 m NW Naturmuseum, N des Gebäudes der Konditorei Klaus, 271 m [9434/3], Parkrasen, unter Hecken, rund 10 Pflanzen, davon 2 blühend, 7.4.2026, T. Wilhalm (BOZ 50233) (vegetative Pflanzen bereits am 17.3.2026 entdeckt von E. Spögler*).
Bemerkungen: Neu für Südtirol. Die mediterran-atlantische Art ist in fast allen Regionen Italiens präsent und indigen. In Norditalien fehlt sie in Aosta (Bartolucci et al. 2024), in Trentino-Südtirol war sie bislang nur aus dem Gardaseegebiet bekannt, wo sie als allochthon und als in Ausbreitung begriffen bewertet wird (Prosser et al. 2019). Der vorliegende Nachweis in Südtirol dürfte hingegen auf eine Einschleppung mit Gartenmaterial zurückzuführen sein.

Status: nicht einheimisch; unbeständig

Rabelera holostea (L.) M. T. Sharples & E. A. Tripp (Caryophyllaceae) (Abb. 11)

Funde: Pustertal, Bruneck, NW Reischach, 0,2 km W Moarberger Weiher (Westufer), 911 m [9237/2], Mischwald, Unterwuchs, 5.5.2023, Annemarie Elzenbaumer* (Fund veröffentlicht auf iNaturalist; an dieser Stelle mitgeteilt mit freundlicher Erlaubnis von A. Elzenbaumer; Beleg nachgesammelt von Felix Faltner am 7.5.2025, BOZ 50387, mit Vermerk: 0,2–0,4 km W Moarberger Weiher, Mischwald mit Fichte, Zitterpappel, Stieleiche und Hasel); ebenda, 0,7 km SW Moarberger Weiher, 935 m [9237/2], Mischwald mit Fichte und Zitterpappel, *Rabelera holostea* in der Krautschicht dominant, 10.5.2026, Felix Faltner*.
Bemerkungen: Neu für Südtirol. Die Große Sternmiere fehlt in den Innenalpen und hat ihre nächsten natürlichen Vorkommen in Ostkärnten (Fischer et al. in Druck) und im Süden der Provinz Trient (Prosser et al. 2019). Für das restliche Italien wird die Art als autochthon in allen Regionen mit Ausnahme von Aosta angegeben (Bartolucci et al. 2024). Aus Nordtirol ist ein unbeständiges Vorkommen bekannt (Pagitz et al. 2023). Das



Abb. 11: *Rabelera holostea*, Reischach (Fotos: F. Faltner)

Auftreten bei Reischach ist als neophytisch einzustufen, allerdings handelt es sich um einen größeren und gut etablierten Bestand in einem naturnahen Lebensraum mit Ausdehnung von einigen hundert Metern. Die Herkunft ist unklar, möglicherweise steht die Einbringung im Zusammenhang mit dem angrenzenden Golfplatz.

Status: nicht einheimisch; lokal beständig

Synonym: *Stellaria holostea*

Soleirolia soleirolii (Req.) Dandy (Urticaceae)

Fund: Bozen, 60 m NW Naturmuseum, N des Gebäudes der Konditorei Klaus, 270 m [9434/3], Parkrasen, unter Hecken, einige Quadratdezimeter großer Bestand, 17.3.2026, E. Spögler (BOZ 50234).

Bemerkungen: Neu für Südtirol. Das natürliche Verbreitungsgebiet des Bubikopfs sind die italienischen Inseln Sardinien und Capraia, wo er an schattigen, tropfnassen Felsen aus Vulkangestein wächst. In den nahegelegenen Küstengebieten Liguriens, der Toskana und Latiums sind die Vorkommen wahrscheinlich adventiv, so wie auch in anderen Regionen Italiens (Pignatti 2017–19). Im Trentino ist ein unbeständiges Vorkommen im Gardaseegebiet dokumentiert (Prosser et al. 2019). Die Art wird als Bodendecker kultiviert und verbreitet sich wohl in erster Linie durch den Gartenhandel. Sie tritt in Mitteleuropa unbeständig in schattig-feuchten, wintermilden Lebensräumen auf, so an Mauern, Gebüschen, auf schattigen Rasen – vornehmlich im Siedlungsraum (cf. FloraWeb 2026; Fischer et al. in Druck).

Status: nicht einheimisch; unbeständig

Thalictrum simplex* subsp. *galioides (DC.) Korsh. (Ranunculaceae) (Abb. 12)

Fund: Südtiroler Unterland, Fleimstal, Kalditsch, ca. 0,27 km W(SW) Rothenhof, 643 m [9633/4], wechselfeuchter, schilfdurchsetzter Trespen-Zwenken-Halbtrockenrasen, kleiner Bestand, 13.6.2024, E. Spögler & Erika Sölva (BOZ 50419; Nachsammlung durch E. Spögler am 1.8.2025, BOZ 50336).

Bemerkungen: Neu für Südtirol. Die Labkraut-Wiesenraute ist ein zentraleuropäischer Endemit, dessen Areal im Wesentlichen die Alpen (inkl. Norditaliens) und das südliche Deutschland umschließt. Südlich des Alpenhauptkammes war die Sippe bisher nur aus einem Streifen zwischen Gardasee und Tagliamento sicher belegt (Hand 2001, S. 226 ff. und Abb. 29). Aus den benachbarten Provinzen Trient und Belluno ist das Taxon mittlerweile mehrfach nachgewiesen (Hand l.c.; Argenti et al. 2019; Prosser et al. 2019), aus



Abb. 12: *Thalictrum simplex* subsp. *galioides*, Kalditsch (Fotos: E. Spögler)

dem östlich angrenzenden Osttirol ist lediglich ein (historisches) Vorkommen bekannt, das aber zweifelhaft erscheint (Pagitz et al. 2023). Die in Südtirol bislang einzig dokumentierte Unterart ist laut Wilhalm et al. (2006) subsp. *tenuifolium*, deren Verbreitungsschwerpunkt die mittleren Lagen der Alpen und die Mittelgebirge Mitteleuropas sind (Hand l.c.).

Der einzig bekannt gewordene Wuchsort in Südtirol wurde in der Zwischenzeit durch den Bau eines Speicherbeckens zerstört.

Status: einheimisch; etabliert

Yucca gloriosa L. (Agavaceae)

Fund: Bozen, 0,25 km SW St. Justina, ‚Weinbergweg', 377 m [9534/1], ruderal beeinflusste Trockenböschung, 2 fruchtende und 2 vegetative Pflanzen, 19.7.2026, T. Wilhalm*; ebenda, 0,22 km SSW St. Justina, 400 m [9534/1], Wegrand, Böschung, 1 fruchtende Pflanze, 19.7.2026, T. Wilhalm*; Untervinschgau, Tschars, Sonnenberg, im Bereich des ‚Kakteenweges', 670–680 m [9331/4], Trockenrasen, felsiger Hang und Robinienbestand (*Melico-Robinietum*), 3 fruchtende Exemplare, zusammen mit *Opuntia humifusa*, 29.7.2026, T. Wilhalm*.

Bemerkungen: Neu für Südtirol. Die Herkunft der Pflanzen ist unklar: Im Falle von Tschars könnten sie in direktem oder indirektem Zusammenhang mit dem ehemaligen Ausbringen von Kakteen im Gebiet, deren Bestand seitdem stark zugenommen hat, stehen. Im Falle von Bozen erscheint ein Aufkommen aus entsorgten Gartenabfällen plausibel.

Die kultivierte, aus Nordamerika stammende Art tritt in fast allen Regionen Italiens als Neophyt auf, im Veneto und in der Toskana ist sie invasiv (Galasso et al. 2024). Bislang wurde in Südtirol nur *Yucca filamentosa* adventiv beobachtet (siehe www.florafauna.it).

Status: nicht einheimisch; unbeständig



Abb. 13: *Adonis annua*, Bruneck (Fotos: J. Hackhofer)

Korrekturen und neue Verbreitungsdaten

Adonis annua (Abb. 13)

Fund: Pustertal, an der Bahnlinie bei Bruneck 0,45 km WNW Lamprechtsburg, 894 m [9237/2], Ruderalfläche, Einzelpflanze, 9.6.2024, Josef Hackhofer*.
Bemerkungen: Wiederbestätigt für Südtirol. Von *Adonis annua* liegen nur historische Angaben aus dem Raum Brixen vor: „Manchmal verwildert in Nähe der Gärten“ (Bachlechner 1859, als *A. autumnalis*, zitiert auch bei Dalla Torre & Sarnthein 1906–13); „Nur selten in Kultur: Stiftsgarten von Neustift und Hofgarten von Brixen; an der erstgenannten Stelle hie und da an Wegen und auf Grasplätzen einzeln verwildert“ (Heimerl 1911).

Status: nicht einheimisch; unbeständig

Amelanchier ovalis subsp. *embergeri* (Abb. 14)

Funde: Wipptal, Gossensaß, Pontigl, ca. 0,36–0,47 km (N)NE Hof Thaler, bergseitig der ehemaligen Bahntrasse (Radweg), 1294 m [9034/2], Felsbänder bzw. -absätze, Kalkschiefer, mehrere Sträucher, 9.6.2026, E. Spögler (BOZ 50377, confirm. Konrad Pagitz); Mauls, in der ‚Maulser Leite‘ ca. 0,3 km NNE Pfarrkirche, 1020 m [9135/1], felsdurchsetzter, thermophiler Föhrenwald, Kalkschiefer, 28.7.2026, E. Spögler & Maria Steger (BOZ 50378). (Der tetraploide Chromosomensatz der beiden angeführten Belege wurde durch E. Spögler durchflusszytometrisch (RGS) an der Universität Innsbruck ermittelt.)
Bemerkungen: Neue Verbreitungsdaten. Seit Favarger & Correvon (1967) und Favarger & Stearn (1983) ist bekannt, dass *Amelanchier ovalis* in zwei Ploidiestufen auftritt, einer diploiden (subsp. *ovalis* im Sinne des Typus) und einer tetraploiden (subsp. *embergeri*).



Abb. 14: *Amelanchier ovalis* subsp. *embergeri*, Pontigl (Fotos: E. Spögler)

Gregor et al. (2018) wiesen für Südtirol bereits beide Ploidiestufen bzw. Unterarten nach: subsp. *ovalis* am Pragser Wildsee und subsp. *embergeri* am Tartscher Sonnenberg (Mals). Mit den vorliegenden neuen Nachweisen wird klar, dass die im Alpenraum bislang mehr im Westen dokumentierte subsp. *embergeri* (vgl. Gregor et al. l.c.) in Südtirol weiter verbreitet ist.

Zur morphologischen Abgrenzung der subsp. *embergeri* von subsp. *ovalis* siehe u.a. Borho et al. (2020).

Status: einheimisch; etabliert

Cyperus longus (Abb. 15)

Fund: Etschtal, Terlan, Siebeneich, Nebengraben des Stampflgrabens 0,58 km (S)SE Hof Großkornell, 239 m [9433/4], Entwässerungsgraben, Grabenufer und Übergangsbereich zu Straße, Bestand auf einer Länge von ca. 10 Metern, 11.9.2025, E. Spögler (BOZ 50304).

Bemerkungen: Wiederbestätigung für Südtirol. Die wenigen Südtiroler Angaben der Art – bei Meran und Bozen sowie beim Schloss Tirol (Zuccarini 1824; Elsmann 1825; Hausmann 1851–54; vgl. auch Dalla Torre & Sarnthein 1906–13) – gehen sämtlich auf das frühe 19. Jahrhundert zurück. Da die angeführten Lebensräume arttypisch sind, haben Wilhalm et al. (2006) die Art trotz der wenigen ehemaligen Vorkommen als einheimisch eingestuft. Auch im Trentino wird *Cyperus longus* als autochthon bewertet, auch wenn nur ein historischer und einige wenige rezente Nachweise – aus dem Gardasee-Gebiet – vorliegen (Prosser et al. 2019). Anders in Nordtirol, dort stufen sie Pagitz et al. (2023) als unbeständigen Neophyten ein.

Um den Status des neu entdeckten Vorkommens richtig einzuschätzen, sind die folgenden Überlegungen hilfreich. Der aktuelle Fundort liegt im Bereich eines historisch dokumentierten: „Bozen: an der Straße nach Meran“ (Elsmann l.c.). Die Pflanzen gehören ferner zur subsp. *longus*, die sich u.a. durch folgende Merkmale von der oft als Zierpflanze kultivierten, in Europa nur im Mittelmeergebiet verbreiteten subsp. *badius* unterscheiden: Ährchen mit rotbraunen, hell berandeten statt mit schwarzroten, kaum berandeten Spelzen (Fischer et al. in Druck); Blütenstand sowohl aus kurzen, Ährchen tragenden Ästen, als auch aus längeren Ästen, die sich nochmal in kürzere, Ährchen tragende Äste verzweigen, bestehend *versus* Blütenstand aus rein kurzen, Ährchen tragenden Ästen (Pignatti et al. 2017–19).



Abb. 15: *Cyperus longus*, Siebeneich (Foto: E. Spögler)

Dies vorausgesetzt, könnte es sich bei dem neu entdeckten Südtiroler Bestand tatsächlich um ein natürliches Vorkommen handeln – ob um einen Restbestand oder um eine Wiederansiedlung aus dem Süden (Arealausweitung), muss allerdings offenbleiben. Die Verwilderung von kultivierten Pflanzen dürfte aber ausgeschlossen werden.

Status: einheimisch; etabliert

Falcaria vulgaris

Fund: Südtiroler Unterland, Kurtatsch, Talboden 0,38 km S(SE) Entiklar (Marienkapelle), ‚Ratscheinerwiese', 218 m [9733/1], in trockenem Weinberg und teils am Randstreifen zum Abzugsgraben, u.a. mit *Cynodon dactylon*, *Silene vulgaris*, *Convolvulus arvensis*, ca. 100 Pflanzen auf 20 m², 28.7.2026, Franziska Zemmer (BOZ 50347).
Bemerkungen: Wiederbestätigt für Trentino-Südtirol. *Falcaria vulgaris* wurde in Südtirol erstmals 1852 von Francesco Facchini entdeckt und publiziert in Ambrosi (1853): „nördlich von Magré". Bei Facchini (1855) lautet die Fundortbeschreibung: „Prope Margreit in valle Athesina, in agris, et vineis, rarissima" (von Dalla Torre & Sarnthein 1906–13 übernommen als: „Auf Äckern, Weinbergen, an Mauern bei Margreid gegen Kurtatsch, sehr selten"). 1853 wird die Art auch von Josef Anton Zallinger „unterhalb von Kurtatsch im Etschlande" gesammelt (Hausmann 1855). Gegen Ende des 19. Jahrhunderts findet sie Ferdinand Sauter noch auf Äckern bei Margreid (Sauter 1899) und in den Aufzeichnungen von Hermann Handel-Mazzetti aus der Mitte des 20. Jahrhunderts heißt es bei der Beschreibung einer Wanderung von Margreid über den Fennberg zum Corno di Tres: „Im Getreide finden wir […] an Doldengewächsen die seegrüne gemeine Sicheldolde […]" (Handel-Mazzetti 1957). Da der Autor nicht explizit erwähnt, was an Pflanzennennungen auf eigenen Beobachtungen oder nur auf Angaben aus der Literatur beruht, ist unklar, ob es sich hier tatsächlich um einen letzten Nachweis in der Mitte des 20. Jahrhunderts handelt oder nicht. Auffallend ist jedenfalls, dass die Art in der

angehängten Pflanzenliste fehlt. In der Folge liegen für die Sicheldolde in Südtirol bis zum Datum des vorliegenden Nachweises keine weiteren Angaben mehr vor.

Das natürliche Areal der eurasischen *Falcaria vulgaris* reicht von Südskandinavien, Mitteleuropa und Teilen Südeuropas (nördliches Spanien und Italien, Griechenland) bis nach Südwest- und Westasien. Die Art ist an Wärme und Trockenheit gebunden und nahezu ausschließlich auf die Tiefländer beschränkt; sie bevorzugt sandige und schwere Böden (Lehm, Löss) und tritt besonders an trockenen, grasigen Rainen auf, häufig aber auch in Weinbergen, (Getreide-)Äckern und auf Ödland (Hegi 1975). In Italien ist die Art für die Lombardei und die Abruzzen als indigen eingestuft, für die wenigen restlichen Regionen als unbeständig und allochthon (Bartolucci et al. 2024). In Prosser et al. (2019) findet sich für das Trentino einzig die historische Angabe „Valle di Non", die im Original „Nonsberg, auf Lehmboden" lautet (Loss in Braungart 1876) und sich möglicherweise sogar auf den Deutschnonsberg in der heutigen Provinz Bozen beziehen könnte. In Wilhalm et al. (2006) werden die historischen Angaben Südtirols als nicht einheimisch und unbeständig bewertet, was sich auch mit der Situation in den angrenzenden Regionen deckt (vgl. Prosser et al. l.c. für das Trentino; InfoFlora 2026 für den gesamten Schweizer Anteil der Alpen; Pagitz et al. 2023 für Nord- und Osttirol), auch wenn die historische Literatur kein Wort über das Indigenat verliert bzw. ein einheimisches Vorkommen impliziert.

Der aktuelle Nachweis der Sicheldolde in der Gemeinde Kurtatsch ist schwer einzuordnen. Entweder gehören die Pflanzen tatsächlich zu einer seit dem 19. Jahrhundert bestehenden, ehemals eingeschleppten Population oder es handelt sich um eine rezente Einschleppung z.B. durch verunreinigtes Saatgut (vgl. Hegi l.c., S. 1179). Vergleiche dazu auch die ausschließlich rezenten Nachweise im Schweizerischen Unterengadin (InfoFlora l.c.).

Status: nicht einheimisch; lokal beständig

Festuca stenantha

Funde: Westliche Dolomiten, Gröden, Wolkenstein, 0,8 km NW Daunei, 1808 m [9436/2], Kalkfels (isolierter Block) im Fichten-Zirbenwald, wenige Pflanzen zusammen mit *Carex mucronata*, 12.7.2026, T. Wilhalm (BOZ 50321); ebenda, 0,35 km S Silvesterscharte, am Aufstieg von Daunei zur Steviahütte, 2017 m [9436/2], Rand Kalkschutt, Initialrasen, ein Dutzend Pflanzen, 12.7.2026, T. Wilhalm (BOZ 50322).
Bemerkungen: Neu für die westlichen Südtiroler Dolomiten. Südtirol liegt am nördlichen Arealrand dieser in den östlichen Südalpen recht häufigen Art montaner Kalkfelsen. Entsprechend sind auch die Vorkommen deutlich seltener. Den ersten Nachweis für das Land erbrachte René de Litardière 1909 am Pragser Wildsee in den östlichen Dolomiten (Markgraf Dannenberg 1979, Beleg in W). Dieser Fundort war über viele Jahrzehnte der einzig bekannte in Südtirol. 1965 gelang – arealgeographisch ziemlich überraschend – ein Nachweis der Art in Trafoi im Ortlergebiet im Bereich der Prader Alm und am Aufstieg zur Berglhütte (F. Pedrotti & E. Orsomando in Markgraf Dannenberg l.c.; wiederbestätigt durch T. Wilhalm 2008, BOZ 12518 bzw. 2015, BOZ 33521), also inmitten der Zentralalpen. Es folgten weitere Funde in den Pragser Dolomiten: 1979 im Höhlensteintal im Bereich der Strudelköpfe (Kiem in Markgraf Dannenberg l.c.; Kiem 1981, 1987, BOZ 39995 und BOZ 40013), später auch im Lärchental bei der Alten Kaser (Andreas Hilpold & Thomas Kiebacher, 2003, BOZ 2788) und im Bereich der Flodige-Alm (E. Spögler und Josef Hackhofer, 2023, BOZ 49562). Zuletzt gelang schließlich auch der Erstnachweis im Südtiroler Anteil des Karnischen Kammes in Sexten (Birgit Holzer in Wilhalm et al. 2023) und mehrfach in den Sextner Dolomiten (unveröff. Daten der floristischen Kartierung).

Das neu nachgewiesene Vorkommen in Gröden dürfte mit jenen im hintersten Fassatal jenseits des Sellajoches im Trentino (vgl. Prosser et al. 2019) in Verbindung stehen und lässt vermuten, dass *Festuca stenantha* auch noch an weiteren Stellen in den Südtiroler Dolomiten zu erwarten ist.

Status: einheimisch; etabliert

Fourraea alpina

Funde: Pustertal, Mühlbach, Vals, Pfunderer Berge, am Forstweg Ochsenalm-Aschilaalm knapp 0,6 km SW Fane-Alm, 1895 m [9135/2], Wegböschung, Lärchenwald, kleiner Bestand, 1.6.2020, Gisella Leitner*; ebenda, 0,78-0,85 km NNW Fane-Alm, SE-Hang am Fuß des Schellenberges, 1995 m [9135/2], Wildheuplanke, im Bereich einer ehemaligen Hangrutschung, Kalkschiefer, 3.7.2022, E. Spögler & Gisella Leitner (BOZ 47794); Wipptal, Mauls, Pfunderer Berge, Sengestal, bergseitig über der Forststraße zur Simile Mahd-Alm ca. 0,26 km (N)NE Obersenges-Alm, 1727 m [9135/1], grasige Lawinenrinne und angrenzender, lichter Lärchenbestand, Kalkschiefer, kleiner Bestand, 2.7.2026, E. Spögler, Peter Schönswetter u.a.*; ebenda, Sengestal, orographisch rechte Talflanke 0,44 km und 0,5 km SW Simile Mahd-Alm, 1888 m bzw. 1902 m [9135/1], Wildheuplanke (Lawinenrinne), lichter subalpiner Lärchenbestand, Kalkschiefer, jeweils ein Massenbestand, 3.7.2026, E. Spögler*.
Bemerkungen: Neu für die Pfunderer Berge. *Fourraea alpina* ist in Südtirol von relativ wenigen Fundorten bekannt, vornehmlich von den Brennerbergen beidseitig des Wipptales zwischen Sterzing und Brenner. Darüber hinaus existieren noch ein punktuelles Vorkommen in Weißenbach (Sarntal) und in Tiers (vgl. www.florafauna.it).
Status: einheimisch; etabliert

Hylotelephium telephium

Fund: Eisacktal, Tiers, Weißlahnbad, Ausgang des Tschamintals ca. 0,18 km WSW Tschamin-Schwaige, 1196 m [9535/1], Straßenrand, Gehölzrand, etwas gestört, ein Individuum mit 5 blühenden Trieben, offensichtlich aus Ablagerung von Gartenmaterial hervorgegangen, 16.9.2026, E. Spögler (BOZ 50415, det. T. Wilhalm).
Bemerkungen: Wiederbestätigt für Südtirol. Die bisher einzige Angabe eines Vorkommens stammt aus dem Jahr 1902: „an einer Mauer vor St. Wallburg [St. Walburg] in Ulten, 1100 m“ (Handel-Mazzetti 1903; zitiert auch in Dalla Torre & Sarnthein 1906–13). Während *Hylotelephium maximum* in Südtirol einheimisch ist, ist *H. telephium* eindeutig als nicht einheimisch und primär wohl als Gartenflüchtling einzustufen. Ähnliches wird auch für das Trentino (Prosser et al. 2019) und für den Rest Italiens angenommen (Galasso et al. 2024). Das natürliche Verbreitungsgebiet von *H. telephium* erscheint insgesamt etwas unsicher: So ist die Art laut POWO (2026) einheimisch in ganz Eurasien einschließlich Südeuropa; auch InfoFlora (2026) und FloraWeb (2026) stufen sie als einheimisch für die Schweiz bzw. für Deutschland ein. Fischer et al. (in Druck) sind sich für Österreich und den gesamten Ostalpenraum hingegen unsicher: „möglicherweise Gartenflüchtling“.
Status: nicht einheimisch; unbeständig

Ophioglossum vulgatum

Funde: Oberes Pustertal, Toblach, 1,8 km SE Pfarrkirche, Schutzgebiet Rohrach, 1190 m [9239/3], Magerwiese, 10 oberirdische Triebe, 14.8.2019, Josef Hackhofer* (wiederbestätigt 2020 mit 2, 2024 mit 3 Trieben*); Südtiroler Unterland, Mendelgruppe, Fennberg, Moor westlich am Fenner See 0,4 km ENE Kirche St. Leonhard, 1035 m [9733/1], Verlandungsmoor, Pfeifengraswiese, rund 20 oberirdische Triebe, 28.6.2024, E. Spögler, T. Wilhalm & Wilhelm Tratter* (wiederbestätigt 2026 durch E. Spögler*); ebenda, am S-Ufer des Fenner Sees, ca. 0,42 km E(NE) Kirche, 1035 m [9733/1], basenreiche Streuwiese, verbracht, kleiner Bestand, 13.6.2026, E. Spögler*.
Bemerkungen: Neu für das Pustertal und wiederbestätigt für das Etschtal südlich von Meran. Nachweise der Art in Südtirol nach 2000 lagen bis dato nur aus dem Vinschgau vor. Aus dem Etschtal südlich von Meran gibt es eine Reihe von historischen Vorkommen (Dalla Torre & Sarnthein 1906–13), die allesamt der Kultivierung der Talsohle, insbesondere der Intensivierung der Landwirtschaft, zum Opfer gefallen sein dürften.

Auch der Bestand in den Fuchsmösern bei Unterrain/Eppan, der noch im 20. Jahrhundert beobachtet worden war (Venanzoni 1986; vgl. auch www.florafauna.it), konnte nicht wiederbestätigt werden.

Status: einheimisch; etabliert

Orobanche salviae

Fund: Etschtal, Nals, Mendelgruppe, 0,7 km WSW Kirche St. Apollonia, ‚Drei Kalköfen', 961 m [9433/3], Wegböschung (Forstweg), Buchenmischwald, wenige Fruchtstände in einem Reinbestand von *Salvia glutinosa*, 5.6.2024, T. Wilhalm & Walter Stockner (BOZ 49442).

Bemerkungen: Wiederbestätigt für Südtirol. Anders als im benachbarten Trentino und Nordtirol, wo die Art zumindest zerstreut vorkommt (Prosser et al. 2019; Pagitz et al. 2023), scheint *Orobanche salviae* in Südtirol sehr selten zu sein. Historisch liegt lediglich eine einzige Angabe aus Aldein vor (Sauter 1899; zitiert auch in Dalla Torre & Sarnthein 1906–13). In der zweiten Hälfte des 20. Jahrhunderts kommen nur zwei, allerdings unbelegte Angaben im Rahmen der allgemeinen floristischen Kartierung hinzu: Umgebung von Tiers (1971, F. Turnowsky), Trenser Höhenweg – Burg Sprechenstein – Sterzinger Moos – Maria Trens (1994, E. Sinn). Aus dem Wipptal wird *O. salviae* auch rezent angeführt: „Eingang des Weißenbachtales, 1 km E Mittewald, sonniger Hang an Bachufer, Granit-Schuttflur" (26.6.2023, Andreas Hilpold*). Da unbelegt, muss dieser Angabe, wie auch den beiden ersteren, nochmals nachgegangen werden, zumal eine Verwechslung mit *O. flava* nicht auszuschließen ist. Letztere ist – neben *O. lucorum* – morphologisch schwer von *O. salviae*, mit der sie nicht selten vergesellschaftet ist, zu unterscheiden (H. Uhlich, pers. Mitt.).

Die Bestimmung erfolgte anhand folgender, am Beleg erkennbarer Differenzialmerkmale gemäß Müller et al. (2021) und Fischer et al. (in Druck): Staubfäden kahl und 4 mm über dem Grund angesetzt, Griffel drüsig, Kelchhälften länger als Kronröhre, Kronoberlippe schwach ausgerandet, Lappen der Unterlippe mit zahlreichen Drüsen.

Status: einheimisch; etabliert

Potamogeton praelongus (Abb. 16)

Funde: Oberes Pustertal, Antholz, Antholzer See, im Bereich des Westufers, 1638 m [9138/2], Gebirgssee, 22.9.2015, Renate Alber (BOZ 33651, confirm. P. Englmaier); Unteres Pustertal, Kiens, östliche Pfunderer Berge, Grünbachsee, 2256 m [9137/1], Bergsee, Massenbestand im gesamten See, 6.9.2025, E. Spögler & Gisella Leitner (BOZ 50303; Fundort entdeckt von Annemarie Elzenbaumer am 3.9.2025 und veröffentlicht auf iNaturalist).

Bemerkungen: Neu für das Pustertal und den Südtiroler Anteil der Zillertaler Alpen. *Potamogeton praelongus* war in Südtirol bislang nur aus dem Haidersee im Oberen Vinschgau bekannt (Melzer et al. 1986; vgl. www.florafauna.it). Für den Grünbachsee lagen bislang nur mehrere Angaben von *Potamogeton alpinus* vor, die sich aber ziemlich sicher auf *P. praelongus* beziehen dürften.

Status: einheimisch; etabliert



Abb. 16: *Potamogeton praelongus*, Kiens, Grünbachsee (Foto: E. Spögler)

Rosa gallica

Fund: Eisacktal, Feldthurns, 0,8 km NE Tschiffnon, 766 m [9335/2], (Halb-)Trockenrasen auf ehemaligen Terrassenkulturen (Weinberge), Hecken, einige wenige Sträucher, 19.5.2026, Andreas Lanthaler, T. Wilhalm & Arbeitskreis Flora von Südtirol (BOZ 50279).
Bemerkungen: Wiederbestätigt für Südtirol. Wilhalm et al. (2006) stufen die Art zwar als einheimisch ein, vermuten aber bei den meisten historischen Angaben nur Verwilderungen kultivierter Pflanzen. Auf autochthone Vorkommen dürfte sich laut den Autoren die Angabe von Sabransky (1902; siehe auch Dalla Torre & Sarnthein 1906–13): „in der niederen Bergregion um Tramin" beziehen. Das Areal der südeuropäischen Essig-Rose erstreckt sich von der Provence über Italien bis zu den Balkanländern. In Italien ist sie in nahezu allen Regionen dokumentiert (Bartolucci et al. 2024); auch im Trentino, wo die Art als autochthon eingestuft wird, wächst sie bis nahe an die Grenze zu Südtirol, wobei viele der ursprünglichen Vorkommen erloschen sind (Prosser et al. 2019). *Rosa gallica* tritt selten bis zerstreut auf und wächst vorzugsweise an sonnigen Waldsäumen im Bereich von Eichen- und Kiefernwäldern, in (aufgelassenen) Weinbergen, auf Magerwiesen und an trocken-warmen Ackerrainen. Der Standort des aktuell einzig bekannten Südtiroler Vorkommens reiht sich sehr gut ein in diese Palette. Ein züchterischer Einfluss lässt sich an den Sträuchern aus Tschiffnon, die morphologisch der Wildform entsprechen, nicht erkennen.

Status: unklar, ob einheimisch oder eingebürgert; lokal etabliert

Sparganium hyperboreum

Funde: Unteres Pustertal, Pfalzen, östliche Pfunderer Berge, 0,44 km ESE Bärentalspitze, ‚Bei die Seaber', nördlicher, kleinerer der beiden Seen, 2339 m [9137/1], Bergsee, großer Bestand, über das ganze Seeufer verteilt, z. T. zusammen mit *Sparganium angustifolium*, 6.9.2025, E. Spögler & Gisella Leitner (BOZ 50301); ebenda, ‚Bei die Seaber', südlicher, größerer der beiden Seen, 2337 m [9137/1], Bergsee, kleiner Bestand, auf das Nordufer beschränkt, größtenteils vegetativ, zusammen mit *Sparganium angustifolium*, 6.9.2025, E. Spögler & Gisella Leitner*. (Wuchsort entdeckt von Annemarie Elzenbaumer am 10.9.2023 und auf iNaturalist ohne exakte Verortung veröffentlicht, an dieser Stelle mit freundlicher Erlaubnis mitgeteilt.)
Bemerkungen: Neu für die Zillertaler Alpen. Das arktisch-alpine *Spaganium hyperboreum* war in den Alpen, seitdem es dort als solches erstmals durch Glück (1938) erkannt worden war, bis 1985 nur von den ‚Königslacken' auf der Sarner Scharte (bzw. am Villanderer Berg, je nach Zuordnung) bekannt (vgl. Müller-Dobiles & Müller-Dobiles 1980). Bruno Wallnöfer stieß 1985 auf ein kleinflächiges Vorkommen auf der Lüsner Alm (Wallnöfer 1988) und erbrachte damit den Nachweis eines neuen, vom bislang bekannten über 30 km entfernt gelegenen Fundortes im Großraum Dolomiten. Dieses Vorkommen konnte am 16.9.2023 von E. Spögler und G. Leitner bestätigt werden (BOZ 49609). Der hier vorliegende neue Nachweis aus den Pfunderer Bergen ist der erste in den Zillertaler Alpen; der Wuchsort liegt über 40 km NE entfernt von jenem klassischen in den Sarntaler Alpen. Bis zum heutigen Tag ist *S. hyperboreum* in den Alpen sowie in ganz Europa außerhalb Nordeuropas nur aus Südtirol bekannt. Wie Glück (l.c.) jedoch bereits indirekt zu verstehen gab, dürfte es sich, wenn überhaupt, nur um sehr wenige und sehr isolierte Vorkommen handeln: „Die Möglichkeit, daß *Sp. hyperboreum* auch noch an anderen Stellen der Tiroler und Europäischen Alpen vorkommt, ist wohl vorhanden; doch habe ich weder für Tirol noch auch für andere Gebiete der europäischen Alpen irgendwelche Spuren nachweisen können."

Das isolierte Vorkommen von *Sparganium hyperboreum* in den Ostalpen bringen Müller-Dobiles & Müller-Dobiles (l.c.) mit Fossilfunden in Polen aus dem Pleistozän in Verbindung und stellen die Frage nach einer möglichen Deutung desselben als Glazialrelikt.

Status: einheimisch; etabliert



Abb. 17: *Trifolium spadiceum*, Plätzwiese (Fotos: E. Spögler)

Trifolium spadiceum (Abb. 17)

Funde: Regglberg, Deutschnofen, 0,72 km (E)SE Hof Wölfl, 1368 m [9534/3], beweidetes Niedermoor, 3.7.2024, Lea Gibitz (BOZ 49722); Pragser Dolomiten, Plätzwiese, 0,46 km S Hotel Hohe Gaisl, ‚Homannerboden', 1958 m [9339/3], subalpine Mähwiese, feucht, teils moorig, 2 nahe beieinander liegende dichte Bestände von ca. 50 bzw. 20 m² Größe, 2.7.2025, T. Wilhalm, E. Spögler & Arbeitskreis Flora von Südtirol (BOZ 50091); ebenda, 0,6 km SSE Dürrensteinhütte, 1920 m [9339/3], Quellmoor, kleinflächiger Bestand, 2.7.2025, Wilhelm Tratter, T. Wilhalm & Arbeitskreis Flora von Südtirol#; ebenda, 0,64 km (S)SE Gasthof Plätzwiese, 1961 m [9339/3], feuchtes Tälchen im Wiesenbereich, kleiner Bestand, vereinzelt stehende Pflanzen, 11.7.2026, T. Wilhalm, Josef Hackhofer & Michele da Pozzo#; Oberes Pustertal, Niederdorf, 0,27 km NNE Bad Maistatt, nordöstlicher Rand des Schutzgebiets ‚Stapfpinglmoos', 1205 m [9239/3], feucht-nasse Wiese am Waldrand, 2 Kleinbestände in 30 m Abstand mit jeweils 30 Pflanzen, 7.6.2026, Birgit Holzer*.
Bemerkungen: Neu bzw. erste gesicherte Nachweise für die Südtiroler Dolomiten und den Regglberg. Wallnöfer (1988) ist der erste, der *Trifolium spadiceum* für Südtirol nachweist und zwar an drei Stellen im Oberen Pustertal: in den Aratzwiesen W Taisten, im Grubermoos N Unterplanken/Gsies und im Silvesteralmmoor bei Toblach. Im genannten Gebiet gelingen in der Folge noch zwei weitere Nachweise: Gsies, 0,5 km N Ragotz-Alm (J. Hackhofer, 2014, BOZ 30237, bestätigt 2021, BOZ 46670); Toblach, 0,5 km N Ratsberg (F. Faltner, 2024*). Jener im Silvesteralmmoor konnte trotz gezielter Nachsuche durch E. Spögler und Simon Stifter am 20.8.2020 nicht mehr bestätigt werden, während der Bestand aus dem Grubermoos bereits von Wallnöfer selbst als in der Folge zerstört bezeichnet wurde. Die vorliegenden Nachweise sind, nach dem bislang einzigen Fund im Trentiner Fleimstal, die einzigen bekannten in den gesamten italienischen Dolomiten (vgl. Argenti et al. 2019 und Prosser et al. 2019).

In IBF liegt zusätzlich ein historischer Beleg mit der Aufschrift: „S. C[h]ristina Gröden" (s.d.), der Friedrich Beer (1871–1914) zugeschrieben wird. Der Beleg bzw. die Angabe fand bislang keinen Niederschlag in der Literatur. Nach Auskunft von M. Thalinger (IBF) bleibt Zweifel am dokumentarischen Charakter des Beleges in seiner heute erhaltenen

Form: Zum einen handelt es sich um einen Mischbeleg aus *Trifolium spadiceum* und *T. badium*, zum anderen ist das Etikett nicht von Beer selbst geschrieben. Zu denken gibt aber vor allem die Tatsache, dass der Beleg laut Stempel ursprünglich vom „Tirolensien-Handherbar zur Flora von Dalla Torre u. Sarnthein" stammt, dieser aber von den Autoren nirgendwo publiziert wurde.

Status: einheimisch; etabliert

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Literatur

Acta Plantarum, 2026: *Cotoneaster divaricatus*. Online verfügbar unter https://www.actaplantarum.org/flora/flora_info.php?id=511627

Ambrosi F., 1853: Flora von Südtirol. Österr. bot. Wochenblatt, 3: 265–268, 273–276, 282–284, 289–292, 296–299, 306–309, 314–317, 323–325, 329–333, 338–341, 347–351, 353–356, 361–365, 370–374, 378–382, 385–389, 392–395, 401–405.

Argenti C., Masin R., Pellegrini B., Perazza G., Prosser F., Scortegagna S. & Tasinazzo S., 2019: Flora del Veneto dalle Dolomiti alla laguna veneziana, vol 1–2. Cierre Edizioni.

Bachlechner G., 1859: Verzeichnis der phanerogamen Pflanzen, welche in der Gegend von Brixen wild wachsen. Weger, Brixen.

Bačič T., Jogan N. & Dolenc Koce J., 2007a: *Luzula* sect. *Luzula* in south-eastern Alps – karyology and genome size. Taxon 56 (1): 129–136.

Bačič T. , Koce J.D. & Jogan N., 2007b: *Luzula* sect. *Luzula* (Juncaceae) in the South-Eastern Alps: morphology, determination and geographic distribution. Bot. Helvetica, 117:75–88.

Bartolucci F., Peruzzi L., Galasso G., Alessandrini A., Ardenghi N. M. G., Bacchetta G., Banfi E., Barberis G., Bernardo L., Bouvet D., Bovio M., Calvia G., Castello M., Cecchi L., Del Guacchio E., Domina G., Fascetti S., Gallo L., Gottschlich G., Guarino R., Gubellini L., Hofmann N., Iberite M., Jiménez-Mejías P., Longo D., Marchetti D., Martini F., Masin R.R, Medagli P., Peccenini S., Prosser P., Roma-Marzio F., Rosati L., Santangelo A., Scoppola A., Selvaggi A., Selvi F., Soldano A., Stinca A., Wagensommer R.P, Wilhalm T. & Conti F., 2024: A second update to the checklist of the vascular flora native to Italy, Plant Biosystems – An International Journal Dealing with all Aspects of Plant Biology, DOI: 10.1080/11263504.2024.2320126

Borho D., Gregor T., Paule J., Bauer J. & Ewald J., 2020: Sind die Zytotypen von *Amelanchier ovalis* s.l. im Lechtal morphologisch unterscheidbar? Ber. Bayer. Bot. Ges., 90: 67–82.

Braungart R., 1876: Die Wissenschaft in der Bodenkunde. Ein Leitfaden für geobotanisch-ökonomische Studien, für Geologen, Botaniker, Land- und Forstwirte, Kultur-Ingenieure etc. wie zum Gebrauche an höheren Lehranstalten. Hugo Voigt, Berlin & Leipzig, 338 S.

Dalla Torre K. W. & Sarnthein L., 1906–1913: Die Farn- und Blütenpflanzen von Tirol, Vorarlberg und Liechtenstein, 4 Teile. Wagner'sche Universitäts-Buchhandlung Innsbruck.

Dickoré W. B. & Kasperek G., 2010: Species of *Cotoneaster* (Rosaceae, Maloideae) indigenous to, naturalising or commonly cultivated in Central Europe. Willdenowia, 40(1): 13–45. https://doi.org/10.3372/wi.40.40102

Elsmann F., 1825: Angabe der Standörter über die in der Umgebung Botzens im Sommer 1824 gesammelten seltenen Pflanzen. Flora, 8: 503–510.

Facchini F., 1855: Flora Tiroliae Cisalpinae. Zur Flora Tirols. 1. Heft. Flora von Südtirol. Herausgegeben von F. Hausmann. Wagner, Innsbruck.

Favarger C. & Correvon P., 1967: Mise en évidence de races chromosomiques chez l'Amélanchier. Bull. Soc. Neuchâteloise, Sci. Nat., 90: 215–218.

Favarger C. & Stearn W. T., 1983: Contribution à la cytotaxonomie de l'*Amelanchier ovalis* Medikus (Rosaceae). Bot. J. Linn. Soc., 87: 85–103.

Fischer M.A., Adler W. & Oswald K. (in Druck): Exkursionsflora für Österreich und die gesamten Ostalpen. 4. Aufl. der „Exkursionsflora von Österreich". Biologiezentrum der Oberösterreichischen Landesmuseen, Linz.

Floraweb, 2026: Floraweb, Bundesamt für Naturschutz, http://www.floraweb.de

Galasso G. & al., 2021: Notulae to the Italian alien vascular flora: 11. Italian Botanist, 11: 93–119.

Galasso G., Conti F., Peruzzi L., Alessandrini A., Ardenghi N. M. G., Bacchetta G., Banfi E., Barberis G., Bernardo L., Bouvet D., Bovio M., Castello M., Cecchi L., Del Guacchio E., Domina G., Fascetti S., Gallo L., Guarino R., Gubellini L., Guiggi A., Hofmann N., Iberite M., Jiménez-Mejías P., Longo D., Marchetti D.,

Martini F., Masin R. R., Medagli P., Musarella C.M., Peccenini S., Podda L., Prosser F., Roma-Marzio F., Rosati L., Santangelo A., Scoppola A., Selvaggi A., Selvi F., Soldano A., Stinca A., Wagensommer R.P., Wilhalm T. & Bartolucci F., 2024: A second update to the checklist of the vascular flora alien to Italy. Plant Biosystems – An International Journal dealing with all aspects of Plant Biology, 158(2), 297–340. https://doi.org/10.1080/11263504.2024.2320129.

Glück H., 1938: Über das Vorkommen des arktischen *Sparganium hyperboreum* in der zentraleuropäischen Alpenkette. Bot. Jahrb. Syst., 69: 220–251.

Gregor T., Bauer J., Engelhardt M., Hand R., Hein H., Lippert W., Mayer A., Meierott L., Parker H. & Paule J., 2018: *Amelanchier ovalis* s.l. – zwei Zytotypen in Deutschland. Kochia, 11: 65–75.

Hand R., 2001: Revision der in Europa vorkommenden Arten von *Thalictrum* subsectio *Thalictrum* (Ranunculaceae). Botanik und Naturschutz in Hessen, Beiheft 9.

Handel-Mazzetti Heinrich, 1903: Beitrag zur Gefäßpflanzenflora von Tirol. Österr. bot. Zeitschr., 53: 289–294, 359–365, 413–420, 456–460.

Handel-Mazzetti Hermann, 1953: Zur floristischen Erforschung von Tirol und Vorarlberg. Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien. Sonderabdruck aus Band 93.

Handel-Mazzetti Hermann, 1957: Floristische Wanderungen im rechtsseitigen Bozner Unterland. Der Schlern, 31(1–2): 46–59.

Hassler M., 2019: Neuer Schlüssel und Atlas der Nachtkerzen Europas. www.friscris.be/files/2061447/OenotheraAtlas13_8red.pdf

Hausmann F., 1851–54: Flora von Tirol. Wagner, Innsbruck.

Hausmann F., 1855: Botanische Durchforschung Tirols im Jahre 1854. Österr. bot. Wochenbl., 5: p. 113–117, 121–124, 130–133.

Hegi G., 1906–: Illustrierte Flora von Mitteleuropa. 1., 2. und 3. Aufl., 7 Bände, z. T. in Teilbänden. - J. F. Lehmann, München; C. Hanser, München; P. Parey, Berlin-Hamburg; Blackwell Wissenschafts-Verlag, Berlin.

Hegi G., 1975: Illustrierte Flora von Mitteleuropa. Bd. V, Teil 2. Verlag Paul Parey, Berlin und Hamburg.

Heimer V., Carnicero P., Carrizo García C., Hilpold A., Koce J. D., Leal J. L., Li M., Varotto C., Schönswetter P. & Božo F., 2025: Hybridization and Polyploidy Shaped the Evolutionary History of a Complex of Cryptic Species in European Woodrushes (*Luzula* sect. *Luzula*). Syst. Biol., 0(0):1–24. https://doi.org/10.1093/sysbio/syaf065

Heimerl A., 1911: Flora von Brixen a. E. Deuticke, Wien und Leipzig.

Hejný S. & Slavík B., 2003: Květena České Republiky, Vol. 3. Academia, Praha.

Hetzel G., 2006: Die Neophyten Oberfrankens. Floristik, Standortcharakteristik, Vergesellschaftung, Verbreitung, Dynamik. Dissertation, Bayerische Julius-Maximilians-Universität Würzburg: 156 p.

Hetzel I. & Gausmann P., 2010: Vorkommen von *Aucuba japonica* Thunb. (Japanische Aukube) in Wäldern des mittleren Ruhrgebietes. Online-Veröff. Bochumer Bot. Ver., 2(4): 66–69.

Horn K. & Korneck D., 2003: Die Einfache Mondraute (*Botrychium simplex* E. Hitchcock) in Tirol. Wulfenia, 10: 145–169.

InfoFlora, 2026: Info Flora. Das nationale Daten- und Informationszentrum der Schweizer Flora, https://www.infoflora.ch/

Kiem J., 1981: Beobachtungen über die Gattung *Festuca* in Südtirol. Ber. Bayer. Bot. Ges. 52: 25-28.

Kiem J., 1987: Die Gattung *Festuca* in Südtirol und in Nachbargebieten. Ber. Bayer. Bot. Ges., 58: 53–71.

Klötzli F., Walther G.-R., Carraro G. und Grundmann A., 1996: Anlaufender Biomwandel in Insubrien. Verh. Ges. Ökol., 26: 537–550.

Lid J., 2005: Norsk flora. 7. Aufl. Det Sorske Samlaget.

Markgraf Dannenberg I., 1979: *Festuca*-Probleme in ökologisch-soziologischem Zusammenhang. Nachheft zum Bericht über die internationale Fachtagung „Bedeutung der Pflanzensoziologie für eine standortgemäße und umweltgerechte Land- und Almwirtschaft“, 12.–13. Sept. 1978, Gumpenstein: 337–368.

Melzer A., Veit E. & Zimmermann S., 1993: Die Makrophytenvegetation des Kalterer-, Tret- und Haidersees in Südtirol. Unveröff. Manuskript Biolog. Labor, Leifers.

Meyer T., 2026: Flora-de: Flora von Deutschland. https://www.blumeninschwaben.de/

Müller-Dobiles U. & Müller-Dobiles D., 1980: Typhales. In: Hegi, Illustrierte Flora von Mitteleuropa. Bd. 2, Teil 1, 3. Auflage. Verlag Paul Parey, Berlin und Hamburg.

Müller F., Rith C. M., Welk E. & Wesche K. (Hrsg.), 2021: Rothmaler. Exkursionsflora von Deutschland. Gefäßpflanzen: Grundband. 22. Aufl. Springer Spektrum.

Pagitz K., Stöhr O., Thalinger M., Aster I., Baldauf M., Lechner Pagitz C., Niklfeld H., Schratt-Ehrendorfer L. & Schönswetter P., 2023: Rote Liste und Checkliste der Farn- und Blütenpflanzen Nord- und Osttirols. Natur in Tirol, naturkundliche Beiträge der Abteilung Umweltschutz, Bd. 16. Land Tirol.

Pignatti S., 2017–2019: Flora d’Italia. 2. Aufl. 4 Bde. Edagricole, Bologna, Milano.

POWO, 2026: Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; http://www.plantsoftheworldonline.org/

Prosser F., Bertolli A., Festi F. & Perazza G., 2019: Flora del Trentino. Fondazione Museo Civico di Rovereto. Edizioni Osiride.

Sabransky H., 1902: Ein Beitrag zur Kenntnis der Flora von Tirol. Österr. bot. Zeitschr., 52: 143–151.

Sauter F., 1899: Funde seltener Phanerogamen in Ost- und Mitteltirol. Österr. bot. Zeitschr., 49: 351–369, 400–405.

Soldano A., 1993: Il genere *Oenothera* L., subsect. *Oenothera*, in Italia (Onagraceae). “Natura Bresciana” Ann. Mus. Civ. Sc. Nat., Brescia, 28: 85–116.

Stace C., 2010: New Flora of the British Isles. 3rd edn. Cambridge University Press, Cambridge, UK.

Venanzoni R., 1986: Segnalazione di piante rare o di particolare interesse vegetazionale di alcuni ambienti umidi dell'Alto Adige. Studi Trentini Sc. Nat., 62: 3–11.

Verloove F., 2026: Manual of the Alien Plants of Belgium. Botanic Garden Meise, Belgium. alienplants belgium.be

Wallnöfer B., 1988: Fünfzig bemerkenswerte Pflanzenarten Südtirols. Verh. Zool.-Bot. Ges. Österreich, 125: 69–124.

Walters S. M., Brady A., Brickell C. D., Cullen J., Green P. S., Lewis J., Matthews V. A., Webb D. A., Yeo P. F. & Alexander J. C. M. (eds.), 1984: The European Garden Flora, vol. 2 (part II). Cambridge University Press: 318 p.

WFO, 2026: World Flora Online. Published on the Internet. http://www.worldfloraonline.org

Wilhalm T., Niklfeld H. & Gutermann W., 2006: Katalog der Gefäßpflanzen Südtirols. Veröffentlichungen des Naturmuseums Südtirol, 3. Folio, Wien und Bozen.

Wilhalm T., Spögler E., Hackhofer J., Zemmer F., Bachmann R., Bertolli A., Hilpold A., Pagitz K., Prosser F., Sölva E., Stockner W., Alber R., Dunkel F. G., Egger W., Englmaier P., Federspieler R., Hotter M., Lechner-Pagitz C., Rohweder K., Thaler B. & Tratter W., 2020: Ergänzungen und Korrekturen zum Katalog der Gefäßpflanzen Südtirols (9). Gredleriana, 20: 29-55.

Wilhalm T., Spögler E., Tratter W., Sölva E., Leitner G., Aichner G., Holzer B., Bachmann R., Fundneider A., Merli M., Zemmer F., Kögl C., Hilpold A., Stockner W., Ebert M., Geurden J. N., Kiebacher T., Mallaun M., Prosser F., Rohweder K. & Schweigkofler H., 2023: Ergänzungen und Korrekturen zum Katalog der Gefäßpflanzen Südtirols (11). Gredleriana, 23: 33–67.

Zuccarini J., 1824: Botanische Notizen über eine im Juli 1823 nach Tyrol und Oberitalien gemachte Reise. Flora, 17: 257–302.

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New species for the orthopteran fauna of South Tyrol (Prov. Bolzano, Italy): *Poecilimon ornatus* (Schmidt, 1850) and new observation of *Bicolorana bicolor* (Philippi, 1830) (Insecta, Orthoptera)

Keywords: Orthoptera, Bush-cricket, faunistics, first records, South Tyrol, expansion

Abstract

We report the first record of *Poecilimon ornatus* (Schmidt, 1850) for South Tyrol (Autonomous Province of Bolzano/Bozen, Italy). The species was found in 2026 in a meadow near Fontanefredde/Kaltenbrunn (Trodena/Truden) during surveys of the Biodiversity Monitoring South Tyrol programme. The same site had been sampled in 2021 without detecting the species, and no further individuals were found during later visits in the same season or in the surrounding meadows. The nearest known records are from Val di Fassa (Trentino), about 25 km away. We suggest that the new record most likely reflects a recent natural spread from Trentino, although an overlooked population, given the early phenology and cryptic behaviour of the species, or accidental human-mediated dispersal cannot be excluded. At the same site we also recorded *Bicolorana bicolor* (Philippi, 1830), which is known in South Tyrol from only a few scattered records. Both findings fit a broader pattern of Orthoptera from southern and south-eastern regions shifting northwards into South Tyrol, possibly linked to climate warming. We provide a short description of both species, with the characters that separate them from similar taxa, and a list of the co-occurring orthopteran species.

Introduction

The orthopteran fauna of South Tyrol is relatively well known thanks to the systematic mapping carried out over the last decades (Kranebitter et al. 2007; Wilhalm et al. 2018), which provided the basis for the current checklist and Red List of the province (Hilpold et al. 2017). Since then, several thermophilous species have been newly recorded, or confirmed, for South Tyrol, among them *Euchorthippus declivus*, *Bicolorana bicolor* (Hilpold & Heimer 2021), *Pezotettix giornae* (Hilpold & Guariento 2022) and *Leptophyes punctatissima*, for which the first established population in the province was recently documented (Repetto et al. 2024). Further distribution data are currently being collected within the Biodiversity Monitoring South Tyrol (BMS), carried out by Eurac Research and co-financed by the Autonomous Province of Bolzano/Bozen (Hilpold et al. 2025). The project surveys 320 terrestrial sites, stratified across the main habitat types of the province, over a five-year cycle (64 sites per year), with orthopterans recorded at every site (Hilpold et al. 2023). Here we report the first record of *Poecilimon ornatus* (Schmidt, 1850) for South Tyrol and a new record of *Bicolorana bicolor* (Philippi, 1830), both made during BMS surveys in 2026 and discuss their possible origin.

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Materials and Methods

The specimens were found during surveys of the Biodiversity Monitoring South Tyrol project (hereafter: BMS), conducted by Eurac Research in Bolzano/Bozen (Hilpold et al. 2023).

All individuals of both species (see Results) were observed at a BMS site near Fontanefredde/Kaltenbrunn (municipality of Trodena/Truden), WGS84 46.33860° N, 11.35709° E, 928 m a.s.l. The site is an extensively managed montane hay meadow receiving High Nature Value subsidies [exposure: 72°; slope: 25°]. The vegetation survey carried out on 20 May 2026 recorded 74 vascular plant taxa. The community was dominated by *Brachypodium rupestre*, *Trifolium montanum*, and *Filipendula vulgaris*, with *Ranunculus nemorosus*, *Ranunculus acris, Carex montana*, *Colchicum autumnale*, and *Salvia pratensis* as further frequent species (Table 1). Orthoptera were sampled within the 10 × 10 m survey area following the BMS protocol (for more details see Hilpold et al. 2023). After this first record, the site was revisited three times during the same season (03.07.2026, 24.07.2026 and 24.08.2026). Meadows about 500 m away were surveyed on an exploratory basis, without strictly following the BMS protocol, using visual and acoustic search, sweep netting and beating of small shrubs.

For completeness, we also checked citizen science platforms for online records (GBIF.org, 2026; iNaturalist.org, 2026; Observation.org, 2026).

Table 1: List of vascular plant species (taxonomical reference: Fischer et al. 2008) and their cover recorded by Roberto Dellavedova and Jona Marie Motzkus on 20.05.2026 on an area of 100 m² at the site of occurrence of *Poecilimon ornatus* (BMS site 020_HEM_8, Fontanefredde/Kaltenbrunn). Cover values are means of the two 10 m² subplots; species recorded only in the remaining area of the 100 m² plot are given as 0.1 (scattered) or 0.01 (rare).

Species	Cover (%/100 m²)	Species	Cover (%/100 m²)
Achillea millefolium agg.	0.3	*Gymnadenia conopsea*	0.05
Agrostis sp.	0.1	*Holcus lanatus*	0.1
Ajuga reptans	0.1	*Hypericum maculatum*	0.1
Alchemilla sp.	0.01	*Knautia arvensis*	0.6
Anemone trifolia	0.3	*Leontodon hispidus*	1.25
Anthoxanthum odoratum	3.87	*Leucanthemum vulgare*	0.65
Arabis sagittata	0.05	*Lotus corniculatus*	0.45
Avenula pubescens	1.5	*Luzula campestris*	1.1
Betonica officinalis	0.5	*Ornithogalum umbellatum* agg.	2
Botrychium lunaria	0.01	*Paradisea liliastrum*	0.5
Brachypodium rupestre	8.82	*Phyteuma orbiculare*	0.55
Briza media	0.5	*Picea abies*	0.01
Bromus erectus	0.1	*Pimpinella saxifraga*	0.9
Campanula glomerata	0.18	*Plantago lanceolata*	1.5
Carex caryophyllea	2	*Plantago media*	1
Carex digitata	1	*Polygala vulgaris*	0.2
Carex flacca	0.01	*Potentilla alba*	1.15
Carex montana	9	*Primula veris*	3
Carex pallescens	1.75	*Prunus* sp.	0.1
Carum carvi	2	*Ranunculus acris*	7
Centaurea jacea	2.65	*Ranunculus nemorosus*	4
Centaurea scabiosa	0.3	*Rhinanthus alectorolophus*	0.2
Cerastium holosteoides	0.05	*Rumex acetosa*	0.3
Clinopodium vulgare	0.2	*Salvia pratensis*	3.5
Colchicum autumnale	9	*Scorzonera humilis*	2.05
Crepis biennis	0.1	*Selaginella helvetica*	0.2
Crocus albiflorus	0.1	*Stellaria graminea*	0.2
Cytisus purpureus	0.1	*Thalictrum minus*	1.35

Species	Cover (%/100 m²)	Species	Cover (%/100 m²)
Dactylis glomerata	0.65	*Trifolium montanum*	8.5
Dactylorhiza sp.	0.01	*Trifolium pratense*	0.3
Festuca nigrescens	2.5	*Trisetum flavescens*	0.28
Festuca pratensis	1.5	*Trollius europaeus*	0.5
Filipendula vulgaris	6.5	*Veronica chamaedrys*	0.1
Galium mollugo	0.1	*Vicia cracca*	0.1
Galium pumilum	0.1	*Vicia sepium*	0.1
Galium verum	0.8	*Viola canina*	0.13
Gentianella sp.	0.001	*Viola riviniana*	0.05

Results and Discussion

On June 12, 2026, 9 adults and 1 sub-adult of *Poecilimon ornatus* were found by E. Repetto and N. Soldovieri near Fontanefredde/Kaltenbrunn at an elevation of 928 m a.s.l. (Figure 1). Two specimens were retained for subsequent confirmation of identification by members of the Orthopteroid Insects Research Group (GRIO) of the World Biodiversity Association. They will be integrated into the collections of the South Tyrol Museum of Nature. *P. ornatus* was not recorded during the subsequent Orthoptera surveys of the site on 3 and 24 July 2026, nor incidentally during a butterfly survey on 24 August 2026, or in the nearby meadows surveyed on an exploratory basis (03.07.2026, 24.07.2026 and 24.08.2026).



Figure 1: *Poecilimon ornatus* male photographed at the site, showing an enlarged abdominal segment caused by infection with an entomopathogenic fungus (Photo by Emanuele Repetto, 12.06.2026).

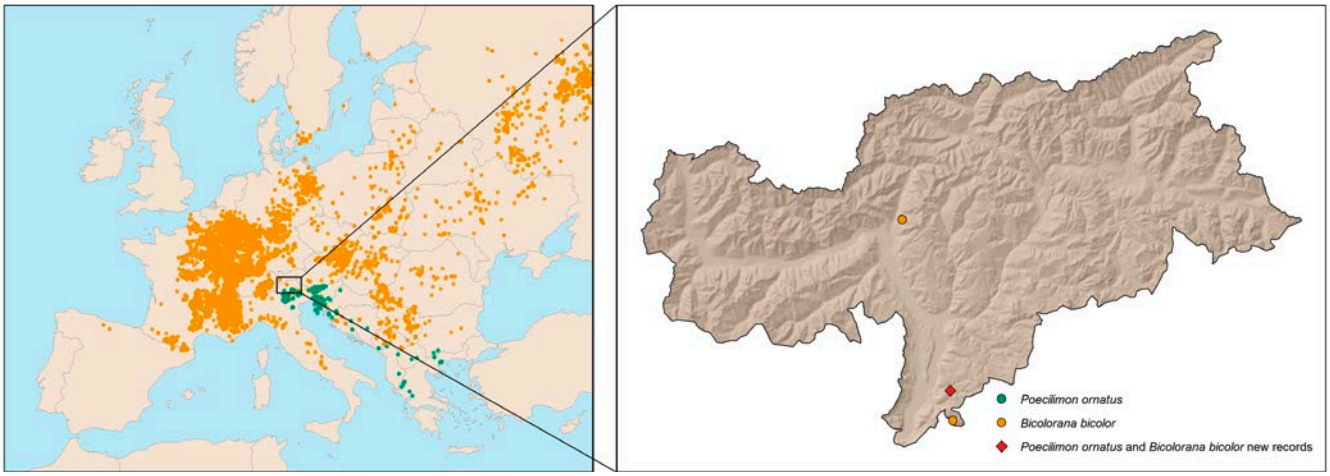


Figure 2: Left: distribution of *Poecilimon ornatus* (green) and *Bicolorana bicolor* (orange) in Europe from GBIF (2026; https://doi.org/10.15468/dl.t48ar2). Right: map of *P. ornatus* and B. *bicolor* in South Tyrol. The red diamond marks the new records of both species reported here. The orange dots mark the known records of *B. bicolor:* the GBIF record and the published record from Anterivo/Altrei (Hilpold & Heimer 2021).

Poecilimon ornatus (Schmidt, 1850) is a flightless Phaneropterinae bush-cricket (Orthoptera: Tettigoniidae) found in montane and subalpine areas. Adults live in tall-herb vegetation, forb-rich grasslands, woodland edges and clearings, where they usually stay and feed on herbaceous plants and low shrubs (Iorio et al. 2019; Scherini 2026). It is one of the earliest Tettigoniidae to mature, with adults appearing from late May and persisting until mid-late summer (Orthoptera.ch 2026a; Scherini 2026).

Its range extends across the Balkan Peninsula and reaches its north-western limit in the south-eastern and eastern Alps (Figure 2). In Italy it is known from the north-eastern regions Friuli Venezia Giulia, Veneto and Trentino (Iorio et al. 2019; Fontana et al. 2002). It had not previously been recorded in South Tyrol and is therefore not included in the Red List of Orthoptera of South Tyrol (Hilpold et al. 2017).

Poecilimon ornatus is a medium-sized species, with a body length of 21–33 mm in males and 22–30 mm in females and an ovipositor 13–21 mm long (Iorio et al. 2019; Orthoptera.ch 2026a; Scherini 2026). Its colouration is highly variable, ranging from dark-spotted green to complex patterns of black and greenish-yellow hues (Orthoptera.ch 2026a; Scherini 2026). Despite this variability, females tend to be uniformly green, while males often show two yellow and two black longitudinal bands running from the pronotum to the cerci.

In males, the posterior half of the pronotum is distinctly saddle-shaped and the yellowish tegmina extend beyond it by about half its length. In females, the pronotum is only slightly raised and the tegmina are barely visible under its posterior margin. The male cerci are stout, long and pale yellowish, bent inwards at about 90° in the apical third. The female ovipositor is straight on the ventral side, slightly upcurved in the last quarter and moderately toothed at the apex (Orthoptera.ch 2026a).

No matter its colouration, the antennae are always banded, with alternating light and dark segments (Orthoptera.ch 2026a; Scherini 2026). This character separates the species from *Polysarcus denticauda*, the only similar species in neighbouring regions, which has not yet been reported from South Tyrol and has unicoloured antennae and a shorter, more pointed ovipositor (Orthoptera.ch 2026a).

The same site had already been sampled in 2021 during the first BMS survey cycle, and the species was not detected then. Moreover, no records of *P. ornatus* from South Tyrol are available on citizen science platforms. The nearest known records are from Tamion (San Giovanni di Fassa) and Soraga (TN), about 25 km from the new site (Gross 2021; Pemberton 2026).

Given the relatively short distance to the population in Trentino, we hypothesize the new record most likely reflects a natural spread of the species along the valley bottoms and low passes connecting Val di Fiemme with the southern part of South Tyrol. However, we cannot exclude that a small population was overlooked in previous years.

The species' early phenology means adults may be missed by surveys carried out later in the season.

A list of all co-occurring orthopteran species that were recorded alongside *Poecilimon ornatus* is provided in Table 2.

Table 2: Species recorded during the Orthoptera surveys at the site of occurrence of *Poecilimon ornatus*. Abundance classes: I = 1 individual, II = 2–5, III = 6–10, IV = 11–20, V = 21–50, VI = > 50 individuals; – = not recorded. The butterfly survey of 24.08.2026 is not included, as Orthoptera were not systematically recorded.

Species	12.06.2026	03.07.2026	24.07.2026
Bicolorana bicolor	–	I	–
Chorthippus dorsatus	–	–	IV
Decticus verrucivorus	III	–	–
Euthystira brachyptera	III	V	V
Gomphocerinae	IV	VI	VI
Gryllus campestris	I	–	–
Leptophyes boscii	–	II	–
Pholidoptera aptera	IV	IV	–
Pholidoptera griseoaptera	–	II	II
Pholidoptera sp.	IV	–	–
Poecilimon ornatus	III	–	–
Pseudochorthippus parallelus	–	V	IV
Stauroderus scalaris	I	I	I
Tetrix bipunctata kraussi	–	–	II
Tetrix sp.	–	–	I
Tettigonia cantans	IV	II	I
Tettigonia caudata	I	–	–

In the same site, *Bicolorana bicolor* (Philippi, 1830) was also recorded on 3 July 2026 (Figure 3).

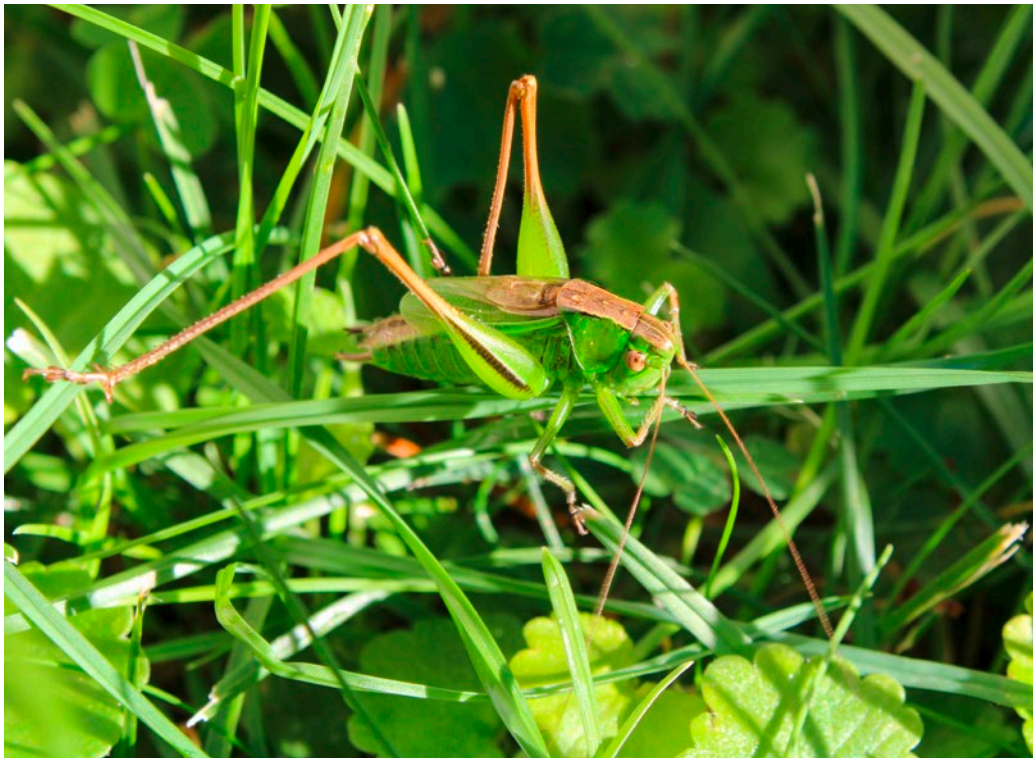


Figure 3: *Bicolorana bicolor* male from archive (Photo by Andreas Hilpold, 03.08.2021).

Bicolorana bicolor (Philippi, 1830) is a small Tettigoniinae bush-cricket (Orthoptera: Tettigoniidae). It lives in dry, warm grasslands, where it prefers tall, dense grass on sunny slopes (Orthoptera.ch 2026b). Adults are found from July to late September (Orthoptera.ch 2026b; Scherini 2026).

The species ranges across much of central and eastern Europe and extends east into temperate Asia (Figure 2). In Italy it is known from the northern regions (Iorio et al. 2019; Scherini 2026). The first record of the species for South Tyrol was published only recently, from Anterivo/Altrei (Hilpold & Heimer 2021).

Bicolorana bicolor is a small, stout species with a body length of 14–17 mm in males and 15–18 mm in females, and an ovipositor 5–7 mm long (Scherini 2026). As its name suggests, it is two-coloured: the body is usually bright green while the dorsal side, top of the head and pronotum, tegmina and top of the abdomen, is brown (Iorio et al. 2019; Scherini 2026). The tegmina are usually shortened and reach about the middle of the abdomen, but long-winged (macropterous) individuals can occur. The female ovipositor is sharply upcurved. The pronotum's lateral lobes are uniformly green, without the pale border that characterises *Roeseliana roeselii* (Orthoptera.ch 2026b).

The species was reported from Anterivo/Altrei in 2021 (Hilpold & Heimer 2021) and has been observed in 2019 near Merano/Meran (Mody 2019a, b). These scattered records may reflect a recent spread of the species within the province. Alternatively, *Bicolorana bicolor* may simply be under-recorded, given the few targeted surveys in its potential habitats. More broadly, the records of *Poecilimon ornatus* and *B. bicolor* fit a pattern of species from southern and south-eastern regions shifting northwards. This has already been suggested for other Orthoptera in South Tyrol, such as *Pezotettix giornae* (Hilpold & Guariento 2022), and may be linked in part to climate warming.

Acknowledgement

We thank the Autonomous Province of Bolzano-South Tyrol for financing the Biodiversity Monitoring programme during which *Poecilimon ornatus* was discovered. We further thank Roberto Dellavedova and Jona Marie Motzkus for their help in the field and for providing the plant data.

Riassunto

Si segnala il primo ritrovamento di *Poecilimon ornatus* (Schmidt, 1850) in Alto Adige (Provincia Autonoma di Bolzano, Italia). La specie è stata osservata nel 2026 in un prato presso Fontanefredde/Kaltenbrunn (Trodena/Truden), nell'ambito dei rilievi del progetto di Monitoraggio della Biodiversità Alto Adige. Lo stesso sito era già stato campionato nel 2021 senza che la specie fosse rilevata, e nessun altro individuo è stato trovato né nelle visite successive della stessa stagione né nei prati circostanti. Le segnalazioni note più vicine provengono dalla Val di Fassa (Trentino), a circa 25 km di distanza. Riteniamo che il nuovo ritrovamento rifletta con buona probabilità una recente espansione naturale dal Trentino, anche se non si può escludere che una popolazione sia passata inosservata, data la fenologia precoce e il comportamento criptico della specie. Nello stesso sito è stata inoltre rilevata *Bicolorana bicolor* (Philippi, 1830), nota in Alto Adige solo da poche segnalazioni sparse. Entrambi i ritrovamenti si inseriscono in un più ampio quadro di spostamento verso nord, in Alto Adige, di specie di ortotteri provenienti da regioni meridionali e sud-orientali, forse legato in parte al riscaldamento climatico. Si fornisce una breve descrizione delle due specie, con i caratteri che le distinguono da taxa simili, e l'elenco delle specie di ortotteri rinvenute insieme a esse.

Zusammenfassung

Wir berichten über den Erstnachweis von *Poecilimon ornatus* (Schmidt, 1850) für Südtirol (Autonome Provinz Bozen, Italien). Die Art wurde 2026 im Rahmen des Biodiversitätsmonitorings Südtirol auf einer Wiese bei Kaltenbrunn (Truden) nachgewiesen. 2021 wurde dieselbe Fläche für das Biodiversitätsmonitoring Südtirol erstmals erhoben. Dabei wurde die Art nicht festgestellt. Auch bei späteren Begehungen im Sommer 2026 sowie auf den umliegenden Wiesen konnten keine weiteren Individuen gefunden werden. Die nächstgelegenen bekannten Vorkommen der Art befinden sich im Fassatal (Trentino) in einer Entfernung von etwa 25 km. Wir vermuten, dass der Nachweis am ehesten auf eine jüngere, natürliche Ausbreitung aus dem Trentino zurückzuführen ist. Aufgrund der frühen Phänologie der Art und ihres kryptischen Verhaltens kann jedoch nicht ausgeschlossen werden, dass eine bereits seit Längerem bestehende Population bislang übersehen wurde. Am selben Fundort wurde zudem *Bicolorana bicolor* (Philippi, 1830) festgestellt, eine Art, von der in Südtirol bisher nur wenige, verstreute Nachweise vorliegen. Beide Funde fügen sich in ein breiteres Muster ein, wonach Heuschreckenarten mit südlicher bzw. südöstlicher Verbreitung ihr Areal nach Norden bis nach Südtirol ausdehnen, möglicherweise begünstigt durch den Klimawandel. In dem vorliegenden Artikel werden beide Arten mit den wichtigsten Unterscheidungsmerkmalen zu ähnlichen Arten beschrieben und eine Liste der gemeinsam vorkommenden Orthopteren-Arten präsentiert.

Bibliography

Fischer M. A., Oswald K. & Adler W., 2008: Exkursionsflora für Österreich, Liechtenstein und Südtirol. 3. Aufl. Biologiezentrum der Oberösterreichischen Landesmuseen, Linz.

Fontana P., Buzzetti F. M., Cogo A. & Odé B., 2002: Guida al riconoscimento e allo studio di Cavallette, Grilli, Mantidi e Insetti affini del Veneto: Blattaria, Mantodea, Isoptera, Orthoptera, Phasmatodea, Dermaptera, Embiidina. Museo Naturalistico Archeologico di Vicenza, Vicenza, 592 pp.

GBIF.org, 2026: GBIF Occurrence Download. Available from: https://doi.org/10.15468/dl.t48ar2 [accessed on 30.09.2026].

Gross M., 2021: *Poecilimon ornatus*. iNaturalist observation. Available from: https://www.inaturalist.org/observations/86834710 [accessed on 30.09.2026].

Hilpold A., Anderle M., Guariento E., Marsoner T., Mina M., Obwegs L., Paniccia C., Seeber J., Strobl J., Vanek M., Bottarin R. & Tappeiner U., 2025: Monitoraggio della Biodiversità Alto Adige – Rapporto I. Eurac Research, Bolzano. doi:10.57749/7nvz-r102

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, Bolzano. doi:10.57749/2qm9-fq40

Hilpold A. & Guariento E., 2022: *Pezotettix giornae* (Rossi, 1794) (Insecta, Acrididae), ein Neufund für die Fauna Südtirols. Gredleriana, 22: 149–152. doi:10.5281/zenodo.7261901

Hilpold A. & Heimer V., 2021: *Euchorthippus declivus* (Brisout de Barneville, 1848) und *Bicolorana bicolor* (Philippi, 1830) (Orthoptera, Insecta) – Neufund bzw. erster gesicherter Nachweis für Südtirol. Gredleriana, 21: 121–124. doi:10.5281/zenodo.5599981

Hilpold A., Wilhalm T. & Kranebitter P., 2017: Rote Liste der gefährdeten Fang- und Heuschrecken Südtirols (Insecta: Orthoptera, Mantodea). Gredleriana, 17: 61–88.

iNaturalist.org, 2026: iNaturalist. Available from: https://www.inaturalist.org [accessed on 30.09.2026].

Iorio C., Scherini R., Fontana P., Buzzetti F. M., Kleukers R., Odé B. & Massa B., 2019: Grasshoppers & crickets of Italy: a photographic field guide to all the species. WBA Handbooks. WBA Project, Verona.

Kranebitter P., Hilpold A. & Wilhalm T., 2007: Die Kartierung der Heuschrecken (Insecta, Saltatoria) Südtirols. Gredleriana, 7: 195–208.

Mody K., 2019a: *Bicolorana bicolor*. iNaturalist observation. Available from: https://www.inaturalist.org/observations/99686707 [accessed on 30.09.2026].

Mody K., 2019b: *Bicolorana bicolor*. iNaturalist observation. Available from: https://www.inaturalist.org/observations/99686917 [accessed on 30.09.2026].

Observation.org, 2026: Observation.org. Available from: https://observation.org [accessed on 30.09.2026].

Orthoptera.ch, 2026a: *Poecilimon ornatus*. Available from: https://www.orthoptera.ch/wiki/arten/ensifera/phaneropterinae/item/poecilimon-poecilimon-ornatus [accessed on 30.09.2026].

Orthoptera.ch, 2026b: *Bicolorana bicolor*. Available from: https://www.orthoptera.ch/wiki/arten/ensifera/tettigoniinae/item/bicolorana-bicolor [accessed on 30.09.2026].

Pemberton P., 2026: *Poecilimon ornatus*. iNaturalist observation. Available from: https://www.inaturalist.org/observations/386816118 [accessed on 30.09.2026].

Repetto E., Guariento E., Marsy A. & Hilpold A., 2024: *Leptophyes punctatissima* (Orthoptera: Tettigoniidae) – Observation of an established population in South Tyrol and report of additional findings. Gredleriana, 24: 73–76. doi:10.5281/zenodo.14035931

Scherini R., 2026: Ortotteri dell'Italia continentale: Ensifera. Natura Edizioni Scientifiche.

Wilhalm T., Hilpold A. & Kranebitter P., 2018: Neue Verbreitungsdaten und aktuelle Verbreitungskarten zur Heuschrecken-Fauna (Orthoptera) Südtirols. Gredleriana, 18: 47–101.



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Proceedings of the First Italian Congress of Orthopterology

September 26–27, 2026

Bolzano/Bozen, Italy

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Proceedings of the First Italian Congress of Orthopterology

September 26–27, 2026
Bolzano/Bozen, Italy

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Abstract

The First Italian Congress of Orthopterology took place on September 26–27, 2026, at the Eurac Research headquarters in Bolzano/Bozen. It brought together 23 participants and featured 15 oral presentations and 4 posters. The topics covered faunistics, ecology and conservation, biomechanics, bioacoustics and artificial intelligence. These proceedings contain the abstracts of all oral and poster presentations.

1. Introduction

On September 26–27, 2026, the First Italian Congress of Orthopterology was held at the Eurac Research headquarters in Bolzano/Bozen. The 23 participants ranged from high-school students to postdoctoral and senior researchers. The programme included 15 oral presentations, among them a keynote lecture, and 4 posters. Topics ranged from faunistic notes to ecology, species conservation, biomechanics, bioacoustics and AI-based tools.

The congress ended with a field excursion from Compaccio/Compatsch (Alpe di Siusi/Seiser Alm) to the Rifugio Bolzano/Schlernhaus. During the excursion, 14 species of Orthoptera, 7 species of Lepidoptera and 4 species of Hemiptera were recorded (Table 1).

Table 1a: Sites of the field excursion of 27 September 2026 from Compaccio/Compatsch (Alpe di Siusi/Seiser Alm) to the Rifugio Bolzano/Schlernhaus (Sciliar/Schlern). Coordinates in decimal degrees.

Site	Locality	Lat. (N)	Long. (E)
S1	Alpe di Siusi/Seiser Alm, trail from Compaccio/Compatsch to Malga Gstatsch, 0.6 km S of Compaccio/Compatsch	46.53529	11.61883
S2	Alpe di Siusi/Seiser Alm, trail from Compaccio/Compatsch to Malga Gstatsch, 0.8 km N of Malga Gstatsch	46.52567	11.60899
S3	Alpe di Siusi/Seiser Alm, trail from Compaccio/Compatsch to Malga Gstatsch, 100 m NE of Malga Gstatsch	46.51887	11.61034
S4	Alpe di Siusi/Seiser Alm, trail from Malga Gstatsch to Malga Salter, 100 m SW of Malga Gstatsch	46.51717	11.60856
S5	Sciliar/Schlern, Sentiero dei Turisti, 1 km W of Malga Salter	46.51252	11.59481
S6	Sciliar/Schlern, Sentiero dei Turisti, 1.5 km W of Malga Salter	46.51184	11.58771
S7	Sciliar/Schlern, 0.5 km NE of Rifugio Bolzano/Schlernhaus, above the trail	46.51042	11.58061
S8	Sciliar/Schlern, 0.3 km ENE of Rifugio Bolzano/Schlernhaus, below the trail	46.50839	11.57888

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Table 1b: Species recorded during the field excursion (14 Orthoptera, 7 Lepidoptera, 4 Hemiptera). Site codes refer to Table 1a; cf. = identification not confirmed.

Order	Family	Species	Sites
Orthoptera	Tettigoniidae	*Anonconotus italoaustriacus*	S6
Orthoptera	Tettigoniidae	*Antaxius difformis*	S6
Orthoptera	Tettigoniidae	*Decticus verrucivorus*	S2
Orthoptera	Tettigoniidae	*Metrioptera brachyptera*	S2
Orthoptera	Tettigoniidae	*Pholidoptera aptera*	S5
Orthoptera	Acrididae	*Chorthippus biguttulus*	S1, S2, S8 (cf.)
Orthoptera	Acrididae	*Euthystira brachyptera*	S1
Orthoptera	Acrididae	*Gomphocerus sibiricus*	S7
Orthoptera	Acrididae	*Melanoplus frigidus*	S7
Orthoptera	Acrididae	*Miramella irena*	S4
Orthoptera	Acrididae	*Omocestus rufipes*	S3
Orthoptera	Acrididae	*Podisma pedestris*	S6
Orthoptera	Acrididae	*Stenobothrus lineatus*	S1, S2, S7, S8
Orthoptera	Tetrigidae	*Tetrix bipunctata* s.l.	S3
Lepidoptera	Pieridae	*Colias croceus*	S3, S8
Lepidoptera	Pieridae	*Colias hyale/alfacariensis*	S3
Lepidoptera	Lycaenidae	*Polyommatus icarus*	S3
Lepidoptera	Nymphalidae	*Erebia pronoe*	S2
Lepidoptera	Nymphalidae	*Issoria lathonia*	S3
Lepidoptera	Nymphalidae	*Vanessa atalanta*	S3, S8
Lepidoptera	Nymphalidae	*Vanessa cardui*	S3, S8
Hemiptera	Miridae	*Adelphocoris seticornis*	S2
Hemiptera	Pentatomidae	*Dolycoris baccarum*	S2
Hemiptera	Pentatomidae	*Neottiglossa pusilla*	S6
Hemiptera	Aphrophoridae	*Philaenus spumarius*	S6

2. Organisation

The congress was co-organised by the Institute for Alpine Environment, Eurac Research, the World Biodiversity Association ETS – Gruppo di Ricerca sugli Insetti Ortotteroidei (GRIO) and the Museo di Archeologia e Scienze Naturali “G. Zannato”.

Scientific Committee: Roberto Battiston, Museo di Archeologia e Scienze Naturali “G. Zannato”, Montecchio Maggiore (Italy); Filippo Maria Buzzetti, Fondazione Museo Civico di Rovereto, Rovereto (Italy); Paolo Fontana, Edmund Mach Foundation, San Michele all’Adige (Italy); Elia Guariento, Institute for Alpine Environment, Eurac Research, Bolzano/Bozen (Italy); Andreas Hilpold, Institute for Alpine Environment, Eurac Research, Bolzano/Bozen (Italy); Bruno Massa, Department of Agricultural, Food and Forest Sciences, University of Palermo, Palermo (Italy); Emanuele Repetto, Institute for Alpine Environment, Eurac Research, Bolzano/Bozen (Italy) and Department of Ecology, University of Innsbruck, Innsbruck (Austria); Nicola Tormen, World Biodiversity Association ETS – GRIO, Verona (Italy).

3. Acknowledgements

We thank Eurac Research for providing the venue and logistical support, the World Biodiversity Association ETS (WBA) and WBA Project for managing registrations and communication, and all participants for their contributions.

4. Congress Programme

The contributions were grouped into the following sessions:
- Faunistics
- Ecology & conservation
- Biomechanics
- AI & bioacoustics

Saturday, September 26, 2026

Oral presentations

9:15 – 9:50 **Keynote:**
Orthoptera of South Tyrol: history of research, diversity and ongoing changes
Andreas Hilpold; Institute for Alpine Environment, Eurac Research, Bolzano (I)

Session: Faunistics 1
Chair: Andreas Hilpold – Institute for Alpine Environment, Eurac Research, Bolzano

9:50 – 10:10 **Monitoring of Orthoptera in the green areas of Venice Marco Polo Airport (Italy)**
Nicola Tormen; World Biodiversity Association ETS – GRIO, Verona (I)

10:10 – 10:30 **The orthopteroid insects of the Canterno Lake Nature Reserve (Latium, Italy) (Polyneoptera: Blattodea, Mantodea, Orthoptera, Dermaptera)**
Alessio Mariani; World Biodiversity Association ETS – GRIO, Verona (I)

10:30 – 10:50 **First records of *Eunemobius carolinus* (Orthoptera: Trigonidiidae) in Europe, one of the exotic crickets new for Italy**
Filippo Maria Buzzetti; Fondazione Museo Civico di Rovereto, Rovereto (I)

10:50 – 11:10 **On the discovery of Nearctic crickets (Orthoptera: Grylloidea) new to Europe in Veneto**
Mathieu Pélissié; Department of Biology, University of Padova, Padova (I)

Session: Faunistics 2
Chair: Andreas Hilpold – Institute for Alpine Environment, Eurac Research, Bolzano

11:40 – 12:00 **New data on the conservation, distribution and ecology of *Zeuneriana marmorata* (Orthoptera: Tettigoniidae)**
Filippo Maria Buzzetti; Fondazione Museo Civico di Rovereto, Rovereto (I)

Session: Ecology & conservation 1
Chair: Roberto Battiston – Museo di Archeologia e Scienze Naturali "G. Zannato", Montecchio Maggiore

12:00 – 12:20 **Alpine orthopteran communities: diversity and community composition along an elevational gradient revisited after five years**
Elia Guariento; Institute for Alpine Environment, Eurac Research, Bolzano (I)

12:20 – 12:40 **Tying the threads between orthopterans, butterflies and plants: a multitaxonomic and genetic approach**
Emanuele Repetto; Institute for Alpine Environment, Eurac Research, Bolzano (I), Department of Ecology, University of Innsbruck, Innsbruck (A)

12:40 – 13:00 **Orthopterans in colour: assessing variation in community colour traits**
Francesco Rocca; Institute for Alpine Environment, Eurac Research, Bolzano (I), Department of Biological, Geological and Environmental Sciences, University of Bologna, Bologna (I)

Session: Ecology & conservation 2
Chair: Roberto Battiston – Museo di Archeologia e Scienze Naturali "G. Zannato", Montecchio Maggiore

14:00 – 14:20 **Anthropic impact on Orthoptera populations in managed meadows**
Alberto Mattia Nodari; Department of Environmental Science and Policy, University of Milan, Milan (I)

14:20 – 14:40 **Hopping over the storm: Orthoptera in the new habitats created by Storm Vaia in 2018 (Alps, Northern Italy)**
Paolo Fontana; Edmund Mach Foundation, San Michele all'Adige (I)

Session: Biomechanics
Chair: Elia Guariento – Institute for Alpine Environment, Eurac Research, Bolzano

14:40 – 15:00 **Latch-mediated actuation in locusts preserves jumping performance over 5 orders of isometric scaling, at the expense of take-off time**
Luca Ruggiero; Department of Biomedical Sciences, University of Padova, Padova (I)

Session: AI & bioacoustics
Chair: Emanuele Repetto – Institute for Alpine Environment, Eurac Research, Bolzano

15:00 – 15:20 **LiRIO: from automated assessments to participatory Red Lists in a national platform for the conservation of Italian orthopteroid insects**
Roberto Battiston; Museo di Archeologia e Scienze Naturali "G. Zannato", Montecchio Maggiore (I)

15:20 – 15:40 **Rthoptera Desk: a new desktop app for sound analysis**
Filippo Maria Buzzetti; Fondazione Museo Civico di Rovereto, Rovereto (I)

15:40 – 16:00 **Digital audio recordings of the song of unseen Orthoptera: guidelines for the empirical visual and aural species-level attribution and introduction of the "Sandwich Method"**
Cesare Brizio; World Biodiversity Association ETS – GRIO, Verona (I)

Poster session (16:00 – 16:45)

What's on the menu for alien mantises? Exploring the genetic diversity and diet of *Hierodula* species (Mantodea: Mantidae) in Italy using DNA barcoding and metabarcoding
Michele Cesari; Department of Life Sciences, University of Modena and Reggio Emilia, Modena (I)

Evidence of phenological segregation in some Mediterranean mantis communities
Oscar Maioglio; ANP (Associazione Naturalistica Piemontese), Carmagnola (I)

Orthoptera in Friuli Venezia Giulia region under climate change
Francesca Tami; World Biodiversity Association ETS – GRIO, Verona (I)

Orthopteroid insects in the diet of the invasive African Sacred Ibis (*Threskiornis aethiopicus*)
Nicola Larroux; Department of Science and High Technology, University of Insubria, Como (I)

Sunday, September 27, 2026

Field excursion

9:00 – 16:00 **Alpe di Siusi/Seiser Alm – Sciliar/Schlern**
Guide: Andreas Hilpold; Institute for Alpine Environment, Eurac Research, Bolzano (I)

5. Abstracts

Abstracts of all oral and poster presentations are listed alphabetically by the first name of the first author, preceded by the keynote lecture. Taxon authorities are given only at the first mention of the taxa that are the subject of each contribution.

Andreas Hilpold[1]

Orthoptera of South Tyrol: history of research, diversity and ongoing changes

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South Tyrol hosts a diverse Orthoptera fauna, shaped by its biogeographical position within the Alps and at the intersection between Central Europe and the Mediterranean. Its exploration has a history of more than 150 years. The foundations were laid by Veit Graber (Graber 1867) and Hermann Krauss (Krauss 1873, 1883). From the mid-twentieth century onwards, Antonio Galvagni and Adolf Nadig substantially advanced knowledge of the regional orthopteran fauna (e.g. Nadig 1987; Galvagni 2001). From the 1990s, Klaus Hellrigl played a central role in compiling historical and contemporary records, resulting in the first Red List (Hellrigl & Mörl 1994), a regional checklist (Hellrigl 1996) and a comprehensive faunistic synthesis (Hellrigl 2006). This work was followed by systematic mapping led by the Museum of Nature South Tyrol (Kranebitter et al. 2007) and the establishment of a comprehensive database connected to the web portal www.FloraFauna.it (Wilhalm et al. 2014). Since 2019, Orthoptera have also been systematically surveyed within the long-term Biodiversity Monitoring South Tyrol programme (Hilpold et al. 2023).

To date, 89 Orthoptera species have been recorded from South Tyrol, including historical and regionally extinct species. Central European elements dominate mesic grasslands, wetlands and wooded habitats; rare or threatened species include *Arcyptera fusca*, *Conocephalus dorsalis, Chrysochraon dispar*, *Pseudochorthippus montanus* and *Stethophyma grossum*. Dynamic riverine habitats support a highly specialized and threatened fauna, including *Chorthippus pullus*, *Tetrix tuerki* and *Sphingonotus caerulans*. Alpine elements include *Aeropedellus variegatus*, *Melanoplus frigidus* and *Gomphocerus sibiricus*, while South-Alpine elements such as *Anonconotus italoaustriacus*, *Miramella irena* and *Antaxius difformis* underline the region's biogeographical distinctiveness. Mediterranean elements include *Calliptamus siciliae*, *Yersinella raymondii* and *Pachytrachis striolatus*, whereas dry inner-Alpine valleys support steppe and xerothermophilous species such as *Omocestus petraeus*, *Stenobothrus nigromaculatus* and *Myrmeleotettix maculatus*.

The orthopteran fauna is undergoing considerable change. *Mecostethus parapleurus*, *Anacridium aegyptium* and *Ruspolia nitidula* are currently expanding their ranges, while *Bicolorana bicolor* and *Euchorthippus declivus* (Hilpold & Heimer 2021), *Pezotettix giornae* (Hilpold & Guariento 2022) and *Poecilimon ornatus* (Repetto et al. in prep.) have recently been added to the regional fauna. Conversely, *Xya variegata*, *Epacromius tergestinus*, *Aiolopus strepens*, *Oedaleus decorus*, *Bryodemella tuberculata* and *Locusta migratoria* are considered regionally extinct or vanished (Hilpold et al. 2017). These contrasting trends highlight the value of combining historical faunistic records, regional databases and standardized long-term monitoring to document and understand ongoing changes in Alpine Orthoptera.

References

Galvagni A., 2001: Gli Ortotteroidei della Val Venosta, detta anche Vinschgau (Alto Adige, Italia settentrionale) (Insecta: Blattaria, Mantodea, Orthoptera, Dermaptera). Atti dell'Accademia Roveretana degli Agiati, 251, ser. VIII, vol. I, B: 67–182.

Graber V., 1867: Die Orthopteren Tirols mit besonderer Rücksicht auf ihre Lebensweise und geographische Verbreitung. Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien, 17: 251–280.

Hellrigl K., 1996: Orthoptera (Saltatoria, Saltatoptera) – Springschrecken. In: Hellrigl K. (ed.), Die Tierwelt Südtirols. Veröffentlichungen des Naturmuseums Südtirol, Bozen: 307–315.

Hellrigl K., 2006: Faunistik der Springschrecken Südtirols (Insecta: Orthoptera). Atti dell'Accademia Roveretana degli Agiati, B, Classe di Scienze Matematiche, Fisiche e Naturali, ser. VIII, 6: 109–213.

Hellrigl K. & Mörl G. von, 1994: Rote Liste der gefährdeten Springschrecken (Saltatoria) Südtirols. In: Gepp J. (Red.), Rote Liste gefährdeter Tierarten Südtirols. Abteilung Landschaft und Naturschutz, Bozen: 322–331.

Hilpold A. & Guariento E., 2022: *Pezotettix giornae* (Rossi, 1794) (Insecta, Acrididae), ein Neufund für die Fauna Südtirols. Gredleriana, 22: 149–152. DOI: 10.5281/zenodo.7261901

Hilpold A. & Heimer V., 2021: *Euchorthippus declivus* (Brisout de Barneville, 1848) und *Bicolorana bicolor* (Philippi, 1830) (Orthoptera, Insecta) – Neufund bzw. erster gesicherter Nachweis für Südtirol. Gredleriana, 21: 121–124. DOI: 10.5281/zenodo.5599981

Hilpold A., Wilhalm T. & Kranebitter P., 2017: Rote Liste der gefährdeten Fang- und Heuschrecken Südtirols (Insecta: Orthoptera, Mantodea). Gredleriana, 17: 61–88.

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, Bolzano/Bozen. DOI: 10.57749/2qm9-fq40

Kranebitter P., Hilpold A. & Wilhalm T., 2007: Die Kartierung der Heuschrecken (Insecta, Saltatoria) Südtirols. Gredleriana, 7: 195–208.

Krauss H., 1873: Beitrag zur Orthopteren-Fauna Tirols. Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien, 23: 17–24.

Krauss H., 1883: Neuer Beitrag zur Orthopteren-Fauna Tirols mit Beschreibung zweier neuer *Pezotettix*-Arten. Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien, 33: 219–224.

Nadig A., 1987: Saltatoria (Insecta) der Süd- und Südostabdachung der Alpen zwischen der Provence im W, dem pannonischen Raum im NE und Istrien im SE (mit Verzeichnissen der Fundorte der Tiere meiner Sammlung). I. Teil: Laubheuschrecken (Tettigoniidae). Revue Suisse de Zoologie, 94 (2): 257–356. DOI: 10.5962/bhl.part.79719

Repetto E., Soldovieri N., Rocca F., Hilpold A. & Guariento E., in prep.: First record of *Poecilimon ornatus* in South Tyrol.

Wilhalm T., Kranebitter P. & Hilpold A., 2014: FloraFaunaSüdtirol (www.florafauna.it). Das Portal zur Verbreitung von Pflanzen- und Tierarten in Südtirol. Gredleriana, 14: 99–110.

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Anthropic impact on Orthoptera populations in managed meadows

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Insect biodiversity and abundance have declined globally, largely due to human activities like intensive agriculture and urbanization. Orthoptera is one of the most threatened groups in the Palearctic, with one-third of species having declined in recent decades. With the aim of assessing the effects of anthropic alteration of the landscape and habitat management, we monitored Orthoptera populations in managed grasslands in northern Italy, a region dominated by urban and agricultural landscapes. We assessed the drivers of variation in community composition and identified the factors associated with species richness. Additionally, for the 22 most widespread species, we evaluated the effect of environmental characteristics on species-specific abundance through N-mixture models, including the prevalence of anthropic landscape in the surroundings of the sites, the number of mowings performed during the monitoring season, and the vegetation cover within the sites. Community analyses revealed clear differences in Orthoptera communities along an altitudinal gradient. Species richness showed a quadratic effect, peaking at intermediate altitudes. Both the amount of anthropic landscape surrounding the site and the mowing frequency showed a negative effect on species richness, while vegetation cover within the site showed a positive effect. The same pattern was found when modelling species-specific abundances: for most species we found a positive effect of vegetation cover and negative effects of anthropic landscape and mowing frequency. Only a few generalist species benefited from mowing disturbance and anthropic landscape presence. Our results indicate that promoting a low-intensity management of grasslands can promote Orthoptera species richness and abundance.

Alessio Mariani[1]

The orthopteroid insects of the Canterno Lake Nature Reserve (Latium, Italy) (Polyneoptera: Blattodea, Mantodea, Orthoptera, Dermaptera)

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The results of a study on the orthopterofauna of the Canterno Lake Nature Reserve (Latium) are presented. To date, no studies have been conducted to analyze the entomofauna in the area under consideration. In addition to the field data collected, the records for this area on the iNaturalist platform are presented. As a result, a provisional checklist of all orthopteroid species recorded in the reserve is presented for the first time, along with associated maps of their distribution range. The presence of the following species is noteworthy: *Yersinella beybienkoi* La Greca, 1974 and *Chorthippus (Chorthippus) dorsatus garganicus* Jannone, 1937, which are recorded for the first time in Latium.

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Digital audio recordings of the song of unseen Orthoptera: guidelines for the empirical visual and aural species-level attribution and introduction of the "Sandwich Method"

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Field recordists often deal with situations where the presence of a species is documented exclusively by an audio file, without accompanying images or physical specimens. Machine Learning (ML) classifiers trained on annotated datasets are increasingly popular for the automated identification of insect species from soundscapes or single-species recording. Such promising technology is generally reliable but cannot correctly classify a species whose time/frequency patterns are not included in the reference datasets. Human experts cannot match the speed of a ML classifier but can provide the flexibility needed to overcome its limitations, by taking advantage of the digital audio software commonplace in the field of bioacoustics and of simple operations such as cut and paste. Such empirical comparisons are complicated by several factors, here individually addressed: guidelines are provided to mitigate the difficulties of specific recognition, both by emphasizing the nature of the obstacles, and by providing step-by-step procedures to overcome them. In light of a growing concern for the lack of verifiability in arthropod research, and a corresponding lack of repeatability in bioacoustic studies, and considering that science is the study of repeatable falsifiable phenomena with a methodology designed to minimize confirmation/cognition biases, we introduce the empirical "sandwich method", which involves two audio files: "the filling", a time slice of 2 seconds – or one echeme, if its duration exceeds two seconds – cut from the novel, unrecognized recording and inserted in "the bread", the exemplary reference audio. On-screen view is then zoomed to "the sandwich", a time window of six seconds (or at least three echemes) centered on the filling. Recognition is based on the similarity of bread and filling as observed side by side first visually (waveform), and then aurally (unaided ear comparison). Recognition of the poorly audible sandwiches can be improved by the frequency-lowering effect granted by playing the audio at lower speed (e.g., 1/4 or 1/10 of the natural speed) thanks to the special functions of the audio software. The method requires saving the decisive sandwich as an audio file and as a screenshot, thus ensuring persistence, verifiability, repeatability and possible correction of the recognition.

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Alpine orthopteran communities: diversity and community composition along an elevational gradient revisited after five years

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Orthopterans are among the most widely used bioindicators of grassland ecosystems due to their sensitivity to land use, environmental change and their close association with habitat structure and microclimatic conditions. Consequently, they are regularly monitored across Europe and are included in several long-term biodiversity assessment programs. Within the Biodiversity Monitoring South Tyrol (BMS), orthopterans represent one of the focal taxonomic groups and are sampled using a standardized protocol spanning the full elevational gradient, from the valley floors to the highest alpine sites.

Alpine environments are of particular ecological interest because they remain among the least studied terrestrial ecosystems while simultaneously being among the most vulnerable to climate change. At high elevations, climate is also one of the primary factors limiting species distributions, making alpine communities especially sensitive to ongoing warming. As climatic conditions change rapidly, these ecosystems are expected to experience pronounced shifts in species distributions, diversity and community composition.

Here, we present preliminary results from 54 sites, ranging from subalpine grasslands to alpine and rocky habitats at the upper distribution limit of orthopteran occurrence. At site level, diversity decreased with elevation, and resampling after five years revealed similar alpha diversity. Interestingly, on a landscape level we recorded a clear increase in species that was consistent in all habitats, with rocky habitats having the highest species increase after five years. The community composition varied significantly between subalpine, alpine and rocky habitats tracking the change of thermal environment. At site level, resampling revealed a significant but undirected overall change in community composition.

We conclude that changes are under way for alpine orthopteran communities, for now with eight species additionally present in these habitats and potentially showing a broader upward movement after five years.

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Orthopterans in colour: assessing variation in community colour traits

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Colouration is an essential functional trait in insects, which affects thermoregulation, predation, vulnerability to parasites, mating and survival in exposed habitats. Orthopterans are a highly diverse group in terms of colouration patterns, exhibiting considerable variation at both the intra- and interspecific levels. Due to their sensitivity to climatic and habitat changes, this insect group is also emerging as a robust ecological indicator for assessing the effects of climate change and habitat alteration on biodiversity.

The orthopterans' wide colour variability is potentially the result of the interaction of genetic expression, phenotypic plasticity and environmental influence. Identifying the drivers affecting their colouration pattern may provide insights into potential effects of climate change on their communities.

In this study, we explore the relationship between the orthopteran communities' colouration and the local climatic and habitat conditions. Our results may prove helpful for future conservation efforts and can shed light on potential responses of orthopteran communities to climate change.

During the 2026 summer fieldwork of the Biodiversity Monitoring South Tyrol project, led by Eurac Research, we surveyed 64 sites along altitudinal gradients. We photographed each individual in the field using a standardised, non-invasive and non-lethal method that we developed. For this preliminary analysis, we selected 12 sites, in similar habitats, chosen based on their environmental parameters to best represent the whole gradient of environmental conditions. We then analysed the pictures from these sites using ImageJ, in order to measure colouration and size and to evaluate the correlation between colour and local environmental conditions.

We did not find any significant correlation between the colour, lightness and saturation of orthopteran communities and the temperature and precipitation of the 12 sites. However, an almost significant positive trend was found between lightness and temperature, possibly consistent with the thermal melanism hypothesis.

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Tying the threads between orthopterans, butterflies and plants: a multitaxonomic and genetic approach

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Orthopterans, butterflies and vascular plants are widely used as indicators of habitat quality and land-use change, yet they are mostly studied separately. This project investigates how these three taxa are linked using the Biodiversity Monitoring South Tyrol (BMS), a province-wide programme run by Eurac Research (Hilpold et al. 2023). The BMS covers 320 terrestrial sites along strong environmental and land-use gradients, from intensively managed valley bottoms to alpine grasslands and rocky habitats. Because botanical and entomological surveys are strictly matched in space within the same plots, we can directly disentangle the roles of vegetation, landscape and disturbance in shaping insect communities.

The project is organised in three work packages. WP1 evaluates the relative importance of vegetation structure and plant diversity for insect communities, and whether temporal changes in plant assemblages predict insect turnover. WP2 tests whether community patterns are driven by fine-scale conditions within plots or by landscape-scale habitat diversity, and whether this depends on dispersal ability. WP3 uses DNA metabarcoding of orthopteran faecal pellets to reconstruct diet breadth and test whether resource use shifts along land-use and vegetation gradients.

As a first step, we fitted a piecewise structural equation model (SEM) on 145 site-years (grassland and rocky habitats, 2019–2023). Climate, topography, land-use intensity and landscape composition (50 m buffer) were modelled as drivers of plant taxonomic and functional diversity, which in turn affect the richness and functional dispersion of orthopterans and butterflies. The model fits the data well, both with all 62 pathways (Fisher's C = 1.68, df = 4, p = 0.79) and after retaining only the 34 pathways with $p < 0.20$ (Fisher's C = 38.7, df = 60, p = 0.985). Orthopteran richness responded mainly to climate and landscape: +10-11% species per additional degree of mean temperature and +27% per +0.5 of landscape Shannon diversity. Butterflies responded to plants, landscape and disturbance: +15-17% species per +0.5 of plant Shannon diversity, +21% per +0.5 of landscape diversity, and lower functional diversity under more intensive land use. Plant diversity itself was only weakly explained by the environmental variables.

These preliminary results suggest that landscape heterogeneity benefits both insect groups, while the two groups differ in their main drivers: orthopterans follow climate and landscape, butterflies follow floristic diversity and disturbance.

References

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, Bolzano/Bozen. DOI: 10.57749/2qm9-fq40

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First records of *Eunemobius carolinus* (Orthoptera: Trigonidiidae) in Europe, one of the exotic crickets new for Italy

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We report the presence of *Eunemobius carolinus* (Scudder, 1877) in some localities of Veneto (Chioggia, Padova, Arzignano and Posina). This is a Nearctic species of cricket (Trigonidiidae, Nemobiinae), new to Europe and never reported outside of North America. The presence is reported for localities from sea level (Chioggia) to 675 m asl (Posina). The song of the species is presented here based on recordings from Padova and Arzignano and compared with recordings from the native range and congenerics, showing the dominant frequency at 8 kHz. Considerations are offered regarding the possible origin, time since arrival, and potential consequences of this species' introduction, given that two other exotic species have recently been found in NE Italy.

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New data on the conservation, distribution and ecology of *Zeuneriana marmorata* (Orthoptera: Tettigoniidae)

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This study provides updates on the conservation status, distribution and ecology of Italian populations of *Zeuneriana marmorata* (Fieber, 1853). Field surveys confirm the full activity of both the Schiavetti Biotope population, resulting from a translocation operation conducted in 2021, and the Lisert population, both in Friuli Venezia Giulia. Furthermore, the Schiavetti population is also showing an expansion of its range in 2026. The translocation operation carried out by the Mincio Park (Lombardy) in preparation for the Venice Biennale in 2025 (https://www.labiennale.org/en/architecture/2025/living-lab/song-cricket), with the subsequent relocation of the egg colonies to the Valle Averto Oasis in the Venice Lagoon (Veneto), was successful, with the eggs hatching in at least one of the three monitored release points. A new inland location for the species has been reported: the Palude della Pellegrina (Veneto, province of Verona), located approximately 20 km from the nearest known population along the Mincio River. All these circumstances, also considering the limited mobility of *Zeuneriana marmorata*, confirm the importance that even limited portions of natural areas have for the conservation of low-mobility Orthoptera. The acquisition of photographic evidence relating to the predation of *Zeuneriana* by the spider *Runcinia grammica* and of the zitting cisticola (*Cisticola juncidis*) demonstrates the role of this orthopteran as a catalyst and key resource within the food web. Finally, the full singing activity of males in the Mincio Park population on 5 September is noteworthy, a fact that significantly extends the species' phenology, which in previous years was observed to be limited to late July and early August. Bioacoustics is therefore confirmed as a non-invasive tool for monitoring this species, not only in terms of distribution but also of phenology.

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Orthoptera in Friuli Venezia Giulia region under climate change

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In recent decades, faunistic changes have been occurring in northern Italy. Among orthopteroid insects, some thermophilic species have been spreading northwards and alien species have become established. These changes are probably related to climate change, especially to temperatures, which have been rising faster in the Mediterranean Basin and in the Alps than globally.

Literature on Orthoptera distribution in Friuli Venezia Giulia was considered; many data collected up to the 1990s are given in Fontana et al. (2005). Field research has been carried out in most areas of the region since 2000. Thus, it is possible to trace the changes regarding Orthoptera occurred in the last 30 years, at least partially.

Some thermophilic species, which before the 1990s were only found along the coast, have been spreading to the Friuli Plain (e.g. *Decticus albifrons* after 2010) and to mountain areas too (e.g. *Anacridium aegyptium* in the 2010s). Moreover, some orthopterans have been going upwards, such as *Ruspolia nitidula*, whose known upper limit shifted from about 950 m (until the 2010s) to 1500 m (in 2025).

On the contrary, some mountain orthopterans have been becoming rarer near their lowest limit, especially on the Karst plateau: here species such as *Arcyptera fusca* and *Dinarippiger discoidalis* are more difficult to find or seem to have become locally extinct after 2015. However, an apparent decline of many species has been observed in the Karst. The situation should be investigated with standardized methods to check these observations.

Climate change could especially affect species living only at high altitudes.

Chorthippus (*Glyptobothrus*) *alticola alticola* Ramme, 1921 is endemic to the southern part of eastern Alps in Italy; it usually lives in grasslands above 1400 m. In the last 25 years, in some localities of the Friulian Prealps its observed lower range limit has been rising; *C. a. alticola* is retreating upwards and onto northern slopes. This flightless orthopteran already lives on the highest parts of the mountains, so it is very vulnerable to the impact of climate change and abandonment of pastures.

In the future, it will be important to monitor Alpine endemic species, to check their altitudinal distribution and their population trends. The situation of Orthoptera in the Karst, which has unique biogeographical characteristics in Italy, should be investigated.

References

Fontana P., La Greca M. & Kleukers R., 2005: Insecta Orthoptera. In: Ruffo S. & Stoch F. (eds.), Checklist e distribuzione della fauna italiana. Memorie del Museo Civico di Storia Naturale di Verona, 2. serie, Sezione Scienze della Vita, 16: 137–139, with data on CD-ROM.

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Rthoptera Desk: a new desktop app for sound analysis

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We present here Rthoptera Desk, as a new desktop app for sound analysis. It is a constantly evolving software package available for Windows, Mac and Linux, the evolution of the R based program Rthoptera. Its features, here illustrated, are more user friendly than the previous release.

1. Import your audio: Use the Audio button in the top toolbar to load one or more files (.wav .mp3 .flac .ogg .aiff). Once loaded, you can optionally bring in existing annotations with Import Selections (Raven-style text/CSV) or Add Excel Selection Table (Train/Motif tables exported from Temporal Analysis). Tag the recording with a Specimen ID (also in the toolbar) if you plan to pool several recordings later in Summarize.
2. Preprocessing: Trim, filter, resample and clean up a recording before analysis. Batch actions apply to whatever's checked in the Loaded Audio list, and edits can be saved back out.
3. Temporal Analysis: Detect peaks/pulses from the envelope and organize them into Trains and Motifs. Results tabs (Peak / Train / Motif / MotifSeq / Summary) can be exported together as one Excel workbook.
4. Spectral Analysis: Inspect the waveform and spectrogram, drag selections or send detections over from Temporal Analysis, then run Spectral Metrics to measure and export frequency features.
5. Plotting: Render publication-ready figures, with sub-tabs for Multiplot (waveform/spectrogram combos), Osc. Stack, Osc. Zoom, Auto-coded Oscillogram (an oscillogram whose colour marks where chosen frequency bands occur) and Habitus plots. Presets let you save/recall your layout settings.
6. Summarize: No audio needed here, load several Temporal/Spectral Analysis .xlsx exports (one animal or several), merge them into one workbook, and get pooled/per-individual stats plus a draft text report.

Luca Ruggiero[1]

Latch-mediated actuation in locusts preserves jumping performance over 5 orders of isometric scaling, at the expense of take-off time

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Rapid force production is a highly sought-after ability in the animal kingdom and in humans. Two mechanisms have been mainly identified across species to produce force as rapidly as possible: the spring- (or latch-) and the muscle-mediated actuation. Latch-mediated actuation is typically restricted to small biological systems (Ilton et al. 2018). Mechanical models have simulated the benefits of latch- over muscle-mediated actuation to produce higher movement velocities with relatively low inertial load (Ilton et al. 2018; Sutton et al. 2019). However, biological models defining the advantages of latch-mediated actuation are still lacking. In this research we developed a mechanical model of a jumping locust. Muscular properties and inertial parameters of the locust, with a body mass typically around 2 g, were isometrically scaled over 5 orders of magnitude (from 20 mg to 200 g). For each simulation, the stiffness of the elastic elements was optimised for energy storage. The kinetics of the model was determined with a Lagrangian approach, and results were derived with numerical simulations. For a 2-g jumping locust, against experimentally collected values (Bennet-Clark 1975; Katz & Gosline 1993) peak power was within 0.04 W (mean experimental vs. model: 0.71 vs. 0.67 W), peak ground reaction force within 0.01 N (0.31 vs. 0.32 N), take-off velocity within 0.05 m s^{-1} (2.50 vs. 2.55 m s^{-1}), and over-ground distance within 0.03 m (0.59 vs. 0.62 m). Over 5 orders of magnitude, vertical take-off velocity (range: 1.53–1.35 m s^{-1}) as well as horizontal (2.08–1.88 m s^{-1}) were remarkably comparable. With increasing body mass, jump height (0.12–0.09 m) and distance (0.65–0.50 m) were curtailed by 3 and 15 cm, respectively. Despite the relatively well-preserved performance with increasing body mass, take-off time greatly increased from 6 to 149 ms. Thus, the latch-mediated mechanism ensures relatively stereotyped take-off velocities with increasing body size, at the expense of longer take-off time. Such analysis should be integrated with other performance metrics regarding flying and climbing, to determine the overall optimum for different functions.

References

Bennet-Clark H. C., 1975: The energetics of the jump of the locust *Schistocerca gregaria*. Journal of Experimental Biology, 63 (1): 53–83. DOI: 10.1242/jeb.63.1.53

Ilton M., Bhamla M. S., Ma X., Cox S. M., Fitchett L. L., Kim Y., Koh J.-S., Krishnamurthy D., Kuo C.-Y., Temel F. Z., Crosby A. J., Prakash M., Sutton G. P., Wood R. J., Azizi E., Bergbreiter S. & Patek S. N., 2018: The principles of cascading power limits in small, fast biological and engineered systems. Science, 360 (6387): eaao1082. DOI: 10.1126/science.aao1082

Katz S. L. & Gosline J. M., 1993: Ontogenetic scaling of jump performance in the African desert locust (*Schistocerca gregaria*). Journal of Experimental Biology, 177 (1): 81–111. DOI: 10.1242/jeb.177.1.81

Sutton G. P., Mendoza E., Azizi E., Longo S. J., Olberding J. P., Ilton M. & Patek S. N., 2019: Why do large animals never actuate their jumps with latch-mediated springs? Because they can jump higher without them. Integrative and Comparative Biology, 59 (6): 1609–1618. DOI: 10.1093/icb/icz145

Mathieu Pélissié[1], Enzo Moretto[2], Filippo Maria Buzzetti[3]

On the discovery of Nearctic crickets (Orthoptera: Grylloidea) new to Europe in Veneto

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The Po Valley is a hotspot of species introduction in Europe likely favoured by particularly suitable climate conditions and intense international exchanges. The panel of alien species that thrive in the area includes mammals, birds, plants, molluscs, and arthropods among which various orders of insects (Coleoptera, Hemiptera, Hymenoptera, Lepidoptera…) are represented but so far very few alien Orthoptera have been documented. Following several night-time surveys conducted in 2025 and 2026, we report the presence of three cricket species native to the eastern USA in the Brenta-Bacchiglione basin (Veneto, Italy), namely *Eunemobius carolinus* (Scudder, 1877), *Hapithus agitator* Uhler, 1864, and *Hapithus saltator* (Uhler, 1864), representing the first established populations of Nearctic Orthoptera in Europe. All three species were often observed on the same sites, the farthest of which were more than 70 km apart along the banks of the Brenta River, suggesting that they might have been present in the area for some time without being detected. This might be explained partly by confusions driven by visual and acoustic similarities with native species like *Pteronemobius heydenii* and *Oecanthus dulcisonans*, respectively, in the case of *E. carolinus*, or because of the cryptic and nocturnal activity of *Hapithus* species. Therefore, we provide key features of the identification and ecology of the species, along with practical advice to search for them in the field. Paying attention to their rather loud song is extremely helpful for detecting their presence, with the exception of *H. agitator*, whose males only emit a very faint courtship song, making it necessary to look for them visually. Since these species may have gone unnoticed for decades, we hypothesize that their impact on human activities is likely to be limited. However, their potential effect on local Orthoptera communities, notably through competition, remains to be assessed, although no obvious exclusion of the most closely related native species has been noticed. The current extent of their range remains to be fully determined, which might require extending the searches to regions neighbouring Veneto especially for *E. carolinus*, which appears to be particularly expansive with individuals found in apparently poorly suitable urban environments and at elevations up to 675 m above sea level. Another challenging but critical goal is to identify the exact introduction locations to limit the establishment of any further alien species through such means. With these discoveries, we demonstrate that not only the biotic communities but also the nocturnal soundscapes of Veneto region are increasingly turning into composite assemblages drawn from diverse origins across the globe.

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What's on the menu for alien mantises? Exploring the genetic diversity and diet of *Hierodula* species (Mantodea: Mantidae) in Italy using DNA barcoding and metabarcoding

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Alien predators can affect native communities and alter the ecosystem services these local species provide. Two alien mantid species belonging to the genus *Hierodula* (*H. tenuidentata* (Saussure, 1869) and *H. patellifera* (Audinet-Serville, 1839)) have recently spread across Mediterranean and continental Europe and are now both present in Italy. In general, the impacts of alien mantises remain poorly understood, as these generalist predators consume arthropods from several different orders, and we currently lack a high taxonomic resolution on their prey. As a first step toward resolving their dietary niches, this study aimed to assess the genetic diversity of *Hierodula* populations in Italy and to validate a metabarcoding-based approach for characterization of their prey diversity. This included determining the post-feeding window of prey DNA detectability.

Nine *H. tenuidentata* specimens collected in Modena were used in controlled feeding trials. Mantises were starved for 10 days and then fed with *Tenebrio molitor* adult beetles. Specimens were frozen within 24 h (N=3), 48 h (N=3) and 72 h (N=3) after feeding. Following dissection under sterile conditions, DNA was extracted from their gut, and the *T. molitor* COI gene was amplified using species-specific primers to determine how long prey DNA remained detectable after consumption. Additionally, 57 *H. tenuidentata* and 6 *H. patellifera* specimens were sampled in different Italian regions (Emilia-Romagna, Veneto, Lombardy, Piedmont, Latium, Trentino-Alto Adige) and immediately preserved in absolute ethanol. DNA was extracted separately from the femur of a midleg and from their gut. Leg-derived DNA was utilized to amplify the mantis COI gene, whereas gut-derived DNA was used to amplify prey COI for metabarcoding analyses.

Feeding tests showed that prey DNA could be amplified up to 48 h after consumption but not at 72 h, indicating that DNA metabarcoding will provide information on the mantises' feeding activity during the preceding two days. DNA barcoding analysis revealed very low mitochondrial haplotype diversity in both species (though the *H. patellifera* sample size was limited). This is consistent with the loss of diversity commonly observed in introduced species and also suggests that each species likely originated from a few introduction events. DNA metabarcoding analyses of the gut contents of field-collected specimens are currently underway.

Overall, the present results establish a robust methodological framework for detecting predation events in *Hierodula* and provide a genetic characterization of its Italian populations. Once completed, the metabarcoding analysis will offer novel insight into the trophic impact of these alien predators on native arthropod communities.

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Orthopteroid insects in the diet of the invasive African Sacred Ibis (*Threskiornis aethiopicus*)

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Terrestrial arthropods represent a major food resource for many vertebrates, and orthopteroid insects, particularly Orthoptera, are important prey for numerous bird species. During the breeding season, some birds may even become specialised in exploiting these insects, whose high local abundance can make them a readily available food source. Moreover, some orthopterans are considered agricultural pests and birds may contribute to their natural regulation. The introduction of alien species can alter trophic interactions in unpredictable ways, potentially affecting native communities. The African Sacred Ibis (*Threskiornis aethiopicus* (Latham, 1790)), an invasive alien species whose trophic niche remains incompletely characterised, has established its largest population outside its native range in Italy. This study investigates the occurrence and consumption patterns of orthopteroid insects in its diet, providing insights into the interaction with predators of these often-overlooked prey. We examined the stomach contents of 189 African Sacred Ibises collected during population management operations in three Italian provinces: Florence (84 individuals), Vercelli (83) and Udine (22). Orthopteroid remains were isolated and identified morphologically to the lowest feasible taxonomic level. The Minimum Number of Individuals (MNI) was used to estimate prey abundance, particularly for mole crickets (*Gryllotalpa* sp.), based on diagnostic anatomical structures, including heads and forelegs. Taxon occurrence and relative contribution to the diet were assessed for each study area.

Four taxa were identified: the earwigs *Forficula auricularia* and *Euborellia* sp. (Dermaptera), and unidentified Gryllidae and *Gryllotalpa* sp. (Orthoptera). Overall, orthopteroid insects represented a minor component of the diet, although marked differences emerged among study areas. In particular, *Gryllotalpa* sp. was a substantial dietary component in the Vercelli area, where its consumption was relevant during summer. More than one-third of the sampled ibises feeding in the rice-growing lowlands of the Vercelli area consumed these mole crickets, with some individuals showing a marked dietary specialisation (*Gryllotalpa* sp. accounting for over 80% of their dietary volume). The occurrence of earwigs also indicates that the African Sacred Ibis preys on insects differing considerably in body size and activity patterns, including predominantly nocturnal species. These findings reveal a spatially and temporally variable pattern of orthopteroid consumption, with locally substantial exploitation of mole crickets. Analysing predator diets thus offers a valuable, relatively unexplored perspective on the interactions of orthopteroid insects within ecological communities. However, the identification of fragmented remains in stomach contents also highlights methodological challenges, particularly concerning accurate taxonomic identification and the estimation of prey abundance.

Oscar Maioglio[1], William di Pietro[2], Roberto Battiston[3]

Evidence of phenological segregation in some Mediterranean mantis communities

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Mantodea communities in the Mediterranean Basin exhibit complex coexistence dynamics, where seasonal segregation may reduce interspecific competition and intraguild predation. However, species-specific responses to micro- and macroclimatic patterns remain poorly documented. In this study, we analyze the phenological structure of some mantis communities along latitudinal and altitudinal gradients across the Central and Eastern Mediterranean. Data collected during field expeditions were analyzed by comparing syntopic species, evaluating intraspecific development variation along regional latitude gradients, and assessing altitudinal effects within the same geographical region. The results highlight sharp interspecific phenological segregation: at the same locality, species differ significantly in their dominant developmental stages in August. At the intraspecific level, altitude emerges as a key driver. Our findings indicate that complex phenological adaptations facilitate the coexistence of different Mediterranean mantis species. However, global warming may alter these delicate balances, potentially inducing phenological overlaps and driving novel interspecific competition.

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Hopping over the storm: Orthoptera in the new habitats created by Storm Vaia in 2018 (Alps, Northern Italy)

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In Europe, very few species of Orthoptera inhabit forest environments, living, at least for part of their lifespan, in the canopy. Some species live on the edges of forests, but the vast majority of European Orthoptera live in open, sunny spaces. What happens in the open spaces created when a large section of forest is felled by a storm or destroyed by fire? This is what the LIFE VAIA project is attempting to determine, especially regarding Apoidea Anthophila and Orthoptera, insects that are very different from each other, but which equally require open spaces rich in diverse vegetation capable of supporting them. The LIFE VAIA Project (Valuing Afforestation of damaged woods with Innovative Agroforestry), funded under the European Community's LIFE Programme 2014-2020, envisions the development of innovative intervention techniques for forest reconstruction, through which it is possible to promote the adaptation of forest vegetation to climate change. The highly innovative element of the project is the use of agroforestry as a solution to address, in the short and long term, the damage caused by extreme weather events, such as Storm Vaia, which hit various locations in the Alps in October 2018. The project included a series of monitoring campaigns in the first few years after the storm, to be repeated at the end of the project. Monitoring of Orthoptera and Apoidea Anthophila highlighted a rapid recolonization of these new open spaces, but with varying consistencies depending on the original position of the sites in relation to the grasslands. Six pilot sites have been identified in three areas in the Italian Alps where Storm Vaia created vast open spaces. The first Orthoptera monitoring was carried out in 2023, 5 years after the storm, and the project foresees another in 2026.

A total of 21 species were recorded: *Barbitistes alpinus, Bicolorana bicolor, Calliptamus italicus, Calliptamus siciliae, Chorthippus biguttulus, C. brunneus, C. vagans, C. dorsatus, Chorthippus* sp.*, Euthystira brachyptera, Gryllus campestris, Nemobius sylvestris, Oedipoda caerulescens, Phaneroptera nana, Pholidoptera griseoaptera, Platycleis grisea, Pseudochorthippus parallelus, Ruspolia nitidula, Tetrix* sp.*, Tettigonia cantans* and *Tettigonia viridissima*.

The sampled sites that were adjacent to grassland areas (pastures or ski slopes) prior to Storm Vaia showed a high number of species, whereas sites where Storm Vaia created open spaces still surrounded by forest yielded very few species.

The first group includes the sites of Tressilla (Pinè Plateau, TN), Gallio (Sette Comuni Plateau, VI), Val Menera (Pian del Cansiglio, BL), and Col Saler (Pian del Cansiglio, BL); located at elevations between 900 and 1,530 m, these sites hosted 9 to 12 orthopteran species with significant populations. The two sites in Asiago (Sette Comuni Plateau, VI), located between 1,400 and 1,450 m and remaining essentially surrounded by forest even after Storm Vaia, yielded only 3 and 4 species, represented by very few individuals.

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Monitoring of Orthoptera in the green areas of Venice Marco Polo Airport (Italy)

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A "Bird strike" is a collision between an aircraft and a bird. The damage caused is often extensive, so much so that since 1910, 350 military deaths and 250 civilian deaths have been recorded due to this phenomenon. The presence of birds near airports can be caused by the presence of insects in the green areas typically found at the edges of runways, which therefore provide a food source for many bird species. Managing these insects is therefore crucial. In the case of Venice, it is Orthoptera that in recent years have developed populations large enough to attract insectivorous birds of prey. The most worrying species from this perspective has been *Calliptamus italicus* (Linnaeus, 1758), which has been producing small outbreaks in several locations in northern Italy for several years. Venice's Marco Polo Airport is a very special case because its runways border the Venice Lagoon, a unique habitat in the Mediterranean that hosts a biodiversity as unique as it is complex. The company that manages the airport (SAVE Group S.p.A.) has therefore commissioned GIMAS s.r.l. of Bolzano, Italy, to identify solutions compatible with safeguarding the lagoon's biodiversity. The World Biodiversity Association ETS was consulted to propose sustainable solutions for controlling these insects and to develop a method for monitoring their populations, considering the challenges of operating within airport runways. Pitfall traps suitable for intercepting Orthoptera were developed and deployed along the runway from 2023 until 2025. In the areas outside the runways, collection with an entomological net was adopted. The monitoring allowed us to intercept about 35 species of Orthoptera and to identify the most frequent ones: *Calliptamus italicus*, *Aiolopus thalassinus*, *Euchorthippus declivus*, *Omocestus rufipes* and *Acrida ungarica mediterranea*. Furthermore, the presence of species typical of the lagoon environment was verified, such as *Roeseliana brunneri*, *Chrysochraon dispar giganteus* and *Epacromius coerulipes coerulipes*. Based on the ecology of the most abundant species, some critical issues inherent in green areas and their vegetative state have been identified.

Roberto Battiston[1]*

LiRIO: from automated assessments to participatory Red Lists in a national platform for the conservation of Italian orthopteroid insects

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National Red Lists are fundamental tools for assessing the conservation status of local biodiversity, identifying research and management priorities, and providing a comparable basis for monitoring changes over time. However, their development and updating require reliable data, the critical involvement of a community of specialists, and substantial time and resources. This represents a challenge both for taxonomically rich groups characterized by heterogeneous levels of knowledge, such as Orthoptera, and for poorly studied groups affected by major data gaps and a limited number of specialist experts, as is the case for much of the remaining orthopteroid insect fauna (Polyneoptera).

Here the LiRIO platform (Lista Rossa degli Insetti Ortotteroidei), hosted on the website (https://www.museozannato.it/lirio) is presented, representing an initial effort towards the development of a national platform dedicated to the Red Listing of Italian orthopteroid insects. The platform currently includes 452 species belonging to the orders: Orthoptera, Mantodea, Blattodea, Phasmatodea, Embioptera, and Dermaptera. A machine-generated database integrates preliminary IUCN categories with parameters including distribution and occurrence data, extent of occurrence (EOO) and area of occupancy (AOO), population trends, indicators of habitat loss and protection, endemism, synthetic threat indices, and explicit estimates of confidence and uncertainty.

Preliminary LiRIO assessments were produced using ARGOS v0.9, a software package currently under development to support, rather than replace, expert assessment. Automation enables the rapid and standardized processing of large volumes of georeferenced data distributed across global open-source databases, producing an initial national baseline of IUCN-like pre-assessments to prioritize potential conservation targets. Current agreement with official IUCN assessments of the European Red List of Orthoptera reaches 55.7% for the exact category and 81.4% including the adjacent category.

The first ARGOS assessment classifies 173 species (38.3%) nationally within the threatened categories CR, EN, and VU, while 103 species (22.8%) are classified as Data Deficient. Extinction risk and knowledge deficiency show different taxonomic patterns: Orthoptera have the highest proportion of preliminarily threatened species (44.0%), whereas data deficiency is particularly high in Embioptera (85.7%), Blattodea (52.7%), and Phasmatodea (50.0%). The 147 endemic species (32.5%) do not show a significantly higher proportion of threatened taxa, but are characterized by substantially more restricted distributions: median EOO is 3,838 km² for endemic species, compared with 271,358 km² for non-endemic species.

LiRIO is therefore designed as a dynamic and participatory platform through which accredited specialists will be able to examine, validate, and modify the pre-generated assessments. The aim is to progressively develop a shared, updateable, and transparent national resource that can contribute to the production and continuous improvement of Red Lists for Italian orthopteroid insects and, ultimately, to their conservation.

Andreas Hilpold[1], Wolfgang Rabitsch[2], Thomas Frieß[3], Audrey Marsy[1], Elia Guariento[1]

New species for the true bug fauna of South Tyrol (Prov. Bolzano, Italy): *Aelia klugii*, *Alydus rupestris*, *Corythucha arcuata*, *Deraeocoris flavilinea*, *Holcogaster fibulata* and *Nagusta goedelii* (Insecta, Heteroptera)

Abstract

Recent investigations of the heteropteran fauna of South Tyrol (northern Italy) revealed several species previously unrecorded from the province. In the present contribution, we report the first records of *Aelia klugii*, *Alydus rupestris*, *Corythucha arcuata*, *Deraeocoris flavilinea*, *Holcogaster fibulata*, and *Nagusta goedelii* for South Tyrol. For each species, data on distribution, ecology and the broader biogeographical context are provided. Several of the recorded taxa, particularly *Corythucha arcuata*, *Holcogaster fibulata*, and *Nagusta goedelii*, are currently expanding their ranges across Europe, likely facilitated by climate warming and increasing globalization. Other species, such as *Alydus rupestris*, may previously have been overlooked due to insufficient sampling of remote habitats. These findings demonstrate that significant knowledge gaps remain despite the comparatively well-studied heteropteran fauna of South Tyrol and underline the importance of continued faunistic investigations, especially in poorly explored habitats and higher elevations.

Keywords: True bugs, Heteroptera, faunistics, first records, South Tyrol, invasive species

Introduction

The true bug fauna of South Tyrol is relatively well-studied (see Hilpold 2020). Nevertheless, records collected during the annual conference of Central European Heteropterologists in 2021 demonstrated that numerous species remain undetected, with 17 species recorded for the first time in the region (Hilpold et al. 2023). These findings indicate that further discoveries can be expected as research on this group continues. Additional species are likely to occur in poorly investigated areas or in habitats that are difficult to access. Furthermore, several species recorded in recent decades appear to be expanding their ranges northwards from southern regions, probably driven by climate warming and increasing globalization, including the accidental introduction and spread of alien species.

Aelia klugii Hahn, 1833 (Fig. 1)

Italy, South Tyrol, Schnals/Senales, path from Vernagt/Vernago to Wilder Hut, 0.5 km WNW of Schröfwand, 2706 m a.s.l., 46.7388466° N, 10.878221° E, south-facing alpine grassland on siliceous bedrock, 01.08.2024, leg. A. Hilpold, det. A. Hilpold, confirm. W. Rabitsch.

Comment: In the collection of the Tiroler Landsmuseum Ferdinandeum (TLMF), Innsbruck, one specimen from the Inn valley is stored (entrance of Ötztal valley; Heiss

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Fig. 1: *Aelia klugii* (Photo from the W. Rabitsch archive)

et al. 2025), about 56 km N of the present location. In iNaturalist there is another observation in alpine terrain from Monte Gronlait east of Pergine in Trentino. Interestingly, in the French Mercantour region (SW Alps) many high-elevation observations of the species are reported on iNaturalist, whereas the German and Austrian records are mostly located in the lowlands.

Alydus rupestris Fieber, 1861 (Fig. 2)

Italy, South Tyrol, Sulden/Solda, valley end, E of road to Schaubachhütte, 1.5 km N of the hut (BMS 084_PAS_2), 2173 m a.s.l., 46.506618° N, 10.599502° E, subalpine pasture, pitfall traps, 23.07.–10.08.2020, leg. J. Plunger, det. A. Hilpold, confirm. W. Rabitsch.

Comment: *Alydus rupestris* is distributed in the Western European Alps and was also found in Central Asia (Kasachstan) (Dolling 2006). It is known from Switzerland (Graubünden, Wallis) and Austria (Tyrol, Ötztal) (Heiss 1976), at elevations around 2000 m in alpine grasslands and beneath dwarf shrubs.



Fig. 2: *Alydus rupestris* (Photo by André Miquet, archive)



Fig. 3: *Corythucha arcuata* (Photo from the W. Rabitsch archive)

Corythucha arcuata (Say, 1832) (Fig. 3)

Italy, South Tyrol, Naraun, N of Tisens/Tesimo, 0.25 km N of Ulpmer farmstead (BMS_extra25/Chestnuts OCM_407), 744 m a.s.l., 46.58044° N, 11.153099° E, chestnut grove, window trap, 17.06.2025, leg. A. Marsy, det. A. Hilpold.

Italy, South Tyrol, Nals/Nalles, within the village settlement, 46.54445° N, 11.20863° E, 16.09.2025, obs. iNaturalist user "Mikahecker", det. S. Meacci ("teuthis"); https://www.inaturalist.org/observations/314868121

Italy, South Tyrol, Burg Hocheppan, 46.49286° N, 11.24245° E, 17.09.2025, obs. iNaturalist user "Mikahecker", det. S. Meacci ("teuthis") and "alexis_loiseau" https://www.inaturalist.org/observations/319017570

Italy, South Tyrol, Brixen/Bressanone, ca. 150 m E of Seeburg, 581 m a.s.l., 46.71873° N, 11.67141° E, mixed oak woodland with some ruderal vegetation, 19.09.2025, leg. & det. A. Hilpold.

Italy, South Tyrol, road from Mahr to Tschötsch, 150 m W of Tölzlhof, 604 m a.s.l., 46.69366° N, 11.63669° E, dry roadside embankment with downy oak and other woody vegetation, 19.09.2025, leg. & det. A. Hilpold.

Italy, South Tyrol, Elvaser Bühel (= Pinatzbühel) near Brixen/Bressanone, southern slope, along trail, 825 m a.s.l., 46.72814° N, 11.66855° E, mixed woodland and forest edge, on downy oak, 02.10.2025, leg. A. Hilpold & E. Guariento, det. A. Hilpold.

Italy, South Tyrol, Brixen/Bressanone, road from Talhofer Hof to Unterebnerhof, 636 m a.s.l., 46.71661° N, 11.64426° E, mixed deciduous woodland with ruderal roadside vegetation, on downy oak, 02.10.2025, leg. & det. A. Hilpold.

Italy, South Tyrol, Bozen/Bolzano, orographic left bank of the Eisack/Isarco River, 0.5 km S of Eurac Research headquarters, 257 m a.s.l., 46.48951° N, 11.34644° E, isolated roadside oak tree, 18.11.2025, leg. A. Hilpold & E. Guariento, det. A. Hilpold.

Comment: *Corythucha arcuata* is a North American species that was introduced to northern Italy (Lombardy, Piedmont) in the early 2000s (Bernardinelli & Zandigiacomo 2000) and has since spread rapidly across large parts of the continent. The species is associated primarily with oak species (*Quercus* spp.) and has become established in several regions of southern and central Europe (Stancă-Moise 2026). In recent years, records from northern Italy and neighbouring Austrian regions (e.g., Sallmannshofer et al. 2021) indicate a continuing expansion into the Alpine area. Given the widespread occurrence of suitable host plants and the favourable climatic conditions in South Tyrol, the species is likely to continue its range expansion and can be considered established in the region.

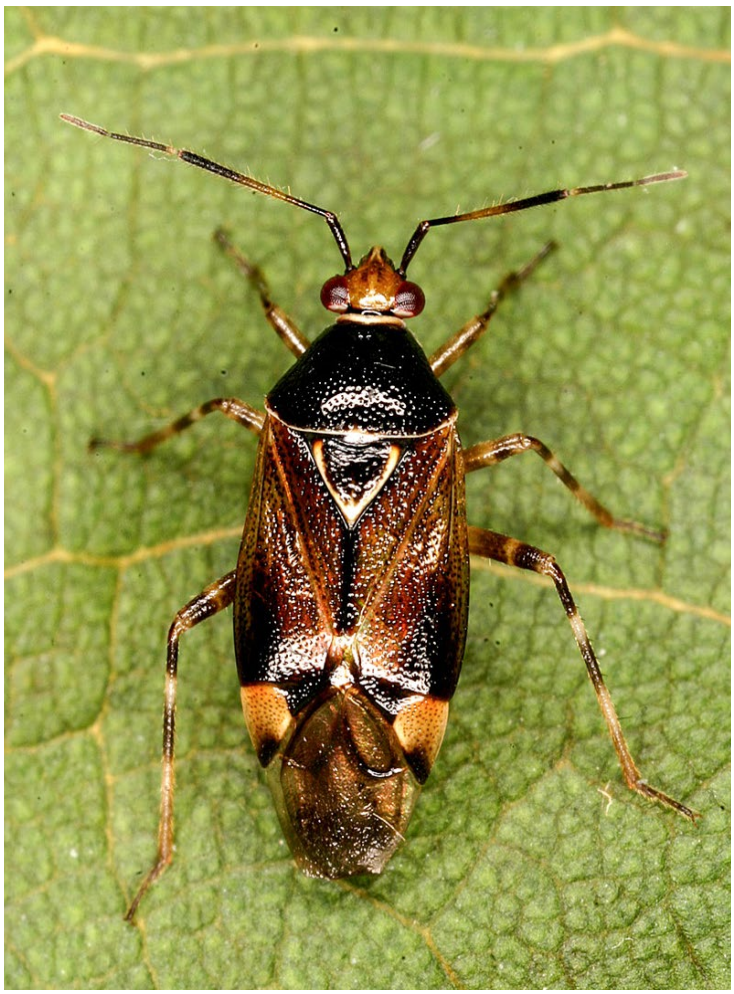


Fig. 4: *Deraeocoris flavilinea* (Photo from the W. Rabitsch archive)

***Deraeocoris flavilinea* (A. Costa, 1862)** (Fig. 4)

Italy, South Tyrol, Bozen/Bolzano, Rentsch/Rencio, 46.49846° N, 11.37136° E, private gardens, 20.06.2021, obs. W. Pichler (iNaturalist), photo det. R. Lupoli.

Italy, South Tyrol, Passeier Valley/Val Passiria, Gomion W of St. Leonhard/San Leonardo, N of the Passer/Passirio River, ca. 700 m a.s.l., 05.06.2022, obs. E. Guariento, photo uploaded to iNaturalist, det. N. Orliac.

Italy, South Tyrol, Brixen/Bressanone, park area of the public swimming pool, 565 m a.s.l., 46.719214° N, 11.657874° E, beneath park trees, 05.07.2024, leg. & det. A. Hilpold, confirm. W. Rabitsch.

Italy, South Tyrol, Bolzano/Bozen, Guntschnapromenade, 46.50769° N, 11.33317° E, 10.05.2026, obs. iNaturalist user "francesco_001", det. S. Meacci ("teuthis"); https://www.inaturalist.org/observations/366437555

Italy, South Tyrol, Glurns/Glorenza, area of "Camping im Park", 46.67015° N, 10.54600° E, 27.05.2026, obs. iNaturalist user "foxeli", det. S. Meacci ("teuthis"); https://www.inaturalist.org/observations/365849720

Comment: *Deraeocoris flavilinea* is a predatory mirid bug primarily associated with deciduous trees and shrubs, where it feeds on small arthropods. It was originally known as endemic to Italy but expanded its range since the 1980s (Aukema 1989; Ehanno 1989; Wachmann et al. 2006; Rabitsch 2008) and occurs now in most parts of Europe (GBIF). It was first reported for Austria from Vienna in 2002 (Rabitsch 2002) and is known from most provinces. Due to the general trend and the climatic and ecological conditions in South Tyrol, we consider the species as established in the area.



Fig. 5: *Holcogaster fibulata* (Photo from the W. Rabitsch archive)

Holcogaster fibulata (Germar, 1831) (Fig. 5)

Italy, South Tyrol, Montiggler Wald/Bosco di Monticolo, natural forest reserve, 0.75 km SW of antenna (BMS-extra 385_FDO_5), 634 m a.s.l., 46.400255° N, 11.285397° E, pitfall traps, 14.06.–28.06.2023, leg. H. Blasbichler, det. T. Frieß.

Italy, South Tyrol, Meran/Merano, NNW of the railway station, area with private gardens and park trees, exact location obscured, Aug. 2023, obs. iNaturalist user "ertap", locality information based on pers. comm. with observer, photo det. R. Lupoli. https://www.inaturalist.org/observations/179697605

Comment: *Holcogaster fibulata* is a thermophilous species that until recently was restricted to Mediterranean countries, but has expanded its range northwards to Western Europe in recent decades. It has been recorded increasingly in central Europe, including several regions north of the Alps, reaching northern France, Switzerland, Luxembourg, Belgium, the Netherlands, and western Germany, among other areas (iNaturalist; Hoffmann & Herr 2020), suggesting an ongoing range expansion likely facilitated by climatic warming. The specimen reported here was collected in a natural forest reserve located far from any settlement area. This indicates that the species is not confined to urban or heavily disturbed habitats and suggests that *H. fibulata* may already be established in near-natural forest ecosystems of South Tyrol.

Nagusta goedelii (Kolenati, 1857) (Fig. 6)

Italy, South Tyrol, Brixen/Bressanone, Millander Au protected area, eastern margin, 555 m a.s.l., 46.69879° N, 11.65364° E, hedgerow with *Corylus avellana* and *Ulmus* sp., 15.10.2025, leg. & det. A. Hilpold.

Italy, South Tyrol, Lana, industrial area (Zona Industriale Lana), ca. 310 m a.s.l., 46.62897° N, 11.16460° E, roadside, 16.10.2026, obs. E. Guariento (iNaturalist observation https://www.inaturalist.org/observations/408972554, det. S. Meacci ("teuthis")).

Comment: *Nagusta goedelii* is a thermophilous predatory species that was formerly restricted to the Eastern Mediterranean and Pontic regions. In recent decades, the species has considerably expanded its European distribution, with first records reported from Austria (since 1999), Italy, France, and Germany (Rabitsch 2001; Dioli 2014; Fadda



Fig. 6: *Nagusta goedelii* (Photo from the W. Rabitsch archive)

& Dusoulier 2016; Dorow et al. 2018; Hemala et al. 2022). The closest observations to South Tyrol are currently located near Mezzocorona in northern Trentino, north of Alleghe, and near Villach in southern Austria (iNaturalist), dating from 2023 to 2025.

Although only a single individual was recorded south of Brixen, the specimen was found in a natural habitat distant from settlements and other potential introduction sites. The second observation comes from an industrial area located at a considerable distance from the first record and can therefore be considered an independent occurrence. Together with the ongoing expansion of the species across Europe, this suggests that *Nagusta goedelii* is already established in the region. Further records, particularly from the lowlands of the Eisack and Etsch valleys, are to be expected.

Conclusions

The present records demonstrate that, despite the comparatively good state of knowledge regarding the heteropteran fauna of South Tyrol, important gaps still remain. In particular, remote areas, higher elevations, and specific natural habitats are still insufficiently investigated and are likely to harbour additional, previously undetected species. Continued faunistic surveys in these habitats will therefore remain essential for improving the understanding of the regional true bug fauna.

At the same time, several of the species reported here reflect broader biogeographical changes currently ongoing across Europe. Thermophilous and alien species such as *Corythucha arcuata*, *Holcogaster fibulata*, and *Nagusta goedelii* have expanded their ranges considerably during recent decades, likely facilitated by climate warming, increasing international trade, and accidental human-mediated transport. South Tyrol, with its comparatively mild inner-Alpine climate and its important transport corridors, is particularly susceptible to such range expansions. Further arrivals and establishment of southern and alien heteropteran species in the region can therefore be expected in the future.

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References

Aukema B., 1989: Annotated checklist of Hemiptera-Heteroptera of the Netherlands. Tijdschrift voor Entomologie, 132: 1–104.

Bernardinelli I. & Zandigiacomo P., 2000: Prima segnalazione di *Corythucha arcuata* (Say) (Heteroptera, Tingidae) in Europa. Informatore Fitopatologico, 12: 47–49.

Dioli P., 2014: Presenza in Italia di *Nagusta goedelii* (Kolenati, 1857) e note sulla sua biologia ed ecologia (Hemiptera: Heteroptera: Reduviidae). Onychium, 10 (2013): 32–39.

Dolling W. R., 2006: Superfamily Coreoidea Leach, 1815. Pp. 1–101. In: Aukema B. & Rieger C. (eds.), Catalogue of the Heteroptera of the Palaearctic Region. Vol. 5, Pentatomomorpha II. The Netherlands Entomological Society, Amsterdam, xiii + 550 pp.

Dorow W. H. O., Voigt K. & Böttge H., 2018: Erstnachweis von *Nagusta goedelii* (Kolenati, 1857) für Deutschland (Heteroptera: Reduviidae). Heteropteron, 52: 17–21.

Ehanno B., 1989: Compléments à la faune de France des Hétéroptères Miridae Hahn, 1831 – *Deraeocoris* (D.) *flavilinea* (Costa, 1860) et *Deraeocoris* (D.) *annulipes* (Herrich-Schaeffer, 1845). Bulletin de la Société Scientifique de Bretagne, 60: 125–148.

Fadda S. & Dusoulier F., 2016: Première observation de *Nagusta goedelii* (Kolenati, 1857) en France (Hemiptera: Reduviidae). L'Entomologiste, 72 (2): 111–112.

Heiss E., 1976: Zur Heteropterenfauna Nordtirols (Insecta: Heteroptera) IV: Reduvioidea und Coreoidea. Berichte des Naturwissenschaftlich-Medizinischen Vereins in Innsbruck, 63: 185–200.

Heiss E., Eckelt A., Lederwasch M. & Unterasinger R., 2025: The Collection of Heteroptera of Ernst Heiss at the Tiroler Landesmuseum Ferdinandeum. Part XX: Pentatomomorpha: Families Pentatomidae, Phloeidae. naturamonta, 2: 147–226. Doi: 10.70787/nm-eysumc.

Hemala V., Ţicu S., Cunev J. & Krištín A., 2022: Recent expansion of the assassin bug *Nagusta goedelii* (Hemiptera: Heteroptera: Reduviidae) within Slovakia and Romania, with additional records from Europe and the Middle East. Klapalekiana, 58 (1–2): 51–67.

Hilpold A., 2020: Überblick über die Geschichte und aktuellen Stand der Erforschung der Südtiroler Wanzenfauna (Teil 1 des Vortrags bei der Wanzentagung in Mallnitz (A)). Heteropteron, 60: 15–17.

Hilpold A., Brandner J., Bräu M., Dorow W., Faraci F., Gossner M. M., Hartung V., Heckmann R., Münch M., Nawratil J., Rabitsch W., Raupach M., Simon H. & Kranebitter P., 2023: Wanzenfunde (Insecta: Heteroptera) der 47. Tagung der „Arbeitsgemeinschaft Mitteleuropäischer Heteropterologen" in Südtirol (Italien) (27.–29.8.2021). Gredleriana, 23: 115–138. Doi: 10.5281/zenodo.10245960.

Hoffmann H.-J. & Herr K., 2020: Ein weiterer Nachweis von *Holcogaster fibulata* (Germar, 1831) in Deutschland. Heteropteron, 59: 35.

Rabitsch W., 2001: Notizen zur Wanzenfauna Österreichs (Insecta, Heteroptera). Linzer biologische Beiträge, 33 (1): 83–86.

Rabitsch W., 2002: *Deraeocoris flavilinea* (A. Costa, 1862) erstmals in Österreich festgestellt (Heteroptera, Miridae). Beiträge zur Entomofaunistik, 3: 181–183.

Rabitsch W., 2008: Alien True Bugs of Europe (Insecta: Hemiptera: Heteroptera). Zootaxa, 1827: 1–44. Doi: 10.11646/zootaxa.1827.1.1.

Sallmannshofer M., Ette S., Hinterstoisser W., Cech Th. L. & Hoch G., 2021: Erstnachweis der Eichennetzwanze, *Corythucha arcuata*, in Österreich. Forstschutz Aktuell, 66: 19–24.

Stancă-Moise C., 2026: Biology, ecology, and management of the invasive *Corythucha arcuata* in Eurasia: A review. Biology, 15 (14): 1191. Doi: 10.3390/biology15141191.

Wachmann E., Melber A. & Deckert J., 2004: Wanzen. Band 2: Cimicomorpha: Microphysidae (Flechtenwanzen), Miridae (Weichwanzen) (= Die Tierwelt Deutschlands und der angrenzenden Meeresteile nach ihren Merkmalen und nach ihrer Lebensweise, 75. Teil). Goecke & Evers, Keltern, 288 pp.

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Monitoring of three protected saproxylic beetles (*Cerambyx cerdo, Osmoderma eremita, Rosalia alpina*) in South Tyrol: Population status and habitat management

Abstract

In this study we present the results of monitoring several important populations of three protected saproxylic beetles: *Cerambyx cerdo, Osmoderma eremita*, and *Rosalia alpina*. These three species are of special interest since their occurrence denotes the presence of old trees and near natural forests.

Cerambyx cerdo and *Osmoderma eremita* were monitored at one site with species-specific standardised sampling techniques (visual survey transects, pheromone, and bait traps). Capture-mark-recapture techniques were employed. However, the low number of recaptures did not allow for a reliable estimate of population size for these species. Furthermore, additional new occurrences were confirmed, expanding the local known distribution.

Finally, a target monitoring on a newly discovered population of *Rosalia alpina* involved surveys of newly placed beech logs and the surrounding natural habitats. This monitoring resulted in 79 individuals counted with 21 recaptures. Using the individual patterns on the elytra, an open population model for capture–mark–recapture (POPAN analysis) was used to estimate a local population of 171 adult individuals.

This study sums up the methods, results and conclusions of coordinated surveys and monitoring of saproxylic beetles from 2023 to 2025 and underlines the need and potential for long-term monitoring to inform targeted habitat management and conservation.

Keywords: capture–mark–recapture, conservation strategy, habitats directive species, forest entomology

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1. Introduction

Saproxylic biodiversity is of undeniable importance to complete the lifecycle of wood and enable the regeneration of organic matter. Among this biodiversity, beetles represent the most species-rich and numerically dominant group of saproxylic invertebrates and occupy one of the most charismatic positions with some species growing to an impressive size and taking several years to complete their life cycle (Parisi et al. 2018; Roth et al. 2019; Haeler et al. 2021; Graf et al. 2022; Seibold et al. 2023). Some of these beetles are specialists that require a specific set of conditions for sustaining viable populations or microhabitats in which they can habit (Bergmark et al. 2024; Soutinho et al. 2025). Their ecological importance led to the inclusion of certain saproxylic beetles, considered umbrella and/or flagship species, in the European Habitats Directive (European Union 1992).

The Habitat Directive together with the Directive 2009/147/EC (European Union 2009) on the conservation of wild birds aims to protect listed species and habitats within the European Union and provides also the legal framework for the designation of Special Areas of Conservation under the Natura 2000 network. This directive aims to

contribute to the conservation of biodiversity by protecting natural habitats and wild fauna and flora across the territory of the member states. Measures adopted under the directive are designed to maintain or restore natural habitats and species of community interest to a favourable conservation status; member states are therefore required to monitor populations and implement appropriate conservation and management actions (European Union 1992).

In the study region Alto Adige/South Tyrol the species *Cerambyx cerdo*, *Lucanus cervus*, *Osmoderma eremita*, and *Rosalia alpina* are reported to be present (Kahlen 2018; Kranebitter & Figl 2024). Further, *Stephanopachys substriatus* was historically reported in the region and was recently detected at a wood-storage site near Mauls; however, its presence in primary habitats has not been demonstrated despite targeted surveys (Degasperi et al. 2022, unpublished report). Furthermore, there are other saproxylic beetles listed in the Habitats Directive and not recorded so far in South Tyrol, that could potentially occur. These species are *Rhysodes sulcatus,* recorded in Italy, but with only two recent observations (Mazzei et al. 2019); *Limoniscus violaceus* that was observed in Austria, France and Italy, with new records from Sicily (Gouix et al. 2012; Gillett & Blanc 2023); *Cucujus cinnaberinus* also reported in southern Italy and recently in Veneto and Austria (Biscaccianti et al. 2008; Stoch 2016; Bonacci et al. 2022; Vicariotto 2025); and *Phryganophilus ruficollis,* a rare species absent from Italy, but recently found in Austria (Eckelt et al. 2020). South Tyrol, due to the conversion of lowland forests into intensive crops and settlements has limited lowland deciduous forests. As a result, suitable habitats for the saproxylic beetles listed in the European Habitat Directive are mostly restricted to old grown forest and mature trees in urban or agricultural environments (Redolfi De Zan et al. 2023).

To comply with the Directive obligations, a collaborative project was started in 2023 in South Tyrol. This project, called "SpeciesMonitoring" coordinated and financed by the Office of Nature of the Autonomous Province of Bolzano-South Tyrol, in collaboration with Eurac Research, aims to monitor selected species of conservation concern. Within this monitoring program the above mentioned saproxylic beetles were monitored and the present study reports and analyses the first results. Previous surveys (Kahlen & Eckelt 2013; Eckelt et al. 2015; Degasperi et al. 2022) were used as baseline information to design the here presented study.

The monitoring of all species followed established protocols (Campanaro et al. 2017; Maurizi et al. 2017; Redolfi De Zan et al. 2017) and ISPRA guidelines (Stoch & Genovesi 2016). All data were geo-referenced and sent to the Museum of Nature South Tyrol and the office of Nature of the Province of Bolzano/Bozen. Permits for collecting and handling the specimens were requested and obtained from ISPRA (Protocol number: 12841/2023). A summary of study areas, sampling design and effort is provided in Table S1.

2. Osmoderma eremita

2.1 Introduction

Osmoderma eremita (Scopoli, 1763) (Figure 1) develops as larvae for two to three years in decaying wood within hollows of old deciduous trees across a wide range of host species. The species has a wide distribution range, being present in central and western Europe and in parts of northern and eastern Europe. Adults emerge from July to September and can live for about one month (Ranius et al. 2005). This species is strongly associated with cavity-rich trees. Suitable habitat trees should preferably be large, sun-exposed and maintain optimal humidity (Dubois 2009; Sabatelli et al. 2023), ideally developing a sparse canopy (Maurizi et al. 2017). Due to the loss of this habitat, *O. eremita* is now mainly found in surrogate habitats maintained by humans, although less stable over time (Ranius & Nilsson 1997; Vignon 2008; Carpaneto et al. 2010; Maurizi et al. 2017). For instance, in France, the species occurs mainly in traditional orchards and hedgerows in agricultural environments, where pruning encourages cavity formation (Vignon 2008; Valladares et al. 2015). In Austria, it is also strongly associated with traditional orchards, particularly old apple trees (Friess et al. 2020).



Fig. 1: *Osmoderma eremita* photographed at the monitoring site Castelfeder (Photo: Elia Guariento)

In South Tyrol, the species is also present in anthropized environments such as peri-urban parks, chestnut groves, and wooded pastures, and its presence has been detected on trees of the genus *Quercus*, *Salix*, and *Castanea*. Historically, the species was distributed in in the main valleys of the province such as the Isarco Valley/Eisacktal, Venosta Valley/Vinschgau and Adige Valley/Etschtal (Kahlen 2018). However, its distribution range has undergone significant contraction and fragmentation. Currently, two populations are known, one in the lower Adige Valley at the N2000 site of Castelfeder, and another in the Vinschgau Valley in the area of Laces/Latsch. In the Isarco Valley around Bressanone/Brixen, individuals were found during safety-related chestnut tree removals, but no broader presence was confirmed (Kahlen & Eckelt 2013; Eckelt et al. 2015;Kahlen 2018, unpublished). However, later findings in 2020 by Georg von Mörl and Thomas Messner (pers. comm.) of larvae and adult remains in nearby chestnut groves suggested a possible extant population in the area.

Prior to this study, the work on this species was to verify the presence of the species in known historical sites and the monitoring based on population metrics (such as the number of adults and/or larvae observed) and habitat assessment using environmental variables (Kahlen & Eckelt 2013; Eckelt et al. 2015, unpublished reports).

2.2 Methods

The species was studied at two sites with different objectives: estimation of the population size at Castelfeder and verification of the actual species presence in the Bressanone/Brixen area.

The Natura 2000 site of Castelfeder (IT3110035, 46.320462, 11.309068) is located on two municipalities of Ora/Auer and Montagna/Montan at 218–382 m a.s.l. and covers an area of 108 ha. This historically significant site, known for its ancient defensive wall, is characterized by dry grassland with mixed oak woods, mainly of the protected habitat 91H0 Pannonian woods with *Quercus pubescens* (Provincia autonoma di Bolzano-Alto Adige 2026) and is managed by extensive grazing. The ideal conditions for saproxylic larvae are gathered in this site, which contains sunny and open areas with isolated old oak trees with dead branches and cavities. Considering the importance of this site for the conservation of saproxylic protected species, a more intensive monitoring design was implemented here, including a higher number of traps and repeated control sessions with the aim of estimating population size.

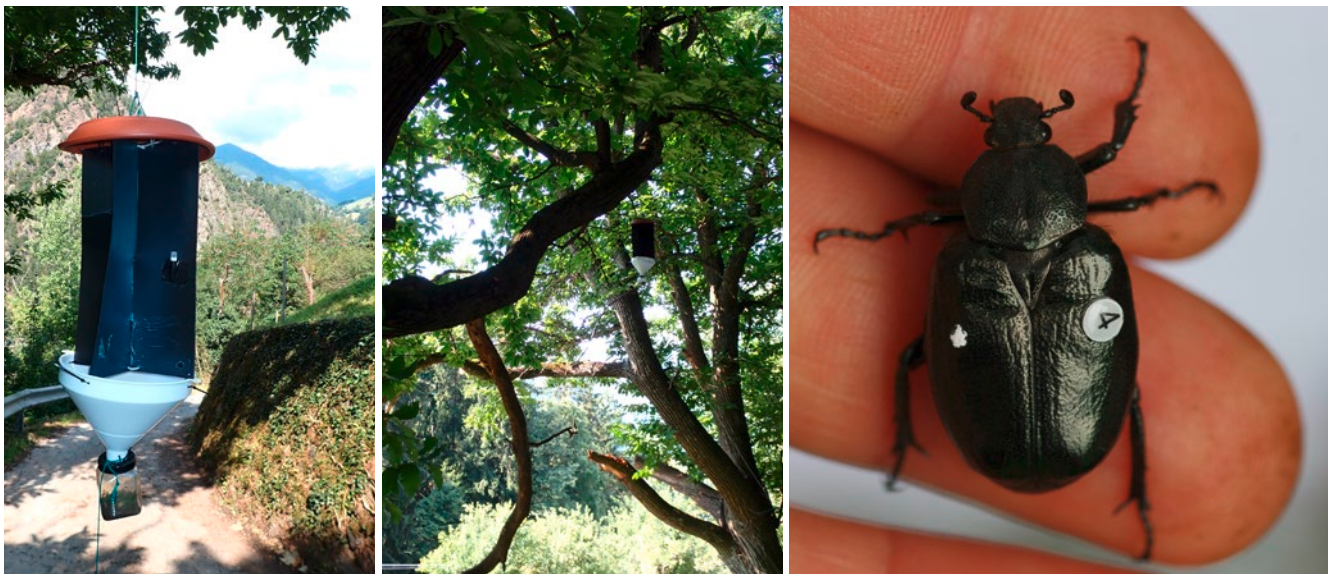


Fig. 2: Left and Center: *Osmoderma eremita* pheromone traps and in a chestnut grove near Bressanone/Brixen.
Right: *Osmoderma eremita* individually marked during the monitoring survey at Castelfeder. (Photo: A. Marsy and E. Guariento)

The monitoring was conducted using custom-built Black Cross Window Trap (BCWT) by assembling two plastic panels (50 × 30 cm, 3 mm thick) arranged in a cross, topped with an inverted plant saucer (30 cm) to form a roof and provide protection from rain. Below, a 30 cm funnel led to a 500 mL plastic container with drainage holes and filled with foam to maintain humidity and prevent beetle mortality. A 1.5 mL Eppendorf tube was attached in the centre of the cross, containing cotton and 1.2 mL of γ-decalactone pheromone (Sigma-Aldrich, W236004) as described by Maurizi et al. 2017 (Figure 2).

At Castelfeder, the monitoring was carried out from 5 July to 4 August 2023. Ten traps were placed at approximately 2 m above ground near suitable cavity trees and spaced by at least 100 m between traps. Traps were checked 2–3 times per week, for a total of 12 control rounds. Captured individuals were sexed and marked (Figure 2).

In the Bressanone/Brixen area where previous signs of the species' presence had been recorded by Georg von Mörl, the possible existence of a population was assumed. Therefore, traditional extensively managed chestnut groves were investigated, and additional potentially suitable sites within a 10 km radius were identified. These sites are characterised by old trees with large cavities, providing suitable microhabitats for *Osmoderma eremita*. (Figure 3).

To detect the species' presence, the same pheromone traps were used, installed at approximately 10 m height due to the position of suitable cavities in the chestnut trees. Five traps were placed across nine suitable sites, remaining active for at least 15 days at each location. The survey was conducted from 26 June to 12 August 2024. Once the species' presence was confirmed, traps were relocated. The traps remained active throughout the period of survey and were checked every 2–3 days. In 2025, from 23 June to 8 August, five additional chestnut sites between Bressanone/Brixen and Chiusa/Klausen were surveyed using the same approach (for more details on the study sites see Table S1 and Figure 3).

2.3 Results

In the capture-mark-recapture study performed at the site in Castelfeder, six individuals were marked, including three males and three females, without recapture. The presence of a population has therefore been confirmed at the site, but this limited number of captures and the absence of recaptures prevented the estimation of population density.

In the study performed in the Bressanone/Brixen area, we recorded the first *Osmoderma eremita* individual (female) in Varna/Vahrn on 7 July 2024 in a private family chestnut grove, managed extensively and composed of very old chestnut trees. Other

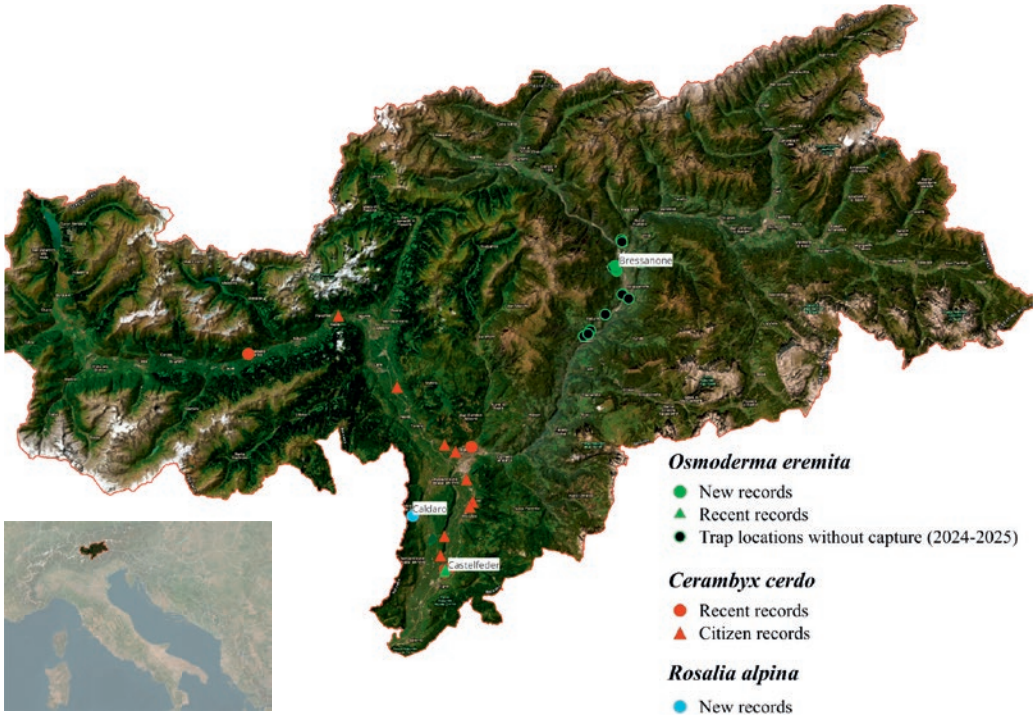


Fig. 3: Study areas and distribution of records for saproxylic beetles investigated in this study in South Tyrol. The study areas described more in detail in this study are marked with the name of the areas. Each species record (2023-2025) has its own colour, *Cerambyx cerdo* records are in red, *Osmoderma eremita* in green and *Rosalia alpina* in blu.

individuals, one male on 22 July and 5 individuals (2 females, 3 males) on 28 July, were captured in another site in Varna/Vahrn, along a wooded path in the immediate vicinity of an old chestnut tree classified as a monumental tree.

No records of *Osmoderma eremita* were obtained from the other seven sites investigated in 2024 and no individuals were captured in the traps installed on 5 suitable sites in July 2025 (Figure 3).

Other species of conservation interest observed during these surveys with the BCWT traps were *Prionychus ater* and *Gnorimus variabilis,* both categorised as near threatened (NT) in Italy (Audisio et al. 2014). Furthermore, in Castelfeder, six specimens of *Elater ferrugineus,* listed as "Near Threatened" (NT) in Europe (Aleksandrowicz et al. 2018) and Vulnerable (VU) in Italy (Audisio et al. 2014), were also found in the traps.

2.4 Discussion

In our survey at Castelfeder (40 ha monitoring area), six individuals were detected over five weeks with no recapture, precluding robust population estimates. However, such low numbers align with results from comparable studies. While in Northern Europe, *Osmoderma eremita* can occur in large populations with high densities (ranging from 2.8 to 14.2 individuals per tree and cavity occupancy rates ranging between 33% and 70%) (Ranius 2000; Lindman et al. 2020), the situation differs considerably in central and southern Europe. For example, in France, emergence rates per tree range from 0 to 9 individuals per year (Vignon 2015) and in Piedmont relatively few individuals were recorded, with 11 and 14 beetles captured across three locations (Perone et al. 2024), comparable to our findings. In Abruzzo, 15 individuals were detected across four out of ten monitored sites using pheromone traps, with populations confined to scattered habitat patches (Giangregorio et al. 2015). By contrast, studies in Lazio reveal a broader range of densities, from very few detections of only 2 individuals (Lenzi et al. 2022) to much higher occupancies and captures up to 35 individuals (Chiari et al. 2013; Sabatelli et al. 2023). Population size may also depend on host-tree characteristics: Castelfeder is dominated by *Quercus petraea*, a medium-sized oak that likely provides smaller cavities than the larger *Q. robur* woodlands typical of northern Europe, which may contribute to the lower densities observed (Ranius et al. 2009).

The flight activity is correlated with daily temperature and varies significantly between years, limiting the effectiveness of pheromone-based monitoring (Larsson & Svensson 2011). Considering the weather of summer 2023, with relatively warm average temperatures (25.1 °C) but frequent rainfall and thunderstorms, it is possible that it might have influenced negatively the outcome of this monitoring. For this reason, such surveys should be repeated at regular intervals to ensure reliable trend assessments (Stoch 2016) recommends repeating the monitoring at least every three years within the six-year reporting cycle of Article 17 of the Habitats Directive.

It is nevertheless conceivable that the relatively low number of individuals captured at this site reflects the small size of the local population. However, given that the environmental conditions at Castelfeder appear to be optimal for the species and that its presence has been confirmed over several years, the population could be considered stable and its current conservation status favourable. Nonetheless, the apparently limited population size, combined with the site's isolation and restricted (or apparent absence of) metapopulation dynamics with the surrounding landscape, may increase its vulnerability to stochastic events, especially considering the species' limited dispersal capacity. Radio-tracking in France has documented a maximum flight distance of 700 m in the wild and of 1454 m in the laboratory (Dubois & Vignon 2008; Dubois 2009). Similarly, Chiari (2011) reported dispersal up to 1504 m in Italy and 39 % of individuals moving beyond 250 m. It is also to consider that not all individuals disperse, which further complicates detection (Chiari 2011), meaning that a substantial proportion of the population may remain undetected during monitoring. Taken together, these findings suggest that the Castelfeder population may function as a relatively isolated unit, whose long-term persistence depends largely on the maintenance of suitable habitat continuity within and around the site.

For *Osmoderma eremita*, cavities should ideally be large, exposed to sunlight while retaining adequate humidity (Dubois 2009; Sabatelli et al. 2023). Oaks take longer to develop such cavities (70–120 years if pruned) but provide more durable microhabitats than faster-growing species (Dubois 2009). In Castelfeder, the site is already protected and managed, with specific recommendations for saproxylic beetles proposed by Degasperi (2018, unpublished report) and integrated in the plan for the management of forest and pasture assets in the municipality of Montagna (Degasperi 2018, unpublished report). These practices should be continued and ensure that existing inhabited trees are conserved to the end of their life cycle, and that young trees are preserved and allowed to mature, to maintain both spatial and temporal continuity of suitable trees. In addition to *O. eremita*, another noteworthy saproxylic species was recorded during the survey. The presence of *Elater ferrugineus,* a predator of *O. eremita* larvae, able to recognise the pheromone emitted by the adult (Svensson et al. 2004), likely explains its attraction to our traps. Although it can also predate other saproxylic larvae, its presence is still of special note due to their rarity. It is considered a valuable indicator of biodiversity-hotspots, often associated with high densities of rare saproxylic beetles (Andersson et al. 2014).

While results were modest, long-term monitoring is essential to assess population trends and a follow-up sampling is strongly suggested to confirm the results here presented. Future monitoring efforts could also consider measuring body weight, as it may reflect resource availability in cavities (Vignon 2015). At present, isolation seems to be the main threat, and future genetic studies could help assess the population's viability and persistence (Melosik et al. 2018).

At one site of record near Bressanone/Brixen, five individuals were captured in a single trap, suggesting a locally high density of individuals, probably linked to a single old tree. This chestnut tree, classified as a natural monument, already benefit from legal protection, with all interventions requiring authorization from the Office of Nature. At the second site, a single individual was recorded. This may reflect that the traditional chestnut grove management has supported population persistence over time. Incentive payments for landscape care and maintenance are already being used by the Province of Bolzano for the preservation of this type of environments (Provincia autonoma di

Bolzano Alto Adige 2025). In addition, some particularly valuable chestnut trees have been placed under protection as natural monuments and are listed among the Italian monumental trees in the national register managed by the Ministry of Agriculture, Food Sovereignty and Forestry (MASAF). The discovery of *O. eremita* in chestnut groves suggests a potentially broader distribution of the species on a local scale, with many suitable habitats remaining yet unexplored also within the agricultural areas.

3. *Cerambyx cerdo*

3.1 Introduction

Cerambyx cerdo Linnaeus, 1758 (Figure 4) occurs throughout southern and central Europe and develops mainly on old living *Quercus* spp.. In southern Europe it can also colonise other broad-leaved trees such as *Salix* spp., *Ulmus* spp., *Castanea sativa*, and *Ilex* spp. (Casula 2017). Adults are active from May to August, with a peak in June to early July, depending on local climatic conditions (Redolfi De Zan et al. 2017). It has been recorded at altitudes up to 1200 m a.s.l., though it is generally encountered below 1000 m (Chittaro et al. 2023). Like *Osmoderma eremita*, strongly associated with veteran trees in semi open woodland, *C. cerdo* is also found in urban and agricultural areas such as tree-lined avenues, parks, and isolated veteran trees or in hedgerows (Mannu et al. 2021; Santarcangelo et al. 2023). *C. cerdo* requires old, but still living trees, with an average diameter of around 50 cm in southern Europe, and sun-exposed trunk (Albert et al. 2013; Redolfi De Zan et al. 2017b), although exceptions can occur (Chittaro et al. 2023). In South Tyrol, the species seems to colonize mainly species of the genus *Quercus*. The species appears to be present in the flat and submontane areas, mainly in the lower Adige valley/Etschtal and on the sunny slopes of the Venosta/Vinschgau valley. However, the species was not recorded in the Isarco valley/Eisaktal, not even considering historical data (Kahlen 2018).



Fig. 4: *Cerambyx cerdo* copula discovered during the monitoring at Castelfeder. (Photo: Audrey Marsy)

3.2 Methods

Surveys were conducted in the Venosta/Vinschgau valley at Castelbello/Kastelbell, where previous records were reported by Kahlen & Eckelt (2013, unpublished report), to confirm the presence of a local population. Two field visits were carried out during the favourable activity period in 2024 (6 and 17 June), followed by two additional surveys in 2025 (29 May and 11 June), including one nocturnal session using a light trap. The light trap was used as previous reports indicated that the species had occasionally been detected during moth surveys.

Furthermore, with the aim of estimating the population size, a monitoring was conducted in the Natura 2000 site of Castelfeder biotope, previously described in the *Osmoderma eremita* section.

At Castelfeder, the monitoring was carried out from 26 May to 6 July 2023. Traps baited with a wine–sugar mixture were assembled following Redolfi De Zan et al. (2017). We assembled two 500 mL plastic containers using plastic cable ties, the lower lid and the bottom of the upper box were pierced with a hole of around 3–4 cm. A metal mesh was placed between them to allow odour dispersion while preventing insects from falling into the attracting liquid. This attractant, prepared one week before deployment, was a mix of white wine, red wine and sugar, and was not changed during the study period (Figure 5).

These traps were activated each Monday and checked daily until Thursday, then deactivated for the weekend by closing the top lid. In total, 20 control rounds were conducted. Ten traps were installed 2–3 m high on suitable 'station' trees (with *C. cerdo* exit holes). In contrast to the above-mentioned protocols (Redolfi De Zan et al. 2017), no traps were set above 10 m, due to the small average height of the trees (mean 10.4 m, SD = 2.32 m) and frequent presence of dead or broken branches. The traps were set at least 100 m from each other and monitored between 9:30 and 18:00.

This approach was also combined with the Visual Encounter Survey (VES) from the 5th of June, along a 1766 m transect between the traps with the same frequency as the trap monitoring. Individuals encountered were captured by hand or by net. Predation remains were also surveyed along this transect. All captured beetles were sexed and marked with numbered stickers on the elytra and with felt-tip pen on the pronotum (Figure 5).

In 2024, spontaneous reports of *Cerambyx cerdo* were received from private citizens. Following this, in 2025, an online call for observations was published on the official website of the Autonomous Province of Bolzano–South Tyrol to encourage further reporting. Submitted records were accompanied by photographs and were validated prior to inclusion in the dataset.



Fig. 5: Left: *Cerambyx cerdo* traps filled with wine and sugar. Center and right: *Cerambyx cerdo* individually marked during the monitoring survey at Castelfeder. (Photo: E. Guariento and A. Marsy)

3.3 Results

In the capture-mark-recapture study carried out at the Castelfeder sites, a total of 24 individuals were marked, including 20 males and four females. Only three were caught by the traps, while the remaining individuals were detected through the VES method. A single individual was recaptured the following day at the same location. Additional 10 individuals were sighted, but not captured, either prior to the monitoring period or at inaccessible heights in the trees. Figure 6 summarises sightings and captures, illustrating the species' phenology at the site. The first detection occurred on 15 May and the last on 31 July, with peak activity observed in June. Nine dead individuals, likely predated, were also found, but as they may have been discovered days or weeks after death they were excluded from the phenological analyses. In total, 34 alive individuals were seen at the Castelfeder site during the entire period (Figure 6).

Despite targeted survey visits at the site in Castelbello/Kastelbell, only a single *Cerambyx cerdo* female was detected, observed during the nocturnal survey using headlamp searches rather than attracted to the moth light trap. A few trees with emergence holes were also recorded, although these could not be reliably attributed to *C. cerdo* and may also originate from *C. welensii* occurring also locally.

Following a public call for observations, we obtained 4 citizen-submitted records in 2024 and 7 in 2025, all validated by experts and included in the map. The additional citizen-submitted records were recorded in the municipalities of Parcines/ Partschins, Gargazzone/ Gargazon, Bolzano/Bozen, Laives/ Leifers and Vadena/ Pfatten, forming a scattered pattern between Ora/ Auer and Merano/Meran (Figure 3).

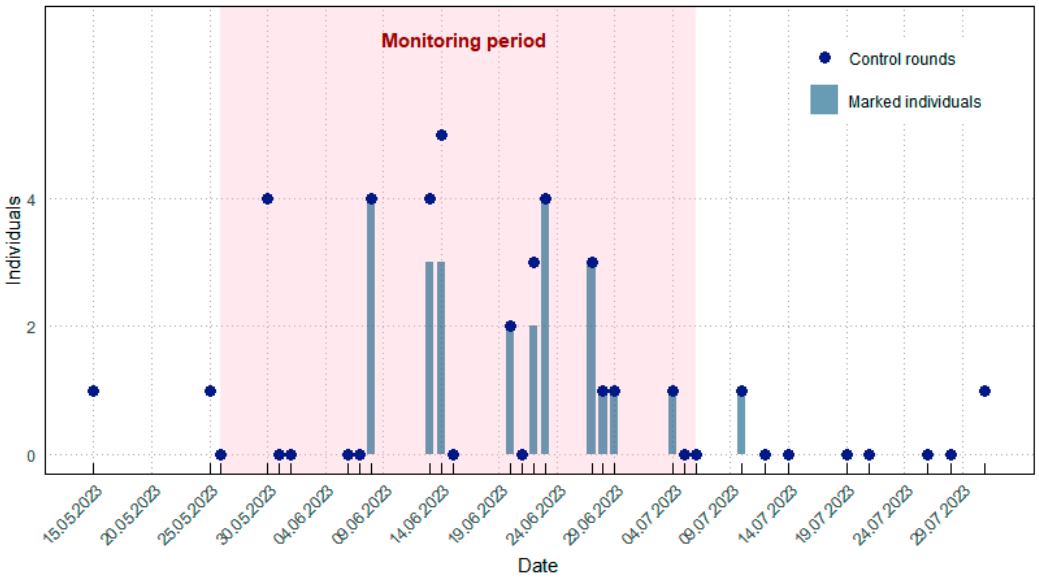


Fig. 6: Monitoring Results (VES and Traps) of *Cerambyx cerdo* at Castelfeder site in 2023. The shaded area marks the time of active trapping, while control round started earlier and ended after this period.

3.4 Discussion

The surveys and data collected confirmed the presence of only one large established population in the Province of Bolzano/South Tyrol at Natura 2000 Site Castelfeder and probably a smaller population in the Castelbello/Kastelbell area. Scattered records between Ora/Auer and Merano/Meran suggest isolated occurrences worth to be investigated closer in the future.

At Castelfeder, trap efficiency was low, with only three individuals captured. The low trap placement (below 10 m) may have influenced negatively the catches. Previous studies have shown a reduced efficacy for the lower height traps due to a higher canopy-level activity (Redolfi De Zan et al. 2017). However, the site at Castelfeder lacks a dense canopy and individuals were frequently observed at the base of trees (21 individuals captured by hand).

This low capture efficiency has also been reported in other studies. Similar results were observed in different regions of Italy and Spain, despite the use of multiple traps, capture success appears highly variable, ranging from zero to hundreds of individuals per trap depending on site and sampling conditions (Redolfi De Zan et al. 2017; Torres-Vila et al. 2022; Sabatelli et al. 2023). Consequently, population estimates often show broad confidence intervals due to limited recaptures (Santarcangelo et al. 2024).

The near absence of recaptures prevented the estimation of population size. Also, the open and non-forest habitat of Castelfeder may allow greater individual mobility, contributing to the lack of recaptures. This is supported by recent radio-tracking studies showing daily movements up to 1,498 m (Drag & Cizek 2018), while Franzen et al. (2025) similarly documented movements exceeding 800 m in a landscape rich in veteran oaks. For *Cerambyx cerdo*, Castelfeder represents a good-quality habitat. As for *Osmoderma eremita*, it is essential to maintain veteran oaks and secure a spatial and temporal continuum in the availability of suitable trees.

In our case, the combination of different methods proved effective, producing more records (43 individuals observed and 24 marked). Since visual encounter surveys (VES) provided the highest detection success, future monitoring could focus primarily on this method, complemented by searches for predation remains. Bait traps could be reduced and deployed strategically in areas with the highest observation records, thereby optimizing survey efficiency.

The management recommendations mentioned for *Osmoderma eremita* are equally relevant for *Cerambyx cerdo*. In addition, particular attention should be given to conserving habitat trees outside protected areas, since the species has a broader distribution and some records originate from non-protected landscapes and areas even bordering the cities of Bolzano and Merano.

The site at Castelbello presents a potentially suitable habitat, with old oaks present, although fewer and more isolated than at Castelfeder. The detection of only a single female of *Cerambyx cerdo*, despite multiple targeted surveys, suggests that the local population may be small. Nevertheless, the species is clearly present in the area, as supported also by older records. Being already under protection, this site should continue to be considered a potential occurrence point in regional conservation planning.



Fig. 7: *Rosalia alpina* female of the newly confirmed population in the forest near Caldaro/Kaltern, spotted on the log pile of *Fagus sylvatica*. (Photo: Audrey Marsy)

4. *Rosalia alpina*

4.1 Introduction

Rosalia alpina (Linnaeus, 1758) (Figure 7) is native to central and southern Europe, ranging from Spain to the Caucasus and from Poland to southern Italy (Cizek et al. 2009; Duelli & Wermelinger 2010). It primarily inhabits open to semi-open deciduous forests with low canopy cover, relying on sun-exposed dead or moribund trees. The main host tree is the European beech (*Fagus sylvatica*), but it can also use other deciduous species from the Aceraceae, Betulaceae, Fagaceae, Oleaceae, Tiliaceae, and Ulmaceae families (Cizek et al. 2009; Russo et al. 2011; Bosso et al. 2013a). The species has been reported at elevations of 500–1900 m a.s.l. (Russo et al. 2011). Their life cycle spans two to four years, depending on climatic conditions and wood quality (Campanaro et al. 2017). The larval stage develops within deadwood. Adults are active from May to August, with a flight peak occurring between mid-July and mid-August, depending on altitude (Duelli & Wermelinger 2010; Drag et al. 2011a). In South Tyrol, *R. alpina* was once relatively widespread (Gredler 1866; 1873), and the last confirmed sighting dating from 1932. Despite multiple targeted surveys (Kahlen & Eckelt 2013; Eckelt et al. 2015, unpublished reports), no further records were found, and the

species was considered locally extinct (Kahlen 2018). However, on 23 July 2021, a single female was discovered in a beech-mixed forest near Caldaro/Kaltern by Dominik Figl (Kranebitter & Figl 2024). On 8 July 2024, a targeted survey by the authors revealed eight individuals, confirming the species' presence and prompting a more in-depth investigation, the results of which are documented in this article.

4.2 Methods

The monitoring of *Rosalia alpina* was conducted in a deciduous (beech) forest near Caldaro/Kaltern where the species was rediscovered (Kranebitter & Figl 2024). The area, within the forests of the Mendola ridge, is managed by the Caldaro forestry station, with a strong focus on biodiversity conservation.

Monitoring of *Rosalia alpina* was carried out at least once a week between 13 June and 13 August 2025. Nine survey stations were prepared and installed by the forestry service within a 2 km radius of the records of the explorative survey of 2024. Each station consisted of a pile of freshly cut European beech logs (approximately 10 logs per station; min. diameter 20 cm and length 1 m of logs, height of pile ~1 m), following the monitoring methods described in Campanaro et al. (2017). In addition, a ~3,000 m^2 natural habitat patch, primarily composed of old beech stumps and fallen beeches, was also regularly surveyed visually (Figure 8).

For each survey day, weather conditions (temperature, sunshine, wind) and time of survey were recorded. Beech logs, tree trunks, and stumps were examined for adult beetles. To minimize disturbance, beetles were photographed in situ without handling. Photographs from Eurac Research surveys were supplemented by images submitted by private citizens encountered on the field, resulting in many additional pictures and a total of 18 survey days.

Individuals of *Rosalia alpina* beetles were identified using the I3S Contour software, which enables photographic recognition based on characteristic elytra markings (Rossi de Gasperis et al. 2016). For each individual, the outlines of the black spots were traced: on the left elytron in a clockwise direction, and on the right elytron counterclockwise,



Fig. 8: Habitat of *Rosalia alpina*: fallen beech trunk and stump (Photo: Audrey Marsy), a female *R. alpina* on a log and monitoring of log piles, attractive pile of beech wood prepared for this monitoring (Photo: Eurac Research, Andrea De Giovanni).



Fig. 9: Four different individuals of *Rosalia alpina* photographed during the monitoring and showing clear different individual patterns (Photo: Audrey Marsy).

starting from the outside of the upper left black marking. Each new capture was compared to the reference database containing previously identified individuals. The software automatically calculated similarity scores, and final identification was confirmed through visual inspection by the authors to determine whether the individual was already recorded or represented a new observation (Figure 9).

The POPAN open-population model, a robust parameterization of the Jolly–Seber model (Jolly 1965), was used to account for recruitment, mortality, and emigration during the survey period. The model estimates survival (phi), capture probability (p), entry probability (pent), and superpopulation size (N). Models were implemented in R (v. 4.5.0) using the RMark package. Candidate models included covariates such as time of day, sun exposure, and temperature (p ~ time + sun + temp), while alternative structures for phi and pent were tested. Time intervals between capture occasions were irregular and specified explicitly. Competing models were ranked using Akaike's Information Criterion corrected for small sample sizes (AICc) (Drag et al. 2011b; Tikkamäki & Komonen 2011; Chiari S. et al. 2014; Quinby et al. 2020).

4.3 Results

Throughout the study period (13 June to 13 August 2025), a total of 79 individuals of *Rosalia alpina* were identified. Twenty-one of which were captured on at least two separate occasions, resulting in an overall recapture rate of 26.5 %. The oldest observed individual, a male, was still alive 21 days after its initial capture and was recaptured five times. On at least 13 occasions, *R. alpina* was found on the provided wood piles. Individuals were found about 500 m from the area discovered in 2024.

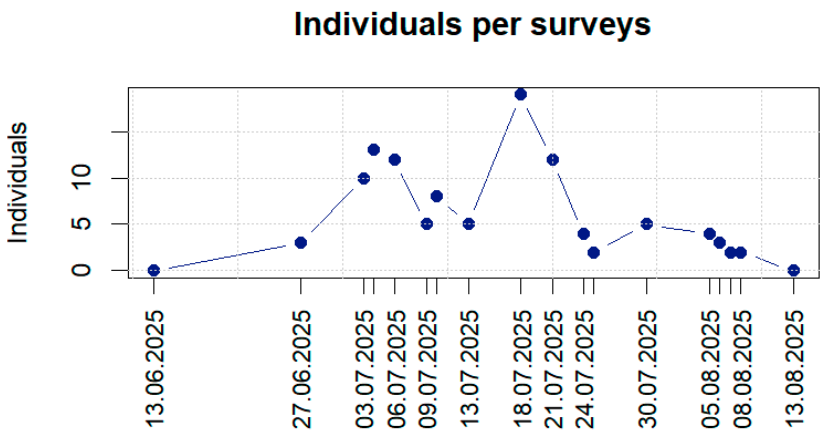


Fig. 10. The abundance of recorded individuals of *Rosalia alpina* showing the overall phenological curve based on monitoring data collected in the Caldaro/Kaltern study area (Mendola woodland), South Tyrol, in 2025.

The best-supported POPAN model included time of day, temperature and sunlight as covariates affecting capture probability (p ~ time + temp + sun), while survival probability (phi) and superpopulation size (N) were held constant across sampling occasions (~1). Entry probability (pent) was modeled as a function of the empirically derived proportion of newly observed individuals per occasion (pent ~ empirical_pent), representing a proxy for hatching rate. This model had the lowest AICc value (312.13) and a model weight of 0.95, indicating strong support relative to competing models.

The estimated superpopulation size (N) was 171.2 individuals (95 % CI: 52–164, log-scale mean ± SE: 4.52 ± 0.29). Based on the observed extent of occurrence of 12 ha, this corresponds to a density of 14,27 individuals per hectare. Apparent survival was constant across the monitoring period (phi = 0.82). Capture probability varied across times and weather, with highest detection around midday (11:00) and a positive, but non-significant effect of sunlight and temperature. Entry probability peaked at two timepoints, consistent with two main hatching waves observed during the field season (Figure 10).

4.4 Discussion

In the case of *Rosalia alpina* the methods used for monitoring proved effective in monitoring the population. The use of combined methods such as visual analysis of areas where the species has been confirmed (VES) and the creation of special wood piles to increase the probability of observing individuals and begin to understand the current distribution area of the species has made it possible to collect sufficient data to estimate the size of the population.

Our study shows that the use of the I3S Contour software for individual identification of *Rosalia alpina* is feasible and produces reliable results under optimal conditions, consistent with earlier applications (Rossi de Gasperis et al. 2016) avoiding so any handling and marking of the individual animals. However, we noticed that the reliability of automated matches is highly influenced by photo angle and resolution, necessitating manual verification.

For population analysis, the POPAN model provided stable estimates despite limited sample sizes, though its parameters remain sensitive to influences such as weather and predation. These dependencies introduce variability that may challenge the robustness of the model under dynamic environmental conditions, requiring cautious interpretation.

The estimated density in our study area (~14,27 individuals/ha, with a 26.5 % recapture rate) is intermediate compared to previous reports. Higher densities were reported in the Czech Republic (42–84 individuals/ha) with recapture rates between 26 and 33 % (Drag et al. 2011b). By contrast, much lower values were recorded by Holzinger et al. (2014) in the Austrian Alps (0.005–0.01 individuals/ha), and in Romania by Minodora et al. (2018) with ~ 0.3 individuals/ha. Italian populations also show strong regional variation, ranging from a few dozen individuals in the Casentinesi forests to several hundred in Abruzzo (Campanaro et al. 2017). These results highlight pronounced geographic variability in density, shaped by local habitat conditions and management.

Our data on adult longevity (up to 21 days) align with previous findings. The individuals we observed showed very limited movements, with the recaptured specimen found within a radius of less than 100 m, whereas literature data indicate a maximum dispersal of 1,628 m with occasional movement estimated up to 3 km (Drag et al. 2011b), underscoring the vulnerability of the species to habitat fragmentation and the importance of maintaining deadwood resources at landscape scales. Considering that the mean dispersal capacity of this species is estimated around 100 m for most individuals and considering that a non-negligible proportion may disperse up to 500 m (Drag et al. 2011b), we estimated the potential inhabited area by identifying suitable forest habitats within a 500 m buffer around the recorded observations. Buffers from multiple observation points were merged, and only beech-dominated forest patches were retained, while non-forested areas were excluded. Based on this habitat-filtered approach, the potentially occupied area is estimated at approximately 150 ha. This estimate should be regarded as indicative, as actual occupancy depends on habitat

availability and connectivity: Here we propose to consider this area additionally to the area of actual occurrence, to optimize the conservation of this special single population occurring in South Tyrol.

Our study confirms that *Rosalia alpina* prefers open-canopy beech forests with abundant sunlit deadwood. Indeed, habitat closure and intensive forestry reduce suitable oviposition sites (Russo et al. 2011; Lachat et al. 2013), while timber stacks may act as ecological traps (Adamski et al. 2018). To minimize such risks, harvested firewood should be removed or stored in shaded areas before emergence, or supplemented with sun-exposed logs placed separately as safe oviposition sites. During logging, selected old trees, high stumps and lower-quality trunks should be retained (Duelli et al. 2010). Conservation strategies should further aim to maintain old-growth structures and at least 20 m^3/ha of deadwood in sunlit positions to support large saproxylic beetles (Gossner et al. 2013).

Although our study area supports a relatively robust population, *Rosalia alpina* remains vulnerable at local scales since it is so far the only known population. Current protected areas in Europe do not fully encompass its distribution (Bosso et al. 2013b). As an umbrella species, its conservation may benefit other taxa reliant on old-growth deciduous trees (Russo et al. 2015). Priorities should therefore include securing this local population, enhancing habitat connectivity, enabling expansion into suitable areas, and establishing long-term monitoring. The species is listed in Annexes II and IV of the Habitats Directive (European Union 1992) and is therefore strictly protected, and its habitat must be preserved and maintained, and appropriate measures must be put in place for its management and conservation. It is also important to define the extent and location of potentially suitable habitats and to encourage and monitor the possible colonisation of the species of new forest patches.

5. Conclusions

The three investigated species are umbrella species, associated with different kind of deadwood in near-natural, primeval forests. While *Rosalia alpina* and *Cerambyx cerdo* are relatively clearly associated with one or a few tree species (beech and various oak species, respectively), *Osmoderma eremita* shows a broader range of tree species that can be colonised. Similar to the surrounding areas, the range of suitable habitats in South Tyrol is very limited. The hardwood riparian forests with old oak trees that probably existed in the valley floors in the past have been almost completely replaced by agricultural land and settlements. The sub-Mediterranean oak trees (*Quercus pubescens* and *Q. petraea*) on slopes are generally small in size with insufficient deadwood for *C. cerdo* and *O. eremita*. Beech forests, on the other hand, are naturally limited to the more southern, less continental areas of the region and have also been replaced in many cases by other forest types or converted to cultivated land (Provincia Autonoma di Bolzano-Alto Adige 2010). The remaining stands have been used for forestry almost continuously over the centuries, which prevented the development of decay phases. While *O. eremita* has shifted its focus to secondary habitats (orchard meadows, chestnut groves, and other wooded pastures), the populations of *C. cerdo a*nd *R. alpina* have obviously shrunk to small remnant populations.

The monitoring and surveys carried out confirmed the presence of the target species *Osmoderma eremita* and *Cerambyx cerdo* in the Castelfeder Natura 2000 site and provided new data on the distribution of this species, but they were not suitable for estimating the size of the populations present.

Monitoring methods can also be optimized by using the techniques that have proven most effective and repeating them over several years, as the species' multi-year larval development, population size and detectability can vary considerably from year to year. It is essential to continue long-term monitoring in the future in order to identify demographic trends and enable long-term conservation.

The site Castelfeder, established for the conservation of dry meadows and saproxylic beetle species, still seems to play an important role in the conservation for two of the

most charismatic and protected saproxylic species occurring in the region and to support their population for longer time periods by providing suitable habitat in form of old oak trees. The preservation of ancient and dying trees, even outside protected areas, is nevertheless important to support these species and to create suitable stepping stones biotopes, which could allow the various populations to connect and expand their range.

Monitoring and CMR techniques applied to *Rosalia alpina* have proven highly effective in defining the current distribution of the species. Monitoring must continue and be extended to all potentially suitable areas. Appropriate conservation measures must be implemented within a 2–3 km buffer zone around the central area of occurrence (promoting forest aging, releasing old trees, increasing solar radiation near trees potentially suitable for colonization, etc.). Moreover, we suggest considering the creation of a protected area of at least 150 ha encompassing the central occurrence of this population.

Recent findings, including new locations for *Osmoderma eremita* and the population of *Rosalia alpina*, show that the potential for new discoveries has not been fully exhausted. Our collaborative approach, between a research centre and the institutions responsible for conservation with the cooperation of organizations, experts, and private citizens, has not only expanded regional knowledge of these threatened beetles, but also serves to prepare the next report of the Habitats Directive and above all helps to preserve these species and the associated habitats.

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References

Adamski P., Michalcewicz J., Bohdan A. & Ciach M., 2018: Potential range of impact of an ecological trap network: the case of timber stacks and the Rosalia longicorn. Journal of Insect Conservation, 22(2): 209–219. https://doi.org/10.1007/s10841-018-0054-z

Albert J., Platek M. & Cizek L., 2013: Vertical stratification and microhabitat selection by the Great Capricorn Beetle (Cerambyx cerdo) (Coleoptera: Cerambycidae) in open-grown, veteran oaks. European Journal of Entomology, 109(4): 553–559. https://doi.org/10.14411/eje.2012.069

Audisio P., Baviera C., Carpaneto G. M., Biscaccianti A., Battistoni A., Teofili C. & Rondinini C., 2014: Lista Rossa IUCN dei Coleotteri saproxilici Italiani. Comitato italiano IUCN e Ministero dell'ambiente e della tutela del territorio e del Mare, Roma, 133 pp.

Bergmark P., Hjältén J., Svensson J., Neumann W. & Hekkala A.-M., 2024: Trait-environment interactions of saproxylic beetles as a guide to biodiversity conservation strategies. Journal of Environmental Management, 360: 121080. https://doi.org/10.1016/j.jenvman.2024.121080

Biscaccianti A., Audisio P. & Monguzzi R., 2008: Aggiornamenti sulla distribuzione di *Cucujus cinnaberinus* e di altri Cucujoidea (Coleoptera, Cucujidae, Laemophloeidae). Boll. ass. romana entomol., 63: 47–57.

Bonacci T., Biscaccianti A., Siclari A., Carlomagno F., Bonelli D., Mendicino F., Plewa R., Jaworski T. & Pezzi M., 2022: Presence of the endangered saproxylic species *Cucujus haematodes* (Coleoptera: Cucujidae) in Aspromonte National Park (Southern Italy). The European Zoological Journal, 89: 115–122. https://doi.org/10.1080/24750263.2022.2030421

Bosso L., Rebelo H., Garonna A. P. & Russo D., 2013a: Modelling geographic distribution and detecting conservation gaps in Italy for the threatened beetle *Rosalia alpina*. Journal for Nature Conservation, 21(2): 72–80. https://doi.org/10.1016/j.jnc.2012.10.003

Bosso L., Rebelo H., Garonna A. & Russo D., 2013b: Modelling geographic distribution and detecting conservation gaps in Italy for the threatened beetle *Rosalia alpina*. *Poster presented at Conference: XXIII Congresso SItE*.

Campanaro A., Redolfi de Zan L., Hardersen S., Antonini G., Chiari S., Cini A., Mancini E., Mosconi F., Gasperis S. R., de Solano E., Bologna M. A. & Peverieri G. S., 2017: Guidelines for the monitoring of Rosalia alpina. Nature Conservation, 20: 165–203. https://doi.org/10.3897/natureconservation.20.12728

Carpaneto G. M., Mazziotta A., Coletti G., Luiselli L. & Audisio P., 2010: Conflict between insect conservation and public safety: the case study of a saproxylic beetle (*Osmoderma eremita*) in urban parks. Journal of Insect Conservation, 14(5): 555–565. https://doi.org/10.1007/s10841-010-9283-5

Casula P., 2017: Monitoring and management of *Cerambyx cerdo* in the Mediterranean region – a review and the potential role of citizen science. Nature Conservation, 19: 97–110. https://doi.org/10.3897/natureconservation.19.12637

Chiari S., 2011: Ecology of the hermit beetie (*Osmoderma eremita*) in Mediterranean woodlands. Doctoral Thesis. Department of Environmental Biology, Roma Tre University, Rome, Italy. 102 pp.

Chiari S., Zauli A., Audisio P., Campanaro A., Donzelli P. F., Romiti F., Svensson G., Tini M. & Carpaneto G. M., 2014: Monitoring presence, abundance and survival probability of the stag beetle, *Lucanus cervus*, using visual and odour-based capture methods: Implications for conservation. Journal of Insect Conservation, 18: 99–109. https://doi.org/10.1007/s10841-014-9618-8

Chiari S., Zauli A., Mazziotta A., Luiselli L., Audisio P. & Carpaneto G. M., 2013: Surveying an endangered saproxylic beetle, *Osmoderma eremita*, in Mediterranean woodlands: a comparison between different capture methods. Journal of Insect Conservation, 17(1): 171–181. https://doi.org/10.1007/s10841-012-9495-y

Chittaro Y., Sanchez A. & Rey E., 2023: Le Grand Capricorne (*Cerambyx cerdo* Linnaeus, 1758) en Valais: répartition, écologie et mesures de conservation. Bull. Murithienne, 140: 7–18.

Cizek L., Schlaghamerský J., Bořucký J., Hauck D. & Helešic J., 2009: Range expansion of an endangered beetle: Alpine Longhorn *Rosalia alpina* (Coleoptera: Cerambycidae) spreads to the lowlands of Central Europe. Entomologica Fennica, 20(3): 200–206. https://doi.org/10.33338/ef.84478

Degasperi G. 2018: Piano di gestione dei beni silvo-pastorali del Comune di Montagna/Bewirtschaftungsplan der Wald- und Weidegüter der Gemeinde Montan. Report.

Degasperi G., Eckelt A. & Kahlen M., 2022: Käfererhebungen in ausgewählten Gebieten Südtirols. Report, 37 p.

Drag L. & Cizek L., 2018: Radio-Tracking Suggests High Dispersal Ability of the Great Capricorn Beetle (*Cerambyx cerdo*). Journal of Insect Behavior, 31(2): 1–6. https://doi.org/10.1007/s10905-018-9669-x

Drag L., Hauck D., Pokluda P., Zimmermann K. & Cizek L., 2011: Demography and Dispersal Ability of a Threatened Saproxylic Beetle: A Mark-Recapture Study of the Rosalia Longicorn (*Rosalia alpina*). PLOS ONE, 6(6): e21345. https://doi.org/10.1371/journal.pone.0021345

Dubois G., 2009: Ecologie des coléoptères saproxyliques: Biologie des populations et conservation d'*Osmoderma eremita* (Coleoptera: Cetoniidae). Phd thesis, Université Rennes 1, 223 p.

Dubois G. & Vignon V., 2008: First results of radio-tracking of *Osmoderma eremita* (Coleoptera: Cetoniidae) in French chestnut orchards. Revue d'Écologie (La Terre et La Vie), 10(1): 131–138. https://doi.org/10.3406/revec.2008.1469

Duelli P. & Wermelinger B., 2010: Der Alpenbock. Ein seltener Bockkäfer als Flaggschiff-Art. 2. überarbeitete Aufl. Merkblatt für die Praxis 39. Birmensdorf: Eidg. Forschungsanstalt WSL. 8 S.

Eckelt A., Degasperi G. & Weigand E., 2020: Der Rothalsige Düsterkäfer, *Phryganophilus ruficollis* (Fabricius, 1798) (Coleoptera: Melandryidae), im Nationalpark Kalkalpen, Oberösterreich. Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 72: 163–176.

Eckelt A., Kahlen M. & Degasperi G., 2015: Erhebung ausgewählter Käferarten (Coleoptera) der Fauna Flora Habitatrichtlinie in Südtirol (Alto Adige, Italia) – Vorkommen und Erhaltungszustände. 23 p.

European Union, 1992: Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Communities, L 206, 7–50.

Franzen M., Jarl N., Forsman A. & Hedin J., 2025: Radio telemetry reveals extensive dispersal capabilities of reintroduced Great Capricorn beetles (*Cerambyx cerdo*) in oak habitats at their Northern range limit. Insect Conservation and Diversity published by John Wiley & Sons Ltd on behalf of Royal Entomological Society, 18: 810–817. https://doi.org/10.1111/icad.12830

Friess T., Bund A., Holzinger W. E. & Sauseng G., 2020: Der Juchtenkäfer in der Steiermark, Österreich (Scarabaeidae, Cetoniinae: *Osmoderma eremita* s.l.). Entomologica Austriaca, 27: 51–63.

Giangregorio, P., Audisio, P., Carpaneto, G. M., Marcantonio, G., Maurizi, E., Mosconi, F. & Campanaro, A. (2015): Updated distribution of Osmoderma eremita in Abruzzo (Italy) and agro-pastoral practices affecting its conservation (Coleoptera: Scarabaeidae). Fragmenta Entomologica, 47(2): 139–146. https://doi.org/10.4081/fe.2015.142

Gillett C. P. D. T. & Blanc M., 2023: Inattesa aggiunta alla fauna saproxilica siciliana di una specie minacciata nuova per l'Italia: *Limoniscus violaceus* (Coleoptera Elateridae Denticollinae). Il Naturalista siciliano, 47(2): 317–328. https://doi.org/10.5281/zenodo.8412656

Gossner M., Lachat T., Brunet J., Isacsson G., Bouget C., Brustel H., Brandl R., Weisser W. & Müller J., 2013: Current Near-to-Nature Forest Management Effects on Functional Trait Composition of Saproxylic Beetles in Beech Forests. Conservation Biology, 27(3):605–14. https://doi.org/10.1111/cobi.12023

Gouix N., Mertlik J., Jarzabek-Müller A., Németh T. & Brustel H., 2012: Known status of the endangered western Palaearctic violet click beetle (*Limoniscus violaceus*) (Coleoptera). Journal of Natural History, 46: 769–802. https://doi.org/10.1080/00222933.2011.651639

Graf, M., Seibold, S., Gossner, M. M., Hagge, J., Weiss, I., Bässler, C. & Müller, J. (2022): Coverage based diversity estimates of facultative saproxylic species highlight the importance of deadwood for biodiversity. *Forest* Ecology and Management, 517: 120275. https://doi.org/10.1016/j.foreco.2022.120275

Gredler V. M., 1866: Die Käfer von Tirol: nach ihrer horizontalen und vertikalen Verbreitung. J. Eberle, Bozen, 491 pp.

Gredler V. M., 1873: II. Dritte Nachlese zu den Käfern von Tirol. Coleopterologische Hefte, 11: 49–78.

Haeler E., Bergamini A., Blaser S., Ginzler C., Hindenlang K., Keller C., Kiebacher T., Kormann U. G., Scheidegger C., Schmidt R., Stillhard J., Szallies A., Pellissier L. & Lachat T., 2021: Saproxylic species are linked to the amount and isolation of dead wood across spatial scales in a beech forest. Landscape Ecology, 36(1): 89–104. https://doi.org/10.1007/s10980-020-01115-4

Holzinger W., Friess T., Mairhuber C., Mehlmauer P., Paill W. & Zimmermann P., 2014: Der Alpenbockkäfer, *Rosalia alpina* (Linnaeus, 1758) (Coleoptera, Cerambycidae), im Nationalpark Kalkalpen (Österreich). Entomologische Nachrichten und Berichte, 58: 113–119.

iNaturalist, 2025: Available from https://www.inaturalist.org. Accessed [12.12.2025].

Jolly G. M., 1965: Explicit estimates from capture-recapture data with both death and immigration-stochastic model. Biometrika, 52(1/2): 225–247. https://doi.org/10.2307/2333826

Kahlen M., 2018: Die Käfer von Südtirol. Ein Kompendium. Naturmuseum Südtirol.

Kahlen M. & Eckelt A., 2013: Basiserhebung, Monitoring - und Kartieranleitung ausgewählter Käfer Arten mit gemeinschaftlicher Bedeutung nach Anhang II. und IV. der Fauna-Flora-Habitat Richtlinie in der Autonomen Provinz Südtirol (Alto Adige, Italia). Report, 28 p.

Kranebitter P. & Figl D., 2024: Faunistische Notiz – Wiederfund von *Rosalia alpina* (Linnaeus, 1758) in Südtirol. Gredleriana, 24: 77 - 82.

Lachat T., Ecker K., Duelli P. & Wermelinger B., 2013: Population trends of *Rosalia alpina* (L.) in Switzerland: a lasting turnaround? Journal of Insect Conservation, 17(4): 653–662. https://doi.org/10.1007/s10841-013-9549-9

Larsson M. C. & Svensson G. P., 2011: Monitoring spatiotemporal variation in abundance and dispersal by a pheromone-kairomone system in the threatened saproxylic beetles *Osmoderma eremita* and *Elater ferrugineus*. Journal of Insect Conservation, 15(6): 891–902. https://doi.org/10.1007/s10841-011-9388-5

Lenzi A., Maurizi E., Mosconi F., Francescato S., Cecchetti M., Dalla Valle M., Noal A., Stolfa G., Roversi P. F. & Campanaro A., 2022: *Osmoderma eremita* (Acopoli, 1763) (Coleoptera Scarabaeidae Cetoniinae) in circeo state forest (Central Italy). Redia, 105: 71–75. https://doi.org/10.19263/redia-105.22.08

Lindman L., Larsson M. C., Mellbrand K., Svensson G. P., Hedin J., Tranberg O. & Ranius T., 2020: Metapopulation dynamics over 25 years of a beetle, *Osmoderma eremita*, inhabiting hollow oaks. Oecologia, 194(4): 771–780. https://doi.org/10.1007/s00442-020-04794-7

Mannu R., Torres-Vila L. M., Olivieri M. & Lentini A., 2021: When a threatened species becomes a threat: a key to reading the Habitats Directive based on occurrence and distribution of *Cerambyx cerdo* L. in Mediterranean urban and peri-urban areas. Insect Conservation and Diversity, 14(6): 730–735. https://doi.org/10.1111/icad.12531

Maurizi E., Campanaro A., Chiari S., Maura M., Mosconi F., Sabatelli S., Zauli A., Audisio P. & Carpaneto G. M., 2017: Guidelines for the monitoring of *Osmoderma eremita* and closely related species. Nature Conservation, 20: 79–128. https://doi.org/10.3897/natureconservation.20.12658

Mazzei A., Audisio P., Taglianti A. & Brandmayr P., 2019: Geographical distribution and conservation status of the threatened saproxylic beetles *Rhysodes sulcatus* (Fabricius, 1787), *Clinidium canaliculatum* (O.. G. Costa, 1839) and *Omoglymmius germari* (Ganglbauer, 1891) in Italy (Coleoptera: Rhysodidae). Fragmenta Entomologica, 51: 89–96. https://doi.org/10.4081/fe.2019.337

Melosik I., Przewoźny M., Winnicka K., Baraniak E. & Staszak J., 2018: Use of a genetically informed population viability analysis to evaluate management options for Polish populations of endangered beetle *Cerambyx cerdo* L. (1758) (Coleoptera, Cerambycidae). Journal of Insect Conservation, 22: 69–83. https://doi.org/10.1007/s10841-017-0039-3

Minodora M., Lotrean N., Badiu D., Bodescu F., Nicoara R. & Onete M., 2018: Monitoring of the saproxylic beetle *Rosalia alpina* (Linnaeus, 1758) (Coleoptera: Cerambycidae) using visual methods in the Măcin Mountains National Park (Romania). Rom. J. Biol. – Zool., 61: 43–59.

Parisi F., Pioli S., Lombardi F., Fravolini G., Marchetti M. & Tognetti R., 2018: Linking deadwood traits with saproxylic invertebrates and fungi in European forests – a review. iForest – Biogeosciences and Forestry, 11(3): 423. https://doi.org/10.3832/ifor2670-011

Perone P., Luca C., Rastelli M. & Gaggino A. M., 2024: New records of *Osmoderma eremita* in protected relict forests of Piedmont lowlands (NW Italy). Fragmenta Entomologica, 56: 111–118. https://doi.org/10.13133/2284-4880/1618

Provincia Autonoma di Bolzano-Alto Adige, 2010: Tipologie forestali in Alto Adige. Vol 1 & 2. Ripartizione per le foreste, Ufficio Pianificazione forestale, Bolzano.

Provincia autonoma di Bolzano Alto Adige, 2025: Castagneti e i prati radi con alberi da frutto. natura-territorio.provincia.bz. https://natura-territorio.provincia.bz.it/it/castagneti-e-i-prati-radi-con-alberi-da-frutto [accessed on 15.11.2025]

Provincia autonoma di Bolzano Alto Adige, 2026: Habitat Natura 2000. https://natura-territorio.provincia.bz.it/it/habitat-natura-2000 [accessed on 19.05.2026]

Quinby B., Creighton C. & Flaherty E., 2020: Estimating population abundance of burying beetles using photo-identification and mark-recapture methods. Environmental Entomology, 50: 238–246. https://doi.org/10.1093/ee/nvaa139

Ranius T., 2000: Minimum viable metapopulation size of a beetle, *Osmoderma eremita*, living in tree hollows. Animal Conservation, 3(1): 37–43. https://doi.org/10.1111/j.1469-1795.2000.tb00085.x

Ranius T., Aguado L., Antonsson K., Audisio P., Ballerio A., Carpaneto G. M., Chobot K., Gjurasin B., Hanssen O., Huijbregts J., Lakatos F., Martin O., Neculiseanu Z., Nikitsky N., Paill W., Pirnat A., Rizun V., Ruicanescu A., Stegner J. & Zach P., 2005: *Osmoderma eremita* (Coleoptera, Scarabaeidae, Cetoniinae) in Europe. Animal Biodiversity and Conservation, 28.1: 1–44.

Ranius T. & Nilsson S. G., 1997: Habitat of *Osmoderma eremita* Scop. (Coleoptera: Scarabaeidae), a beetle living in hollow trees. Journal of Insect Conservation, 1(4): 193–204. https://doi.org/10.1023/A:1018416000766

Ranius T., Svensson G., Berg N. & Niklasson M., 2009: The successional change of hollow oaks affects their suitability for an inhabiting beetle, *Osmoderma eremita*. Annales Zoologici Fennici, 46(3): 205–216.

Redolfi De Zan L., Bardiani M., Antonini G., Campanaro A., Chiari S., Mancini E., Maura M., Sabatelli S., Solano E., Zauli A., Peverieri G. S. & Roversi P. F., 2017: Guidelines for the monitoring of Cerambyx cerdo. Nature Conservation, 20: 129–164. https://doi.org/10.3897/natureconservation.20.12703

Redolfi De Zan L., Rossi de Gasperis S., Andriani V., Bardiani M., Campanaro A., Gisondi S., Hardersen S., Maurizi E., Mosconi F., Nardi G., Zapponi L., Rombolà P. & Romiti F., 2023: The big five: species distribution models from citizen science data as tool for preserving the largest protected saproxylic beetles in Italy. Diversity, 15(1): 96. https://doi.org/10.3390/d15010096

Rossi de Gasperis S., Carpaneto G. M., Nigro G., Antonini G. S. C., Cini A., Mancini E., Franco M., Mosconi F., Redolfi DeZan L., Roversi P., Sabbatini Peverieri G., Solano E. & Campanaro A., 2016: Computer-aided photographic identification of *Rosalia alpina* (Coleoptera: Cerambycidae) applied to a mark-recapture study. Insect Conservation and Diversity, 10: 54–63. https://doi.org/10.1111/icad.12199

Roth N., Doerfler I., Bässler C., Blaschke M., Bussler H., Gossner M. M., Heideroth A., Thorn S., Weisser W. W. & Müller J., 2019: Decadal effects of landscape-wide enrichment of dead wood on saproxylic organisms in beech forests of different historic management intensity. Diversity and Distributions, 25(3): 430–441. https://doi.org/10.1111/ddi.12870

Russo D., Cistrone L. & Garonna A. P., 2011: Habitat selection by the highly endangered long-horned beetle Rosalia alpina in Southern Europe: a multiple spatial scale assessment. Journal of Insect Conservation, 15(5): 685–693. https://doi.org/10.1007/s10841-010-9366-3

Russo D., Di Febbraro M., Cistrone L., Jones G., Smeraldo S., Garonna A. P. & Bosso L., 2015: Protecting one, protecting both? Scale-dependent ecological differences in two species using dead trees, the *Rosalia* longicorn beetle and the barbastelle bat. Journal of Zoology, 297(3): 165–175. https://doi.org/10.1111/jzo.12271

Sabatelli S., Parisi F., Vangi E., Francini S., D'Amico G., Chirici G., Travaglini D., Rignanese D., Muambalo K. & Audisio P., 2023: Relationship between tree-related microhabitats and the captures obtained using different trap methods for large threatened saproxylic beetles. Redia, 106: 45–56. https://doi.org/10.19263/REDIA-106.23.06

Santarcangelo V., Altieri G. M., De Capua E. L., Grossi G. & Tarasco E., 2023: Monitoring biodiversity in oak woods: structure and composition of Great Capricorn Beele (*Cerambyx cerdo*) populations. IOBC-WPRS Bulletin, 168: 79–82. ISBN 978-92-9067-355-2.

Santarcangelo V., Altieri G. M., De Capua E. L & Tarasco E., 2024: Digital Techniques for Monitoring *Cerambyx cerdo* in SAC 'Gravine di Matera': Population Size Insights. International Journal of Zoology and Animal Biology, 7(3): 000589. https://doi.org/10.23880/izab-16000589

Seibold S., Weisser W. W., Ambarli D., Gossner M. M., Mori A. S., Cadotte M. W., Hagge J., Bässler C. & Thorn S., 2023: Drivers of community assembly change during succession in wood-decomposing beetle communities. Journal of Animal Ecology, 92(5): 965–978. https://doi.org/10.1111/1365-2656.13843

Soutinho J. G., Carvalho J., Matos M., Grosso-Silva J. M., Moreira-Pinhal T. C., Rego C., Ferreira S., Abreu J. G., Gonçalves A. R., Ceia H., Fonseca C., Rufino C., Müller J., Vierling K. T., Vierling L. A. & Gonçalves J., 2025: Conserving saproxylic flagship species by complementing 150 years of natural history with citizen science data—the case of the stag beetles (Lucanidae, Coleoptera) of Portugal. Biodiversity and Conservation, 34: 793–822. https://doi.org/10.1007/s10531-024-02961-3

Stoch F. & Genovesi P., 2016: Manuali per il monitoraggio di specie e habitat di interesse comunitario (Direttiva 92/43/CEE) in Italia: Specie animali. ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale. Serie Manuali e linee guida, 141/2016.

Svensson G., Larsson M. & Hedin J., 2004: Attraction of the larval predator *Elater ferrugineus* to the sex pheromone of its prey, *Osmoderma eremita*, and its implication for conservation biology. Journal of chemical ecology, 30: 353–63. https://doi.org/10.1023/B:JOEC.0000017982.51642.8c

Tikkamäki T. & Komonen A., 2011: Estimating population characteristics of two saproxylic beetles: A mark-recapture approach. Journal of Insect Conservation, 15: 401–408. https://doi.org/10.1007/s10841-010-9313-3

Torres-Vila L. M., Mendiola-Díaz F., Moral García F. J. & Canelo T., 2022: Large-scale geostatistical mapping and occupancy-abundance patterns of *Cerambyx species* threatening SW Spain oak forests. European Journal of Forest Research, 141: 1045–1057. https://doi.org/10.1007/s10342-022-01487-z

Valladares L., Gouix N. & Brustel H., 2015: Bilan de la politique conservatoire des habitats du pique-prune en Midi-Pyrénées après 15 ans d'inventaires. MNHN Museum National d'Histoire Naturelle, Conference Papers : Les Invertébrés dans la conservation et la gestion des espaces naturels, Toulouse, France. Patrimoines naturels, 76: 183–186. ISBN 978-2-85653-795-4.

Vicariotto M., 2025 : *Cucujus cinnaberinus* [online observation]. iNaturalist. Available at: https://www.inaturalist.org/observations/266284387 (accessed 18 February 2026).

Vignon V., 2008: Comparing size of *Osmoderma eremita* populations and habitat quality in different french localities: conservation perspectives. Revue d'Écologie Sup,10: 123–129.

Vignon V., 2015: Parts of the life history of *Osmoderma eremita*'s metapopulations in two study areas in the West of France (Coleoptera, Cetoniidae). Mitteilungen der schweizerischen entomologischen gesellschaft – Bulletin de la société entomologique suisse, 88: 39–48. https://doi.org/10.5169/SEALS-514992

Table S1: Summary of study areas, sampling design and sampling effort for the three saproxylic beetle species investigated in this study.

Species	Study area	Area / Sites	Objective	Sampling period	Sampling effort	Monitoring type
Osmoderma eremita	Castelfeder	1 site (108 ha)	Population estimation	5 July – 4 Aug 2023	10 BCWT traps; 12 control rounds; 2–3 checks/week	Intensive monitoring (mark–recapture)
Osmoderma eremita	Bressanone/ Brixen area	9 chestnut sites	Presence verification	26 June – 12 Aug 2024	5 BCWT traps (1 per site); relocated after ≥15 days; checks every 2–3 days	Presence search
Osmoderma eremita	Bressanone/ Brixen area	5 chestnut sites	Presence verification	23 June – 8 Aug 2025	5 BCWT traps (1 per site); checks every 2–3 days	Presence search
Cerambyx cerdo	Castelfeder	1 site (108 ha)	Population estimation	26 May – 6 July 2023	10 baited traps; 3–4 checks/week; 20 control rounds; VES transect (1766 m)	Intensive monitoring (mark–recapture)
Cerambyx cerdo	Castelbello/ Kastelbell	1 site	Presence verification	6 and 17 June 2024; 29 May – 11 June 2025	4 field visits (incl. 1 light trap)	Presence search
Cerambyx cerdo	Province of Bolzano–South Tyrol	Province-wide	Data collection through public reporting	2024–2025	Online call for observations; expert validation of submitted photographs	Citizen science
Rosalia alpina	Caldaro/ Kaltern (Mendola woodland)	9 log stations + 3000 m² patch	Population estimation	13 June – 13 Aug 2025	18 survey days; weekly checks	Intensive monitoring (mark–recapture)

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New breeding evidence of Zitting Cisticola *Cisticola juncidis* in South Tyrol after 1970/1980s

Abstract

Cisticola juncidis was considered extinct in Trentino-South Tyrol since 1980, but recent records indicate that the species is recolonizing the region. Initial detections were made during standardized monitoring programs conducted by local research institutes, followed by additional observations reported through citizen science platforms. Confirmed reproduction over two consecutive years suggests a potential expansion of the species within the region. Most observations occurred inside protected areas where open habitats are maintained through extensive management practices. These findings underline the importance of protected areas providing crucial habitats in an intensively managed agricultural landscape and highlight the effectiveness of combining citizen science data with standardized monitoring for tracking species distribution shifts and detecting new occurrences or for tracking restricted populations.

Keywords: Citizen science, standardized survey, range expansion, protected areas.

Introduction

The Zitting Cisticola *Cisticola juncidis* is the only European representative of the genus *Cisticola* and currently comprises 18 recognized subspecies (Ryan 2020). It occupies a vast distribution range from the Mediterranean region to Southern Africa, South and Southeastern Asia, and Northern Australia. In the 19th century, the species was restricted to the Mediterranean region. Since the early 20th century, it has expanded northward, mainly due to relatively mild winters (Németh & Cs 2008; Maumary et al. 2021; Schulz & Günther 2024). It is generally resident throughout its entire range, and in Europe, it occasionally expands into new territories during irruptive movements. However, its distribution is limited by harsh temperatures, and it tends to disappear from new areas after severe winters (Bensusan 2008; Lardelli 2022) resulting in highly fluctuating population trends in Europe (Škorpilová et al. 2025).

Associated with open habitats such as grasslands (i.e. meadows and pastures) or extensive crop fields, the Zitting Cisticola primarily requires tall and dense herbaceous covering, as its nest is built from intertwined grass stems. It prefers to build nests near waterbodies or within wetlands using plants such as *Juncus* and *Phragmites*. The species can also inhabit drier environments where it utilizes various species of *Poaceae* to build its nest (Ryan 2020).

In Italy, the Zitting Cisticola is widely distributed, and its population showed an increasing trend between 2000 and 2011 (Silva & Rossi 2011). The species is currently classified as Least Concern (LC) at both national and global levels (BirdLife International 2017; Gustin et al. 2021), and is cited in annex II of EU Birds directive (2009/147/EC). The northern part of its distribution in Italy is mostly limited by the Alps (Figure 1).

Based on available data, the species is currently considered extinct in South Tyrol as a breeding species, with no confirmed nesting records since the 1970s–1980s (Unterholzner 2018; Ceresa & Kranebitter 2020). However, recent sightings reported both in

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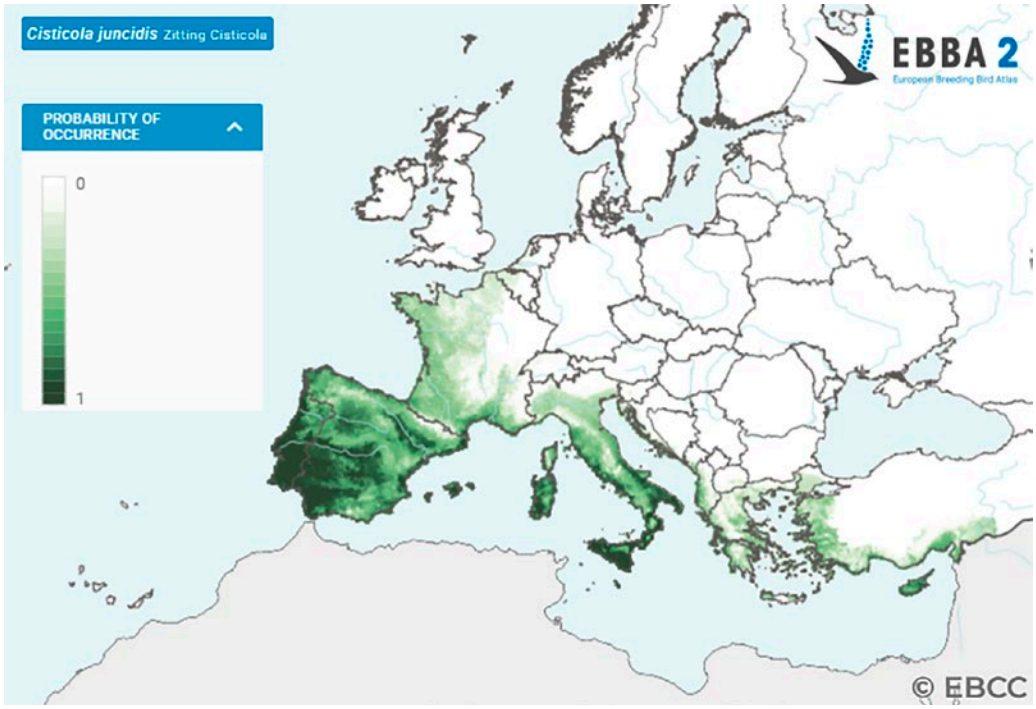


Figure 1: *Cisticola juncidis*: distribution in Europe (EBCC 2022).

Citizen Science platforms and during standardized bird monitoring schemes suggest that the species may be recolonizing the province, with confirmed nesting.

Methods

As a part of the long-term Biodiversity Monitoring of South-Tyrol (BMS) carried out by Eurac research since 2019 (Hilpold et al. 2023), standardized bird monitoring was conducted within the province using point counts and integrated in 2024 by passive acoustic monitoring. In total, 64 different points are sampled every year using AudioMoth 1.2.0 recorders from Open Acoustic Devices (Hill et al. 2019) which are usually deployed during the breeding season (mid-April to mid-July). Each recorder is active for two periods of four hours per day: one starting one hour before sunrise and one starting three hours before sunset (Scanferla et al. 2025). Each point is also sampled three times during the same period by a professional ornithologist counting every bird heard or seen for 10 minutes within the three hours following sunrise (Hilpold et al. 2023).

A further bird monitoring scheme in South Tyrol is focused on the breeding species listed in the Annex I of the Birds Directive (2009/47/EC) and other species of particular conservation interest and is conducted by the Museum of Nature South Tyrol and the Autonomous Province of Bolzano/Bozen since 2023 (2022 for farmland birds). This scheme includes a detailed monitoring scheme of meadow and shrubland birds, using a high number of point counts (N = 240) and territory mapping designed especially for rare species (Ceresa et al. 2025). The main wetlands within the province are also regularly surveyed applying the same scheme and period.

The data from citizen science were derived from Ornitho.it (Ornitho.it 2025) and iNaturalist (iNaturalist 2025), two platforms increasingly used in South Tyrol (Guariento et al. 2019), and eBird (eBird 2025) which is widely used worldwide (Sullivan et al. 2009). Sightings of the Zitting Cisticola were extracted from all available records since the creation of the different platforms across the region Trentino-South Tyrol.

Results

Since the last documented reproduction in the 1980's (Unterholzner 2018), different individuals of Zitting Cisticola were observed in several sites across the region (Table 1; Figure 2). An individual was caught during a ringing session in April 1996 in Foci dell'Avisio (Adige valley) (Pedrini et al. 2005). The next sighting occurred in September 2000 within a bog in the Biotopo Lake Caldaro without reporting an atlas code. Moreover, in 2023, two singing males were recorded: one at Biotopo Lake Caldaro in July (atlas code reported 3) and another in the meadows near Monguelfo (Pusteria valley) in June (atlas code reported 3), during the meadow/shrubland bird monitoring conducted by the Museum of Nature South Tyrol. In 2024, citizen science platforms reported 28 sightings (Figure 3), all from the Lake Caldaro area, including observations of fledglings (atlas code reported 13) in August. The other sightings reported an atlas code 2 for individuals found in suitable habitat (n=4) and atlas code 3 for a singing male spotted (n=9). In 2025, a total of 31 observations were documented through both standardized monitoring projects and citizen science contributions (Figure 4). In this year, the species was detected not only at the Biotopo Lake Caldaro but also at three additional sites in Trentino: La Rocchetta (maximum atlas code reported 3), Foci dell'Avisio (no atlas code reported) and Torbiera delle Viote (maximum atlas code reported 3). Fledglings were again observed in the southern part of Lake Caldaro during the Biodiversity Monitoring South Tyrol long-term project, indicating a second consecutive successful breeding event for the species in the same area.

Table 1: Description of the sites where the Zitting Cisticola was observed within Trentino-South Tyrol.

Name	Protection status	Surface (ha)	Description
Lake Caldaro	Protected: ("Biotopo")	241	A mosaic of reed beds, wet meadows, and patches of colonizing woodland and shrubs.
La Rocchetta	Protected: ("Biotopo")	89	Humid grasslands with dense herbaceous cover along the Noce stream.
Foci dell'Avisio	Protected: ("Biotopo")	100	Grasslands and marshes distributed along the meanders of the Avisio stream.
Torbiera delle Viote	Protected: ("Biotopo")	24	High-altitude peatland composed of bogs, fens, and wet meadows.
Monguelfo meadows	None	62	Agricultural areas dominated by wide meadows.

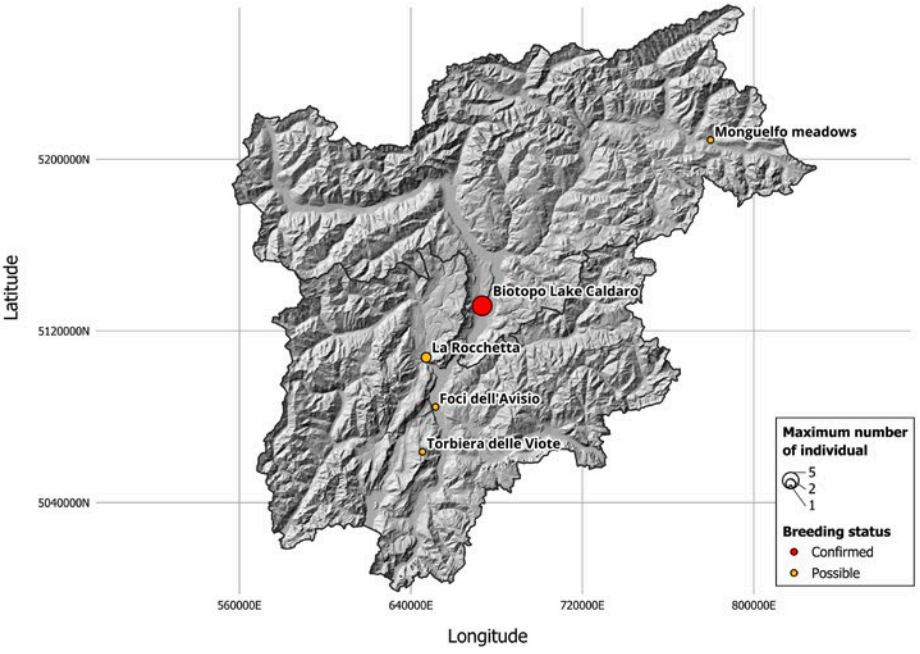


Figure 2: Zitting Cisticola sightings within Trentino-South Tyrol from citizen science platforms and monitoring projects from local research institutes.



Figure 3: Individual of *Cisticola juncidis*, taken on 14 June near the Biotopo Lake Caldaro (Photo: R. Maistri).

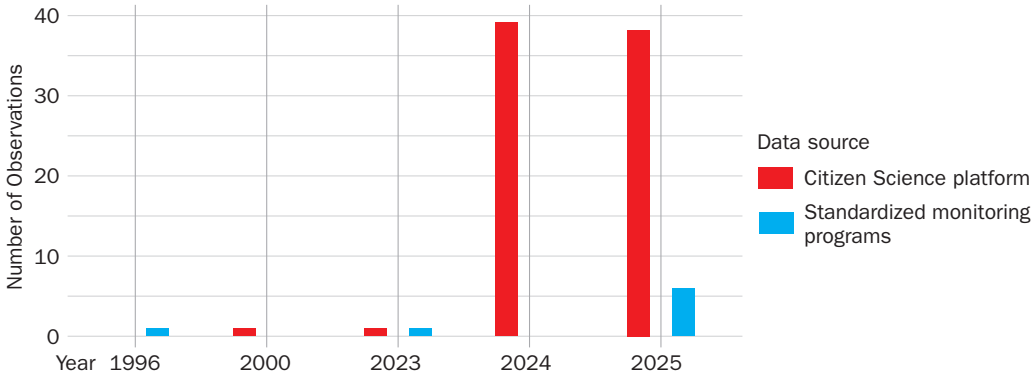


Figure 4: Annual number of Zitting Cisticola records in Trentino-Alto Adige submitted to Citizen Science platforms or observed through standardized monitoring projects since 1980.

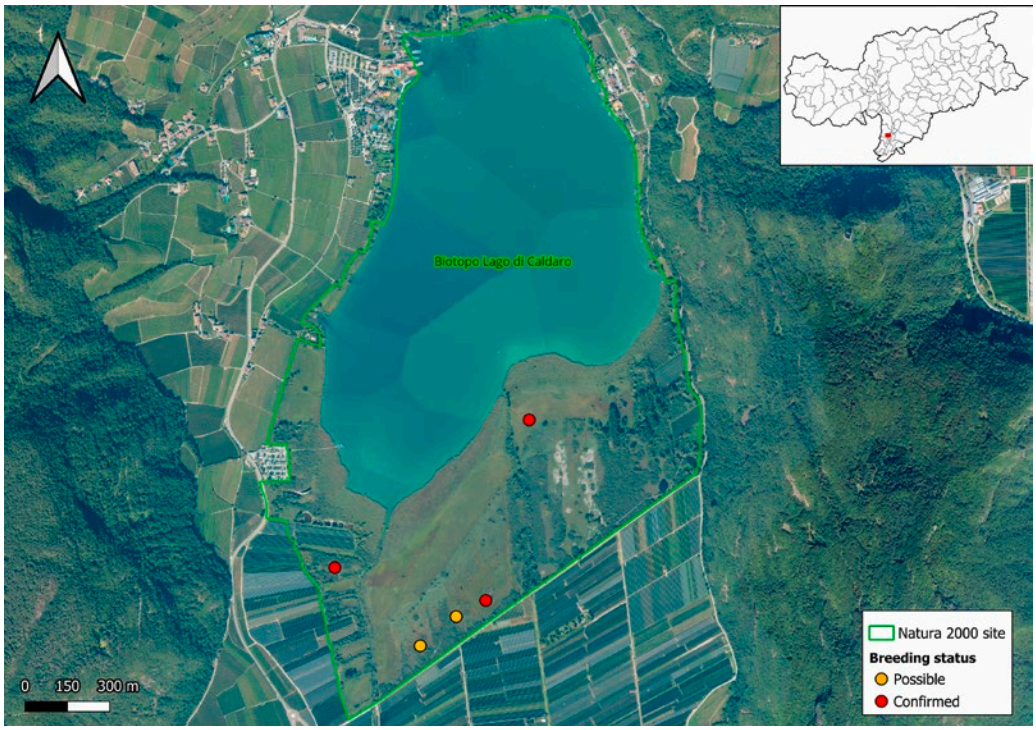


Figure 5: Zitting Cisticola sightings in Biotopo Lake Caldaro in South Tyrol since 1980.

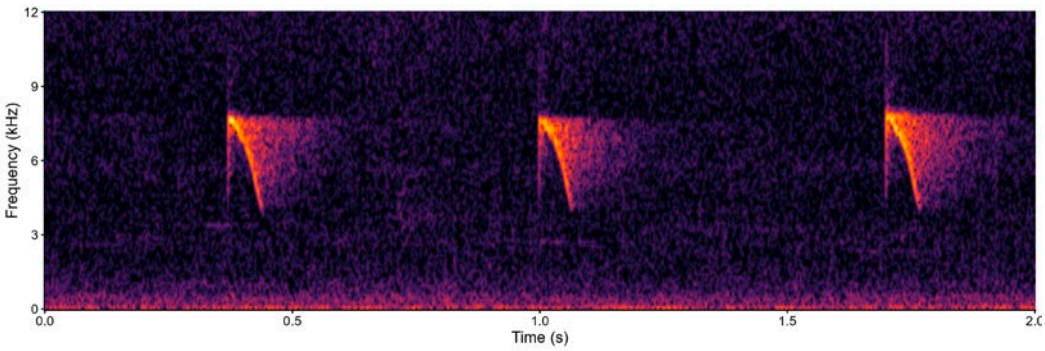


Figure 6: Example of the song of *Cisticola juncidis*, recorded on July 18, 2025, at 6:30 a.m. near the Biotopo Lake Caldaro.

Within the suitable habitats in the southern part of Lake Caldaro, Zitting Cisticola was observed at multiple sites. Juveniles were recorded in both 2024 and 2025. In 2024, a juvenile was observed being fed by an adult in July, followed by sightings of three molting juveniles in August, located approximately 300 meters apart (observed by R. Maistri). In 2025, three juveniles were observed in a different section of the wetland, near the BMS sampling site (Figure 5).

Overall, the species was observed in Trentino-South Tyrol from June to September. The first singing male recorded by means of recording device was in the evening of the 1st of June 2025 (Figure 6). From that date until August 27th, the species was detected by the recording device almost daily.

Discussion

Joint survey efforts by citizens and local research institutes provided new insights on the Zitting Cisticola status in the Trentino-South Tyrol region. It was assessed that the species successfully bred at the Biotopo Lake Caldaro for two consecutive years, possibly involving several breeding pairs. This represents the northernmost confirmed breeding site in Italy. Additional singing males were recorded in other suitable areas across the region indicating potential further breeding events in the near future, a situation that must be kept under observation. These findings suggest a possible settlement of a local breeding population in the region.

If the species breeds in the region, its year-round resident status remains unconfirmed. All sightings occurred between June and September, with the first singing male recorded on the 1st of June whereas in the northern part of its range, the Zitting Cisticola typically begins singing in March (Faune-France 2025). This temporal shift suggests that the species is absent in the region in winter and returns in late spring possibly undertaking short-distance migrations to overwinter in more southern areas, such as the Po valley or the Adriatic coast. However, given its discreet and cryptic behavior outside the breeding season, the area will be intensively monitored during the next winters to clarify its status. Bird ringing sessions at Lake Caldaro, scheduled between December and March in collaboration with several organizations, may help determine whether the species overwinters in the area. These sessions are part of the MonITRing project coordinated by ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) which focuses on constant-effort monitoring of Italian birdlife.

The species' range is known to be expanding northwards in other parts of Europe due to milder winters related to climate change (Németh & Cs 2008; Maumary et al. 2021; Schulz & Günther 2024).Therefore, the rising temperatures observed in our province (Schlögel et al. 2020; Dumont et al. 2025) could be a facilitating factor for the recolonization of this species sensitive to winters severity. Its return to the area may also have been favored by the presence of protected areas. Indeed, the species was almost exclusively observed in legally protected areas of high ecological value called Biotopi (Provincia Autonoma di Trento 2007; Provincia Autonoma di Bolzano 2018). These areas

mostly consist of open habitats maintained through late mowing or extensive grazing, and public access is limited (European Commission 2001; European Environment Agency 2025a, 2025b). Such conditions not only minimize disturbances but also match the ecological requirements of the Zitting Cisticola. This highlights the importance of those protected lowland wetlands and grasslands, especially under rapidly changing climate, that constitute a rare habitat in the region where open landscapes are dominated by vineyards or apple orchards directly and indirectly impacting the bird species (Anderle et al. 2025). However, although they represent crucial refuges for many species, Brambilla et al. (2020) showed that these lowland protected areas in Trentino are not sufficiently interconnected and that their management is not adapted to the most specialized species, which showed strong declines in the last decades (e.g., Reed bunting *Emberiza shoeniclus* and Great reed warbler *Acrocephalus arundinaceus*) (Franzoi et al. 2024). The same scenario is very likely to occur also in South Tyrol, given the decline and the critical conservation status of the same species (Ceresa & Kranebitter 2020). The recolonization by a species with relatively broad ecological requirements, such as the Zitting Cisticola (see Ryan 2020), further supports this pattern of positive outcomes for generalist species within the network of protected lowland areas in Trentino-South Tyrol, while for more specialized species there remains a need to develop and implement more targeted and effective habitat management strategies. Despite the current availability of potentially suitable habitat, this newly established Zitting Cisticola population can be threatened by exceptionally cold temperatures (Bensusan 2008; Lardelli et al. 2022) and the loss of open habitats due to the progressive encroachment observed within the Biotopo Lake Caldaro (European Environment Agency 2025a).

Like in other regions, citizen science data uploaded to different platforms (e.g., Ornitho, iNaturalist, and eBird) are increasing (Guariento et al. 2019) and have already enabled the discovery of new species colonizing the region (Guariento et al. 2021). Despite this growth, the activity of citizen scientists is mostly concentrated in species rich hotspots (Callaghan et al. 2022) in highly accessible, low-elevation areas such as the Lake Caldaro (European Commission 2001; Anderle et al. 2022), while remote and difficult to access areas are scarcely visited. Thus, despite the strong growth of citizen science platforms, rigorously standardized monitoring schemes remain indispensable. Not only to obtain reliable estimations of species' trends and population sizes, but also to properly describe species' distributions in scarcely accessible areas, through representative and balanced sampling designs.

The specific case reported in this study confirms the importance of combining citizen science data and standardized monitoring projects to enable more fine-scale, accurate, and responsive tracking of species distribution changes, new species occurrence or monitoring small and isolated populations. This data is crucial for adapting management plans in protected areas, implementing new conservation measures, and improving our understanding of large-scale changes in animal communities (Guariento et al. 2019). Therefore, additional surveys will be conducted over the coming years to monitor the development of the breeding population of the Zitting Cisticola in Trentino-South Tyrol. This will allow us to assess whether the management plans for protected areas enable the species to establish in the longer term, although targeted monitoring of specialist species remains essential to evaluate their effectiveness.

References

Anderle M., Ceresa F., Hilpold A., Marsoner T., Roilo S., Scanferla J., Dellavedova R., Tappeiner U. & Brambilla M., 2025: Direct and indirect ecological drivers of bird communities in intensively cultivated landscapes. Journal of Environmental Management, 393: 127169.

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.

Bensusan K., 2008: The impact of a cold spell on populations of Sardinian Warblers *Sylvia melanocephala* and Zitting Cisticolas *Cisticola juncidis* at Windmill Hill Flats, Gibraltar. Bird Report, 47.

BirdLife International, 2017: *Cisticola juncidis*. The IUCN Red List of Threatened Species. https://doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22713491A111070621.en [accessed on 21.11.2025]

Brambilla M., Rizzolli F., Franzoi A., Caldonazzi M., Zanghellini S. & Pedrini P., 2020: A network of small protected areas favoured generalist but not specialized wetland birds in a 30-year period. Biological Conservation, 248: 108699. https://doi.org/10.1016/j.biocon.2020.108699.

Callaghan C. T., Bowler D. E., Blowes S. A., Chase J. M., Lyons M. B. & Pereira H. M., 2022: Quantifying effort needed to estimate species diversity from citizen science data. Ecosphere, 13(4): e3966.

Ceresa F. & Kranebitter P., 2020: Lista Rossa 2020 degli uccelli nidificanti in Alto Adige. Gredleriana, 20: 57–70.

Ceresa F., Ligazzolo G., Mulser J., Hilpold L. & Kranebitter P., 2025: Developing a standardized monitoring scheme of the Annex I Birds Directive species breeding in South Tyrol: methods and first results. In Mair et al. (eds.), Proceedings of the Euregio Biodiversity Research Conference (EUBIRECO) 2024, Tyrol-South Tyrol-Trentino, November 22–23, 2024, Bolzano, Italy. Gredleriana, 25: 13–16. https://doi.org/10.5281/zenodo.17190891

Dumont M., Monteiro D., Filhol S., Gascoin S., Marty C., Hagenmuller P., Morin S., Choler P. & Thuiller W., 2025: The European Alps in a changing climate: physical trends and impacts. Comptes Rendus. Géoscience, 357(G1): 25–42.

EBCC, 2022: European Breeding Bird Atlas 2 website. European Bird Census Council. https://ebba2.info/maps/ [accessed on 21.11.2025]

eBird, 2025: eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. http://www.ebird.org [accessed on 18.11.2025]

European Commission, 2001: Lake Caldaro – an oasis for migratory birds in the heart of the Alps. *LIFE Public Database*. https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE98-NAT-IT-005032/lake-caldaro-an-oasis-for-migratory-birds-in-the-heart-of-the-alps [accessed on 21.11.2025]

European Environment Agency, 2025a: Natura 2000 Standard Data Form: IT3110034 – Biotopo Lago di Caldaro. https://eunis.eea.europa.eu/sites/IT3110034 [accessed on 08.10.2025]

European Environment Agency, 2025b: Natura 2000 Standard Data Form: IT3120061 – La Rocchetta. https://natura2000.eea.europa.eu/Natura2000/sdf/#/sdf?site=IT3120061&release=55 [accessed on 15.10.2025]

Faune-France, 2025. Faune-France. https://www.faune-france.org/ [accessed on 05.11.2025]

Franzoi A., Pedrini P., Marchesi L., Micheli A., Nicolodi S., Osele E., Rizzolli F., Segata M., Speranza G., Uber L. & Brambilla M., 2024: L'avifauna nidificante delle zone umide protette della Rete Natura 2000 del Trentino: andamento e stato di conservazione delle popolazioni. Studi Trentini di Scienze Naturali, 104: 83–96.

Guariento E., Anderle M., Colla F. & Steinwandter M., 2019: Citizen Science for biological data in the Tyrol–South Tyrol–Trentino Euroregion: Comparing options and a call for participation. Gredleriana, 19: 77–86.

Guariento E., Anderle M. & Paniccia C., 2021: *Hystrix cristata* (Mammalia: Rodentia: Hystricidae) newly recorded in South Tyrol (Italy) at its current northernmost distribution limit. Gredleriana, 21: 187–191.

Gustin M., Brichetti P., Nardelli R., Battistoni A., Rondinini C., & Teofili C., 2021: Lista rossa degli uccelli nidicanti in Italia. https://www.iucn.it/pdf/Lista_Rossa_Uccelli_nidificanti_Italia_2021.pdf

Hill A. P., Prince P., Snaddon J. L., Doncaster C. P. & Rogers A., 2019: AudioMoth: A low-cost acoustic device for monitoring biodiversity and the environment. HardwareX, 6: e00073. https://doi.org/10.1016/j.ohx.2019.e00073

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.

iNaturalist, 2024: iNaturalist. California Academy of Sciences and National Geographic Society. https://www.inaturalist.org [accessed on 18.11.2025]

Lardelli R., Bogliani G., Brichetti P., Caprio E., Celada C., Conca G., Fraticelli F., Gustin M., Janni O., Pedrini P. & others, 2022: Atlante degli uccelli nidificanti in Italia. Edizioni Belvedere.

Maumary L., Epars O., Fivat J.-M., Luisier C. & Revaz E., 2021: Nidifications de la Cisticole des joncs *Cisticola juncidis* dans le Chablais (Vaud & Valais, Suisse) en 2019 et 2020. Nos Oiseaux, 68(1).

Németh Á. & Cs V., 2008: First record of the Zitting Cisticola (*Cisticola juncidis* Rafinesque, 1810) in Hungary. Opusc. Zool. Budapest, 2006 (2008), 37: 89–90.

Ornitho.it, 2025: Ornitho.it. https://www.ornitho.it [accessed on 11.11.2025]

Provincia Autonoma di Bolzano, 2018: Legge Provinciale 10 luglio 2018, n. 9: Territorio e paesaggio. https://lexbrowser.provincia.bz.it/doc/it/212899/legge_provinciale_10_luglio_2018_n._9.aspx [accessed on 07.01.2026]

Provincia Autonoma di Trento, 2007: Legge Provinciale 23 maggio 2007, n. 11: Legge provinciale sulle foreste e sulla protezione della natura. https://www.consiglio.provincia.tn.it/leggi-e-archivi/codice-provinciale/Pages/legge.aspx?uid=16530 [accessed on 10.03.2026]

Pedrini P., Caldonazzi M. & Zanghellini S. (a cura di), 2005: Atlante degli uccelli nidificanti e svernanti in provincia di Trento. Museo Tridentino di Scienze Naturali, Trento. Studi Trentini di Scienze Naturali, Acta Biologica, 80 (2003) suppl. 2: 692 pp.

Ryan P., 2020: Zitting Cisticola (*Cisticola juncidis*). In del Hoyo et al. (Eds.), Birds of the World. Cornell Lab of Ornithology. https://doi.org/10.2173/bow.zitcis1.01

Scanferla J., Brambilla M., Brambilla G., Hilpold A., Marchetti A. E., Puff F., Tappeiner U. & Anderle M., 2025: Determining species-specific thresholds to improve precision in passive acoustic monitoring. Ecological Informatics, 103423. https://doi.org/10.1016/j.ecoinf.2025.103423

Schlögel R., Kofler C., Gariano S. L., Van Campenhout J. & Plummer S., 2020: Changes in climate patterns and their association to natural hazard distribution in South Tyrol (Eastern Italian Alps). Scientific Reports, 10(1): 5022.

Schulz M., & Günther A., 2024: Erster Nachweis des Zistensängers *Cisticola juncidis* in Sachsen. Mitt. Ver. Sächs. Ornithol., 12: 617–621.

Silva L. & Rossi P., 2011: Uccelli comuni in Italia. Aggiornamento degli andamenti di popolazione e del Farmland Bird Index al 2011. https://doi.org/10.13140/RG.2.2.24759.04005

Škorpilová J., Šilarová E., Klvaňová A., Doležalová I., Wagtail G. & Mikulka Š., 2025: The State of Europe's Wild Birds 2025. CSO.

Sullivan B. L., Wood C. L., Iliff M. J., Bonney R. E., Fink D., & Kelling S., 2009: eBird: A citizen-based bird observation network in the biological sciences. Biological Conservation, 142(10): 2282–2292.

Unterholzner L., 2018: Atlante degli uccelli nidificanti dell'Alto Adige, 2010–2015. Arbeitsgemeinschaft für Vogelkunde und Vogelschutz-Südtirol. www.vogelschutz-suedtirol.it

GREDLERIANA (Naturmuseum Südtirol, Bozen)

Richtlinien für Autorinnen und Autoren (Jänner 2022)

Inhalt: Originalarbeiten aus den Bereichen Zoologie, Botanik und Mykologie, möglichst mit Bezug zu Südtirol. Bevorzugt werden Arbeiten zu Faunistik und Floristik, Biogeografie, Systematik, (Aut)Ökologie und Vegetationskunde.

Sprache: Es werden Arbeiten in deutscher, italienischer und englischer Sprache angenommen. Im Falle eines deutschen oder italienischen Textes sind eine englische Zusammenfassung und zusätzlich englische Legenden bei Abbildungen und Tabellen erforderlich (vgl. auch die Punkte Abstract und Legenden unten).

Formale Anforderungen:
• Das Manuskript sollte einen dem Thema angemessenen Umfang haben, aber 30 Seiten nicht überschreiten. Bei größeren Arbeiten, z. B. bei solchen mit monografischem Charakter, ist Rücksprache mit der Redaktion erforderlich.

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• Sind im Titel Arten erwähnt, sollten die höheren Taxa (Klasse, Familie) dort auch angeführt werden, insbesondere bei taxonomischen oder floristisch-faunistischen Arbeiten sowie im Falle wenig bekannter Arten.

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• Keywords: Sind im Anschluss an das Abstract zu stellen und in englischer Sprache zu verfassen. Empfohlen werden maximal 6 Keywords. Es sollten keine Wörter verwendet werden, die bereits im Titel aufscheinen.

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Baroni-Urbani C., 1971: Catalogo delle specie di Formicidae d'Italia. Mem. Soc. ent. ital., 50: 1–287.

Gerardi R. & Zanetti A., 1995: Coleotteri Stafilinidi ripicoli della Val di Ronchi (Trentino meridionale) (Coleoptera: Staphylinidae). Studi Trentini di Scienze Naturali - Acta Biologica, 70 (1993): 139–156.

Handel-Mazzetti H., 1943: Zur floristischen Erforschung des ehemaligen Landes Tirol und Vorarlberg. Ber. Bayer. Bot. Ges., 26: 56–80.

Festi F. & Prosser F., 2000: La flora del Parco Naturale Paneveggio Pale di S. Martino. Atlante corologico e repertorio delle segnalazioni. Supplemento agli Annali Museo Civico di Rovereto, 13 (1997).

Fischer M. A., Adler W. & Oswald K., 2008: Exkursionsflora für Österreich, Liechtenstein und Südtirol. 3. Aufl. der „Exkursionsflora von Österreich". Biologiezentrum der Oberösterreichischen Landesmuseen, Linz.

Wildi O. & Orloci L., 1990: MULVA 5. Numerical Exploration of Community Patterns. SPB Academic Publishing, Den Haag, 171 pp.

Conert H. J., 1983: Eragrostoideae. In: Hegi, Illustrierte Flora von Mitteleuropa, Bd. 1, Teil 3, 3. Aufl. Parey, Berlin.

Grabherr G., Greimler J. & Mucina L., 1993: Seslerietea albicantis. In: Grabherr G. & Mucina L. (eds.), Die Pflanzengesellschaften Österreichs. Teil II. Fischer, Jena, Stuttgart, New York: 402–446.

CABI, 2018: *Centaurea macrocephala*. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc [abgerufen am 10.4.2020].

Calflora, 2014-: Calflora: Information on California plants for education, research and conservation, Berkeley, California: The Calflora Database: https://www.calflora.org/ [abgerufen am 25.6.2019].

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GREDLERIANA (Museo di Scienze Naturali dell'Alto Adige, Bolzano)

Linee guida per gli autori (gennaio 2022)

Contenuti: Contributi originali nell'ambito della zoologia, botanica e micologia, preferibilmente riferiti all'Alto Adige. Si darà preferenza a lavori di faunistica, floristica, biogeografia, sistematica, (auto)ecologia e fitosociologia.

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CABI, 2018: *Centaurea macrocephala*. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc [consultato il 10.4.2020].

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Content: Original papers in the fields of zoology, botany and mycology, preferably with reference to South Tyrol. Preference will be given to papers on faunistics and floristics, biogeography, systematics, (aut)ecology and vegetation science.

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Handel-Mazzetti H., 1943: Zur floristischen Erforschung des ehemaligen Landes Tirol und Vorarlberg. Ber. Bayer. Bot. Ges., 26: 56–80.

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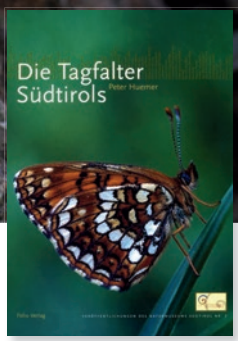
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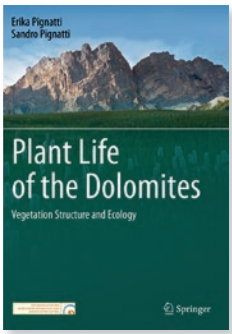
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Inhaltsverzeichnis / Indice

Dallinger R. & Kirchmair M.: *Gastrosporium simplex*. Ein pannonischer Steppenpilz aus dem Nordtiroler Karwendel-Gebirge 5

Schaub F., Zeni T. & Schönswetter P.: Morphological and elevational differentiation between diploid and tetraploid cytotypes of the *Lotus corniculatus* aggregate (Fabaceae) along three elevational transects in the Vinschgau/Val Venosta valley 13

Iberl K., Kirschner P., Koç A., Hasáková T., Wellstein C. & Štenc J.: Camera-based monitoring of floralvisitors on vertical rock faces: A pilot study in the Eastern Alpine endemic *Physoplexis comosa* (Campanulaceae) 25

Wilhalm T. & Spögler E. (eds.): Notulae Florae austrotiroliensis (3) 33

Repetto E., Soldovieri N., Rocca F., Hilpold A. & Guariento E.: New species for the orthopteran fauna of South Tyrol (Prov. Bolzano, Italy): *Poecilimon ornatus* (Schmidt, 1850) and new observation of *Bicolorana bicolor* (Philippi, 1830) (Insecta, Orthoptera) 59

Repetto E., Battiston R., Tormen N., Guariento E. & Hilpold A.: Proceedings of the First Italian Congress of Orthopterology 67

Hilpold A., Rabitsch W., Friess T., Marsy A. & Guariento E.: New species for the true bug fauna of South Tyrol (Prov. Bolzano, Italy): *Aelia klugii*, *Alydus rupestris*, *Corythucha arcuata*, *Deraeocoris flavilinea*, *Holcogaster fibulata* and *Nagusta goedelii* (Insecta, Heteroptera) 93

Marsy A. A. N., Guariento E., Ligazzolo G., Dallmöller S. S., Repetto E., von Mörl G. & Hilpold A.: Monitoring of three protected saproxylic beetles (*Cerambyx cerdo, Osmoderma eremita, Rosalia alpina*) in South Tyrol: Population status and habitat management 101

Requena E., Ceresa F., Franzoi A., Maistri R., Scanferla J. & Anderle M.: New breeding evidence of Zitting Cisticola *Cisticola juncidis* in South Tyrol after 1970/1980s 121

Richtlinien für Autorinnen und Autoren 129

Linee guida per gli autori 133

Guidelines for authors 137

Veröffentlichungen des Naturmuseums Südtirol 141

Verantwortlicher Leiter / Direttore responsabile: David Gruber
Autorizzazione della Cancelleria del Tribunale di Bolzano N. 25/2001,
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