Research Article

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(Re)discovery of four annual vascular plant species in dry grasslands in the Southwestern Alps (NW Italy)

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Abstract: The Eurasian Dry Grassland Group (EDGG) has developed a rigorous sampling methodology aimed at comprehensively documenting plant diversity across non-forest habitats in the Palaearctic realm. During the 18th EDGG Field Workshop devoted to the dry grasslands in the Southwestern Alps, three annual vascular plant species not observed in the Aosta Valley for over one century were rediscovered: *Bupleurum baldense*, *Hypochaeris glabra*, and *Trifolium dubium*. Moreover, the annual grass species *Brachypodium distachyon* was recorded for the first time from the Piedmont Region in the Susa valley. We provide here details on the identification and distribution of these four species, along with some environmental features of the discovery sites. Our findings do not only enrich the regional flora but also underscore the importance of historical records and accurate floristic exploration for biodiversity assessment.

Keywords: Aosta Valley; *Brachypodium distachyon*; *Bupleurum baldense*; *Hypochaeris glabra*; inneralpine dry valley; Italy; new record; Piedmont; regional flora; *Trifolium dubium*.

Nomenclature: Bartolucci et al. (2024) for vascular plants; Nimis et al. (2018) for lichens; Mucina et al. (2016) for syntaxa.

Abbreviations: EDGG = Eurasian Dry Grassland Group.

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Introduction

The Eurasian Dry Grassland Group (EDGG) has developed a thorough sampling methodology to ensure high-quality data collection on plant diversity from non-forest habitats across the Palaearctic realm. This approach includes precisely delimited plots, standardized plot sizes, and meticulous sampling techniques that pay equal attention to vascular plants, terricolous bryophytes, and lichens, alongside measurements of a range of environmental variables (Dengler et al. 2016).

Such accurate exploration often leads to significant discoveries, including new regional or national records (Dengler & Boch 2007; Moysiyenko et al. 2022; Boch et al. 2024; Dengler et al. 2024), and even species new to science (Khodosovtsev et al. 2024). This highlights the critical importance of comprehensive floristic exploration for biodiversity assessment, which is essential for conservation efforts and advancing our understanding of ecological communities.

During sampling of semi-natural grasslands with the EDGG methodology in the Southwestern Alps (Abdulhak et al. 2024), an annual grass not recorded for the Piedmont region before was found in the Susa valley. Moreover, three annual species not observed in Aosta Valley for over a century and thus requiring confirmation for the regional flora, were rediscovered. We thus provide here a detailed overview of the species identification, their overall distribution and some environmental features of the discovery sites.

Methods

The 18t^{h} EDGG Field Workshop took place in the inner-alpine dry valleys of the Southwestern Alps, from June 1st to 11th 2024 (Abdulhak et al. 2024). This research expedition focused on three valleys with a continental climate: Aosta and Susa in Italy, and Durance in France. In total, 43 nested plots (nested-plot series of 0.0001–100 m², see Dengler et al. 2016) and 155 single plots, 10 m² each, were sampled, resulting in 241 single 10 m² plots if the 10 m² subplots from the nested-plot series are counted. Plots were distributed across semi-natural grassland types of the three mentioned valleys, between 296 and 1880 m a.s.l., with the aim of portraying most of the variability of the dry grassland types occurring there.

Three species targeted in this floristic report were collected in the lower south-eastern reaches of Aosta Valley (NW Italy), where sub-Mediterranean species are more frequent. The fourth species was collected in the furthest downstream part of the Susa Valley (Piedmont region), on the lower slopes of Mount Musinè. The climate in the studied area is typical of the inner valleys of the Alps, with annual precipitation ranging from 460 to 700 mm (Mercalli 2003).

The collected specimens were examined using a stereomicroscope, identified with the Flora of Italy (Pignatti et al. 2017–2019), pressed, dried, and deposited at the Herbarium AO or at the Herbarium TO (all herbarium codes mentioned here refer to Thiers 2022+). Information on regional historical records of the re-discovered species proceeds from the Vascular Flora of Valle d'Aosta (Bovio 2018+).

Results

Brachypodium distachyon (L.) P.Beauv. was sampled in the plot SDA01x on 2 June 2024. This plot was located in the municipality of Almese, on the south-facing slope of Mount Musinè (45.10392° N, 7.44489° E). It grew in a xeric grassland at 420 m a.s.l. (Fig. 1). Based on a preliminary phytosociological classification, the stand belonged to the *Diplachnion serotinae*. The herb layer covered 67% and the cryptogam layer 6%. The total plant species richness in 100 m^2 was 26 (23 vascular plants, 2 bryophytes and 1 lichen). The most dominant species were *Heteropogon contortus* (36.5%), *Chrysopogon gryllus* (19%), *Thymus oenipontanus* (5.5%), *Fumana procumbens* (3.8%), *Cleistogenes serotina* (3.5%) in the herb layer, and *Weissia sp.* (6.5%) in the cryptogam layer.

Brachypodium distachyon, a new model plant for functional genomics of grasses and monocots (Garvin et al. 2008; Catalán et al. 2012), has a native distribution range from the Mediterranean basin to Central Asia. The species has also been introduced to Central Europe, North and South America, Australia and South Africa. It grows across a broad range of elevations, from the sea level to about 2000 m a.s.l. (Garvin et al. 2008; Catalán et al. 2012). In Europe, the species gives the name to the alliance *Trachynion distachyae* (*Stipo-Trachynietea distachyae*), distributed in the Western Mediterranean. Before the present discovery, the species was reported to occur in most of the Italian territory, except for Piedmont and Aosta Valley. Today, *Brachypodium distachyon* has been proposed as a complex of three distinct species having cytotypes of 2n = 10, 20, and 30 chromosomes (Catalán et al. 2012) and characterized by different environmental niches (López-Alvarez et al. 2015). Ecological niche models suggest that our specimen probably refers to *Brachypodium distachyon* s.str. growing in colder, wetter and higher-elevated conditions than the other taxa of the complex.

Bupleurum baldense Turra was sampled in the plot SDAR205 on 8 June 2024. This plot was located in the municipality of Montjovet (Aosta Valley), next to the south-facing walls of the Chenal Castle (45.73007° N, 7.67184° E). It grew in a xeric grassland topping a sheepback rock at 692 m a.s.l. (Fig. 2). Based on a preliminary phytosociological classification, the stand belonged to the alliance *Stipo-Poion xerophilae*. The herb layer covered 94% and the cryptogam layer 7%, and the total plant species richness in 10 m^2 was 45 (40 vascular plants, 2 bryophytes and 3 lichens). The most dominant species were *Bromopsis erecta* (27%), *Trifolium arvense* (15%); *Aira caryophyllea, Festuca* cf. *laevigata* and *Sempervivum tectorum* (all 12%) in the herb layer and *Cladonia foliacea* (3%) and C*. rangiformis* (2%) in the cryptogam layer.

Bupleurum baldense (incl. *B. veronense* Turra) is endemic to

Southern and Western Europe, ranging from Southern Britain and France to the Eastern Iberian Peninsula, Balearic Islands, Sardinia, Corsica, Italian Peninsula, Maltese Archipelago, Sicily, and Western Balkan Peninsula (Snogerup & Snogerup 2001). In Italy, it has been recorded in all regions except for Trentino-Alto Adige and Molise, from the sea level to 1500 m a.s.l. (Bartolucci et al. 2024). However, only two historical records were available from Aosta Valley, both of which repeatedly reported in recent floras as putatively disappeared from the region. The first record is an herbarium specimen collected by Charles Ferina (sine die) from Montjovet and verified and cited by Lino Vaccari (1904–1911), who also collected the species in Montjovet on the hills of Plout, a village located at about 3 km south of the site of the present note. Our finding matches also very well the location and altitude of the old herbarium sheet collected by an unknown collector and stored in AO-S.SFV (sub *Bupleurum odontites* L., Montjovet, 600 m a.s.l.), which could perhaps be the otherwise lost Ferina's specimen cited by Vaccari (Bovio 2014; 2018+).

The specimens studied by us correspond to the var. *aristatum* (Bartl.) Briq., typically found in xeric grasslands on heterogeneous, limestone-rich substrates (also on recent alluvial depositions and screes), in continental valleys of the lower mountain belt of NW Alps, where it was indicated by Braun-Blanquet (1961) as a typical taxon of the *Stipo-Poion xerophilae* (*Festucetalia valesiacae*).

Hypochaeris glabra L. and ***Trifolium dubium*** Sibth. were sampled in the plot SDAR020 on 8 June 2024. This plot was located 60 m WNW of Chenal Castle, in the municipality of Montjovet (Aosta Valley, 45.73049° N, 7.67084° E). It grew in a mesoxeric grassland at 627 m a.s.l. (Fig. 3). Based on a preliminary phytosociological classification, the stand belonged to the *Brachypodietalia pinnati*. The herb layer covered 85% and the cryptogam layer 5%, and the total plant species richness in 10 m^2 was 43 (38 vascular plants, 4 bryophytes and 1 lichen). The most dominant species were *Carex humilis* (30%), *Bromopsis erecta* (13%), *Filipendula vulgaris* (9%), and *Peucedanum oreoselinum* (6%) in the herb layer and *Weissia sp*. (4%) in the cryptogam layer.

Hypochaeris glabra has a Mediterranean-temperate distribution, encompassing Europe, North Africa, and warm-temperate western Asia. It is also widely naturalised across Australia, New Zealand, South Africa, South America and North America (Stroh 2015). In Italy, it has been recorded in all regions except for Trentino-Alto Adige and Molise, from the sea level to 1500 m a.s.l.; however, the only record of this species from Aosta Valley relates to a historical specimen stored in TO, collected by Antonio Carestia at Albard from Donnas in 1871. This occurrence was mentioned by Vaccari (1904–1911) and reported as no longer found by Bovio (2014, 2018+). Our finding is located much further into the Aosta Valley than Carestia's find, about 20 km WNW from Albard di Donnas.

Trifolium dubium is an allotetraploid native to most of Europe and the Caucasus region, resulting from the hybridization of *T. campestre* and *T. micranthum*. It has naturalised as an adventive pasture species and as a weed of wasteland and roadsides in North America and many countries of the southern hemisphere (Ansari et al. 2008). It occurs in all regions of the Italian Peninsula, between 200 and 1600 m a.s.l., but it has never been observed in Sicily and Sardinia. As for Aosta Valley, there was only historical bibliographic data, not supported by recent findings. Favre (1874) reported it below Saint-Rhémy, at 1620 m a.s.l. Vaccari (1904–1911) added the following personal observations to Favre's record: Cignai, Bard, Arnad, lower Valley of Champorcher, Valley of Cogne above Vieyes, and between Châtillon and Valtournenche. However, considering the many localities mentioned in Vaccari's Catalogue, the lack of specimens in his herbarium leads to suppose that his reports of *T. dubium* could be due to misidentified exsiccata, which were later corrected and attributed to other species. For this reason, and the lack of recent findings, Bovio (2014, 2018+) suggested that the occurrence of this species in Aosta Valley needed to be confirmed.

Discussion

The finding of *Brachypodium d*istachyon in Susa Valley and the rediscovery of *Bupleurum baldense, Hypochaeris glabra*, and *Trifolium dubium* in Aosta Valley after more than one century since the last observation emphasizes the value of comprehensive and accurate floristic surveys in semi-natural grasslands. The application of the EDGG sampling methodology, which incorporates multi-taxon approaches and standardized plot sizes, along with particularly accurate sampling, has proven instrumental in detecting these elusive species.

Interestingly, all four species are annuals, which in general have higher dispersal ability. However, the sites in which we found them were neither recently disturbed nor close to typical entry paths of (regional) neophytes, such as cities and traffic networks. Rather than a recent (re-)introduction, this suggests that the species had strived in the regions for a longer period of time and just due to their small stature and low number of individuals had been overlooked by botanists.

Our study confirms that xeric and semi-natural grasslands in the inner-alpine dry valleys are highly valuable for preserving plant species with fragmented and isolated distributions, otherwise absent or rarely found in the Alpine Region (Dengler et al. 2020). The climate uniqueness of these valleys, hosting relict populations of many plant species that reached these isolated outposts during Pleistocene climatic fluctuations, makes the continental xerothermic islands of the inner Alps a priority target for the conservation of European biodiversity. Our findings also underscore the importance of botanical collections and historical records to reconstruct the history, dynamics, and current distribution of plant species (Buldrini et al. 2023), as well as the need for continued fieldwork to integrate historical botanical records with contemporary data.

Author contributions

Most authors were involved in the field sampling of the three plots. D.V. and J.D. are coordinating the EDGG Field Workshops, M.L., A.M. and G.N. co-organized the 18th Field Workshop; R.G. planned and drafted the article, G.N. drafted the section on *Brachypodium distachyon*, all other authors revised and commented on the text.

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Figure 1. "Biodiversity Plot" SDA01x in a stand of the *Diplachnion serotinae* on Mount Musinè, Susa valley, where *Brachypodium distachyon* was recorded for the first time in the Region of Piedmont. Photo: J. Dengler.

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Figure 2. Vegetation plot SDAR205 in a stand probably belonging to the *Stipo-Poion xerophilae* at the Chenal castle, where *Bupleurum baldense* was rediscovered for the Aosta Valley. Photo: I. Biurrun.

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Figure 3. Vegetation plot SDAR020 in a stand probably belonging to the mesoxeric order *Brachypodietalia pinnati* at Chenal castle, where *Hypochaeris glabra* and *Trifolium dubium* were rediscovered for Aosta Valley. Photo: M. Janišová.