Botanica Sudalpina Conference

26–27 March 2021
online
botanicasudalpina.ch

MUSEO CANTONALE DI STORIA NATURALE LUGANO

FRANKLIN UNIVERSITY SWITZERLAND

SBT Società Botanica Ticinese

info flora

STSN Società ticinese di scienze naturali

ASSOCIAZIONE GIARDINO BOTANICO ISOLE DI BRISSAGO

Welcome

The Organizing Committee welcomes you at the Botanica Sudalpina Conference 2020 (2021)! This year has certainly been a challenging one for all of us and we are delighted that, despite the delays and the new format, we have been able to make it happen and engage with all of you to share our common appreciation for the flora of the Southern Alps.

As with its predecessor in 2017, this conference has sought to bring together the many parties active in scientific research into the flora of the Southern Alps and in particular of Canton Ticino. The platform and the network created in 2017 continue to allow us to share in the exciting findings of the many research projects taking place across the region, but also to facilitate new possibilities for collaboration and new directions for research. We continue to be awed by the diversity of topics being explored in our region, exploring topics ranging from alien species to systematics and everything in-between.

It goes without saying that this event would not have been possible without the generous support of the organizing institution and sponsors, as well as the devoted work and help of many people. In particular, we would like to thank the Scientific Committee for their valuable collaboration with the review of sub-missions and the award contest. Finally, we would also like to thank the guest speakers for their fascinating presentations.

We hope you will enjoy the conference!

Brigitte Marazzi
Info Flora & Museo cantonale di storia naturale, Lugano, CH
Sofia Mangili
Museo cantonale di storia naturale, Lugano, CH
Alessio Maccagni
University of Basel, Basel, CH
Brack W. Hale
Franklin University Switzerland, Sorengo, CH
Daniela Scheggia
Giardino botanico del Cantone Ticino, Isole di Brissago, CH
Laura Torriani,
Info Flora, Lugano, CH

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Saturday 27 March 2021 –Afternoon

Time	Session	Title	Speaker
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Scientific committee

Bruno E.L. Cerabolini
University of Insubria, Varese, IT
Roberta Ceriani
Centro Flora Autoctona della Lombardia, Galbiate, IT
Elena Conti
University of Zurich, CH
Stefan Eggenberg
Info Flora, Bern, CH
François Felber
Botanical museum and garden of Lausanne, CH
David Frey
Swiss Federal Research Institute WSL, Birmensdorf, CH
Rodolfo Gentili
University of Milano-Bicocca, Milan, IT
Mauro Jermini
Agroscope, Cadenazzo, CH
Catherine Lambelet
Societé Botanique de Genève, Chambésy, CH
Guido Maspoli
Ufficio cantonale della natura e del paesaggio, Bellinzona, CH
Giorgio Moretti
Ufficio cantonale della selvicoltura e del Demanio, Bellinzona, CH
Marco Moretti
Swiss Federal Research Institute WSL, Birmensdorf, CH
Andrea Persico
Pro Natura, Bellinzona, CH
Boris Pezzati
Swiss Federal Research Institute WSL, Birmensdorf, CH
Filippo Rampazzi
Museo cantonale di storia naturale, Lugano, CH
Nicola Schoenenberger
Innovabridge Foundation, Caslano, CH

Collaborators
IT Department, Franklin University
Michele Jurietti, photo credits *Androsace brevis*
Adriano Nicolosi, graphic designer
Ivan Sasu, webmaster

General information

Satellite events and the conference with oral presentations will be held with ***Zoom***; poster sessions and breaks with ***Wonder.me***.
We suggest installing the free version of Zoom, to avoid technical problems due to the participations via web. The application can be downloaded free of charge at www.zoom.us.
Oral presentations will be recorded in advance and broadcast as video, and speakers will be available online in person for questions at the end of their presentation.
Posters will be available and visible on the congress website one week before the event.
The login links and detailed instructions for participation will be sent via email one week prior to the conference.

Oral presentations
Each speaker's time slot consists of max 15 min divided into 10-12 min for the presentation and 3-5 min for questions. We kindly ask speakers to hold on to these time indications.
Talks must be in English and shown at the conference as videos (mp4 format) recorded in advance by presenters.

Posters
To ensure good visibility, posters will be made available to the participants on the conference website (www.botanicasudalpina.ch) starting from one week before the conference.
Poster sessions will be held during the morning and afternoon coffee breaks (see program). During these breaks, a virtual discussion room will be created, where participants will be able to talk directly with the authors of the posters and ask questions.
Poster authors may choose to prepare a classic poster in PDF format (dimensions 84 x 119 cm - A0, vertical) or an electronic poster as a short video (e-poster, max 4 slides for 3 min, in mp4 format). Posters can be in Italian or English.

Award for the best talks
The best talks will receive an award by the Botanical Society of Ticino (Società Botanica Ticinese – SBT).
The winners will be selected by a special jury of the scientific committee, and they will be awarded during the closing ceremony.
The award contest for the best poster was cancelled.

Guest speakers

26/03 14h20 Gabriele Carraro
27/03 09h20 Willy Tinner
27/03 13h30 Simon Pierce

Ing. Forst. Dipl. ETH Gabriele Carraro
Dionea SA, Locarno, Switzerland

The forest vegetation of the Onsernone Valley, 100 years ago, today and future trends.

It has been more than 100 years ago, that Johannes Bär studied and mapped the forest vegetation of the Onsernone valley (Ticino): rare, scientific work in our Alpine valleys, with great benefits for today's understanding of evolutionary dynamics and for the management of forest ecosystems. For the comparison of the current state of vegetation with that of the past and for processing of future development scenarios, an updated mapping was required in addition to Bär's map. A detailed mapping carried out solely by terrestrial surveys, in rough and partly inaccessible regions, which extends over 100 km^2, is difficult and very costly. To overcome these difficulties, an alternative method was developed, based on existing terrestrial surveys and supplemented by trans-sectoral mapping over a total area of 10 km^2. These assessments were the basis for an area-wide modelling using Random Forest Models. Considering the large number of forest types present in the valley (31), the model is able to forecast effectively. In an area with many newly formed forests, reliability of results could be increased by the evolutionary dynamics derived from historical maps. Hence, J. Bär's map represents a valuable data set that contributes to a better understanding of the present vegetation distribution. Subsequently, results of the modelling and the quality of the forest vegetation map could be improved thanks to existing and additional terrestrial surveys and to the use of aerial photographs and drones for quality control. Based on these findings combined with contributions in the field of forest history, landscape studies, palynology and local climatic conditions, it was possible to reconstruct the dynamics of forest vegetation in the Onsernone valley with its evolutionary potential, considering also climate change scenarios.

Prehistoric land-use change and its long–term legacy for future European vegetation dynamics

Prof. Dr. Willy Tinner
Oeschger Centre for Climate Change Research and Institute of Plant Sciences, University of Bern, Switzerland

Legacies comprise human and ecological memories or carryover of the ecosystem, they are effects of past events that influence extant ecosystems. In this lecture we consider four legacy examples that have wide consequences for European vegetation and its services to the society. First, we discuss if climate change, specifically the interglacial-glacial cycles have created empty niches in Europe, making the continent particularly susceptible to invasions of plant species coming from continents that are floristically more diverse. Second we assess the Vera hypothesis, a speculation that has been controversially debated in European ecosystem management. The question that can be checked by palaeoecological approaches is, whether (apart from the eastern steppes) European ecosystems would be naturally forested or kept open by megaherbivores such as elephants, hippos or ruminants.
Third we discuss the course of biodiversity in and around the Alps, specifically the reasons and processes that shaped significant biodiversity declines in forests and biodiversity increases in open lands during the past 5000 years.
Finally, we use palaeoecological and palaeoclimatic evidence as well as process-based dynamic modelling to address the question, whether humans changed the realized climatic niches of species during the past 5000 years, creating a continental disequilibrium of species distributions with current climatic conditions.
On the basis of these four examples, we suggest the use of palaeo-validated process-based dynamic models to better assess future vegetation dynamics under global change conditions.

Dr. Simon Pierce
University of Milan, Department of Agricultural and Environmental Sciences, Italy

What is the minimum viable population size for rare plant species?

Population size is a key parameter in conservation biology, and the number of individuals necessary for a population to persist over time is known as the 'minimum viable population (MVP) size'. Calculating the MVP size for rare plant species can guide the planning of conservation actions and help understanding of whether conservation projects have been successful, but it is extremely difficult to determine what this number actually is. In the words of one conservationist, "how much is enough?". Traditionally, MVP size has been estimated using computer models but, like weather forecasting, environmental variability over time cannot be predicted with certainty. Here, I suggest that a valuable approach may be to observe the biological effects evident in populations of different sizes in the wild. I show that a range of studies of reproductive effort (fruit and seed production) and genetic variability for rare and endangered plant species indicate that decreasing population size has a gradual effect until a critical point, beyond which any further decline in population size has a drastic impact on plant fitness. These 'tipping points' or 'critical thresholds' are not exactly the same thing as MVP size, but they do give a realistic indication of when populations are at particularly high risk. Usually, these tipping points occur when population size falls below around 50 to 500 individuals (depending on the species). Estimating tipping points for each species can show which populations are likely to respond positively to conservation actions.

Talk abstracts

In chronological order

Is climate the main driver of the spreading of broadleaved evergreen species in southern Switzerland?

1.1 10h05

Gianni Boris Pezzatti[1*]
Marco Conedera[1]
Thomas Wohlgemuth[2]
Matteo Tanadini[3]
Alessia Prospero[1]
*boris.pezzatti@wsl.ch

Background and Aims
The spreading and establishment of non-native species into resident communities may be driven by different factors linked to global change. By analyzing the presences of native (*Hedera helix* and *Ilex aquifolium*) and non-native (*Prunus laurocerasus* and *Trachycarpus fortunei*) evergreen species in mature deciduous forests in southern Switzerland, we aim at disentangling the role of selected climate and non-climate drivers.

Methods
Covers of target evergreens were recorded in 200 quadratic plots of 100 m2 on both south- and north-facing steep slopes of the Swiss shores of Lago Maggiore. The plots are distributed on a climatic gradient ranging from −0.4 to 3.0 °C in the average temperature of the coldest month. Former land use at each point was reconstructed from historical aerial photographs (1946, 1983, 1995) and species covers were used as response variables to be related to climate, stand structure, disturbances, propagule pressure and geomorphological proxies.

Results
Propagule pressure was the main driver of occurrence for both non-natives and *H. helix*, while meso-climate and stand structure played a secondary role. In contrast, the presence of the native *I. aquifolium* was correlated with the temperature of the coldest month, though with a low impact on cover. Our results highlight diverging drivers of invasion for native and non-native species with similar life history traits. In particular, differences emerge in terms of ecological niche, propagule pressure and former land use.

Conclusions
Evergreens invade an empty ecological niche, mainly issued by land-use change rather than climate warming. The relative contribution of climate may, however, increase at a later invasion stage, when seed-bearing adult individuals become evenly distributed in the area.

[1]Insubric Ecosystems Research Group, Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Cadenazzo, Switzerland
[2]Disturbance Ecology, Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland
[3]Seminar für Statistik, Departement Mathematik, ETH Zurich, Zürich, Switzerland

Sexual and genetic patterns of the invasive palm *Trachycarpus fortunei* (Arecaceae) in southern Switzerland and northern Italy

1.2 10h20

Antoine Jousson[1*]
Fred Stauffer[1]
Camille Christe[1]
Brigitte Marazzi[2]
Yamama Naciri[1]
*a.jousson@hotmail.com

Background and Aims
Trachycarpus fortunei (Arecaceae: Coryphoideae) is an Asian palm that has become an invasive alien plant in southern Switzerland and northern Italy. It is characterized by an unstable and complex sexual expression, ranging from dioecy to polygamy. In addition, the knowledge about its genetics is very scant. We aimed at understanding the floral structural mechanisms, characterizing its genetic diversity, clarifying the sexual expression strategy, and identifying patterns that could promote its invasiveness.

Methods
Different developmental stages of floral organs and fruits were studied, looking for patterns explaining sexual differentiation. Organs were cross-sectioned and stained. Genetic diversity was analyzed using eight microsatellites and 31'000 SNP markers. Genetic analyses were carried out for 200 individuals sampled from 21 populations in Ticino (Switzerland), Lombardy and Piedmont (Italy). The genetic sex determination was explored using GWAS analyses searching for correlation between SNP markers and sex traits.

Results
Morpho-anatomical aspects of flowers and fruits that could promote dispersal were observed, such as well-differentiated septal nectaries for cross-pollination. Sexual differentiation appears late in floral development. Genetic diversity found for both SNPs and microsatellites appears to be related to the colonization process, with lack of genetic structure and bottleneck signatures occurring at the colonization front. Similar and different sex alleles with closely linked regions were found to match with gender determination in female and male individuals, respectively, indicating that *T. fortunei* is a polygamous species with a tendency to gynodioecy.

Conclusions
This study allowed to better understand dispersion of *T. fortunei* in southern Switzerland and northern Italy. Its unstable sexual expression may have played a role in promoting its colonization ability, as bisexual individuals contribute to an increased seed production with ageing and/or depending on environmental conditions. Results of this study could allow to explore new management strategies of this species.

[1]Plant Systematics and Biodiversity, University of Geneva, Switzerland. Conservatory and Botanical Garden of Geneva, Geneva, Switzerland
[2]Info Flora c/o Natural History Museum of Canton Ticino, Lugano, Switzerland

Automated pollinators monitoring on sympatric cytotypes of *Senecio doronicum*

1.3 10h35

Luca Pegoraro[1,2*]
Ellen C Baker[1,3]
Manica Balant[4,7]
Sarah Barlow[4]
Ilia J Leitch[1]
Andrew R Leitch[2]
Luis Palazzesi[6]
Robyn Powell[1]
Oriane Hidalgo[1,7]
Jaume Pellicer[1,8]
*l.pegoraro@kew.org

Background and Aims
The Southern Alps harbour most of the Alps' flora and glacial refugia (i.e. biodiversity hotspots), and evolution produced unique species and interactions in these regions. Sympatric mixed-cytotype (i.e. chromosomal variants of the same species populations are natural experiments that can uncover these evolutionary processes, however they are poorly studied from the biological interactions point of view, including pollination.

Methods
We studied *Senecio doronicum* (found throughout the Alps) in SW France: for ~500 individuals we gathered data on ploidy level, morphometrics, and pollinator visits. We deployed an automated monitoring system (Rana) that uses computer vision to individuate insects visiting a focal plant in real-time video, while suppressing noise (e.g. shadows, wind movement), allowing to collect data more efficiently than manual observations.

Results
We found divergent flowering times between cytotypes, with octoploids (2n = 8x = 80) flowering earlier than tetraploids (2n = 4x = 40). Also, octoploids were taller and had larger capitula with more florets, while tetraploids had more numerous, but smaller capitula with fewer florets. Likewise, cytotypes exhibited micro-niche differences: octoploids occupied a larger niche and grew in denser communities, while tetraploids occupied marginal habitats with sparse vegetation. The use of automated pollinator monitoring provided unprecedented detail into pollinator communities visiting sympatric cytotypes, and evidenced differentiation within *S. doronicum*, a generalist species thought to have little pollinator specificity. The main visitors were short-tongued insects (e.g. flies and bees), mostly hoverflies. Octoploids received less visits and a lower proportion of feeding visits than tetraploids, with most of the feeding visits to octoploids made by *Syrphus*, and to tetraploids by *Eristalis*.

Conclusions
Cytotypes were morphologically differentiated and exhibited similar extents of variation, however their pollinators pools were distinct. This is the first extensive monitoring of high-elevation sympatric cytotypes, and further studies in the Southern Alps are likely to highlight novel plant-pollinator interactions, enhancing the understanding and conservation of these regions' unique plant and insect species.

[1]Jodrell Laboratory, Royal Botanic Gardens, Kew, Richmond, Surrey, UK
[2]School of Biological and Chemical Sciences, Queen Mary University of London, London, UK
[3]Department of Zoology, University of Oxford, Oxford, UK
[4]Department of Biodiversity, University of Primorska, Koper, Slovenia
[5]Red Butte Garden and Arboretum, University of Utah, Salt Lake City, USA
[6]Museo Argentino de Ciencias Naturales, CONICET, División Paleobotánica, Buenos Aires, Argentina
[7]Laboratori de Botànica - Unitat associada CSIC, Facultat de Farmàcia i Ciències de 20 l'Alimentació, Universitat de Barcelona, Spain
[8]Institut Botànic de Barcelona (IBB, CSIC-Ajuntament de Barcelona), Passeig del Migdia sn, Barcelona, Catalonia, Spain

Modelling range dynamics of terricolous lichens of the genus *Peltigera* Willd. in the Alps under a climate change scenario

2.1 11h20

Chiara Vallese[1*]
Juri Nascimbene[1]
Paolo Giordani[2]
Renato Benesperi[3]
Gabriele Casazza[4]
*chiara.vallese2@unibo.it

Background and Aims
Climate change is expected to strongly impact biodiversity in Alpine ecosystems and species distribution modeling is increasingly used to provide anticipatory information to guide conservation.

Methods
Species distribution models were constructed using four selected climatic variables from CHELSA website, and species occurrence data of 15 species belonging to the genus *Peltigera*, a group of terricolous lichens widespread across the Alps. The models were then applied to future conditions according to two representative concentration pathways, representing moderate (RCP4.5) and extreme (RCP8.5) possible future emission scenario. Finally, 1) we quantified the range loss, range gain, range change and range turnover caused by climate change, and then 2) we evaluated the relationships between the predictors of range dynamics and functional traits of the species belonging to the genus *Peltigera*.

Results
Our results indicate moderate range dynamics for species of the genus *Peltigera* across the Alps under a climate change scenario. This would imply a relative stability and resistance of these lichens to climate change that may reflect the local persistence of the species under sub-optimal conditions. Our results also suggest that range dynamics could be associated with functional traits mainly related to water-use strategies and to a trade-off between dispersal and establishment ability. This finding suggests that functional traits may strongly modulate the lichen response to climate change and that species with similar functional traits are prone to similar selective pressures.

Conclusions
This work demonstrates that coupling species distribution modeling with trait-based analysis provided a promising hint to better understand the mechanisms that determine the response of these organisms to climate change.

[1]BIOME Lab, Department of Biological, Geological and Environmental Sciences Alma Mater Studiorum - University of Bologna, Bologna, Italy
[2]DIFAR, University of Genoa, Genoa, Italy
[3]Department of Biology, University of Florence, Florence, Italy
[4]DISTAV, University of Genoa, Genoa, Italy

Limits to Phenotypic Evolution along Elevational Gradients within and among *Saxifraga* species.

2.2 11h35

Seraina E. Rodewald[1*]
Jurriaan M. de Vos[1]
*seraina.rodewald@unibas.ch

Background and Aims
It is well established that plants display radically different phenotypes at different elevational belts, as a response to changing environmental conditions. Yet patterns of variation within species do not necessarily reflect those among species. In the literature, these hierarchical scales are often conflated, leading to confusion, for instance regarding whether covariance structure may restrain evolution to "lines of least resistance". We aim to understand whether among species diversification within genera along elevational gradients mirrors within species phenotypic variation.

Methods
Here, we compare within and among species responses to elevation and associated environmental variables in a genus of mountain plants that spans a remarkably wide elevational range (from 200 to 4200 m in Switzerland), *Saxifraga*. We measured 16 morphological traits from 264 georeferenced herbarium specimens representing 9 species. We use uni- and multivariate comparative methods to determine which environmental variables (extracted from CHELSA) best explain overall phenotypic variation, and whether these relations are the same within- and among species.

Results
Among-species response to environmental variables is congruent with, but much stronger than within-species, with architecture and resource-related traits showing a stronger signal than floral traits. Maximum branching order within inflorescences correlates best with environmental,variables followed by rosette leaf length and inflorescence height. The environmental variables length and temperature of the growing season best predict morphological variation.

Conclusions
Within-species variation is rather limited, as the underlying architecture and branching pattern are largely fixed, limiting species' elevational breadth. Adaptation and evolution of species along elevational gradients mostly means changing the rules of inflorescence architecture, rather than occupying the higher or lower end of the within-species morphological gradients. The primary limitation of low-elevation species with large, highly branching inflorescences might be short growing seasons at high elevation, suggesting that limited time to develop highly branched inflorescences constitutes a critical adaptation of alpine plants.

[1]Department of Environmental Sciences, Botany, University of Basel, Basel, Switzerland

Living on the edge. Unravelling biology and ecology of the endangered endemic alpine plant *Androsace brevis* (Hegetschw.) Cesati (Primulaceae) by a multidisciplinary approach

2.3 11h50

Marco Bonelli[1*]
Elena Eustacchio[1]
Alessio Minici[1]
Erica Dinatale[1]
Andrea Melotto[2]
Federico Mangili[3]
Mauro Gobbi[4]
Mario Beretta[1]
Emanuele Gatti[1]
Elisabetta Onelli[1]
Luca Gianfranceschi[1]
Morena Casartelli[1]
Marco Caccianiga[1]
*marco.bonelli@unimi.it

Background and Aims
High-mountain ecosystems are strongly influenced by climate change, affecting biodiversity at all levels, from genetic diversity of populations to changes in the web of interactions. We propose a model species to address biogeographic issues and investigate biotic interactions in high-mountain ecosystems threatened by climate change. *Androsace brevis* is a Southern Alpine narrow endemic plant growing above 2000 m showing a very restricted distribution, with scattered populations of limited size. Climate warming could represent a serious threat for this species, since an upward range shift is almost impossible. Moreover, it flowers very early, in a critical moment for plant-pollinator interactions.

Methods
We investigated the geographic distribution, the reproductive strategies, and the genetic variability of *A. brevis* through nSSR markers. Moreover, we studied the role of arthropods as pollinators by exclusion experiments, identification of flower-visiting species, analysis of their behavior through video recording, and palynological analyses. Finally, we evaluated the presence of a possibly endophytic symbiotic bacterium by molecular techniques.

Results
We clarified the reproductive biology of *A. brevis*, the extent of allogamy, autogamy and vegetative reproduction, the genetic structure of populations, the roles of flower-visiting arthropods. We also identified a possible symbiotic bacterium: preliminary sequence analysis revealed protein functional domains likely involved in the symbiotic relationship with the plant.

Conclusions
Our data offer new insights into the biology of *A. brevis* and the biogeography of the Southern Alpine area, and help to reduce the current lack of knowledge about high-altitude ecological interactions, a key aspect for the conservation of Alpine biodiversity. Our data could help to make prediction about future scenarios for the survival of Alpine species under a warming climate.

[1]University of Milan, Department of Biosciences, Italy
[2]University of Milan, Department of Environmental Science and Policy, Italy
[3]Gruppo Flora Alpina Bergamasca, Italy
[4]MUSE, Section of Invertebrate Zoology and Hydrobiology, Italy

Ancient ecotypes of *Secale cereale* and *Fagopyrum esculentum* in Valtellina (Central Alps): characterization by morphological, genetic and nutraceutic traits

2.4 12h05

Rodolfo Gentili[1*]
Elisa Cardarelli[1]
Giuseppe Pezzotti[2]
Davide D'Apollo[1]
Fausto Gusmeroli[3]
Giampaolo Della Marianna[3]
Roberta M. Ceriani[4]
Jessica Bellingardi[4]
Giancarla Maestroni[5]
Jonatan Fendoni[6]
Riccardo Finotti[7]
Andrea Fanchi[8]
Jolanta K. Wilkosz[9]
Marco De Filippi[9]
Elio Moretti[10]
Paolo Pedroli[10]
Patrizio Mazzucchelli[11]
Sandra Citterio[1]
*rodolfo.gentili@unimib.it

Background and Aims
The cultivation of common buckwheat (*Fagopyrum esculentum*) and rye (*Secale cereale*) has been documented since ancient times in Valtellina (Central Alps). Historically, the germplasm has been subject to human selection at the farm level and has led to the formation of ecotypes adapted to local agro-environmental conditions. Nowadays, some ecotypes handed down by small-scale farmers' families are deemed to still survive among commercial varieties introduced during the XX century. This project, funded through PSR 2014-2020 of Regione Lombardia (ConserVa), aimed at recognizing and conserving, *in-situ* and *ex-situ*, local ecotypes of common buckwheat and rye in Valtellina, in relation to commercial varieties.

Methods
Morphologic and colorimetric characterization of seeds, nutraceutical analysis by biochemistry and Raman spectroscopy, and population genetic analysis by microsatellite markers were performed for rye (15 accessions) and common buckwheat (22 accessions).

Results
Preliminary results of morphologic analyses highlighted a differentiation in seed size and color of some ecotypes from the commercial varieties. Nutraceutical and population genetic analysis are in progress.

Conclusions
The characterization of the two species may recreate a short local supply chain to support the mountain economy of Valtellina. Suitable ecotypes may be selected and conserved to respond to extreme climatic conditions foresee within the end of century.

[1]University of Milano-Bicocca, DISAT, Milan, Italy
[2]Kyoto Institute of Technology, Ceramic Physics Laboratory, Kyoto, Japan
[3]Fondazione Fojanini, Sondrio, Italy
[4]Centro Flora Autoctona, Galbiate (LC), Italy
[5]Associazione per coltura del grano saraceno di Teglio e dei cereali alpini tradizionali, Teglio (SO), Italy
[6]Orto Tellinum, Teglio (SO), Italy
[7]Rosa dei Venti, Teglio (SO), Italy
[8]Teglio (SO), Italy
[9]Cof e Casele, Teglio (SO), Italy
[10]Comune di Teglio, Teglio (SO), Italy
[11]Raetia Biodiversità Alpine, Teglio (SO), Italy

Nationwide revisitation reveals thousands of local extinctions across the ranges of 713 threatened and rare plant species

3.1 14h15

Anne Kempel[1,2*]
Christophe N. Bornand[3]
Andreas Gygax[3]
Philippe Juillerat[4]
Michael Jutzi[3]
Lionel Sager[4]
Beat Bäumler[5]
Stefan Eggenberg[3]
Markus Fischer[1,2]
*anne.kempel@ips.unibe.ch

Background and Aims
Despite increasing awareness of global biodiversity loss, we lack quantitative data on local extinctions for many species. This is especially true for rare species, for which estimates of trends are typically assessed on the basis of expert judgement rather than data. Revisiting previously assessed populations enables estimation of local extinction rates and the identification of species characteristics and habitats with high local extinction risk.

Methods
Between 2010–2016, in a nationwide revisitation study, 420 volunteer botanists revisited 8024 populations of the 713 rarest and most threatened plant species in Switzerland recorded between 1960–2001. This large re-visitation project enabled a quantitative estimate of species trends for a large number of species in a large number of habitats throughout a whole county.

Results
Of the revisited 8024 populations, 5859 (73 %) were confirmed, whereas 2165 (27 %) had gone locally extinct. Among critically endangered species, the local extinctions increased to 40%. Species from ruderal and freshwater habitat types showed the highest proportion of local extinctions, which mirrors European trends in the threat status of habitats.

Conclusions
Our results provide compelling evidence for rapid and widespread local extinctions and suggest that current conservation measures are insufficient. Despite large efforts to protect habitats of threatened species, local extinctions precede and provide early warnings for global extinctions. The ongoing loss of populations suggest that we will lose species diversity unless we scale up species-targeted conservation and restoration measures, especially in anthropogenic landscapes. Going forward we need to develop a comprehensive landscape approach, involving the creation of ecological infrastructure and translocation and assisted migration of threatened species into suitable habitats. The study has been recently published in the Journal "Conservation Letters" (DOI: 10.1111/conl.12749).

[1]Institute of Plant Sciences, University of Bern, Bern, Switzerland.
[2]Oeschger Centre for Climate Change Research (OCCR), University of Bern, Bern, Switzerland.
[3]Info Flora, c/o Botanischer Garten, Bern, Switzerland.
[4]Info Flora, c/o Conservatoire et Jardin botaniques, Chambésy-Genève, Switzerland.
[5]Conservatoire et Jardin botaniques de la Ville de Genève, Chambésy, Switzerland.

Strong decline of grassland habitat quality on the southern side of the Alps

3.2 14h30

Steffen Boch[1*]
Ariel Bergamini[1]
*steffen.boch@wsl.ch

Background and Aims
Since the early 1990s, Switzerland designated about 7000 sites of national importance to protect precious habitats and their biodiversity. These legally protected sites include mires dry grasslands, flood plain habitats and amphibian breeding sites, and are a crucial element of the network of protected sites in Switzerland. In 2011, the program "Monitoring the effectiveness of habitat conservation in Switzerland (WBS)" was initiated by the Federal Office for the Environment (FOEN) and the WSL Swiss Federal Research Institute to 1) observe changes, 2) evaluate whether conservation targets are met and 3) assess whether the area and quality of habitats is being maintained.

Methods
Using remote sensing approaches, changes of structures, such as tree and shrub cover, of all 7000 sites of national importance are regularly measured. Of these 7000 sites (366 on southern side of Alps (SA)) about 900 (83 SA) were selected for vegetation surveys. In these 900 sites, the vegetation is sampled in more than 7000 (>700 SA) permanent 10-m2 plots. Each plot is surveyed once in a six-year cycle. The first survey period was finished in 2017.

Results
Analysis of remote-sensing data showed an overall increasing wood cover in mires and dry grasslands, indicating land-use abandonment. These patterns were exceptionally strong on the SA. The increase was at least three times higher in dry grasslands of SA than in other biogeographic regions and was particularly pronounced at higher elevation (>800m). Results of vegetation resurveys in dry grasslands underline these findings, as negative vegetation changes increased with elevation.

Conclusions
Our results of negative vegetation changes because of wood encroachment suggest the urgent need to re-establish traditional land-use regimes in abandoned sites to prevent further habitat and diversity losses, particularly on the southern side of the Alps. We therefore established an early-recognition system, enabling federal and cantonal offices for the environment to identify changes and to take measures to counteract negative developments.

[1]WSL Swiss Federal Research Institute, Birmensdorf, Switzerland

The importance of genetic diversity and habitat suitability for in-situ conservation and translocations of threatened plant species

3.3 14h45

Deborah Schäfer[1*]
*deborah.schaefer@boga.unibe.ch

Background and Aims
The conservation of threatened plant species includes two important aspects, in-situ conservation with habitat protection and restoration, and ex-situ measures, like ex-situ cultivation or translocations. Here, two studies highlight the importance of habitat suitability and genetic diversity for the success of both, in-situ and ex-situ conservation measures.

Methods
In a first study, Giotto Roberti-Maggiore visited populations of eight orchid species of varying sizes. With vegetation records and Ellenberg indicator values, he determined abiotic conditions (e.g. nutrients, temperature, light availability) of 76 study sites. By comparing these with the orchids' indicator values he estimate habitat suitability. Further, he counted the number of flowers and fruits and measured in-vitro germination rates as a measure of plant fitness for all eight orchid species. In a second study, I translocated eight threatened plant species, each including a low genetic diversity (offspring of one mother plant) and a high genetic diversity (offspring of several mother plants) treatment to estimate the importance of genetic diversity for the short-term survival. The design was species specific, depending on their germination.Both studies included sites all over Switzerland, including the canton of Ticino.

Results
For the orchids, a larger deviation from their niche optimum was related with smaller population size, when analyzed together. Further, smaller populations were related with lower fruit production and germination rates, possibly indicating pollinator limitation
and inbreeding depression. In the translocation study, higher genetic diversity increased short-term survival.

Conclusions
In populations of decreasing sizes, habitat suitability for the threatened plant species should be assessed. If unsuitable, habitat restoration or translocations should be considered. In small populations, low genetic diversity and, consequently, inbreeding depression are important factors to consider. Increasing genetic diversity by transplanting individuals from nearby, ecologically similar populations is a possible solution. When doing translocations as the next action, aiming at increasing genetic diversity (e.g. collecting seeds from many plants, transplanting many individuals) is crucial.

[1]Botanical Garden of the University of Bern, Bern, Switzerland

Plant adaptive strategies in the dark diversity of forest vegetation in the province of Varese (Lombardy)

4.1 15h30

Michele Dalle Fratte[1*]
Simon Pierce[2]
Magda Zanzottera[1]
Bruno E.L. Cerabolini[1]
*michele.dallefratte@uninsubria.it

Background and Aims
Biodiversity has long been at the center of ecological research, however there is still no clear understanding of why some species are absent in a given location, although they could be potentially present. This undetectable component of biodiversity is defined as "dark diversity", and its study can provide insights into the missing functions of an ecosystem.

Methods
We carried out 47 relevés distributed randomly within a study area of 10 km radius in the province of Varese (Lombardy, Northern Italy), and representative of eight types of broad-leaved deciduous forest vegetation: species-poor and species-rich acidophilic beech forests (*Luzulo-Fagion*), basophilic beech forests (*Aremonio-Fagion*), neutrophilic beech forests (*Asperulo-Fagetum*), oak and birch forests (*Querco-Betuletum* s.l.), oak and ash tree forests (*Querco-Fraxinetum* s.l.), mixed ravine and slope forests (*Tilio-Acerion*) and mixed recolonization forests (*Corylo-Fraxinetalia*). For each relief, we calculated the community weighted mean of observed and dark diversity of three plant functional traits (LA, LDMC and SLA) and Grime's CSR ecological strategies.

Results
The highest probability of dark diversity was identified for mixed recolonization forests (mean value = 0.54), while the lowest was evident in both species-poor and species-rich acidophilic beech forests (mean value = 0.42). In general, dark diversity exhibited high degree of ruderality (R)as opposed to a selection towards more competitive (C) strategies in the observed diversity ($p < 0.001$ for both R and C).

Conclusions
We hypothesized that the balance of competitiveness and ruderality between observed and dark diversity could be the basis of the properties of broad-leaved forest plant communities respectively linked to resistance and resilience.

[1]Department of Biotechnology and Life Sciences (DBSV), Università degli Studi dell'Insubria, Varese, Italy
[2]Department of Agricultural and Environmental Sciences (DiSAA), Università degli Studi di Milano, Milano, Italy

Grouping of floristic quadrants with similar vegetation using beta diversity

4.2 15h45

Michael Kleih[1*]
*michael.Kleih@neplan.ch

Background and Aims
The flora between Lago Maggiore and Lago di Como has been mapped in the last 25 years. About 50 quadrants of the grid of the "Floristic Mapping of Central Europe" were considered. Aim in this work was to find similarities and differences between the flora of the single quadrants and to group similar ones using cluster analysis.

Methods
A C#-Program was written allowing comparing the checklist of each quadrant with each other quadrant. The degree of similarity was determined using beta diversity defined as ratio between the number of common species between two quadrants and the total number of species in the two quadrants. Afterwards they were grouped using cluster analysis. The software also calculates the average values of different bio-indicators for each quadrant, allowing to validate the grouping.

Results
Three main groups could be clearly identified: One of the calcareous mountains with medium elevation, one of the siliceous mountains with high altitudes and one of the plain and the low hills with many humid areas but also many anthropic habitats. These characteristics were also confirmed by comparing the groups with the average bio-indicators of their quadrants.

Conclusions
The approach used is very reliable to find similarities in vegetation of large areas. Using even bigger areas it could be used for the creation of phytogeographic maps.

[1]Società Botanica Ticinese, Minusio, Svizzera

Taxonomy and distribution of the Sheep Fescues (*Festuca ovina* s. lat.) in the Alps and surrounding areas: current state of knowledge

4.3 16h05

Peter Englmaier[1,2*]
*peter.franz.josef.englmaier@univie.ac.at

Background and Aims
Due to the morphological similarities between several taxa of the diploid-polyploid species complex of sheep fescues, the binomial name *"Festuca ovina"* is frequently misapplied, and the geographical distribution of the diploid *F. ovina* L. s. str. is conspicuously overestimated in floristic mapping projects. The aim of this contribution is to elucidate the actual distribution of *F. ovina* L. s. str. and similar taxa in the Alps and surrounding areas.

Methods
The recent literature is reviewed and presented together with own data from field surveys, revised herbarium material (W, WU, LI, GJO and others) and biometric measurements.

Results
In Central Europe, *F. ovina* L. s. str. has a very scattered distribution and is restricted to near-natural grasslands of Central European Uplands. In the Alps, the species is replaced by *F. airoides* LAM. and *F. eggleri* TRACEY. The tetraploid *F. guestfalica* BOENNINGH. ex RCHB. occurs throughout the Central European Uplands and is scattered distributed mainly in the Eastern Alps. The tetraploid Eastern Alpine-Carpathian *F. supina* SCHUR reaches its western range margin in western Austria. Generally, herbarium records labelled as *F. ovina* L. s. str. are doubtful, most of them are misidentified *F. guestfalica*. Own field obser-vations in the Swiss Central Plateau in 2001 and 2018 only revealed *F. guestfalica*. More-over, the presence of *F. filiformis* LAM. and *F. airoides* in Switzerland could be confirmed.
Fresh and herbarium material of *F. ovina* L. s. str. (and other diploid species) and *F. guestfalica* (and other tetraploid species) can be distinguished by smaller lemmas (3-3.5 mm vs. 4-4.5 mm), smaller anthers (1.2-1.5 mm vs. 1.8-2.5 mm) and shorter stomata (diploids generally 22 -30 µm, tetraploids 28-35 µm).

Conclusion
The simplified taxonomy commonly used for the *Festuca ovina* species complex leads to misinterpretations in the geographical distribution of its members. Thus, a revision of floristic mapping data is strongly recommended. Diploid and tetraploid species can be sufficiently distinguished based on morphological characteristics.

[1]OECONSULT - Expert Consultancy for Ecological Sciences, Vienna, Austria
[2]University of Vienna, Vienna, Austria

The multiple identities of the common moonwort, *Botrychium lunaria*

4.4 16h20

Vinciane Mossion[1*]
Jason Grant[1]
Don Farrar[2]
Michael Kessler[3]
*vinciane.mossion@unine.ch

Background and Aims
Botrychium lunaria (L.) Sw., a cosmopolitan fern species, was thought to show important intra-specific variation until recent studies proposed the creation of multiple new taxa in North America. Similarly, European populations are likely to harbor yet undescribed taxa. Across the Alps, *B. lunaria* is a common species of open habitats. Here, we aim to unravel the diversity of the *B. lunaria* group across the Northern hemisphere with a specific focus on the southern regions of the Alps.

Methods
Plant material was collected between 2012 and 2019 both in situ and from herbaria. Four-non-coding plastid regions (trnH^{GUG}-psbA intergenic spacer, trnL^{UAA}-trnF^{GAA} intergenic spacer, rpl16 intron and matk intron) were used to assess the phylogenetic relationships within the *B. lunaria* group. Morphological traits were measured on herbarium sheets and their relevance for clade discrimination was analyzed using multivariate statistics. Relative genome size and spore length measurements were used to estimate the ploidy level.

Results
Our phylogenetic trees recovered five well-supported clades co-occurring in the southern regions of the Alps. Among these clades, two are described species, the common *B. lunaria* and *B. tunux* found only in the Swiss part of the southern Alps, two are widespread uncharacterized species (*i.e.* species 2 and species 3) and one is a new taxon (*i.e.* species 8) for central and eastern Europe. Morphometric analyses mostly distinguished the five taxa from each other but not all traits showed conclusive differentiation. Relative genome size and spore measurements found no evidence of polyploids in the southern regions of the Alps.

Conclusions
We provide evidence for the presence of five species of the *B. lunaria* group across the southern regions of the Alps of which one is new for Switzerland (*B. tunux*) and two are yet uncharacterized. Based on genetic and morphological differentiation of the latter two, we propose a new species (*i.e.* species 3) and the rehabilitation of one species name, *B. onondagense* (*i.e.* lunaria 2), previously synonymized with *B. lunaria*. Future investigation of the climatic niches might help to further distinguish the *B. lunaria* species of the Alps.

[1]Laboratory of Evolutionary Genetics, University of Neuchâtel, Neuchâtel, Switzerland
[2]Department of Ecology, Evolution and Organismal Biology, Iowa State University of Science and Technology, Ames, United-States of America
[3]Department of Systematic and Evolutionary Botany, University of Zürich, Zurich, Switzerland

Poster abstracts

In alphabetical order of the presenting author

A possible endophytic symbiotic bacterium of endemic species *Androsace brevis* (Primulaceae)

Erica Dinatale[1*]
Marco Bonelli[1]
Elena Eustacchio[1]
Morena Casartelli[1]
Alessio Minici[1]
Marco Caccianiga[1]
Luca Gianfranceschi[1]
*erica.dinatale@studenti.unimi.it

Background and Aims
Androsace brevis (Hegetschw.) Ces. is a narrow endemic plant living on ridges in a restricted area of the Southern Alps in Lombardy (Italy) and Switzerland. It prefers acid soils with low nitrogen content and blooms immediately after the snowmelt. *Androsace brevis* is proposed as a model species to study the effects of climate change on the web of interactions in mountain ecosystems (plant-arthropod, plant-microorganisms). During the sequencing of A. brevis genome carried out in a preliminary work, a significant amount of DNA belonging to a prokaryotic organism and not compatible with environmental contamination was detected. Our aim is to identify and characterise this microorganism.

Methods
To evaluate the presence and diffusion of the bacterium, specific PCR primers were designed and tested on *A. brevis* individuals belonging to eight different natural populations. To isolate the bacterium from plant tissues, different growth media and conditions were tested. Bioinformatics analyses were performed to classify the bacterium and to identify protein functional domains trying to understand its relationship with the plant.

Results
The bacterial genome was *de novo* assembled and identified as belonging to the Beijerinkiaceae family, Rhizobiales order. Nor the genus neither the species could be identified: at present there is no perfect match with any bacterial genome in public sequence databases. The Beijerinckiaceae family includes bacteria living in the phyllosphere, often methylotrophs or methanotrophs sharing nitrogen fixation capability and promoting plant growth.
PCR assays confirmed the presence of the bacterium in all samples tested. However, so far, any attempt of isolating the bacterium has been unsuccessful. The *in-silico* analysis of the predicted functional domains suggests a likely symbiotic relationship with the plant, and preliminary microscope observations confirm the presence of endophytic bacteria inside plant tissues (leaves).

Conclusions
The molecular and functional characterization of this microorganism could help to clarify the ecology of *A. brevis* and to reduce the current lack of knowledge about high-altitude plant-bacteria interactions.

[1]University of Milan, Department of Biosciences, Italy

High mountain plant-pollinator interactions: the case study of the narrow endemic alpine plant *Androsace brevis* (Hegetschw.) Ces. (Primulaceae)

Elena Eustacchio[1*]
Marco Bonelli[1]
Alessio Minici[1]
Andrea Melotto[2]
Erica Dinatale[1]
Mauro Gobbi[3]
Luca Gianfranceschi[1]
Morena Casartelli[1]
Marco Caccianiga[1]
*elena.eustacchio@unimi.it

Background and Aims
Global warming may threaten mountain ecosystems by altering plant-arthropod interactions, for instance by causing phenological mismatches between flowering time and pollinator activity. Especially plants having an early and short flowering period may be at risk, since an earlier snowmelt can lead to a greater anticipation of flowering than pollinators emergence. Here we study the structure of a high mountain plant-pollinator network by taking the narrow endemic *Androsace brevis* as an example of an early flowering plant species.

Methods
Fieldwork was conducted in the Orobian Alps (Bergamo, Italy) for three years and in the Lepontine Alps (Como, Italy) for two years. *Androsace brevis* flower-visiting arthropods were sampled with the timed observation method. In addition, we sampled pollen of each blooming plant species within a radius of 500 meters around the focal plant to create a pollen library. Arthropods were identified to the lowest possible taxonomic level and quali-quantitative pollen analyses were performed to identify actual pollinators. To achieve this, pollen grains carried by arthropods were isolated, acetolysed, prepared for light microscopy observation and identified with the help of the pollen library and pollen identification keys. After creating a plant-pollinator matrix, we obtained quantitative plant-pollinator networks by bipartite analysis with RStudio Software.

Results
We identified 50 arthropod families, and could attribute the pollen samples to 25 plants species. We identified Diptera (Anthomyiidae) and Hymenoptera (Apoidea) as main pollinators of *A. brevis*. Moreover, we observed well-structured plant-pollinator networks, with many links between plants and arthropods, despite the early flowering period of *A. brevis*.

Conclusions
Our results contribute to a better understanding of the pollination biology of *A. brevis*. More generally, our results give insight into high mountain early-season plant-pollinator networks, which are important but little-known and potentially vulnerable components of high-mountain ecosystems.

[1]University of Milan, Department of Biosciences, Italy
[2]University of Milan, Department of Environmental Science and Policy, Italy
[3]MuSe Science Museum, Section of Invertebrate Zoology and Hydrobiology, Italy

Invasion of *Sorghum halepense* in the Insubric region

Matteo Gentilini[1*]
Sofia Mangili[2]
Rodolfo Gentili[1]
Brigitte Marazzi[2,3]
*mat.gentilini@gmail.com

Background and Aims
Aleppo grass (*Sorghum halepense* L., Poaceae) is a species from Eastern Mediterranean, which is considered an invasive alien species in many parts of the world. It is also expanding across the Insubric region, including Canton Ticino, raising concern among authorities. This work aimed at investigating the historic introduction and current distribution of Aleppo grass in this region, and its aptitude to invade ruderal and semi-natural habitats.

Methods
Distribution analysis was performed in GIS using specimen data from herbaria in Northern Italy and Switzerland and floristic observations from the Info Flora database. The species' invasion aptitude will be investigated analysing 45 vegetation plots and measuring plant traits of different populations.

Results
A total of 131 herbarium specimens were found. The oldest ones date back to the first half of 19th century and come from the Po valley; in the Insubric region, occurrences were registered since the beginning of 20th century in Lecco, Como, and Canton Ticino. The highest elevation recorded is at 720 m. a.s.l. (Mergoscia, Canton Ticino); the northern-most occurrence is in Semione. Our data shows that Aleppo grass preferably occurs in thermophilic, human-disturbed environments. Urban areas, road sides, and cultivations are the most invaded habitats, whereas it was not recorded in semi-natural habitats like forests, riverbanks, pastures and non-managed meadows.

Conclusions
Our investigation of herbarium specimens and floristic databases highlights the recent expansion of Aleppo grass in the Insubric region. The high propagation ability (i.e. propagule dispersal) of the species and the anthropogenic global warming favouring this thermophilic species, might explain its rapid recent expansion across human-disturbed habitats. The species is currently still restricted to anthropized environments, where a further expansion is to be expected.

[1]University of Milano-Bicocca, DISAT, Piazza della Scienza 1 and 4, Milan, Italy
[2]Natural History Museum of Canton Ticino, Lugano, Switzerland
[3]Info Flora c/o Natural History Museum of Canton Ticino, Lugano, Switzerland

Climb every mountain (and take a photo): social media photos and plant conservation in the Northern Ticino Alps

Brack W. Hale[1*]
Lily Pifferini-Carter[1]
Matthew Tralka[2]
*bhale@fus.edu

Background and Aims
Geotagged photos posted to social media provide a potential source of information on the biodiversity of landscapes. This study examines the flora documented in publicly-available, geotagged photos posted on the website Flickr in northern Ticino, Switzerland between 2015 and 2020. Specifically, it seeks to assess the taxa of plants documented in the photos and the users' understanding of the flora, using user-identified information as a proxy.

Methods
Using the Flickr API and a GIS project in QGIS, the study collected photographs taken in and above the subalpine zone (defined here as starting at 1500 m a.s.l.) in Northern Ticino between 1 April and 31 October (in 2020, only until 20 July); we sampled up to ten photos per user. The authors performed a content analysis to categorize the main subjects of the photos. For photos containing plants as visible subjects, we further identified plants to genus or species, when possible. We also collated user's comments and tags related to plants.

Results
Of the 540 photos in the final dataset, 80 (14.8%) photos contained individual plants that could be visually identified. In contrast, only 28 (5.2%) photos contained plant-related tags. Identifiable plants came from 26 genera, the most common being *Larix*, *Epilobium*, and *Eriophorum*. All identified taxa are considered common plants; none were on the Red, Black, or Watch Lists in Canton Ticino. Conspicuously missing were Orchidaceae species and two "symbolic" floral taxa of the Alps (*sensu* Schirpke et al. 2018): *Gentiana* (*acaulis* and *clusii*) and *Leontopodium alpinum*. Users rarely identified taxa (5%), but were generally correct (100%), when they did.

Conclusions
Our initial findings demonstrate that a visual content analysis captures more taxa than a simple analysis of user-generated content would. Further, it shows that visitors, while not always specifically recognizing it, appreciate the flora of mountain areas. This highlights the need for continued conservation and education efforts.

[1]Franklin University Switzerland, Sorengo, Switzerland
[2]University of Maryland, College Park, MD

Using drone imagery and deep learning to map the distribution of the invasive neophyte *Trachycarpus fortunei*

Vasco Lepori[1,2]
Alessia Prospero[1]
Gianni Boris Pezzatti[1*]
Claudio Bozzini[1]
Marco Conedera[1]
*boris.pezzatti@wsl.ch

Background and Aims
Invasive alien species can present a threat to native biodiversity and compromise ecosystem services. In this study, we focus on novel methodologies to assess the current distribution of *Trachycarpus fortunei* (Windmill palm) in Ticino, Switzerland. The proposed approach automates the necessary steps following image acquisition, i.e., object classification and georeferencing, to generate the distribution map of the target species in the surveyed areas.

Methods
We performed 65 drone flights over a two-months winter period over selected locations where we knew the species to be present, amounting to a total area of 2'162'000 m2. The image classification used a deep learning model (convolutional neural network) implemented in Keras / Tensorflow, which was trained on a dataset of thousands of manually annotated tiles of 100x100 pixels. Subsequently, the locations of identified objects in the images were georeferenced using the monophotogrammetry tool WSL Monoplotting, drone sensor data (position, orientation), camera parameters and a Digital Elevation Model. The accuracy of the automated geo-referencing was assessed in a separate trial with ground markers.

Results
In a validation dataset consisting of 32'550 manually verified image-tiles from 50 randomly chosen images, the trained model accurately classified the target species from the surrounding vegetation (97% accuracy, AUC = 0.92). The accuracy of the automated geo-referencing was in the range of 3.9 ± 1.5 meters at 65 meters but increased with drone altitude. These encouraging early results hint at the potential of the semi-automated approach for mapping of species.

Conclusions
The technologies presented have the potential to improve the scale, efficiency, and reproducibility of data collection. By leveraging both these approaches and traditional data sources, we hope to get a more precise understanding of the Windmill palm's environmental niche at different scales and help predict its future potential range.

[1]Federal Institute for Forest, Snow and Landscape Research WSL, Cadenazzo, Switzerland
[2]Department of Biology, University of Fribourg, Fribourg, Switzerland

Not so simple(x): new insight on the distribution of *Botrychium simplex* in the Alps

Alessio Maccagni[1*]
Vinciane Mossion[2]
Jason Grant[2]
*alessio.maccagni@unibas.ch

Background and Aims
Botrychium Sw. is a world-wide distributed fern genus having the highest species diversity under temperate and cold climates. It contains 35 species, of which seven occur in Europe, with the little grape fern *Botrychium simplex* E. Hitchc. being one of the rarest and most endangered species. It has a circumboreal-oceanic distribution, including Japan, North America, and Europe. Within the Central-European Mountain System, *B. simplex* is known in less than twenty localities. However, recent studies suggest that some of these locations belong to the var. *tenebrosum*, recently elevated to the rank of species. Our aim is to clarify the taxonomy of *B. simplex* within the Alps.

Methods
Leaf material was collected from 2015 to 2020 in the central Alps (Switzerland, Italy, and Austria). Four non-coding plastid loci (*matK* and *rpl16* introns and, $trnH^{GUG}$-*psbA* and $trnL^{UAA}$-$trnF^{GAA}$ intergenic spacers) were sequenced. This dataset was combined with available *B. simplex* sequences from northern Europe and North America. Phylogenetic relationships were assessed using maximum likelihood and Bayesian methods. Taxonomically relevant morphological traits were evaluated on fresh and dry material.

Results
Preliminary phylogenetic trees revealed two well-supported clades corresponding to *B. simplex* and *B. tenebrosum*. *Botrychium simplex* was the most common species, occurring in Italy, Austria, and Switzerland, while *B. tenebrosum* was identified only among Swiss samples. The length of the sporophore stalk and the ratio between the sporophore stalk and the part bearing sporangia allowed it to morphologically separate specimens according to their genetic differentiation. Moreover, the common stalk length tended to be longer in *B. tenebrosum*.

Conclusions
Our study provides molecular and morphological evidence for two distinct taxa within the Central-European Mountain System, i.e., *B. simplex* and *B. tenebrosum*. This highlights the need to assess their conservation status.

[1]University of Basel, Plant ecology and evolution, Basel, Switzerland
[2]University of Neuchâtel, Laboratory of evolutionary genetics, Neuchâtel, Switzerland

Distribuzione consistenza delle popolazioni e sinecologia di *Androsace brevis* (Hegetschw.) Ces

Federico Mangili[1*]
Marco Graziani[2]
Elena Tonini[2]
Vincenzo di Michele[2]
Elena Eustacchio[2]
Marco Bonelli[2]
Marco Caccianiga[2]
*f.mangili@yahoo.it

Introduzione e obiettivi
Androsace brevis (Hegetschw.) Ces, è una steno-endemita, esclusiva di ambienti di crinale silicei sulle Alpi centro-meridionali a ridosso del Lago di Como. Obiettivo dello studio è produrre una mappa dettagliata delle popolazioni di *A. brevis*, conteggiare gli individui e definirne la sinecologia, che la letteratura assegna all'*Androsacion vandellii*, categoria non corrispondente a quanto osservato in campo.

Metodi
L' areale di *A. brevis* è stato suddiviso in 3 sottozone: Prealpi Luganesi e Alpi Lepontine sud-orientali (Alto Lario, Ticino centro-orientale, Mesolcina sud-orientale), Alpi Orobie Occidentali e Alpi Retiche Occidentali (Val Masino e Val Codera). Ogni sottozona è stata esplorata, individuando località di presenza e popolazioni. Le popolazioni individuate, sono state mappate con GPS conteggiando gli individui presenti. Per quanto riguarda l'inquadramento sinecologico si è rilevata la flora presente insieme ai pulvini di *A. brevis* con il metodo del rilievo fitosociologico. Tutti i dati sono stati registrati in appositi database Excel per permetterne l'elaborazione.

Risultati
Allo stato attuale, sono state conteggiati oltre 1'000 individui in 5 località in Alto Lario (di cui una in Mesolcina, le restanti in provincia di Como e Ticino), oltre 800 individui in 7 località nelle Alpi Orobie e poco più di 50 individui in 3 località nelle Retiche Occidentali. Per quanto riguarda l'analisi sinecologica stati realizzati 49 rilievi fitosociologici, che analizzati tramite *cluster-analysis* hanno evidenziato la presenza di 5 differenti *cluster* sinecologici.

Conclusioni
Il conteggio ha permesso di realizzare una mappa distributiva di dettaglio, fino ad oggi la più aggiornata disponibile, di fornire precise indicazioni sulle popolazioni a rischio di estinzione, e di fornire dati di base per la realizzazione di studi successivi in corso d'opera (biologia riproduttiva, biogeografia e filogeografia). L'esplorazione dell'areale sta proseguendo, con l'individuazione di nuove popolazioni. I rilievi hanno permesso di inquadrare meglio la fitosociologia di riferimento di *A. brevis*, mostrando una sua capacità di adattarsi anche a contesti non inquadrabili nell'*Androsacion vandellii*.

[1]Gruppo Flora Alpina Bergamasca (FAB), Bergamo, Italy
[2]Università degli Studi di Milano, Dipartimento di Bioscienze, Milano, Italy

Current situation and future perspectives of the only Swiss population of *Adenophora liliifolia* (Campanulaceae)

Sofia Mangili[1*]
Brigitte Marazzi[2]
*sofia.mangili@ti.ch

Background and Aims
Adenophora liliifolia (L.) A.DC. is a perennial herbaceous species with Eurasian distribution, critically endangered in Switzerland. The only known Swiss population occurs on Mount San Giorgio, in meadows of conservation value, and relatively isolated at the western margin of the species' range. The population's reproductive success appears to have been declining in the last two decades. In this study, we aim at clarifying its current situation by investigating demographic and reproductive aspects, also considering past and current habitat management.

Methods
Total population was censed in 2019 at the beginning of the flowering season. Each plant stem (i.e. here as the population unit) was numbered, and the reproductive ones were surveyed once a month, from June to September. For each plant stem, leaf number and stem height were recorded in June, and phenological state (reproductive, sterile or dead), inflorescence type (simple or compound), reproductive success (number of flowers and fruits) and presence/absence of damages were recorded throughout the survey. Reproductive success was analyzed for the total population and for three subsets defined by their management plan ('bush removal only', 'biennial mow' and 'annual mow').

Results
The population of *A. liliifolia* consisted of 996 plant stems, 37.4% of which were flowering. Reproductive plant stems are taller and bear more leaves than sterile ones. Only 5.4% of the total population, or 14.5% of the flowering stems, managed to produce at least one mature fruit. The reproductive success differs among management plans: it was the highest (12.3%) in 'bush removal only', followed by "biennial" (5.8%) and 'annual' (0.4%) mows. Aboveground plant senescence occurs late in Fall.

Conclusions
Reproductive success of the Swiss *A. liliifolia* population appears critical, as characterized by a high plant stem and floral organ mortality in which fruit development seems the most susceptible phenological stage. But this needs further investigations. The management of *A. liliifolia*'s habitats could also play a role: preliminary results suggest that individuals perform better when habitat management is minimal. In case of mowing, timing should be considered as well.

[1]Natural History Museum of Canton Ticino, Lugano, Switzerland
[2]Info Flora c/o Natural History Museum of Canton Ticino, Lugano, Switzerland

Expert knowledge wanted: Filling the gaps on environmental impacts of alien species in Switzerland

Brigitte Marazzi[1*]
Lisanna Schmidt[2,3]
Sibyl Rometsch[2]
*brigitte.marazzi@infoflora.ch

Background and Aims
Assessing risk assessment and impact of alien species are fundamental to management and action. Current approaches to classify the impact of alien species on the environment are evidence-based, but the relevant scientific literature is still poor and scattered. To fill such gaps in Switzerland, we explored the possibility to use expert knowledge and observations for inferring impact scores following EICAT (Environmental Impact Classification of Alien Taxa).

Methods
In October 2019, 102 experts (field-botanists, practitioners, ecc.) from Switzerland were provided by Info Flora with a list of 124 selected alien plants and were asked to fill out an online standardized form for each observation of one alien species at a specific site. They were asked to prioritize species for which our global literature search had found no or little EICAT-relevant scientific literature. Requested information included: observation time, site surface and vegetation, abundance of the alien species, affected native species, and estimated impact level and impact mechanism.

Results
A total of 69 reports from 19 experts were received, with impact-relevant information on 38 alien species in eight Cantons: Only 8 were prioritized species with no EICAT-relevant literature and 7 with a single publication, while for 12 the literature search was not done yet. In most cases, alien species represented >50% of the total vegetation at the reported site. Experts listed a total of 143 native plant species affected. Inference of EICAT scores resulted in 26 "Moderate" and 2 "Major"/"Massive" impacts. Competition was the most-mentioned mechanism to explain impact on native species.

Conclusions
Because many experts do not publish their studies in scientific peer-reviewed journals, their expertise on alien species could be recorded via a standardized document, which could be used and cited by impact and risk assessments. Therefore, although rated with "low confidence" by EICAT guidelines, expert reports can fill existing knowledge gaps. A standardized recording tool for expert knowledge could also be useful for early detection of new invasive or potentially invasive alien species and for identifying research needs on environmental impacts of alien species or on their possible assimilation into ecosystems.

[1]Info Flora c/o Natural History Museum of Canton Ticino, Lugano, Switzerland
[2]Info Flora, c/o Botanical Garden Bern, Bern
[3]University of Fribourg, Department of Biology, Fribourg, Switzerland

Video analysis as an innovative approach to investigate plant-arthropod interactions in high mountain environments: The case study of *Androsace brevis* (Primulaceae)

Alessio Minici[1*]
Andrea Melotto[2]
Marco Bonelli[1]
Elena Eustacchio[1]
Erica Dinatale[1]
Andrea Conti[2]
Mauro Gobbi[3]
Luca Gianfranceschi[1]
Morena Casartelli[1]
Marco Caccianiga[1]
*alessio.minici@studenti.unimi.it

Background and Aims
Little is known about the interactions between arthropods and plants in high altitude environments. However, these interactions are a fundamental component of mountain ecosystems, and may be highly affected by climate change. The use of video observations to investigate arthropod communities is less invasive than manual sampling and allows to study behaviours that may not be identified by field observation. We employed this methodological approach on flower-visiting arthropods of the narrow endemic alpine plant *Androsace brevis* (Hegetschw.) Ces. as a model of interactions that may be affected by climate change.

Methods
We recorded about 87 hours of video in two years during the flowering period of A. brevis (May-June) in two sites of central southern Alps (Lombardy, Italy). During the recording sessions we also registered environmental parameters possibly impacting arthropods' presence and activity. Subsequently, videos were analysed with a behavioural observation software (BORIS) to investigate the arthropod activity on A. brevis flowers, with a focus on the identification of possible pollinators.

Results
The method allowed to record the activity and time budget of arthropods on flowers. We assessed a high variability in behaviour among taxa, for instance in the mean number of flowers visited, corolla tubes entered, time spent on flower and corolla tube. Moreover, we identified different interactions occurring with the plant. Our results lead us to hypothesize the possible ecological role of flower-visiting arthropods, for instance highlighting the role of Diptera Brachycera and Hymenoptera Apoidea in pollination. Furthermore, we were able to assess correlations between environmental parameters (i.e., temperature, illuminance and wind speed) and arthropods activity in high mountain environments.

Conclusions
Our approach has proven to be effective to gain deep insight into the relationships between plants and associated fauna in high mountain ecosystems. In particular, our work represents a contribution towards a better understanding of plant-pollinator interactions in alpine environments.

[1]University of Milan, Department of Biosciences, Italy
[2]University of Milan, Department of Environmental Science and Policy, Italy
[3]MuSe Science Museum, Section of Invertebrate Zoology and Hydrobiology, Italy

Multiple lines of evidence support plant conservation in the southwestern Alps: the DBIOS and CBV joint effort

Marco Mucciarelli[1]*
Wanda Camusso[2]
Martino Adamo[1]
Francesco Dovana[1]
Anna Fusconi[1]
*marco.mucciarelli@unito.it

Background and Aims
Many species survived glaciations in refuge areas of the southwestern Alps (SWA). A flora rich of endemisms established there, thanks to the presence of different environments and the climatic influence of the Mediterranean Sea. The Department of Life Sciences and Systems Biology (DBIOS) in collaboration with the Regional Centre for Plant Biodiversity "Emile Burnat" (CBV) operates through a multidisciplinary approach aimed at the ex situ conservation of rare species now threatened by climate change.

Methods
Morphological and morphometric analyses were conducted on flowers of three endemic *Fritillaria* taxa and on the leaves of *Tephroseris balbisiana* in order to disentangle variation at the population level. Genetic variability was quantified within twenty populations by microsatellite, RAPD and SCoT polymorphisms. Taxonomic relationships between these taxa and their alpine relatives were studied by Bayesian and Maximum Likelihood analyses of the ITS region. Population distribution was modelled in *T. balbisiana* according to occurrences on the SWA and in northern Apennines in order to predict habitat suitability. Germination tests were conducted to monitor viability in fresh and cold-stored seeds at the CBV seed bank. Protocols for plant propagation from *in vitro* cultures of cells and tissues of *Fritillaria moggridgei* and *T. balbisiana* were developed.

Results
Fritillaria: RAPD and microsatellite polymorphisms together with the ITS phylogeny have shown that *Fritillaria burnatii* and *F. tubaeformis* are two distinct taxa. *F. tubaeformis* subsp. *moggridgei*, of the Ligurian sector, deserves the rank of species. For the latter, long-term cold storage of seeds and plant *in vitro* propagation is feasible.
Tephroseris balbisiana: Leaf analyses in morphospace and SCoT fingerprinting of populations from the *locus classicus* and the Ligurian and Emilian Apennines have shown levels of variability greater
than previously thought. Species distribution modelling highlighted distinguished ecological needs in "peripheral" populations.

Conclusions
Species delimitation at morphological, genetic and ecological levels is crucial for the conservation of plant germplasm. Effective *ex situ* conservation of these taxa has been accomplished with a multifaceted approach.

[1]Department of Life Sciences and Systems Biology, University of Torino, Torino, Italy
[2]Associazione Parco del Nobile, Torino, Italy

Patterns of multitaxon diversity along elevational gradients in the Alps and in the Majella massif

Juri Nascimbene[1]*
Chiara Vallese[1]
Luca Di Nuzzo[1,2]
Renato Benesperi[1,2]
Alessandro Chiarucci[1]
Gabriele Gheza[1]
Paolo Giordani[3]
Walter Di Cecco[4]
Luciano Di Martino[4]
Michele Di Musciano[4]
Chiara Lelli[1]
Petra Mair[5]
Daniel Spitale[5]
*juri.nascimbene@unibo.it

Background and Aims
Climate change is increasingly threatening biodiversity worldwide, potentially becoming one of the major causes of species extinctions in the next decades. Altitudinal gradients are ideal systems to explore the effects of climatic-induced changes on biodiversity. A multitaxon approach coupled with a species traits analysis along elevational gradients is a promising approach to elucidate diversity patterns.

Methods
We explored the influence of climatic factors on diversity patterns of lichens, bryophytes and vascular plants along steep elevational gradients both in the Alps and in the Majella Massif (Abruzzo, Italy) to predict biodiversity scenarios under future climate change.

Results
We found contrasting responses to climate change among taxonomic groups. The main differences, in terms of community richness and composition, were found between lichens and bryophytes (cryptogams) on the one hand, and vascular plants on the other hand. The contrasting responses to climate change among these groups seem to be mediated by functional traits.

Conclusions
Our findings suggest that lichens and bryophytes could be more impacted by climate change than vascular plants. However, contrasting species-climate and traits-climate relationships were also found between lichens and bryophytes suggesting that each group may be sensitive to different components of climate change.

[1]BIOME Lab, Department of Biological, Geological and Environmental Sciences Alma Mater Studiorum, University of Bologna, Italy
[2]Department of Biology, University of Florence, Florence, Italy
[3]DIFAR, University of Genoa, Genoa, Italy
[4]Majella National Park, Sulmona, Italy
[5]Museum of Nature South Tyrol, Bozen/Bolzano, Italy

Juglans ailantifolia – Dal Giappone al Ticino

Andrina Rosselli[1*]
Brigitte Marazzi[2,3]
Giorgio Moretti[1]
*andrina.rosselli@ti.ch

Introduzione e obiettivi
Nella flora spontanea della Svizzera sono attualmente riconosciute due specie di alberi caducifogli del genere *Juglans: J. regia* (indigena) e *J. nigra* (nordamericana). Nel 2019 è stata trovata nel Cantone Ticino allo stato selvatico una terza specie, *J. ailantifolia* Carrière, originaria del Giappone. È qui presentata con le caratteristiche per riconoscerla e valutata come specie forestale, analizzando il suo potenziale invasivo.

Metodi
La specie è stata documentata e caratterizzata morfologicamente con rilievi zin campo, fotografie e campioni d'erbario di riferimento. Per valutare la vitalità e il potenziale di formazione di ricacci, su 30 alberi è stato applicato il metodo di cercinatura con tre anelli, seguito da rilievi di controllo.

Risultati
Juglans ailantifolia possiede foglie composte lunghe fino 90 cm con 11-19 foglioline densamente pelose; infiorescenze maschili verdi pendenti, quelle femminili erette di colore rosso-pink; fino a 13 frutti indeiscenti (drupe) con esocarpo tomentoso, mesocarpo legnoso (="noce") relativamente spesso. È presentata una chiave dicotomica per l'identificazione delle tre specie di *Juglans* in Ticino. La specie è stata trovata nel Bellinzonese e nel Mendrisiotto, in ambienti freschi; non è segnalata altrove in Svizzera. I due popolamenti più estesi sembrerebbero derivare da piantumazioni private risalenti a vari decenni fa. La cercinatura ha mostrato una debole capacità rigenerativa: gli alberi muoiono entro un anno e la formazione dei ricacci è bassa. Tuttavia, sono stati osservati alberi tagliati al piede che hanno formato polloni vigorosi e in grado di raggiungere la maturità.

Conclusioni
Questo studio ha permesso di documentare la naturalizzazione di *J. ailantifolia* in Ticino, dove è passata inosservata per decenni. Le sue caratteristiche biologiche (pochi frutti dispersi solo a ridosso degli alberi maturi, nessuna riproduzione vegetativa) e la sua diffusione limitata (nonostante l'età degli alberi più grandi) non indicano attualmente un comportamento invasivo. È comunque consigliato sorvegliarne l'evoluzione, considerando la sua capacità rigenerativa in caso di disturbo umano (taglio/cercinatura). Per un uso forestale è preferibile utilizzare l'indigena *J. regia*.

[1]Sezione forestale Cantone Ticino, Bellinzona, Svizzera
[2]Info Flora c/o Museo cantonale di storia naturale, Lugano, Svizzera
[3]Museo cantonale di storia naturale, Lugano, Svizzera

Long-term changes in the composition of plant communities dominated by *Carex curvula* in the Orobian Alps

Diana Sciandra[1*]
Federico Mangili[2]
Marco Caccianiga[1]
*diana.sciandra@studenti.unimi.it

Background and Aims
Climate change is a potential threat to high mountain ecosystems through major shifts in the composition of biotic communities. We aimed to quantify the taxonomic and structural changes in the composition of high-altitude plant communities of the Orobian Alps, based on recent and historical phytosociological relevés.

Methods
We selected 36 relevés spanning a period of 39 years of late-successional grassland communities dominated by Carex curvula All. and compared them with the same relevés made between 2018-2020 using cluster analysis. To investigate potential temporal shifts in environmental conditions, we used cluster analysis of indicator values (Temperature, Humidity, Light, Nutrient and Humus values).

Results
Cluster analysis identified different groups, which underline the differences between the investigated Carex curvula communities. We observed that 23 out of 36 couples of relevés separated in different clusters: most of those couples shifted to a lower-altitude community. Landolt indices showed a slight reduction in humidity and light values, while nutrient and temperature values increased. Humus values showed a consistent increase, especially under dry conditions.

Conclusions
The observed decrease of cold-demanding species suggests a shift in the composition of high mountain plant communities driven by climate change. Moreover, our results provide evidence for temporal shifts in the ecological conditions, possibly due to a combination of climate and land-use change.

[1]Department of Life Sciences, University of Milan, Via Celoria 26, 20133 Milan, Italy
[2]FAB, Gruppo Flora Alpina Bergamasca, Bergamo, Italy

Primary succession on carbonate glacier forelands: the case study of three dolomitic glaciers

Barbara Valle[1*]
Mauro Gobbi[2]
Roberto Seppi[3]
Marina Borgatti[1]
Marta Tognetti[1]
Michael Bernasconi[1]
Marco Caccianiga[1]
*barbara.valle@unimi.it

Background and Aims
Biological community dynamics on recently-deglaciated glacier forelands offer a unique opportunity for studying the primary succession, a phenomenon seldom studied on Alpine glaciers on carbonate bedrock because of the overall low number and dimension of such glaciers, often located in low-elevation peripheral chains. However, these sites host a high level of biodiversity, including many endemics. The aim of this research is to investigate by comparing three glacier foreland, similar for bedrock composition, climatic regime and altitude, but in different biogeographic context: Agola glacier (Brenta Dolomites, Trento, Italy; min altitude: 2600 m a.s.l.), Western Sorapiss and Central Sorapiss glacier (Ampezzo Dolomites, Belluno, Italy; min altitude: 2250 and 2210 m a.s.l., respectively).

Methods
Sampling was performed from the supraglacial debris to the Little Ice Age (LIA) moraines on sampling sites corresponding to known deglaciation ages, identifying a space-for-time transect. For each site vegetation was detected with 5 m × 5 m quadrats. Soil samples were collected for physical and chemical analyses. Late Glacial substrata outside LIA moraines (c.10.000 years) were also sampled as reference for late successional stages, 1, 0.8 and 0.6 km far from Western Sorapiss, Central Sorapiss and Agola glaciers, respectively. In order to highlight ecological peculiarities of supraglacial debris with respect to the adjacent ice-free habitat Landolt indices were used.

Results
Our results indicated an increase of diversity of plants along the foreland chronosequence in relation to soil parameters evolution that lead to acidification and increase of organic matter content. Some species were useful to identify successional stages, like *Dryas octopetala* that at Sorapiss glaciers consolidates areas freed from ice since the LIA. Supraglacial debris were colonized by cold- and wet-adapted species.

Conclusions
Succession evolves fast during the first decades, suggesting the need for greater temporal detail to better understand ecological gradients in the first part of the space-for-time transect. Dolomitic glaciers are currently responding to climate change with a fast transformation into debris-covered glaciers, offering the possibility to study the colonization of the supraglacial debris. The occurrence of cold- and wet-adapted species indicated by Landolt indices suggests that supraglacial debris can act as refugium for threatened cold-adapted species.

[1]Department of Biosciences, University of Milan, Milan, Italy
[2]MUSE-Museo delle Scienze, Corso del Lavoro e della Scienza, Trento, Italy
[3]Dipartimento di Scienze della Terra e dell'Ambiente, Università di Pavia, Pavia, Italy

List of all participants

Name	Affiliation	E-mail
Matteo Arrighi	Università degli studi di Milano	matteo.arrighi@studenti.unimi.it
Ariel Bergamini	Swiss Federal Research Institute WSL	ariel.bergamini@wsl.ch
Irene Bisang	Swedish Musuem of Natural History	Irene.Bisang@nrm.se
Steffen Boch	Swiss Federal Research Institute WSL	steffen.boch@wsl.ch
Marco Bonelli	University of Milan	marco.bonelli@unimi.it
Christophe Bornand	Info Flora	christophe.bornand@infoflora.ch
Antonella Borsari	Società botanica ticinese	aborsari@bluewin.ch
Jonas Brännhage	Swiss Federal Research Institute WSL	in_flames197@gmx.net
Sébastien Buchet		buchet.sbastien13@gmail.com
Wanda Camusso	Associazione Parco del Nobile	wanda.camusso@gmail.com
Ivan Candolfi	Università di Berna	ivan.c94@hotmail.com
Gabriele Carraro	Dionea SA	carraro@dionea.ch
Bruno E.L. Cerabolini	Università degli Studi dell'Insubria	bruno.cerabolini@uninsubria.it
Marco Conedera	Swiss Federal Research Institute WSL	marco.conedera@wsl.ch
Michele Dalle Fratte	Università degli Studi dell'Insubria	michele.dallefratte@uninsubria.it
Jurriaan de Vos	University of Basel	jurriaan.devos@unibas.ch
Erica Dinatale	Università degli Studi di Milano	erica.dinatale@studenti.unimi.it
Stefan Eggenberg	Info Flora	stefan.eggenberg@infoflora.ch
Peter Englmaier	University of Vienna, Faculty of Life Sciences	peter.franz.josef.englmaier@univie.ac.at
Elena Eustacchio	Università degli Studi di Milano	elena.eustacchio@unimi.it
Andrea Ferrario	Studio F.A. Natura	fanatura14@gmail.com
David Frey	Swiss Federal Research Institute WSL	david.frey@wsl.ch
Luca Gaggini		lucagaggini@bluewin.ch
Rodolfo Gentili	Università di Milano-Bicocca - Dipartimento di Scienze dell'Ambiente e della Terra	rodolfo.gentili@unimib.it
Matteo Gentilini	Università di Milano-Bicocca, DISAT	mat.gentilini@gmail.com
Jason Grant	Université de Neuchâtel	jason.grant@unine.ch
Giuliano Greco	Oikos Sagl	giuliano.greco@oikos.swiss
Andrin Gross	Swiss Federal Research Institute WSL	andrin.gross@wsl.ch
Vincent Guerra		vinceguerra20@gmail.com
Andreas Gygax	Info Flora	andreas.gygax@infoflora.ch
Brack Hale	Franklin University Switzerland	bhale@fus.edu
Candida Haritz	Consultati SA	candida.haritz@consultati.ch
Corinne Huck	Info Flora	corinne.huck@infoflora.ch
Gregory Jäggli	Universität Zürich, Institut für Systematische und Evolutionäre Botanik	gregory.jaeggli@uzh.ch
Cersare Jermini	Ass. Giardino Botanico Isole di Brissago	cjermini@bluewin.ch
Antoine Jousson	University of Geneva (BIVEG), Botanical Garden of Geneva	a.jousson@hotmail.com
Michael Jutzi	Info Flora	michael.jutzi@infoflora.ch
Anne Kempel	Institute of Plant Sciences, University of Bern	anne.kempel@ips.unibe.ch
Thomas Kiebacher	Swissbryophytes, Department of Systematic & Evolutionary Botany, University of Zürich UZH	thomas.kiebacher@uzh.ch
Michael Kleih	Società botanica ticinese	michael.kleih@neplan.ch
Bärbel Koch		baerbel.koch@hotmail.com
Rachel Korn	University of Fribourg	rachel.korn@unifr.ch
Danièle Lagnaz	ZHAW	daniele.lagnaz@zhaw.ch
Elisa Legoratti		elisa.legoratti@gmail.com
Andrea Brian Leo	Università statale di Milano	leius@hotmail.it
Vasco Lepori	Swiss Federal Research Institute WSL	vasco.lepori@unifr.ch
Lara Lucini	Museo cantonale di storia naturale	lara.lucini@ti.ch
Alessio Maccagni	University of Basel	alessio.maccagni@unibas.ch
Sofia Mangili	Museo cantonale di storia naturale	sofia.mangili@ti.ch
Federico Mangili	Gruppo Flora Alpina Bergamasca	f.mangili@yahoo.it
Brigitte Marazzi	Info Flora & Museo cantonale di storia naturale	brigitte.marazzi@ti.ch
Guido Maspoli	Ufficio della natura e del paesaggio	guido.maspoli@ti.ch
Vust Mathias		lichens.vust@rossolis.ch
Jermini Mauro	Agroscope	mauro.jermini@agroscope.admin.ch
Emiliano Medici		emiliano.medici@gmail.com
Alessio Minici		alessio.minici@studenti.unimi.it
Adrian Möhl	Info Flora	adrian.moehl@infoflora.ch
Giorgio Moretti	Sezione forestale, Cantone Ticino	giorgio.moretti@ti.ch
Marco Moretti	Swiss Federal Research Institute WSL	marco.moretti@wsl.ch
Vinciane Mossion	University of Neuchâtel	vinciane.mossion@unine.ch
Marco Mucciarelli	Department of Life Sciences and Systems Biology	marco.mucciarelli@unito.it
Ramon Müller	Info Flora	ramon.mueller@infoflora.ch
Juri Nascimbene	Università di Bologna	juri.nascimbene@unibo.it
Marie Florence –Sandrine Ngo Ngwe	Université de Fribourg	marie.ngongwe@unifr.ch
Gisella Novi		gisellanovi79@gmail.com
Gilberto Parolo		gilberto.parolo@oikos.swiss
Nicola Patocchi	Fondazione Bolle di Magadino	fbm@bluewin.ch
Luca Pegoraro	Royal Botanic Gardens, Kew	l.pegoraro@kew.org
Blaise Petitpierre	InfoFlora	blaise.petitpierre@infoflora.ch
Gianni Boris Pezzatti	Swiss Federal Research Institute WSL	boris.pezzatti@wsl.ch
Julia Pick		pick.julia@yahoo.fr
Simon Pierce	University of Milan	simon.pierce@unimi.it
Lily Pifferini-Carter	Franklin University Switzerland	lily.pifferini.carter@gmail.com
Anna Probert	University of Fribourg	anna.probert@unifr.ch
Alessia Prospero	Swiss Federal Research Institute WSL	prosperoalessia@gmail.com
Anita Python		anita.python@bluewin.ch
Filippo Rampazzi	Museo cantonale di storia naturale	filippo.rampazzi@ti.ch
Giotto Roberti		giotto.roberti@protonmail.com
Seraina Rodewald	University of Basel	seraina.rodewald@unibas.ch
Neria Römer	Museo cantonale di storia naturale	neria.roemer@ti.ch
Jacqueline Royer	Franklin University Switzerland	Jacqueline.royer@student.fus.edu
Ervan Rutishauser	Info Flora	ervan.rutishauser@infoflora.ch
Deborah Schäfer	Botanical Garden of the University of Bern	deborah.schaefer@boga.unibe.ch

Hansjörg Schlaepfer		hjschlaepfer@bluewin.ch
Nicola Schoenenberger. Innovabridge Foundation		schoenenberger@innovabridge.org
Anna–Katherina –Schoenenberger		akschoenenberger@hotmail.com
Diana Sciandra	Università degli Studi di Milano	diana.anaid@hotmail.it
Sandro Silva	University of Bern	sandro.silva@students.unibe.ch
Silvana Soldini		silvana.soldini@gmail.com
Cristina Spinelli		cristina.spinelli@bluewin.ch
Daniel Ston	Biologist	daniel.ston@bluewin.ch
Silvia Stofer	WSL, Birmensdorf	silvia.stofer@wsl.ch
Ursina Studer		ursina.studer@unibas.ch
Nicolò Tartini	Swiss Federal Research Institute WSL	nico.tartini@bluewin.ch
Willy Tinner	Università di Berna	willy.tinner@ips.unibe.ch
Laura Torriani	Info Flora	laura.torriani@infoflora.ch
Prisca Valenti		prisca.v.94@gmail.com
Barbara Valle	Università degli Studi di Milano	barbara.valle@unimi.it
Chiara Vallese	Alma Mater Studiorum–Università di Bologna	vallese.chiara@gmail.com
Manuela Varini	STSN	manuela.varini@stsn.ch
Diana Verdiani		verdiani.diana@gmail.com
Giovanni Vimercati	University of Fribourg	gvimercati@outlook.com
Lara Volery	University of Fribourg	lara.volery@unifr.ch
Alice Zanzottera		alice.zanzo96@gmail.com
Niklaus Zimmermann	Swiss Federal Research Institute WSL	niklaus.zimmermann@wsl.ch

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